SOIL SURVEY OF

Meade County, South Dakota, Southern Part

United States Department of Agriculture
Soil Conservation Service and Forest Service
in cooperation with
South Dakota Agricultural Experiment Station

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. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1962 to 1974. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service, the Forest Service, and the South Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the Elk Creek Conservation District.

HOW TO USE THIS 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 Meade County, Southern Part, 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 survey area in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the windbreak group, range site, and pasture 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 suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

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

Wildlife managers and others can find information about soils and wildlife in the section "Wildlife."

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.

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

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

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

Cover: Bear Butte is a prominent feature observable from most parts of the survey area. Pond in the foreground is in the Kyle-Pierre-Hisle association.

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Issued July 1978

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Foreword

The Soil Survey of Meade County, South Dakota, Southern Part contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

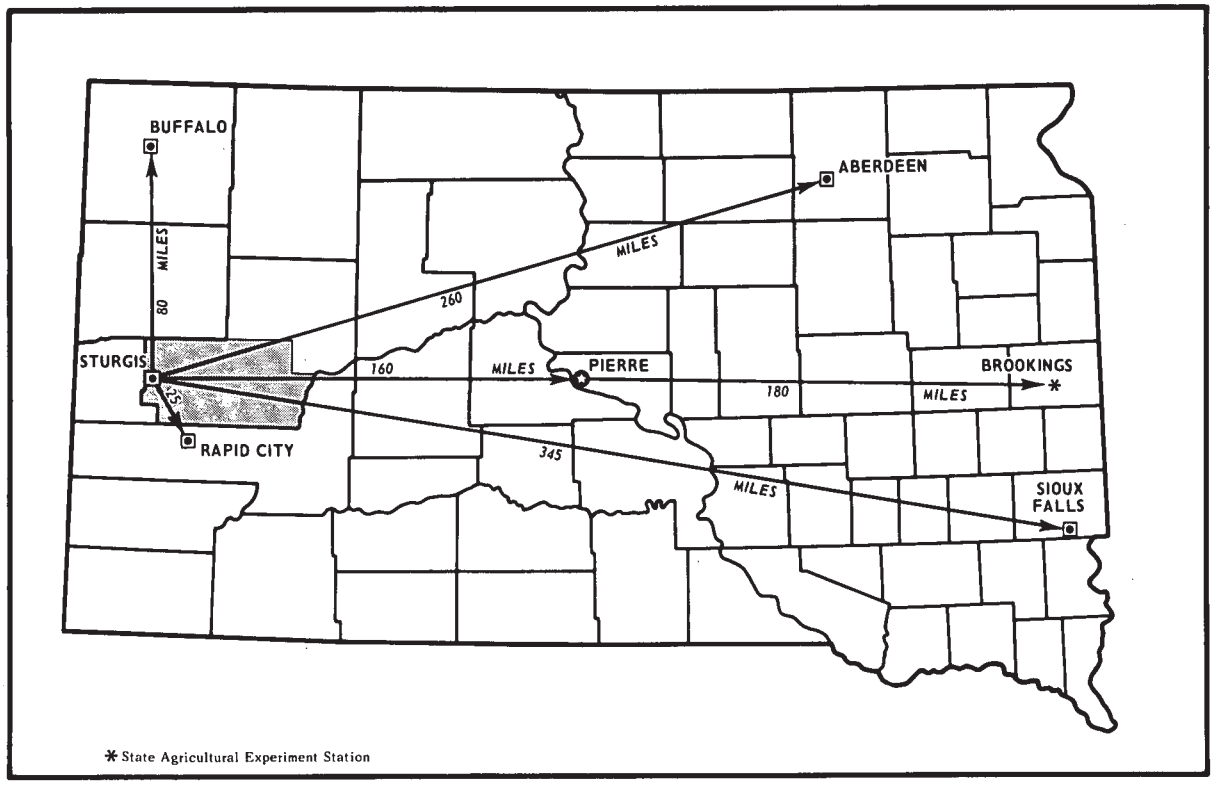
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

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

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

R. D. Swenson
State Conservationist
Soil Conservation Service



Location of Meade County, South Dakota, Southern Part.

SOIL SURVEY OF MEADE COUNTY, SOUTH DAKOTA, SOUTHERN PART

By Toivo J. Ollila, Soil Conservation Service [1]

United States Department of Agriculture, Soil Conservation Service and Forest Service, in cooperation with the South Dakota Agricultural Experiment Station

MEADE COUNTY, SOUTHERN PART, is in the northwestern part of South Dakota. The survey area is 1,152,200 acres of which 4,825 acres are water areas that are greater than 5 acres in size. Sturgis, the county seat and principal town in Meade County, is in the extreme western part of the survey area. Other towns, rural stores, and post offices are Bear Butte, Black Hawk, Elm Springs, Enning, Piedmont, Tilford, and Union Center.

Most of the survey area is in the Great Plains. The extreme southwestern part is in the Black Hills. The relief is gently sloping to strongly sloping in much of the survey area but is hilly to steep in the Black Hills and in the breaks of the Belle Fourche and Cheyenne Rivers. It is nearly level in stream valleys and on high terraces and tablelands. The northern two-thirds of the survey area is drained by the Belle Fourche River, and most of the southern part is drained by Elk Creek. These streams flow into the Cheyenne River in the eastern part of the survey area. The principal streams flowing out of the Black Hills and across parts of the survey area are Bear Butte, Box Elder, Elk, and Whitewood Creeks.

Raising livestock is the main agricultural enterprise. About 79 percent of the area is in native grass and is used for range and hay. About 14 percent is cropland. Winter wheat, oats, and alfalfa are the main crops. Spring wheat, corn, sorghum, barley, and rye are other crops. About 4 percent is woodland, most of which is in the Black Hills National Forest.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

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

The areas shown on a detailed soil map are called mapping units. Some mapping units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Mapping units are discussed in the section "Descriptions of the soils."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is

[1] ARVID C. MELAND, Soil Conservation Service, helped to prepare this survey.

readily useful to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map

The general soil map at the back of this publication shows, in color, the soil associations in the survey area. A soil association is a unique natural landscape that has a distinct pattern of soils and of relief and drainage. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one association differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

The boundaries of the soil associations in this survey area match those of the previously published survey of Butte County, but the names do not fully agree because of changes in concepts of soil series in the application of the soil classification system, or because of differences in the proportional extent of the major soils.

The terms for texture used in the headings of the soil associations and the groupings of associations apply to the texture of the surface layer. For example, in the heading of the Delphill-Assinniboine association, the word "loamy" refers to the texture of the surface layer.

Well drained, loamy and silty soils on uplands and high terraces

In this group are moderately deep and deep, loamy and silty soils on uplands and high terraces. The soils formed in old alluvium or in friable material that weathered from the underlying sandstone, siltstone, or shale. Most of these soils are medium in fertility, have moderate or high available water capacity, and have moderate or moderately slow permeability in their subsoils. Most of the dryfarming in the survey area is on the soils in this group. Conserving moisture and controlling erosion and soil blowing are concerns of management. Raising livestock and growing wheat are the main enterprises.

1. Delphill-Assinniboine association

Moderately deep and deep, well drained, gently sloping to strongly sloping, loamy soils over sandstone, siltstone, or shale

This association is on an upland plain that is underlain by soft sandstone, siltstone, or shale. Slopes are mostly long and smooth and gently sloping to moderately sloping. They are steeper and short and broken on the sides of some ridges and on the sides of entrenched drainageways. Major drainageways in this association generally flow south or southeast.

This association makes up about 3 percent of the survey area. It is about 55 percent Delphill soils, 30 percent Assinniboine soils, and 15 percent minor soils.

Delphill soils are on the tops and upper side slopes of ridges and on the sides of entrenched drainageways. They are moderately deep and are moderately sloping to strongly sloping. They have a thin surface layer of brown loam that is underlain by very pale brown, calcareous loam. Light gray, calcareous, soft siltstone is at a depth of 32 inches.

Assinniboine soils are on broad, smooth ridgetops and in the lower part of the landscape below Delphill soils. They are gently sloping to moderately sloping, and they are deep. Their surface layer is grayish brown fine sandy loam. The subsoil is brown sandy clay loam in the upper part and pale brown fine sandy loam in the lower part. The underlying material is pale yellow and light gray, calcareous fine sandy loam.

The minor soils in this association are Arvada soils along small drainageways, Cabbart soils on the tops and upper side slopes of some ridges and entrenched drainageways, Glenberg soils on bottom land, Hoven soils in closed depressions, and Onita soils in swales.

The Delphill soil is low in fertility, has low available water capacity, and generally is not suited to cultivation. The Assinniboine soil is medium in fertility, has moderate available water capacity, and is easy to work. These soils have moderate permeability, and runoff is medium. Controlling erosion and soil blowing is the main concern of management.

Much of this association is in native grass and is used for range. Some areas of the Assinniboine soil are farmed. Wheat, oats, corn, and alfalfa are the main crops. Raising livestock is the main enterprise.

2. Nunn-Satanta-Zigweid association

Deep, well drained, nearly level to strongly sloping, loamy soils that formed in alluvium

This association is on high terraces and tablelands between the Black Hills and the Cheyenne River. Slopes are mostly long and smooth and nearly level to gently sloping. Steeper slopes are on the sides of drainageways that cut back into the areas.

The association makes up about 24 percent of the survey area. It is about 45 percent Nunn soils, 20 percent Satanta soils, 10 percent Zigweid soils, and 25 percent minor soils (fig. 1).

Nunn soils are mostly nearly level to gently sloping, but some are moderately sloping. Their surface layer is dark grayish brown clay loam. The subsoil is brown clay and clay loam in the upper part and light brownish gray, calcareous silty clay loam in the lower part. The underlying material is grayish-brown, calcareous clay loam.

Satanta soils are mostly nearly level, but some are gently sloping to moderately sloping. Their surface layer is grayish brown loam. The subsoil is dark grayish brown loam in the upper part, brown clay loam in

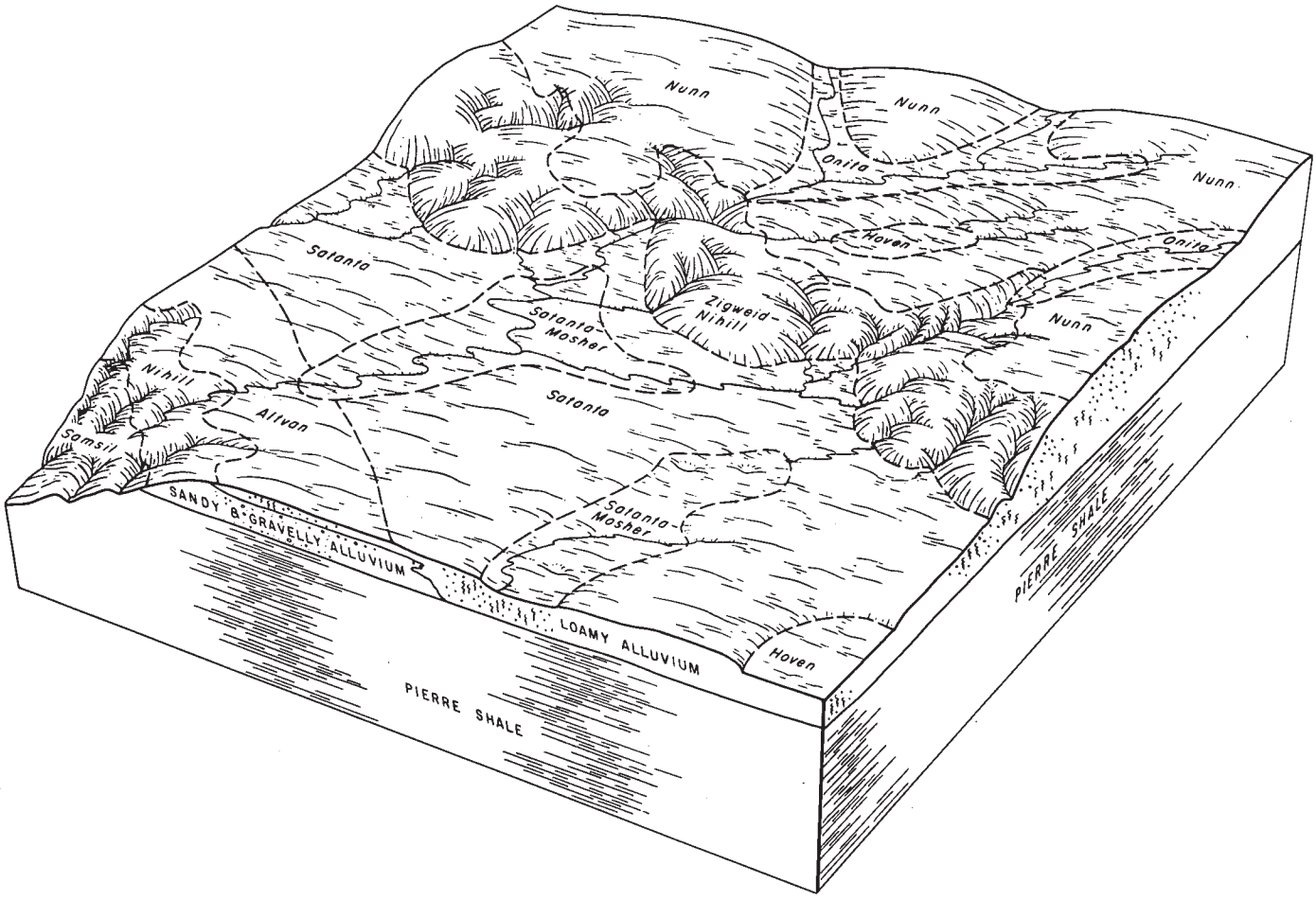


Figure 1.—**Pattern of soils, topography, and underlying material in the Nunn-Satanta-Zigweid association.**

the middle part, and pale brown, calcareous loam in the lower part. The underlying material is pale brown, calcareous loam that is stratified with thin layers of silt loam and very fine sandy loam below a depth of 40 inches.

Zigweid soils generally are on the sides of terrace fronts and on the upper side slopes of entrenched drainageways that cut back into the area. They are moderately sloping to strongly sloping. Their surface layer is grayish brown clay loam. The subsoil is calcareous clay loam that is grayish brown in the upper part and light brownish gray in the lower part. The underlying material is light brownish gray, calcareous clay loam that is stratified with thin layers of loam.

The minor soils in this association are Altvan soils on the edges of some terraces, Arvada and Mosher soils in slightly concave low areas along ill-defined drainageways, Hoven soils in closed depressions, Nihill soils on rounded knolls and ridgetops above the Zigweid soil or on terrace fronts on the edges of the areas, Onita soils in swales, and Samsil soils on the sides of deeply entrenched drainageways that cut back into the areas.

The dominant Nunn and Satanta soils are medium in fertility, have high or moderate available water capacity, are easy to work, and are well suited to dryfarming. Zigweid soils generally are not suited to cultivation because of slope, low fertility, and high susceptibility to erosion. Conserving moisture and controlling erosion and soil blowing are the main concerns of management.

Most of the dryfarming in the survey area is on the soils of this association. Wheat, oats, corn, sorghum, and alfalfa are the main crops. Small areas remain in native grass and are used for range and hay. Growing wheat and raising livestock are the main enterprises. A few dairy farms are in this association.

3. Blackpipe-Savo-Manvel association

Moderately deep and deep, well drained, nearly level to moderately steep, silty soils over siltstone or shale

This association is on an upland plain that is underlain by siltstone and chalky shales. Slopes are typically long and smooth and are mostly gently sloping to strongly sloping. Steeper slopes are on the sides or ridges, escarpments, and entrenched drainageways. Ridges, or secondary hogbacks resulting from the Black Hills uplift, are prominent in parts of this association.

This association makes up about 8 percent of the

survey area. It is about 30 percent Blackpipe soils, 25 percent Savo soils, 10 percent Manvel soils, and 35 percent minor soils (fig. 2).

Blackpipe soils are on the sides of ridges, are mostly gently sloping to strongly sloping, and are moderately deep. Their surface layer is grayish brown silt loam. The subsoil is grayish brown silty clay in the upper part, grayish brown silty clay loam in the middle part, and light brownish gray, calcareous silty clay loam in the lower part. The underlying material is light brownish gray, calcareous silty clay loam. Light gray soft shale is at a depth of 34 inches.

Savo soils are in the lower part of the landscape on foot slopes, fans, and terrace flats. They are nearly level to gently sloping and are deep. Their surface layer is thin, grayish brown silty clay loam. The subsoil is dark grayish brown silty clay loam in the upper part; grayish brown, calcareous silty clay in the middle part; and grayish brown, calcareous silty clay loam in the lower part. The underlying material is light brownish gray, calcareous silty clay loam.

Manvel soils are on the sides and foot slopes of ridges and escarpments, on the sides of entrenched drainageways, and they are deep and calcareous. They typically are gently sloping to strongly sloping but are moderately steep in places. They have a thin surface layer of grayish brown silt loam that is underlain by a thin layer of brown silt loam. The underlying material below a depth of 7 inches is very pale brown silt loam.

The minor soils in this association are Arvada soils in swales and on flats; Enning and Midway soils on the crests and upper sides of ridges and escarpments and on shoulders of entrenched drainageways; Grummit and Pierre soils on ridges that are underlain by clay shale; and Lohmiller soils on bottom land along the larger drainageways. Also included in this association are areas of Rock outcrop intermingled with the Enning and Grummit soils.

The dominant Blackpipe and Savo soils are medium in fertility, but the Manvel soils are low in fertility and have a high content of lime. Runoff is medium in most of this association. Controlling erosion and soil blowing and conserving moisture are the main concerns of management.

Many areas of the Blackpipe and Savo soils that are

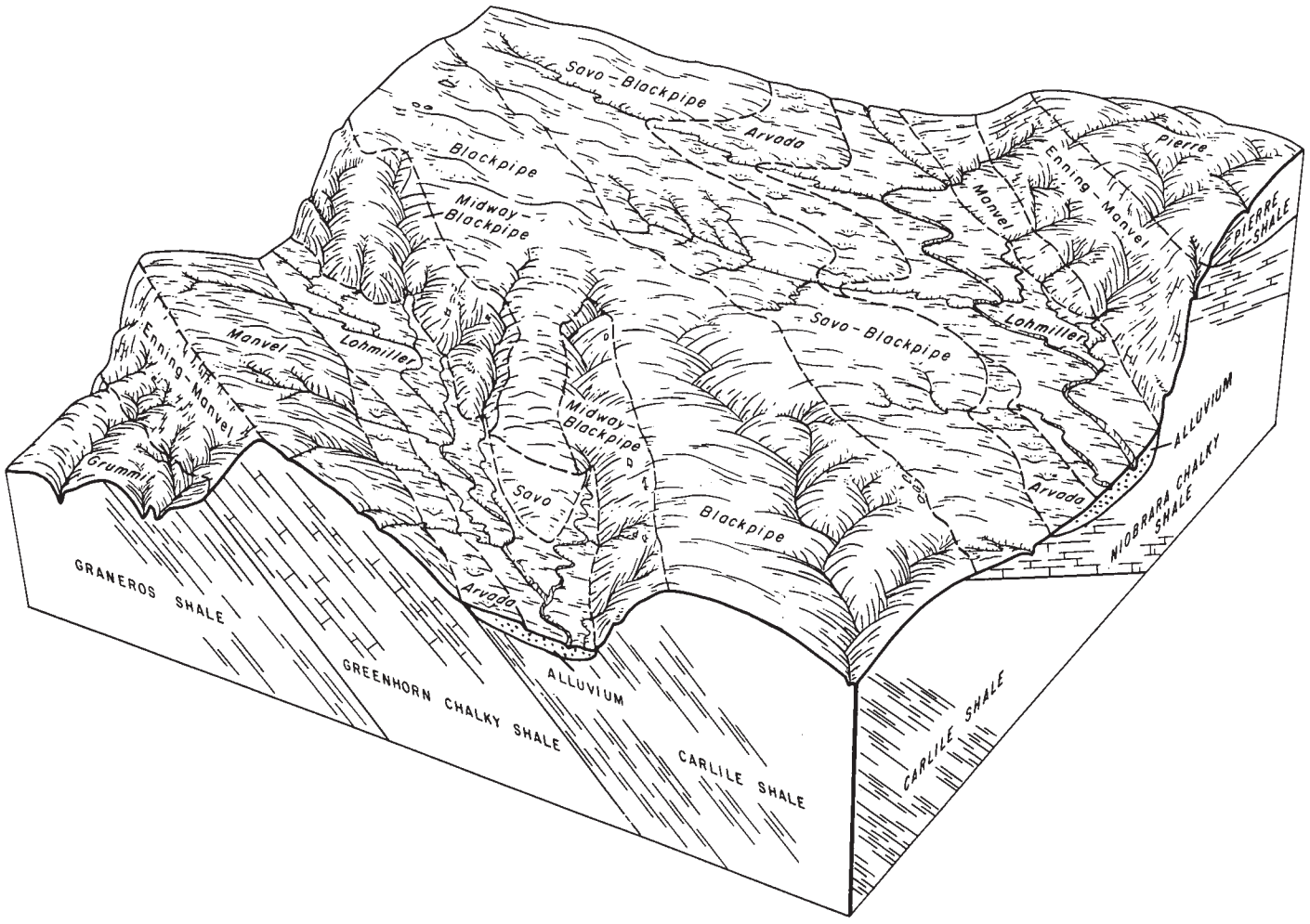


Figure 2.—**Pattern of soils, topography, and underlying material in the Blackpipe-Savo-Manvel association.**

nearly level to gently sloping are used for wheat, feed grain, and alfalfa. Most of this association is in native grass and is used for range and hay. Raising livestock is the main enterprise. Wheat farming and a few dairy farms are other enterprises.

4. Blackpipe-Assinniboine-Savo association

Moderately deep and deep, well drained, nearly level to strongly sloping, silty and loamy soils over sandstone siltstone, or shale

This association is on an upland plain that is underlain by sandstone, siltstone, or shale. Slopes are mostly long and gently sloping, but some are nearly level, and some on sides of ridges and entrenched drainageways are moderately sloping to strongly sloping. A few closed depressions are scattered throughout the area.

This association makes up about 4 percent of the survey area. It is about 50 percent Blackpipe soils, 25 percent Assinniboine soils, 10 percent Savo soils, and 15 percent minor soils.

Blackpipe soils are gently sloping to strongly sloping, and they are moderately deep. Their surface layer is grayish brown silt loam. The subsoil is grayish brown silty clay in the upper part, grayish brown silty clay loam in the middle part, and light brownish gray, calcareous silty clay loam in the lower part. The underlying material is light brownish gray, calcareous silty clay loam. Light gray soft shale is at a depth of 34 inches.

Assinniboine soils are on broad, smooth ridges at a higher elevation than Blackpipe soils. They are gently sloping to moderately sloping, and they are deep. Their surface layer is grayish brown fine sandy loam. The subsoil is brown sandy clay loam in the upper part and pale brown fine sandy loam in the lower part. The underlying material is pale yellow and light gray, calcareous fine sandy loam.

Savo soils are on foot slopes and flats, generally below Blackpipe soils. They are nearly level to gently sloping and are deep. Their surface layer is grayish brown silty clay loam. The subsoil is dark grayish brown silty clay loam in the upper part; grayish brown, calcareous silty clay in the middle part; and grayish brown, calcareous silty clay loam in the lower part. The underlying material is light brownish gray, calcareous silty clay loam.

Minor soils in this association are Arvada and Mosher soils in sags and swales, Hoven and Macken soils in closed depressions, Satanta soils in places underlain by old alluvium, and Shingle soils on ridge crests and around the head and on shoulders of drainageways.

The dominant soils in this association are medium in fertility and are suited to dryfarming. Permeability is moderate to moderately slow in the subsoil. The available water capacity generally is moderate or high but is low or moderate in Blackpipe soils. Runoff is slow to medium. Controlling erosion and soil blowing and conserving moisture are the main concerns of management.

Much of this association is in native grass and is used for range and hay. Some areas are used for wheat, feed grain, and alfalfa. Raising livestock is the main enterprise.

Well drained, loamy and silty soils on uplands in the Black Hills

In this group are shallow to deep soils that are mostly hilly to steep and are not suited to farming. They are in the Black Hills part of the survey area. Controlling erosion is the main concern of management. The most extensive association in this group is largely within the boundary of the Black Hills National Forest and is used for timber production, woodland grazing, recreation, and wildlife. The other associations are used for raising livestock, for dairying, and diversified farming. A significant acreage in the "strip" along Interstate Highway 90 is used for non-farm uses including residential and commercial.

5. Canyon-Lakoa-Maitland association

Shallow and deep, well drained, moderately sloping to steep, loamy soils over sandstone, siltstone, or shale

This association is on a prominent ridge that rims the Black Hills and commonly is referred to as the outer hogback. The inner face of the ridge toward the Black Hills is sharp and angular, but the outer face has long, smooth slopes that are notched by deeply entrenched drainageways or canyons. The difference in elevation is as much as 400 feet within 1 mile. Slopes are mostly hilly to steep, but the ridgetop is gently sloping to moderately sloping in places.

This association makes up about 2 percent of the survey area. It is about 40 percent Canyon soils, 25 percent Lakoa soils, 15 percent Maitland soils, and 20 percent minor soils (fig. 3).

Canyon soils are throughout the survey area. They are moderately sloping to steep and are shallow. They have a thin surface layer of dark grayish brown loam that is underlain by thin layers of light brownish gray and light gray silt loam. White and very pale brown interbedded soft shale, siltstone, and weakly-cemented sandstone are at a depth of 11 inches.

Lakoa soils are in wooded coves and on the wooded sides, generally north and east, of the hogback ridge. These soils are deep and mostly hilly. They have a thin surface layer of dark gray loam. The subsurface layers are light brownish gray and pale brown very fine sandy loam and loam. The subsoil is light yellowish brown clay loam and the underlying material is very pale brown, calcareous loam.

Maitland soils generally are in swales and on foot slopes below Lakoa soils and are on the edges of and in parklike openings on wooded ridgetops. They are deep and mostly hilly. Their surface layer is very dark grayish brown loam. Below this are thin layers of grayish brown and brown loam. The subsoil, to a depth of 30 inches, is brown and pale brown clay loam. The lower part of the subsoil and the underlying material are very pale brown loam.

The minor soils in this association are Bridget soils below Canyon soils on the lower side slopes of the hogback ridge; Butche soils on the upper side slopes of the hogback ridge; Keith soils on smooth, grassed ridgetops; Nihill soils on gravelly knolls; and Onita soils on foot slopes and in swales. Also included are areas of Rock outcrop where hard sandstone is exposed on the

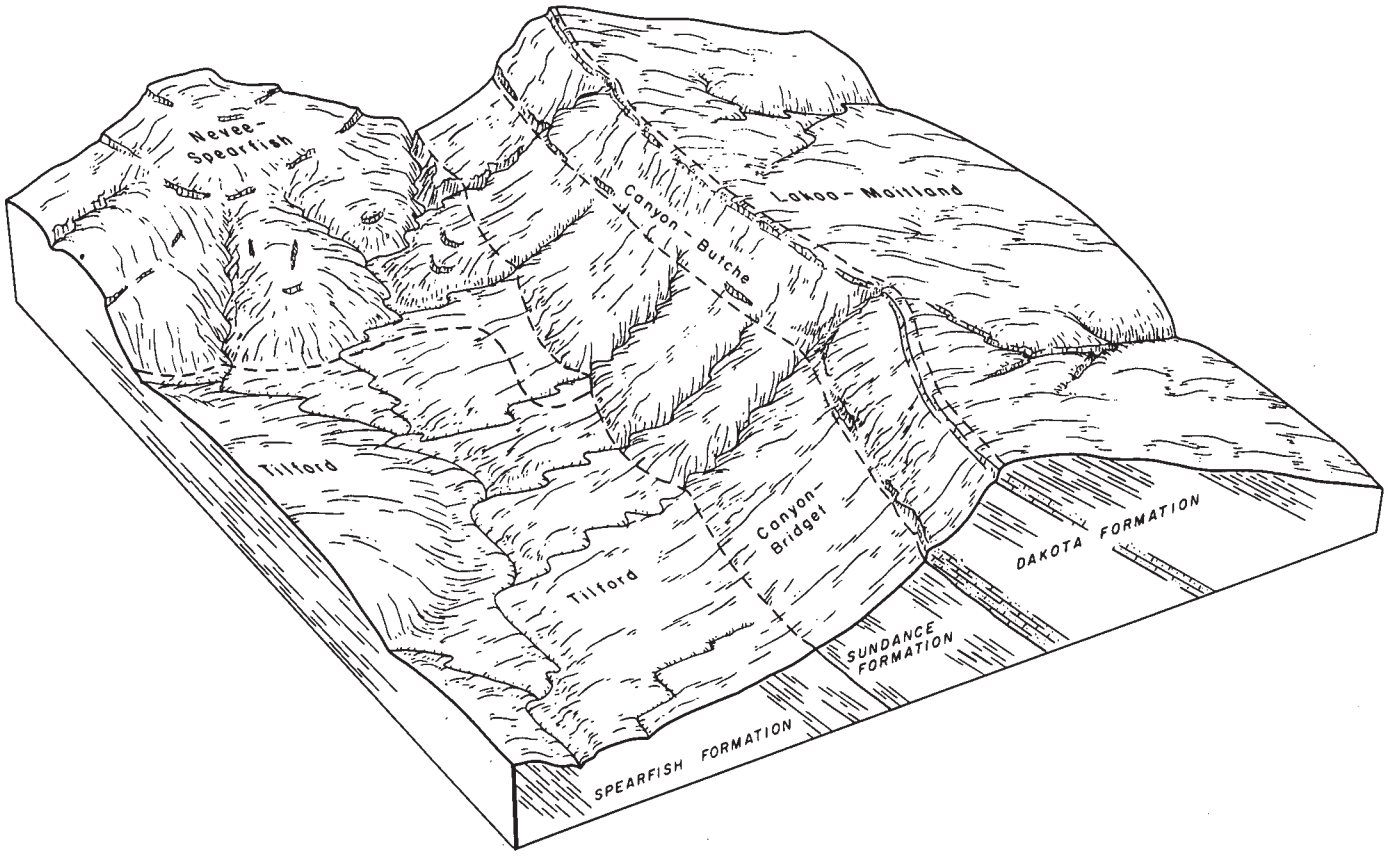


Figure 3.—**Pattern of soils, topography, and underlying material in the Canyon-Lakoa-Maitland association on the right and the Tilford-Nevee association on the left.**

upper side slopes of the hogback ridge and on the sides of deep canyons.

The Canyon and Lakoa soils are low in fertility, and the Maitland soils are medium in fertility. The major soils in this association have moderate permeability; but because runoff is medium to rapid, the hazard of erosion is severe where the plant cover is removed.

Excluding some minor soils, all of this association remains in native vegetation and is used mainly for range, timber production, and wildlife. Most areas of the Lakoa and Maitland soils are in ponderosa pine forest. Raising livestock is the main enterprise.

6. Citadel-Vanocker association

Deep, well drained, hilly to steep, silty and loamy soils over limestone, sandstone, or shale

This association is on a mountainous uplift in the extreme southwestern part of the survey area. It consists mainly of a rolling to hilly limestone plateau deeply dissected by canyons that were formed by streams and drainageways flowing out of the Black Hills. The elevation ranges from 3,600 feet on the eastern edge of the area to 5,400 feet on some ridges and peaks. The difference in elevation commonly is 200 to 300 feet within 1 mile. Slopes are mostly hilly to steep but are less sloping in upland valleys and on broad plateaus and very steep on the sides of some canyons. This association includes Bear Butte, a prominent uplift outside the Black Hills, which rises several hundred feet above the surrounding plain.

This association makes up about 4 percent of the survey area. It is about 65 percent Citadel soils, 25 percent Vanocker soils, and 10 percent minor soils (fig. 4).

Citadel soils are on the timbered sides of ridges and valleys throughout the area. Their surface layer is pale brown and pinkish gray silt loam, and their subsoil is light brown silty clay and silty clay loam. The underlying material is light brown and pink clay loam.

Vanocker soils are on stony ridges and on sides of canyons. They are mostly steep and in places are very steep. These soils have a thin surface layer of dark grayish brown channery loam and a subsoil that is brown channery clay loam in the upper part and light brown very channery loam in the lower part. The underlying material is pale brown very channery clay loam.

The minor soils in this association are Maitland soils on the edge of mountain valleys and grassed meadows; Marshdale soils in the lower part of mountain valleys; Nevee, Spearfish, and Tilford soils in areas underlain by reddish shale or siltstone; Paunsaugunt soils on limestone ridges and above the rim of canyons; and Winetti soils on bottom lands in canyons. Also included

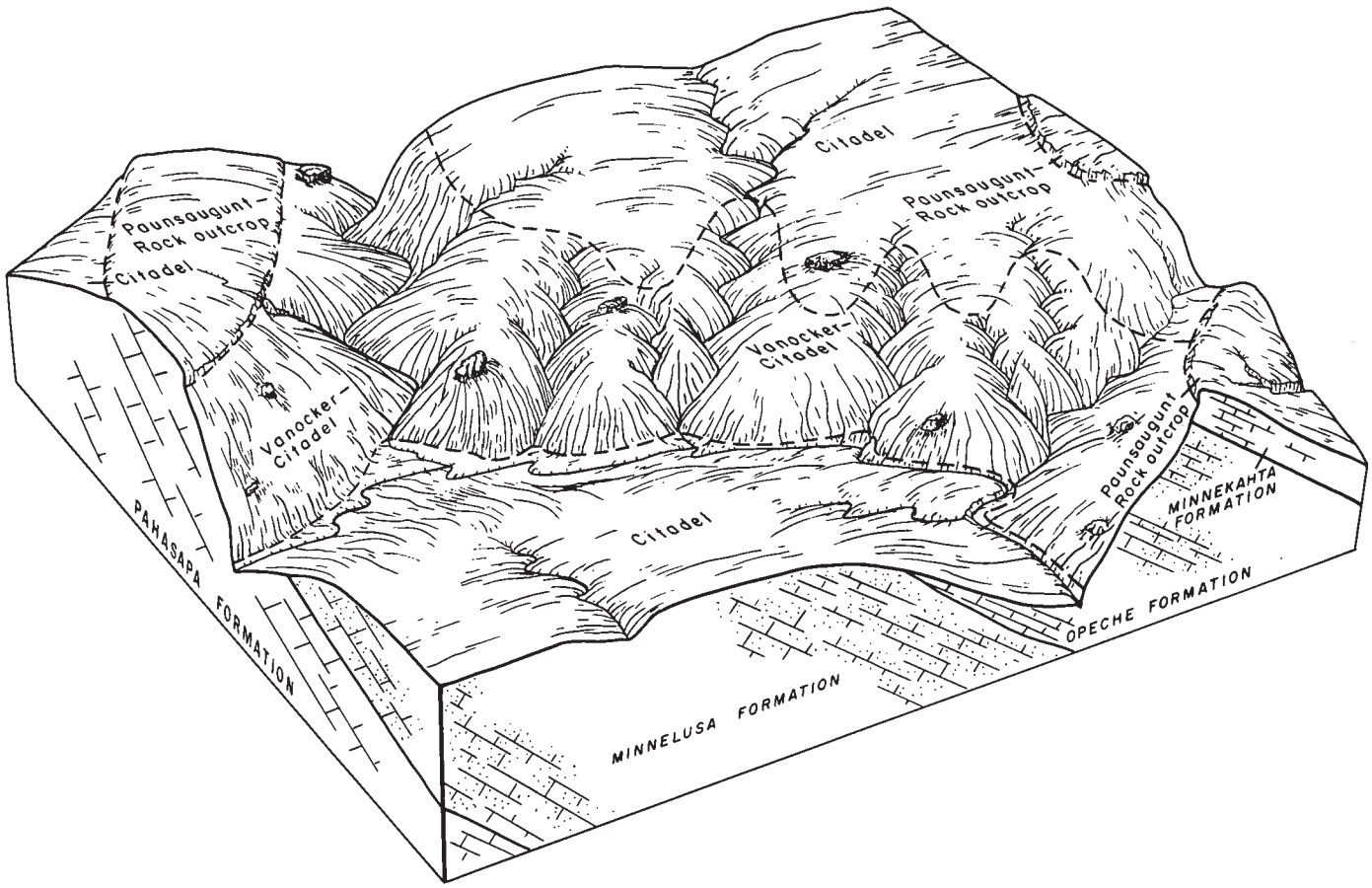


Figure 4.—**Pattern of soils, topography, and underlying material in the Citadel-Vanocker association.**

are small areas of Butche, Canyon, and Lakoa soils in the Bear Butte area and small areas of Rock outcrop that form almost vertical cliffs on the sides of ridges and canyons.

The major soils in this association are medium to low in fertility and have low to high available water capacity. Permeability in the subsoil is moderate to moderately slow. Runoff is medium to rapid. The soils in this association are not suited to farming because of steep slopes, stoniness, and high susceptibility to erosion if the plant cover is removed.

Most of this association is in the Black Hills National Forest and is in ponderosa pine forest. Bear Butte is a State park. Soils in some narrow upland valleys are used for oats and tame grasses, but timber production, woodland grazing, wildlife, and recreation are the main uses.

7. Tilford-Nevee association

Deep, well drained, nearly level to strongly sloping, soils over siltstone or shale

This association is on an uplift trench between the outer hogback of the Black Hills and the Black Hills proper. It is between the Canyon-Lakoa-Maitland and Citadel-Vanocker associations. The elevation ranges between 3,400 and 3,700 feet. This area is commonly referred to as the "redbed valley." Slopes are mostly long and nearly level to strongly sloping, but hilly to steep, broken slopes are on the sides of ridges and entrenched drainageways.

This association makes up about 1 percent of the survey area. It is about 70 percent Tilford soils, 15 percent Nevee soils, and 15 percent minor soils.

Tilford soils generally are in the lower part of the landscape in swales, on the sides of gentle rises, and on small terraces and fans. They are nearly level to gently sloping. Their surface layer is dark brown silt loam. The subsoil is dark reddish gray and reddish brown, calcareous silt loam in the upper part and reddish yellow, calcareous loam in the lower part. The underlying material is light reddish brown, calcareous loam.

Nevee soils generally are above the Tilford soils on the sides and foot slopes of ridges and knolls. They are moderately sloping to strongly sloping. Their surface layer is reddish brown, calcareous silt loam. The underlying material is reddish yellow, calcareous silt loam.

The minor soils in this association are Nihill soils on gravelly knolls and ridges, Spearfish soils on the tops and upper side slopes of ridges and on the sides of

entrenched drainageways, and St. Onge and Winetti soils on bottom land and fans along some of the streams and drainageways that cross the area. Also included are small areas of Rock outcrop on the upper side slopes of some ridges and along eroding drainageways.

The dominant Tilford soils are medium in fertility, have high available water capacity, absorb water readily, and are well suited to crops. The Nevee soils are low in fertility and erode easily. Controlling erosion and conserving moisture are the main concerns of management.

About 25 percent of this association is used for crops and tame pasture and hay. A significant part is used for highways, campgrounds, cemeteries, suburban housing, and other nonfarm uses. Dairying and diversified farming are the main enterprises.

Well drained and moderately well drained, loamy and silty soils on bottom land and terraces

In this group are soils on bottom land and terraces along streams flowing out of the Black Hills and along the Belle Fourche and Cheyenne Rivers. Most of these soils are medium to high in fertility and have moderate to high available water capacity. Slopes are mostly nearly level. Conserving moisture is the main concern of management. Much of the alfalfa grown in the survey area is in this group. Wheat is an important crop on the terraces and on some of the high bottoms. This group is an important feed base for livestock ranches that extend into adjacent associations. Many ranch headquarters are in this area.

8. St. Onge-Keith association

Deep, moderately well drained and well drained, nearly level to gently sloping, loamy and silty soils that formed in alluvium and in loess

This association is on bottom land and terraces along streams flowing out of the Black Hills. Slopes are mostly nearly level, but some are gently sloping on the terraces. Steeper slopes are on terrace fronts in some areas.

This association makes up about 3 percent of the survey area. It is about 35 percent St. Onge soils, 30 percent Keith soils, and 35 percent minor soils.

St. Onge soils are on bottom land and are moderately well drained to well drained. They have a thick surface layer of dark grayish brown and dark gray loam. The underlying material is pinkish gray loam. All layers are calcareous.

Keith soils are on terraces that are a few to as much as 30 feet above the St. Onge soils, and are well drained. Their surface layer is dark grayish brown silt loam. The subsoil is silty clay loam that is dark grayish brown, brown, and light brownish gray from the upper part to lower part. The underlying material is light brownish gray, calcareous silty clay loam.

The minor soils in this association are Altvan soils on the edges of some terraces; Glenberg and Lohmiller soils on bottom land; Kyle soils on low terraces, foot slopes, and fans; and Onita soils in swales on terraces.

The major soils in this association are medium to high in fertility, have high available water capacity, and have moderate permeability. Runoff is slow to medium. The St. Onge soils are subject to flooding in some years, but damage generally is minor and some areas rarely flood. The soils in this association are well suited to crops. Conserving moisture is the main concern of management in much of the area. Controlling erosion and soil blowing is an important concern on the gently sloping Keith soils.

Most of this association is cultivated. Wheat, oats, corn, and alfalfa are the main crops. Wheat farming, raising livestock, and dairying are the main enterprises. Native trees and shrubs along stream channels provide cover for wildlife and winter protection for livestock.

9. Lohmiller-Glenberg association

Deep, well drained, nearly level, silty and loamy soils that formed in alluvium

This association is on bottom land along the Belle Fourche and Cheyenne Rivers and along the lower reaches of some of their tributaries. Meandering channels and old flooding scars are common in most areas. Surfaces are uneven or hummocky in areas near the river channels.

This association makes up about 7 percent of the survey area. It is about 45 percent Lohmiller soils, 30 percent Glenberg soils, and 25 percent minor soils.

Lohmiller soils have a surface layer and underlying material of light brownish gray silty clay loam. All layers are calcareous.

Glenberg soils have a surface layer of grayish brown fine sandy loam. The underlying material, to a depth of 26 inches, is brown, calcareous fine sandy loam. Below that, the material is pale brown, calcareous, stratified fine sandy loam, loamy fine sand, or very fine sandy loam.

The minor soils in this association are Arvada and Kyle soils on valley terraces, Bankard soils near the river channels, Hisle and Swanboy soils on foot slopes and fans on the edges of the association, and Stetter soils in low areas on the river bottoms and along some of the tributary drainageways.

The major soils in this association are medium to low in fertility. The Lohmiller soils have moderate or high available water capacity, and the Glenberg soils are somewhat droughty. Runoff is slow. Most areas are subject to flooding in some years, but damages generally are minor. Controlling soil blowing on the Glenberg soils and conserving moisture are the main concerns of management.

Some areas are used for crops, and some of these are irrigated. Some areas that remain in native grass are used for hay and pasture. Native trees and shrubs along the channels provide cover for wildlife and winter protection for livestock. Raising livestock is the main enterprise.

Moderately well drained to excessively drained, clayey soils on uplands

In this group are shallow to deep, clayey soils on an upland plain underlain by soft clayey shales. These soils are medium to low in fertility and have moderate to very low available water capacity. Permeability is slow or very slow in most of the soils. Runoff is medium to rapid in much of the group. A large part of this

group is not suited to cultivation because of shallow soils and steep slopes. Controlling erosion and soil blowing and conserving moisture are the main concerns of management. Raising livestock is the main enterprise.

10. Kyle-Pierre-Hisle association

Deep and moderately deep, well drained and moderately well drained, nearly level to strongly sloping, mainly clayey soils over shale

This association is on an upland plain that is underlain by soft clayey shale. Slopes are long and smooth and mostly nearly level to moderately sloping, but some are strongly sloping.

This association makes up about 12 percent of the survey area. It is about 55 percent Kyle soils, 20 percent Pierre soils, 15 percent Hisle soils, and 10 percent minor soils (fig. 5).

Kyle soils generally are in the mid and lower parts of the landscape and on terraces along drainageways. They are nearly level to gently sloping and are deep and well drained. They have a thin surface layer of grayish brown clay. The subsoil and underlying material also are grayish brown clay and are calcareous below a depth of 5 inches.

Pierre soils are on the sides of ridges. They are moderately deep, well drained, and are gently sloping to strongly sloping. They have a profile similar to that of the Kyle soils except that soft shale is at a depth of 34 inches.

Hisle soils are on foot slopes and in slight sags and swales. They are moderately deep and well drained to moderately well drained. They have a thin surface layer of light brownish gray loam. The upper part of the subsoil is grayish brown clay. The lower part of the subsoil is light brownish gray clay that is calcareous and has spots and streaks of salt and lime. The underlying material is light brownish gray shaly clay. Light olive gray shale is at a depth of 34 inches.

The minor soils in this association are Lismas and Samsil soils on some ridgetops and on shoulders of entrenched drainageways, Lohmiller and Stetter soils on bottom land along drainageways, Nihill and Zigweid soils on gravelly ridges, Nunn soils on flattened ridgetops, and Swanboy soils on foot slopes and fans. Slickspots are intermingled with the Hisle soils in this association.

The major soils in this association are medium to low in fertility, are difficult to work, and absorb water slowly. Available water capacity is moderate to very low, and runoff is slow to medium. Controlling erosion and soil blowing, conserving moisture, and improving water intake are the main concerns of management.

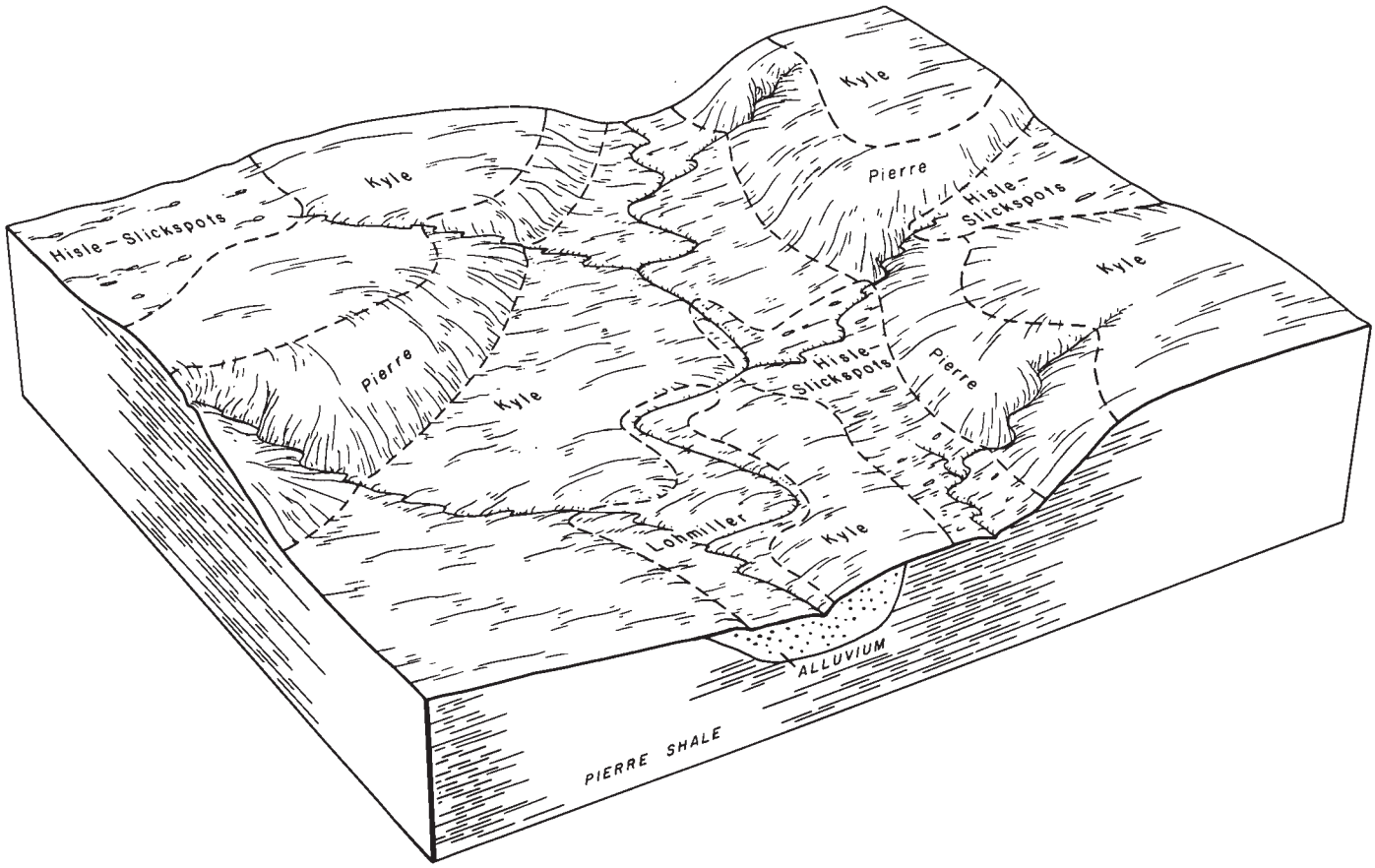


Figure 5.—**Pattern of soils, topography, and underlying material in the Kyle-Pierre-Hisle association.**

Much of this association remains in native grass and is used for range and hay. Some areas of the Kyle and Pierre soils are used for wheat, feed grain, and alfalfa. Raising livestock is the main enterprise.

11. Winler-Lismas-Swanboy association

Shallow to deep, well drained and moderately well drained, nearly level to steep, clayey soils over shale

This association is on an upland plain that is underlain by soft clayey shale. Slopes are mostly long and smooth and gently sloping to strongly sloping, but some are nearly level. Steep, broken slopes are on the sides of entrenched drainageways that cut back into the area.

This association makes up about 11 percent of the survey area. It is about 35 percent Winler soils, 30 percent Lismas soils, 10 percent Swanboy soils, and 25 percent minor soils (fig. 6).

Winler soils are gently sloping to strongly sloping and are moderately deep and well drained. They have a thin surface layer of grayish brown clay. The subsoil is grayish brown clay that is calcareous in the lower part. The underlying material is olive gray, calcareous clay. Olive gray soft shale is at a depth of 21 inches.

Lismas soils are on the tops and upper side slopes of ridges and on the sides of entrenched drainageways. They are moderately sloping to steep and are shallow and well drained. They have a thin surface layer of light brownish gray clay that is underlain by a thin layer of grayish brown clay. The underlying material is light brownish gray clay. Bedded soft shale is at a depth of 15 inches.

Swanboy soils are on foot slopes and fans. They are moderately well drained to well drained, nearly level to gently sloping, and are deep. They have a thin surface layer of light brownish gray clay. The subsoil is light brownish gray clay that has visible salts in the lower part. The underlying material is light brownish gray clay. All layers are calcareous.

The minor soils in this association are Hisle soils in slight sags and in swales, Kyle soils on some of the rises, Pierre soils on the tops and upper side slopes of some ridges, and Stetter soils on bottom land along the larger drainageways. Small areas of Slickspots are intermingled with Hisle and Swanboy soils.

The major soils in this association are not suited to cultivation because of low fertility, very poor tilth, and high susceptibility to erosion. Runoff is medium to rapid.

Much of this association remains in native grass and is used for range. Raising livestock is the main enterprise

12. Samsil-Lismas-Pierre association

Shallow and moderately deep, well drained to exces-

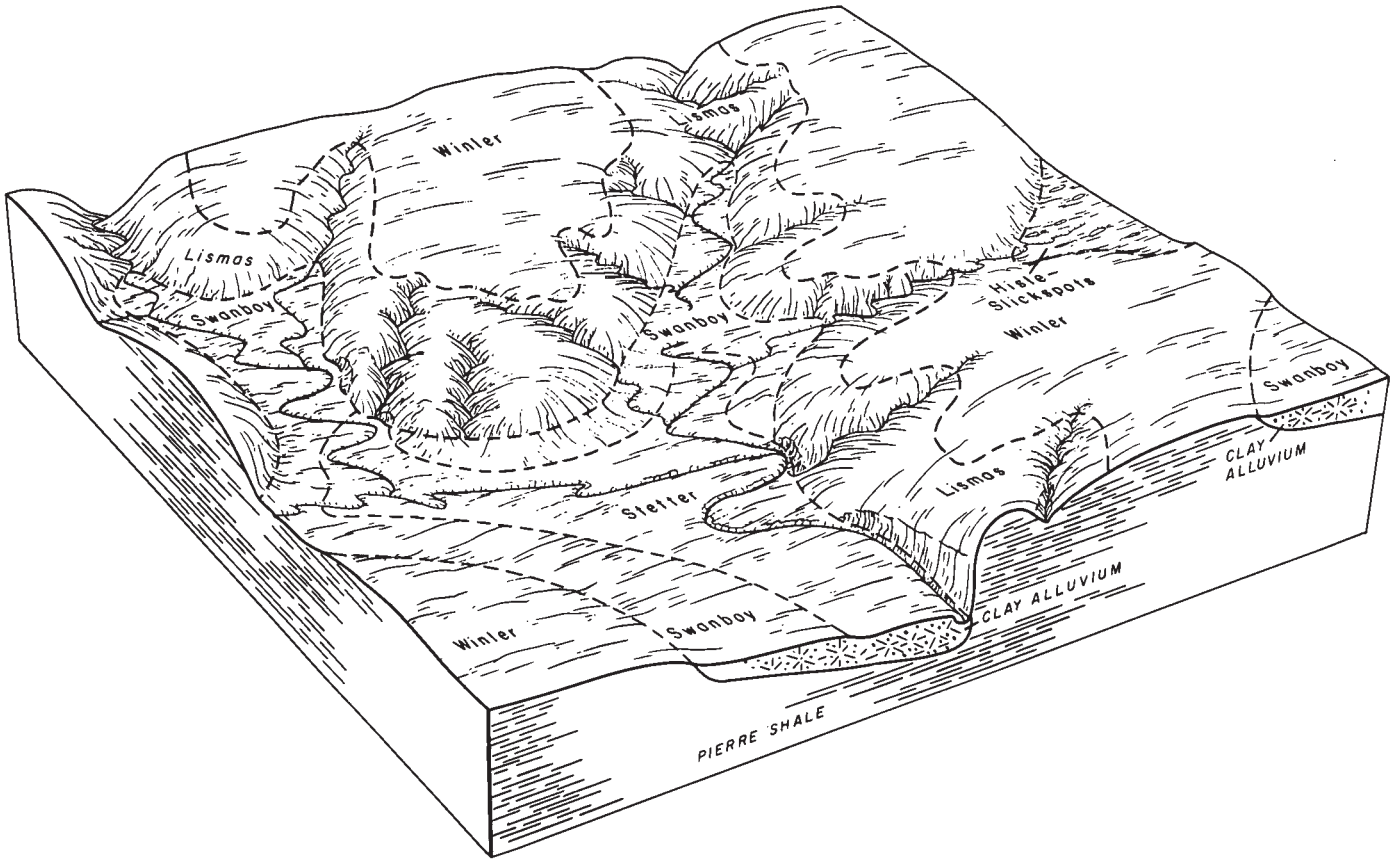


Figure 6.—Pattern of soils, topography, and underlying material in the Winler-Lismas-Swanboy association.

sively drained, moderately sloping to steep, clayey soils over shale

This association is on prominent upland ridges and the breaks along the Belle Fourche and Cheyenne Rivers and their tributaries. Slopes are mostly hilly to steep, but some are moderately sloping to strongly sloping. Many drainageways lace the areas, and some of these are gullied.

This association makes up about 20 percent of the survey area. It is about 35 percent Samsil soils, 25 percent Lismas soils, 20 percent Pierre soils, and 20 percent minor soils.

Samsil soils are moderately sloping to steep, are well drained to excessively drained, and are shallow. The upper 8 inches is grayish brown, calcareous clay. The underlying material is light brownish gray, calcareous shaly clay. Bedded soft shale is at a depth of 14 inches.

Lismas soils also are shallow over shale, are moderately sloping to steep, and are well drained. They have a profile similar to Samsil soils except they are harder when dry and more firm when moist.

Pierre soils generally are in the lower part of the landscape below Lismas and Samsil soils. They are moderately deep and are well drained. They have a thin surface layer of grayish brown clay. The subsoil is grayish brown, calcareous clay. The underlying material is light olive brown, calcareous clay. Bedded soft shale is at a depth of 34 inches.

The minor soils in this association are Hisle and Swanboy soils on foot slopes and fans and in swales, Nihill and Zigweid soils on gravelly ridges in the higher part of the river breaks, and Stetter soils on bottom land along drainageways in the lower part of the association. Rock outcrop is in places where shale outcrops on cut banks, shale slides, and around the heads of eroding drainageways. Slickspots are intermingled with Hisle and Swanboy soils in some areas.

The major soils in this association are not suited to cultivation because of steep slopes, shallowness, low fertility, and high susceptibility to erosion. Runoff is medium to rapid.

This association remains in native grass and is used for range. Raising livestock is the main enterprise.

13. Grummit-Pierre association

Shallow and moderately deep, well drained, gently sloping to steep, clayey soils over acid shale

This association is on uplands immediately east and northeast of the outer hogback of the Black Hills and is underlain by acid shale. The short and irregular slopes are mostly moderately sloping to strongly sloping, but range from gently sloping to steep. The steeper slopes are on the sides of some ridges and on the sides of entrenched drainageways.

This association makes up about 1 percent of the survey area. It is about 50 percent Grummit soils, 35 percent Pierre soils, and 15 percent minor soils.

Grummit soils are on the sides of ridges and escarpments. They are moderately sloping to steep, shallow, and acid. They have a thin surface layer of gray clay that is underlain by grayish brown and light brownish gray shaly clay. Gray acid shale is below a depth of 15 inches.

Pierre soils are on broad ridgetops and in the lower part of the landscape below Grummit soils. They are gently sloping to strongly sloping and are moderately deep. Their surface layer and subsoil is grayish brown clay. The underlying material is light olive brown clay. Soft shale is at a depth of 34 inches. Pierre soils in this association commonly are less alkaline and have smaller amounts of free carbonates than is typical for the series. They also are commonly underlain by acid shale.

The minor soils in this association are Arvada soils on terrace flats, Hisle soils in slight sags and swales, Kyle soils on foot slopes and stream terraces, Lohmiller soils on bottom land along drainageways, and Nunn soils on some ridgetops. Rock outcrop is prominent on the sides of some ridges and escarpments. Small areas of Slickspots are intermingled with Hisle soils.

The major soils in this association are low to medium in fertility and have low or very low available water capacity. Runoff is medium to rapid. In most areas these soils are not suited to farming because of slope, shallowness, and high susceptibility to erosion and soil blowing.

Most of this association remains in native vegetation and is used for range. Some of the Pierre soils and some of the minor soils are used for feed grain and alfalfa. Raising livestock is the main enterprise.

Descriptions of the soils

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

The mapping units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a soil series. A profile is the sequence of horizons, or layers, from the surface down to rock or other underlying material. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Tilford series, for example, was named for the town of Tilford in Meade County.

The soil profile is an important part of the description of each soil series. The profile of each series is described twice. The first description is brief and in terms familiar to a layman. The second is 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.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other character-

istics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a soil phase commonly indicates a feature that affects use or management. For example, Nunn clay loam, 0 to 2 percent slopes, is one of several phases within the Nunn series.

Some mapping units are made up of two or more dominant kinds of soil. Such mapping units are called soil complexes, soil associations, and undifferentiated groups.

A soil complex consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Enning-Manvel complex, 6 to 20 percent slopes, is an example.

A soil association is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Canyon-Butche association, steep, is an example.

An undifferentiated group is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Lohmiller and Glenberg soils, channeled, is an undifferentiated group in this survey area.

Most mapping units include small, scattered areas of soils other than those that appear in the name of the mapping unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the mapping unit. These soils are described in the description of each mapping unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, range site, and windbreak suitability group in which the mapping unit has been placed. Also listed is the woodland group for those soils that have been placed in woodland groups. The page where each capability unit, range site, windbreak group, or other interpretative group is described is listed in the "Guide to Mapping Units" at the back of this survey.

The names of some soils do not agree fully with those appearing in previously published soil surveys of adjacent counties because of changes in concepts of soil series in the application of the soil classification system.

The acreage and proportionate extent of each mapping unit are given in table 1, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary and in the Soil Survey Manual (*6*).[2]

Altvan series

The Altvan series consists of well drained, nearly level to gently sloping, loamy soils that are moderately deep over gravelly sand. These soils are on terraces and alluvial fans. They formed in alluvium. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is dark brown loam about 7 inches thick. The subsoil is about 18 inches thick. It is dark brown clay loam in the upper part, brown clay loam in the middle part, and pale brown, calcareous loam in the lower part. The underlying material, to a depth of 32 inches, is pale brown, calcareous fine sandy loam. Below that it is calcareous gravelly sand.

Altvan soils are medium in fertility and moderate in organic-matter content. The available water capacity is moderate. Permeability is moderate in the subsoil and very rapid in the underlying gravelly sand.

About half the acreage is cultivated, and a few small tracts are irrigated. Other areas remain in native grass and are used for range and hay.

Representative profile of Altvan loam, 0 to 2 percent slopes, in a cultivated area, 400 feet east and 150 feet south of the northwestern corner of sec. 18, T. 5 N., R. 10 E.

Ap—0 to 7 inches; dark brown (10YR 4/3) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; abrupt smooth boundary.

B21t—7 to 14 inches; dark brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm; thin shiny films on faces of peds; slightly acid; gradual wavy boundary.

B22t—14 to 22 inches; brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2) moist; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard, firm; thin shiny films on faces of peds; neutral; clear smooth boundary.

B3ca—22 to 25 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, friable; few fine segregations of lime; violent effervescence; mildly alkaline; gradual smooth boundary.

C1ca—25 to 32 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; very weak coarse prismatic structure; slightly hard, very friable; common threads of segregated lime; violent ef-

[1] Italic numbers in parenthesis refer to References p. 134.

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil	Acres	Percent
AlA	Altvan loam, 0 to 2 percent slopes	4,690	0.4
AlB	Altvan loam, 2 to 6 percent slopes	5,565	0.5
AnB	Arvada silt loam, 0 to 6 percent slopes	18,990	1.6
ArB	Arvada-Slickspots complex, 0 to 6 percent slopes	990	0.1
AsB	Assinniboine fine sandy loam, 2 to 9 percent slopes	23,515	2.0
Ba	Bankard soils	7,060	0.6
BlD	Blackpipe silt loam, 6 to 15 percent slopes	21,460	1.9
BsD	Blackpipe-Shingle complex, 6 to 15 percent slopes	10,670	0.9
CaE	Cabbart loam, 15 to 40 percent slopes	2,005	0.2
CbD	Canyon-Bridget loams, 6 to 20 percent slopes	11,720	1.0
CDE	Canyon-Butche association, steep	7,620	0.7
CTE	Citadel association, hilly	20,990	1.8
DaD	Delphill loam, 6 to 15 percent slopes	21,435	1.9
EaD	Enning-Manvel complex, 6 to 20 percent slopes	8,115	0.7
EbE	Enning-Rock outcrop complex, 20 to 40 percent slopes	3,190	0.3
Ga	Glenberg soils	9,195	0.8
GbD	Grummit clay, 6 to 15 percent slopes	7,865	0.7
GcE	Grummit-Rock outcrop complex, 15 to 40 percent slopes	2,985	0.3
HbB	Hisle-Slickspots complex, 0 to 6 percent slopes	35,695	3.1
Ho	Hoven silt loam	1,590	0.1
KaA	Keith silt loam, 0 to 2 percent slopes	4,590	0.4
KaB	Keith silt loam, 2 to 6 percent slopes	6,250	0.5
KbA	Kyle clay, 0 to 2 percent slopes	20,060	1.7
KbB	Kyle clay, 2 to 6 percent slopes	50,095	4.3
KcB	Kyle soils, 2 to 6 percent slopes, mounded	9,380	0.8
LAD	Lakoa-Maitland association, hilly	13,605	1.2
LbE	Lismas clay, 15 to 40 percent slopes	78,430	6.8
LCD	Lismas-Winler association, sloping	47,345	4.1
Le	Lohmiller silty clay loam	17,920	1.5
Lh	Lohmiller and Glenberg soils, channeled	41,330	3.6
Ma	Macken silty clay	915	0.1
MbB	Manvel silt loam, 4 to 9 percent slopes	9,305	0.8
McB	Marshdale-Maitland loams, 2 to 9 percent slopes	530	(1)
MdD	Midway-Blackpipe complex, 9 to 40 percent slopes	8,750	0.8
NaD	Nevee-Spearfish complex, 6 to 15 percent slopes	3,350	0.3
NbE	Nihill gravelly loam, 9 to 40 percent slopes	6,655	0.6
NcA	Nunn clay loam, 0 to 2 percent slopes	39,855	3.5
NcB	Nunn clay loam, 2 to 6 percent slopes	77,385	6.7
NcC	Nunn clay loam, 6 to 9 percent slopes	11,910	1.0
OaA	Onita clay loam, 0 to 4 percent slopes	4,490	0.4
PaE	Paunsaugunt-Rock outcrop complex, 3 to 40 percent slopes	10,235	0.9
PbB	Pierre clay, 2 to 6 percent slopes	15,395	1.3
PbC	Pierre clay, 6 to 15 percent slopes	70,935	6.1
SaE	Samsil clay, 15 to 40 percent slopes	71,020	6.2
SBD	Samsil-Pierre association, sloping	6,860	0.6
SCE	Samsil-Rock outcrop association, steep	18,400	1.6
SdA	Satanta loam, 0 to 2 percent slopes	12,750	1.1
SdB	Satanta loam, 2 to 6 percent slopes	37,825	3.3
SdC	Satanta loam, 6 to 9 percent slopes	5,280	0.5
SeA	Satanta-Mosher loams, 0 to 3 percent slopes	9,960	0.9
ShA	Savo silty clay loam, 0 to 2 percent slopes	9,260	0.8
SkB	Savo and Blackpipe soils, 2 to 6 percent slopes	41,065	3.6
SlE	Spearfish-Rock outcrop complex, 15 to 40 percent slopes	930	0.1
So	St. Onge loam	13,510	1.2
St	Stetter clay	17,020	1.5
SwB	Swanboy clay, 2 to 6 percent slopes	11,345	1.0
SyB	Swanboy-Slickspots complex, 0 to 6 percent slopes	1,220	0.1
TaA	Tilford silt loam, 0 to 2 percent slopes	4,510	0.4
TaB	Tilford silt loam, 2 to 6 percent slopes	5,580	0.5
VAE	Vanocker-Citadel association, steep	27,630	2.4
Wa	Winetti gravelly loam	2,780	0.2
WbC	Winler clay, 2 to 9 percent slopes	20,620	1.8
WcB	Winler-Swanboy clays, 0 to 6 percent slopes	9,800	0.8
ZaD	Zigweid-Nihill complex, 6 to 15 percent slopes	45,600	4.0
	Borrow areas	350	(1)
	Water area, greater than 5 acres	4,825	0.4
	Total	1,152,200	100.0

[1] Less than 0.1 percent.

fervescence; mildly alkaline; clear smooth boundary.

IIC2—32 to 60 inches; multicolored, mostly brownish gravelly sand; single grained; loose; strong effervescence; mildly alkaline.

Depth to carbonates ranges from 17 to 28 inches. Depth to gravelly sand or sand and gravel ranges from 20 to 40 inches. Small pebbles are on the surface and throughout the solum in most pedons. Reaction is mildly alkaline to strongly alkaline in the B3 and C horizons. The A horizon is dominantly loam but ranges from fine sandy loam to silt loam. It is dark grayish brown to brown and is 6 to 12 inches thick. The B horizon ranges from dark grayish brown to light brown in hue of 10YR or 7.5YR. The B2t horizon commonly is clay loam, but in places it is heavy loam or sandy clay loam. It is 11 to 15 inches thick. The B3ca horizon, is loam or light clay loam and has few or common segregations of lime. The C horizon above the IIC horizon ranges from loam to gravelly sandy loam and is lacking in some pedons. In places the IIC horizon is noncalcareous.

Altvan soils are near Assinniboine, Keith, Nihill, Nunn, and Satanta soils. Unlike Assinniboine, Keith, Nunn, and Satanta soils, they have a gravelly sand C horizon at a depth of less than 40 inches. Altvan soils are deeper to gravelly sand than Nihill soils.

A1A—Altvan loam, 0 to 2 percent slopes. This nearly level soil is on terraces and alluvial fans in irregularly shaped areas that range from 20 to 150 acres in size. This soil has the profile described as representative of the series. In places the surface layer is fine sandy loam. Also in places the underlying material is gravelly sandy loam.

Included with this soil in mapping are small areas of Arvada, Mosher, Nunn, Onita, and Satanta soils. Arvada and Mosher soils are along poorly defined drainageways. Nunn and Satanta soils are in places where gravelly sand is at a depth of more than 40 inches. Onita soils are in swales. Small wet spots are in some areas and are shown on the soil map by the symbol for a wet spot.

Runoff is slow, and the hazard of erosion is slight. This soil is somewhat droughty, and there is a moderate hazard of soil blowing if the soil is farmed. Conserving moisture is the main management concern.

Over half the acreage is used for crops. This soil is better suited to small grain than to late-maturing row crops. Many areas are in native grass and are used for range and hay. Silty range site, capability unit IVs–1, windbreak group 6.

A1B—Altvan loam, 2 to 6 percent slopes. This gently sloping soil is on terraces and alluvial fans in irregularly shaped areas that range from 15 to 100 acres in size. In a few places, the surface layer is fine sandy loam. The depth to gravelly sand is slightly less than 20 inches in some places.

Included with this soil in mapping are small areas of Arvada, Nihill, Nunn, Onita, and Satanta soils. Arvada soils are along drainageways and on foot slopes. Nihill soils are on rounded knolls in the higher part of the landscape. Nunn and Satanta soils are in the lower part of the landscape. Onita soils are in swales. Small wet spots are in a few areas and are shown on the soil map by the symbol for a wet spot.

Runoff is medium. The hazards of erosion and soil blowing are moderate to severe if this soil is farmed. This soil is also somewhat droughty. Controlling erosion and soil blowing and conserving moisture are the main management concerns.

Many areas are in native grass and are used for range, and some areas are used for crops. This soil is better suited to small grain than to late-maturing row crops. Silty range site, capability unit IVe–2, windbreak group 6.

Arvada series

The Arvada series consists of deep, well drained, nearly level to gently sloping, silty soils that have a claypan subsoil. These soils are on stream terraces and uplands. They formed in alluvium. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is light brownish gray silt loam about 3 inches thick. The subsoil is about 15 inches thick. It is grayish brown clay in the upper part and grayish brown, calcareous clay loam in the lower part. The underlying material is light brownish gray, calcareous clay loam.

Arvada soils are low in fertility and moderately low in organic-matter content. The available water capacity is low or moderate, and permeability is very slow.

Most areas are in native grass and are used for range. A few areas are cultivated.

Representative profile of Arvada silt loam, 0 to 6 percent slopes, in native grass, 150 feet east and 75 feet north of the southwestern corner of sec. 19, T. 7 N., R. 6 E.

A2—0 to 3 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) moist; weak thin platy structure; soft, very friable; neutral; abrupt smooth boundary.

B21t—3 to 5 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate medium columnar structure parting to moderate medium blocky; very hard, very firm; moderately alkaline; clear wavy boundary.

B22t—5 to 12 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium blocky; very hard, very firm; slight effervescence; moderately alkaline; gradual wavy boundary.

B3casa—12 to 18 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; very hard, very firm; common fine segregations of salts and lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1casa—18 to 39 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm; common fine segregations of salts; common threads of lime; strong effer-

vescence; moderately alkaline; clear smooth boundary.

C2casa—39 to 60 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable; common fine segregations of salts; common threads of lime; slight effervescence; moderately alkaline.

The solum is 15 to 30 inches thick. Depth to free carbonates ranges from 2 to 10 inches. Coarse fragments are in some pedons, but make up less than 15 percent of the soil mass. The A horizon is 1 to 5 inches thick. Some pedons have a thin A1 horizon. The A2 horizon commonly is silt loam but ranges from fine sandy loam to silt loam. It is grayish brown to pale brown in hue of 10YR or 2.5Y. The B2 horizon is clay loam or clay and ranges from dark grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is 8 to 16 inches thick and is mildly alkaline to strongly alkaline. The B3 horizon ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. The C horizon is moderately alkaline or strongly alkaline. In places the lower part of this horizon is bedded soft shale below a depth of 40 inches.

Arvada soils are near Altvan, Blackpipe, Manvel, Nunn, Satanta, and Savo soils, and are similar to Mosher soils. They contain more sodium in the B horizon than Altvan, Blackpipe, Manvel, Nunn, Satanta, and Savo soils. Arvada soils have a less clayey B horizon and are deeper to shale than Hisle soils. They have a thinner A horizon than Mosher soils.

AnB—Arvada silt loam, 0 to 6 percent slopes. This nearly level to gently sloping soil is on terraces and uplands in irregularly shaped areas that range from 15 to 150 acres in size. The surface commonly is uneven. Many small mounds rise a few inches above the intervening low areas that range from 3 to 30 feet in diameter. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Altvan, Blackpipe, Nunn, and Savo soils. These inclusions are on slight rises where the surface is smooth. Also included are small areas of Slickspots in some of the low areas.

Runoff is slow to medium and commonly ponds in the low areas. This soil has poor tilth and is difficult to work. It generally is not suited to cultivation because of poor tilth, very slow permeability, and droughtiness. The claypan subsoil absorbs water slowly and releases it slowly to plants.

Most areas remain in native grass and are used for range. Thin Claypan range site, capability unit VIs–3, windbreak group 10.

ArB—Arvada-Slickspots complex, 0 to 6 percent slopes. These soils are on terraces and along drainageways on uplands in irregularly shaped areas that range from 10 to 100 acres in size. Surfaces are uneven. Small mounds rise from 4 to 10 inches above the intervening low areas, which range from 3 to 50 feet in diameter. Arvada soils are on the mounds. Slickspots are in the low areas, have a puddled or "slicked-over" surface, and commonly have spots and streaks of salt within a few inches of the surface. This complex is about 65 percent Arvada soils, 20 percent Slickspots, and 15 percent other soils.

Included with this unit in mapping are small areas of Blackpipe, Hoven, and Savo soils. Blackpipe and Savo soils are on slight rises and have smooth surfaces. Hoven soils are in small, closed depressions some of which are shown on the soil map by the symbol for a wet spot. Also included in some areas is a soil that is wetter and more saline than Arvada soils.

Runoff is slow to medium on the Arvada soil and ponds on Slickspots. Tilth is poor to very poor, and the claypan subsoil of the Arvada soil absorbs water slowly and releases it slowly to plants. This mapping unit generally is not suited to cultivation because of poor tilth, very slow permeability, and droughtiness.

Almost all areas remain in native vegetation and are used for range. The Slickspots part of this complex has little or no vegetation. Arvada soil is in Thin Claypan range site, capability unit VIs–3, windbreak group 10; Slickspots is in capability unit VIIIs–3, not placed in a range site or a windbreak group.

Assinniboine series

The Assinniboine series consists of deep, well drained, gently sloping to moderately sloping, loamy soils on uplands. These soils formed in material that weathered from soft shale and sandstone either in place or transported locally. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is grayish brown fine sandy loam about 5 inches thick. The subsoil, about 20 inches thick, is brown light sandy clay loam in the upper part and pale brown fine sandy loam in the lower part. The underlying material, to a depth of 41 inches, is pale yellow, calcareous fine sandy loam. Below that it is light gray, calcareous fine sandy loam stratified with fine sand, loam, and very fine sandy loam.

Assinniboine soils are medium in fertility and moderate in organic-matter content. The available water capacity and permeability are moderate.

These soils are used for cultivated crops and for range and hay.

Representative profile of Assinniboine fine sandy loam, 2 to 9 percent slopes, in cropland, 1,300 feet west and 200 feet south of the northeastern corner of sec. 19, T. 7 N., R. 12 E.

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

B21t—5 to 10 inches; brown (10YR 5/3) light sandy clay loam, very dark brown (10YR 3/3) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable; neutral; gradual wavy boundary.

B22t—10 to 17 inches; brown (10YR 5/3) light sandy clay loam, dark brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to weak medium subangular blocky, hard, friable; neutral, gradual wavy boundary.

B3—17 to 25 inches; pale brown (10YR 6/3) fine sandy loam, dark brown (10YR 4/3)

moist; weak very coarse prismatic structure parting to weak coarse, subangular blocky; slightly hard, friable; mildly alkaline; gradual wavy boundary.

C1ca—25 to 41 inches; pale yellow (2.5Y 7/4) fine sandy loam, light olive brown (2.5Y 5/4) moist; few fine distinct strong brown and brown mottles; very weak and very coarse prismatic structure; slightly hard, friable; few fine segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2ca—41 to 60 inches; light gray (2.5Y 7/2) fine sandy loam stratified with fine sand, loam, and very fine sandy loam, light brownish gray (2.5Y 6/2) moist; massive; slightly hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline.

Depth to carbonates ranges from 15 to 25 inches. The A horizon commonly is fine sandy loam, but ranges from sandy loam to loam. It is dark grayish brown to brown and is 4 to 8 inches thick. The B2t horizon ranges from dark brown to light yellowish brown in hue of 10YR or 2.5Y. It is 8 to 12 inches thick and is neutral to moderately alkaline. The B3 horizon is very fine sandy loam in places, and ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is 4 to 12 inches thick. The C horizon commonly is fine sandy loam or loamy fine sand and ranges from grayish brown to pale yellow in hue of 2.5Y or 10YR. It is mildly alkaline or moderately alkaline. In places soft bedrock is at a depth of 40 inches or more.

Assinniboine soils are near Altvan, Cabbart, Delphill, and Satanta soils. They contain more sand in the B horizon than Altvan and Satanta soils and they lack the gravelly sand C horizon of the Altvan soils. Assinniboine soils are deeper to bedrock than Cabbart and Delphill soils.

AsB—Assinniboine fine sandy loam, 2 to 9 percent slopes. This soil is on uplands in irregularly shaped areas that range from 20 to 100 acres in size. It is mostly gently sloping, but in some areas it is moderately sloping. In a few places the surface layer is loam and the subsoil is light clay loam.

Included with this soil in mapping are small areas of Arvada, Delphill, Hoven, Onita, and Satanta soils. Arvada soils are in sags and along drainageways. Delphill soils are on the tops and upper side slopes of ridges. Hoven soils are in closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Onita soils are in swales. Satanta soils are on foot slopes. Also included in some places are small stony areas, which are shown on the soil map by a spot symbol for stony areas.

Runoff is slow to medium. This soil is easy to work, but the hazard of erosion and soil blowing is moderate to severe. Controlling erosion and soil blowing is the main management concern.

About half the acreage is cultivated. Some areas remain in native grass and are used for range and hay. This soil is moderately well suited to crops. Sandy range site, capability unit IVe–7, windbreak group 5.

Bankard series

The Bankard series consists of deep, well drained to somewhat excessively drained, nearly level soils on bottom land. These soils formed in alluvium. The native vegetation consisted mainly of a mixture of tall, mid, and short grasses. A few native trees, mainly cottonwood, are in some areas.

In a representative profile the surface layer is light brownish gray very fine sandy loam about 5 inches thick. The underlying material is about 3 inches of grayish brown loamy fine sand that is underlain by about 7 inches of light brownish gray very fine sandy loam. Below a depth of 15 inches it is light brownish gray fine sand stratified with loamy fine sand and fine sandy loam. All layers are calcareous.

Bankard soils are low in fertility and organic-matter content. The available water capacity is low, and permeability is rapid.

Almost all areas remain in native grass and are used for range and hay.

Representative profile of Bankard very fine sandy loam in an area of Bankard soils, in native grass, 600 feet south and 400 feet east of the northwestern corner of sec. 31, T. 4 N., R. 15 E.

A1—0 to 5 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; very weak fine granular structure; soft, very friable; strong effervescence; mildly alkaline; clear wavy boundary.

C1—5 to 8 inches; grayish brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) moist; single grained; loose; strong effervescence; mildly alkaline; clear wavy boundary.

C2—8 to 15 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; strong effervescence; mildly alkaline; clear wavy boundary.

C3—15 to 60 inches; light brownish gray (10YR 6/2) fine sand stratified with loamy fine sand and fine sandy loam, dark grayish brown (10YR 4/2) moist; single grained; loose; strong effervescence; mildly alkaline.

Free carbonates commonly are at the surface, but some pedons are noncalcareous in the upper few inches. Pebbles and cobbles are few or common in some pedons. Reaction is mildly alkaline or moderately alkaline throughout the profile. The A horizon ranges from loamy fine sand to clay and is grayish brown to light yellowish brown in hue of 10YR or 2.5Y. The C horizon ranges from grayish brown to pale yellow in hue of 10YR or 2.5Y.

Bankard soils contain more sand than the nearby Glenberg and Lohmiller soils.

Ba—Bankard soils. These are nearly level soils on bottom land along the Belle Fourche and Cheyenne Rivers. Slope is 0 to 2 percent. Surfaces commonly are uneven. Low mounds rise 1 to 3 feet above swales or flood routes. Texture of the surface layer differs from

one area to another and commonly ranges from loamy fine sand to very fine sandy loam or loam. In a few areas, however, the surface layer is clay loam or clay because of recent deposition.

Included with these soils in mapping are small areas of Glenberg, Lohmiller, and Stetter soils. Glenberg and Lohmiller soils are in swales and in places where slopes are smooth. Stetter soils are in meander scars or old channels.

Runoff is slow, and in some years the areas are subject to stream flooding. These soils blow readily if the vegetative cover is removed. Controlling soil blowing is the main management concern.

Most areas are in native vegetation and are used for range. These soils are poorly suited to crops. Scattered cottonwood trees provide winter protection for livestock and some cover for wildlife. Sands range site, capability unit VIe–8, windbreak group 7.

Blackpipe series

The Blackpipe series consists of moderately deep, well drained, gently sloping to moderately steep, silty soils on uplands. These soils formed in material that weathered from the underlying soft shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown silt loam about 6 inches thick. The subsoil is about 19 inches thick. It is grayish brown silty clay in the upper part, grayish brown silty clay loam in the middle part, and light brownish gray silty clay loam in the lower part. The lower part of the subsoil is calcareous and contains spots and streaks of soft lime. The underlying material, to a depth of 34 inches, is light brownish gray calcareous silty clay loam. Below that, it is light gray soft shale.

Blackpipe soils are medium in fertility and moderate in organic-matter content. The available water capacity is low or moderate, and permeability is moderately slow.

Many areas are in native grass and are used for range and hay. Some areas are cultivated.

Representative profile of Blackpipe silt loam in an area of Savo and Blackpipe soils, 2 to 6 percent slopes, in native grass, 550 feet east and 75 feet south of the northwestern corner of sec. 14, T. 7 N., R. 6 E.

A1—0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; many fine and medium roots; neutral; clear smooth boundary.

B21t—6 to 13 inches; grayish brown (2.5Y 5/2) light silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to moderate medium blocky; hard, firm, sticky and plastic; common fine and medium roots; neutral; clear wavy boundary.

B22t—13 to 17 inches; grayish brown (2.5Y 5/2) heavy silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate medium prismatic structure parting to moderate medium blocky; hard, firm, sticky and plastic; common fine and medium roots; slight effervescence; mildly alkaline; gradual wavy boundary.

B3ca—17 to 25 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; hard, friable, slightly sticky and slightly plastic; few fine roots; common fine segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

Cca—25 to 34 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few medium segregations of lime; strong effervescence; mildly alkaline; clear smooth boundary.

Cr—34 to 60 inches; light gray (2.5Y 7/2) soft shale, grayish brown (2.5Y 5/2) moist; platy bedrock structure; crushes to silty clay loam; reddish yellow (7.5YR 6/6) stains on some shale plates; few nests of gypsum crystals; slight effervescence in the upper part; mildly alkaline.

Depth to free carbonates ranges from 12 to 25 inches. Depth to siltstone or silty shale ranges from 20 to 40 inches. The A horizon commonly is silt loam, but in places it is clay loam or silty clay loam. It ranges from very dark grayish brown to grayish brown. It is 3 to 7 inches thick and is slightly acid or neutral. The B2t horizon is clay loam, silty clay, or clay and has a clay content ranging from 35 to 50 percent. It ranges from very dark grayish brown to light olive brown in hue of 10YR or 2.5 Y. The B2t horizon is 9 to 18 inches thick. Some pedons lack a B3ca horizon. The Cca horizon is silt loam, silty clay loam, or clay loam and ranges from gray to light gray in hue of 10YR or 2.5Y. There are few to many segregations of lime in the B3ca and Cca horizons. These horizons are mildly alkaline or moderately alkaline. The bedrock in the lower part of the C horizon is soft silty shale or siltstone.

Blackpipe soils are near Midway, Nunn, Savo, Satanta, and Shingle soils. They are deeper over bedrock than Midway and Shingle soils and are shallower over bedrock than Nunn, Satanta, and Savo soils. Blackpipe soils also have more clay in the B horizon than Satanta soils.

BlD—Blackpipe silt loam, 6 to 15 percent slopes. This soil is on uplands in irregularly shaped areas that range from 20 to 70 acres in size. Slopes in most places are less than 9 percent. This Blackpipe soil contains more sand and is less silty than the soil described as representative of the series. Also, small stony areas are in some places and are shown on the soil map by a spot symbol.

Included with this soil in mapping are small areas of Arvada, Midway, and Savo soils. Arvada soils are in swales and along drainageways. Midway soils are on

the tops and upper side slopes of some of the ridges and on the sides of entrenched drainageways. Savo soils are on foot slopes. In places these soils make up 25 percent of the area.

Runoff is medium. The hazard of erosion is severe, and there is a moderate risk of soil blowing if this soil is farmed. Controlling erosion and soil blowing is the main management concern.

Many areas are in native grass and are used for range, but some are farmed. This soil is better suited to small grain than to row crops because of the erosion hazard. Silty range site, capability unit IVe–1, windbreak group 3.

BsD—Blackpipe-Shingle complex, 6 to 15 percent slopes. These moderately sloping to strongly sloping soils are on uplands in irregularly shaped areas that range from 20 to 100 acres in size. This complex is about 50 percent Blackpipe soils, 30 percent Shingle soils, and 20 percent other soils. Blackpipe soils are on broad ridgetops in the mid and lower parts of the landscape where slopes are mostly less than 9 percent. Their surface layer is silt loam, and in places they have a thinner surface layer and subsoil than those described as representative of the series. Shingle soils are on the upper sides of ridges, and their surface layer is loam. Shingle soils have the profile described as representative of the Shingle series, except in a few places the depth to shale is more than 20 inches.

Included with these soils in mapping are small areas of Arvada, Hoven, Onita, Samsil, and Savo soils. Arvada soils are in sags. Hoven soils are in small, closed depressions, some of which are shown in the soil map by a symbol for a wet spot. Onita soils are in swales. Samsil soils are on the sides of entrenched drainageways that cut back into the lower part of the mapping unit. Savo soils are on foot slopes below the Blackpipe soils.

Runoff is medium. These soils are subject to erosion and soil blowing if the plant cover is removed. The Shingle soil is shallow, low in fertility, and low in available water capacity. Controlling erosion and soil blowing is the main management concern.

Most areas are in native grass and are used for range. A few areas are cultivated. The Blackpipe soil can be used for growing close-sown crops such as small grain, grasses, and alfalfa; but the Shingle soil generally is not suited to crops. Blackpipe soil is in Silty range site, capability unit IVe–1, windbreak group 3; Shingle soil is in Shallow range site, capability unit VIe–11, windbreak group 10.

Bridget series

The Bridget series consists of deep, well drained, moderately sloping to moderately steep, loamy soils on uplands. These soils formed in local alluvium. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The next layer is brown very fine sandy loam about 4 inches thick. The underlying material is calcareous very fine sandy loam that is pale brown and light brownish gray to a depth of 28 inches. Below that it is pale yellow.

Bridget soils are medium in fertility and moderate in organic-matter content. The available water capacity is high, and permeability is moderate.

Most areas are in native grasses and are used for range and hay. A few small areas are in tame grass and alfalfa.

Bridget soils are mapped only in complex with Canyon soils.

Representative profile of Bridget loam in an area of Canyon-Bridget loams, 6 to 20 percent slopes, in native grass, 2,300 feet east and 500 feet north of the southwestern corner of sec. 32, T. 6 N., R. 5 E.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular stucture; soft, very friable; neutral; clear wavy boundary.

AC—7 to 11 inches; brown (10YR 5/3) very fine sandy loam, dark brown (10YR 3/3) moist; weak coarse prismatic structure; slightly hard, friable; neutral; clear wavy boundary.

C1—11 to 14 inches; pale brown (10YR 6/3) very fine sandy loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure; slightly hard, very friable; slight effervescence; mildly alkaline; clear wavy boundary.

C2—14 to 28 inches; light brownish gray (10YR 6/2) very fine sandy loam, grayish brown (10YR 5/2) moist; massive; thin layers of white (10YR 8/2), light brownish gray (10YR 6/2) moist; strong effervescence; moderately alkaline; clear wavy boundary.

C3—28 to 60 inches; pale yellow (2.5Y 8/4) very fine sandy loam, pale yellow (2.5Y 7/4) moist; massive; soft, very friable; strong effervescence; moderately alkaline.

The solum is 7 to 24 inches thick. Depth to free carbonates commonly ranges from 7 to 15 inches, but in places lime is at or near the surface. Horizons between depths of 10 and 40 inches commonly are very fine sandy loam, but in places they are light loam or silt loam. The A horizon ranges from dark grayish brown to brown and is 7 to 15 inches thick. The A and AC horizons are neutral or mildly alkaline. Some pedons lack an AC horizon. In places the C horizon is stratified with thin layers of fine sandy loam, loam, or silt loam. In places soft bedrock is at a depth of 40 to 60 inches.

Bridget soils are near Blackpipe, Butche, Canyon, and Keith soils. They have less clay than Blackpipe and Keith soils and are deeper over bedrock than Butche and Canyon soils.

Butche series

The Butche series consists of shallow, well drained to excessively drained, steep, loamy soils on uplands. These soils formed in material that weathered from the underlying sandstone. The native vegetation consisted of mid and short grasses. A few ponderosa pine grow singly or in clumps in some areas.

In a representative profile the surface layer is dark brown loam about 4 inches thick. Below that is a transitional layer of yellowish red stony loam about 5 inches

thick. The underlying material, to a depth of 14 inches, is reddish brown stony loam. Pink and light brown sandstone is at a depth of 14 inches (fig. 7).

Butche soils are low in fertility and in organic-matter content. The available water capacity is very low, and permeability above the sandstone is moderate.

All areas are in native grass and are used for range.

Butche soils are mapped only in association with Canyon soils.

Representative profile of Butche loam in an area of Canyon-Butche association, steep, in native grass, 1,450 feet west and 450 feet south of the northwestern corner of sec. 4, T. 2 N., R. 7 E.

A1—0 to 4 inches; dark brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable; neutral; clear wavy boundary.

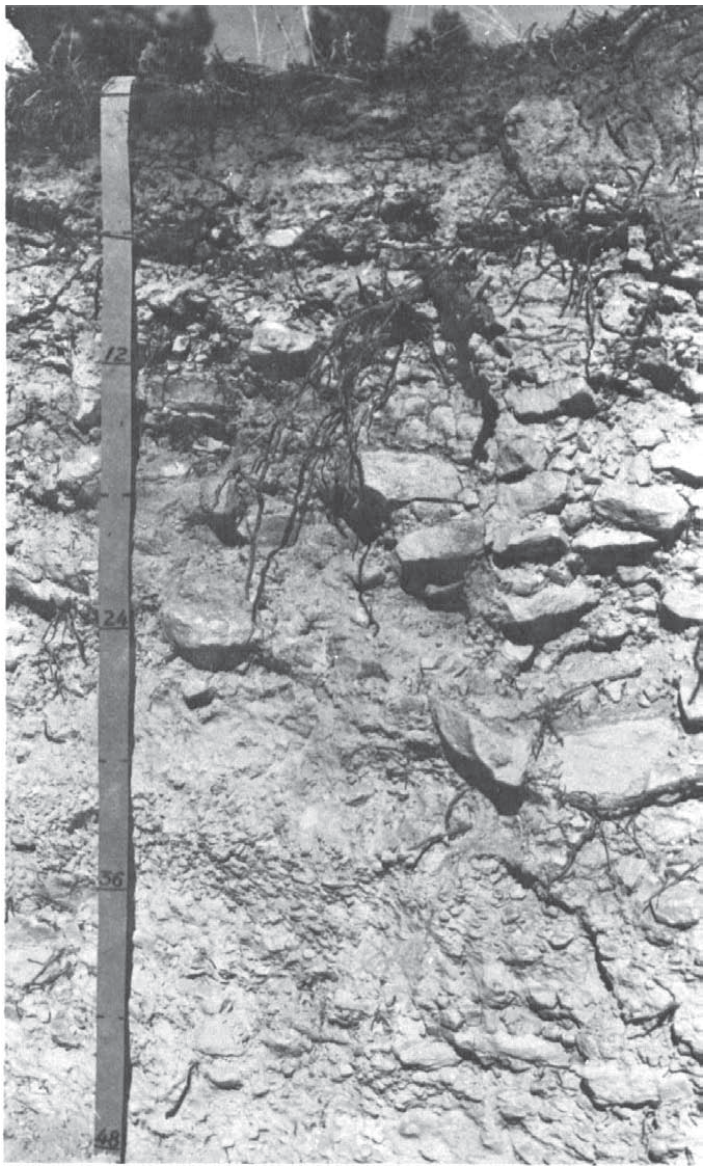


Figure 7.—**Fractured sandstone is at a depth of about 14 inches in this profile of Butche loam in an area of Canyon-Butche association, steep.**

AC—4 to 9 inches; yellowish red (5YR 4/6) loam, reddish brown (5YR 4/4) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable; about 15 percent rock fragments; neutral; abrupt smooth boundary.

C—9 to 14 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable; about 25 percent rock fragments; neutral; abrupt smooth boundary.

R—14 to 20 inches; pink (7.5YR 7/4) and light brown (7.5YR 6/4) indurated sandstone, light brown (7.5YR 6/4) and brown (7.5YR 5/4) moist; bedded and fractured; neutral.

Depth to sandstone ranges from 7 to 20 inches. Rock fragments are channery sandstone or rounded pebbles, cobbles, and stones of metamorphic or igneous origin that are on the surface or throughout the soil. They make up 10 to 30 percent of the soil mass. Reaction typically is slightly acid or neutral but ranges to mildly alkaline. The A horizon is loam, stony loam, or fine sandy loam, and ranges from dark brown to light brown in hue of 10YR or 7.5YR. It is 3 to 5 inches thick. Some pedons lack an AC horizon. The C horizon ranges from grayish brown to reddish yellow in hue of 10YR, 7.5YR, or 5YR.

Butche soils are mapped with or are near Bridget, Canyon, Lakoa, and Maitland soils. They are shallower over bedrock than Bridget, Lakoa, and Maitland soils and are underlain by harder bedrock and are less calcareous than Canyon soils.

Cabbart series

The Cabbart series consists of shallow, well drained to excessively drained, moderately steep to steep, calcareous, loamy soils on uplands. These soils formed in material that weathered from the underlying soft shale and sandstone. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is light brownish gray loam about 4 inches thick. The underlying material, to a depth of 18 inches, is light brownish gray and very pale brown loam. Below that it is very pale brown, soft shale and sandstone.

Cabbart soils are low in fertility and in organic-matter content. The available water capacity is low or very low, and permeability is moderately slow or slow.

All areas are in native grass and are used for range.

Representative profile of Cabbart loam, 15 to 40 percent slopes, in native grass, 1,500 feet north and 650 feet west of the southeastern corner of sec. 34, T. 7 N., R. 12 E.

A1—0 to 4 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; clear wavy boundary.

C1—4 to 11 inches; light brownish gray (10YR 6/2) loam, dark brown (10YR 4/3) moist; very weak coarse prismatic struc-

ture; slightly hard, friable; slight effervescence; mildly alkaline; clear smooth boundary.

C2ca—11 to 18 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; massive; bedding planes evident; slightly hard, friable; common fine fragments of soft shale; few segregations of lime; strong effervescence; moderately alkaline clear smooth boundary.

Cr—18 to 60 inches; very pale brown (10YR 7/3) bedded soft shale, stratified with thin layers of soft sandstone, brown (10YR 5/3) moist; platy bedrock structure; slight effervescence; moderately alkaline.

Depth to soft sandstone or shale ranges from 10 to 20 inches. The horizons above the bedrock are loam, silty clay loam, or clay loam. The A horizon ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is 1 to 4 inches thick and is mildly alkaline or moderately alkaline. The C horizon ranges from light brownish gray to yellow in hue of 10YR or 2.5Y and is mildly alkaline to strongly alkaline. The underlying soft sandstone or shale is multi-colored in some pedons and has streaks and bands of light gray and reddish yellow. It is unconsolidated to weakly consolidated and is easily penetrated with a spade.

Cabbart soils are near Assinniboine and Delphill soils and are similar to Canyon, Enning, Midway, and Shingle soils. They are shallower over bedrock than Assinniboine and Delphill soils. Cabbart soils have slightly cooler temperatures than Canyon, Enning, Midway, and Shingle soils. They have less clay than Midway soils.

CaE—Cabbart loam, 15 to 40 percent slopes. This moderately steep to steep soil is on ridges, buttes, and the sides of deeply entrenched drainageways in irregularly shaped areas that range from 15 to 120 acres in size. In places the surface layer is clay loam. Also in a few areas the soil contains more sand than the soil described as representative of the series and has a fine sandy loam surface layer.

Included with this soil in mapping are small areas of Assinniboine and Delphill soils. Assinniboine soils are on foot slopes and swales. Delphill soils are scattered through the mid and lower parts of the landscape below the Cabbart soils. Also included in some places are small areas of Rock outcrop on the sides of entrenched drainageways and on the upper sides of sandstone-capped ridges.

Runoff is rapid, and the hazard of erosion is very severe if the plant cover is removed. Controlling erosion is the main management concern.

All areas remain in native grass and are used for range. This soil is too shallow and too steep for cultivation. Shallow range site, capability unit VIIe-4, windbreak group 10.

Canyon series

The Canyon series consists of shallow, well drained, moderately sloping to steep, calcareous, loamy soils on uplands. These soils formed in material that weathered from the underlying sandstone, siltstone, and shale. The native vegetation consisted mainly of mid and short grasses. Short, limby ponderosa pine are scattered throughout some areas.

In a representative profile the surface layer is dark grayish brown loam about 4 inches thick. The next layer is light brownish gray silt loam about 3 inches thick. The underlying material, to a depth of 11 inches, is light gray silt loam. Below that, it is white and very pale brown interbedded weakly-cemented sandstone, loamy shale, and siltstone. All layers are calcareous.

Canyon soils are low in fertility and in organic-matter content. The available water capacity is very low, and permeability is moderate.

Most areas are in native grass and are used for range.

Representative profile of Canyon loam in an area of Canyon-Bridget loams, 6 to 20 percent slopes, in native grass, 2,000 feet north and 2,400 feet east of the southwestern corner of sec. 32, T. 6 N., R. 5 E.

A1—0 to 4 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10 YR 3/2) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; gradual wavy boundary.

AC—4 to 7 inches; light brownish gray (10YR 6/2) silt loam, light brownish gray (10 YR 5/2) moist; very weak coarse prismatic structure parting to weak fine granular; slightly hard, friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C—7 to 11 inches; light gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, friable; common fine fragments of shale; strong effervescence; mildly alkaline; gradual smooth boundary.

Cr—11 to 60 inches; white (10YR 8/2) and very pale brown (10YR 8/3) interbedded loamy shale, siltstone, and weakly-cemented sandstone, light gray (10YR 7/2) and pale brown (10YR 6/3) moist; crushes easily to material that is slightly hard, friable; strong effervescence; moderately alkaline.

Depth to bedrock ranges from 7 to 20 inches. Reaction of the horizons above the bedrock is mildly alkaline or moderately alkaline. The A horizon is loam, silt loam, or very fine sandy loam and is noncalcareous in places. It ranges from dark grayish brown to very pale brown and is 3 to 6 inches thick. Some pedons lack an AC horizon. The C horizon above the bedrock ranges from light brownish gray to very pale brown and is loam, silt loam, or very fine sandy loam.

Canyon soils are mapped with or are near Bridget, Butche, Lakoa, and Midway soils and are similar to Enning and Shingle soils. They are shallower over bedrock than Bridget and Lakoa soils and are more calcareous than Butche soils. Canyon soils are less calcareous than Enning soils, have less clay than Midway soils, and contain more very fine sand than Shingle soils.

CbD—Canyon-Bridget loams, 6 to 20 percent slopes. These moderately sloping to moderately steep soils typically are in the lower part of the inner face of the outer hogback of the Black Hills. The areas are 20 to

150 acres in size. This mapping unit is about 45 percent Canyon soils, 30 percent Bridget soils, and 25 percent other soils. Canyon soils are on the top and upper side slopes of ridges and knolls where slopes are short and convex. Bridget soils are in the lower part of the landscape where slopes are typically plane to concave. They are mostly moderately sloping to strongly sloping. Both soils have the profiles described as representative of their respective series. In places the surface layer is very fine sandy loam or silt loam. In places stones and cobbles are on the surface, and these areas are shown on the soil map by a spot symbol.

Included with these soils in mapping are small areas of Blackpipe, Butche, Keith, Midway, Nihill, and Winetti soils. Blackpipe and Midway soils are on the sides of ridges where soft shale is near the surface. Butche and Nihill soils are on the top of some of the ridges and knolls. Keith soils are on wide ridgetops or on the southeastern side of some of the ridges. Winetti soils are on narrow bottom land and alluvial fans. Also included in some places are small areas of Rock outcrop, some of which are shown on the soil map by a spot symbol.

Runoff is medium to rapid, and the hazard of erosion is severe to very severe. The Canyon soil generally is not suited to cultivation because of shallowness, low fertility, and very low available water capacity; but the Bridget soil has a potential for crops if erosion is controlled.

Most areas are in native grass and are used for range. In places the Bridget soil is used for crops and hay. Canyon soil is in Shallow range site, capability unit VIe-11, windbreak group 10; Bridget soil is in Silty range site, capability unit IVe-1, windbreak group 3.

CDE—Canyon-Butche association, steep. These soils are on the top and upper side slopes of a prominent ridge that forms the outer hogback of the Black Hills. The areas generally are long and irregularly shaped and range from 40 to 400 acres in size. They are about 50 percent Canyon soils, 25 percent Butche soils, and 25 percent other soils. Butche soils generally are in the higher part of the landscape near outcrops of hard sandstone. Both soils have a surface layer that commonly is loam, but in places it is very fine sandy loam or silt loam. Stones ranging up to 4 feet in diameter are scattered on the surface in places.

Included in mapping are small areas of Bridget, Lakoa, Midway, Nihill, and Satanta soils. Bridget and Satanta soils are on foot slopes. Lakoa soils are in wooded coves. Midway soils are on the sides of the ridge where soft, clayey shale is near the surface. Nihill soils are on gravelly ridges. Also included are small areas of Rock outcrop that form almost vertical cliffs (fig. 8).

Runoff is rapid, and the hazard of erosion is very severe if the plant cover is removed.

All areas remain in native vegetation and are used for range. Clumps of short, limby ponderosa pine provide winter protection for livestock and some cover for wildlife. Shallow range site, capability unit VIIe–4, windbreak group 10.

Citadel series

The Citadel series consists of deep, well drained, moderately sloping to steep, silty soils on uplands. These soils formed in material that weathered mainly from calcareous sandstone, limestone, and soft shale. The

Figure 8.—**Rock outcrop in an area of Canyon-Butche association, steep.**

native vegetation consisted mainly of ponderosa pine.

In a representative profile the surface is covered with about 2 inches of forest litter. The surface layer is about 8 inches thick. It is silt loam that is pale brown in the upper part and pinkish gray in the lower part. The subsoil is about 21 inches thick. It is light brown silty clay in the upper part and light brown silty clay loam in the lower part. The underlying material is light brown and pink clay loam. It is calcareous at a depth of 33 inches.

Citadel soils are medium in fertility and moderately low in organic-matter content. The available water capacity is high, and permeability is moderately slow.

Most areas are forested and are used for timber production, limited grazing, wildlife, and recreation.

Representative profile of Citadel silt loam in an area of Citadel association, hilly, in ponderosa pine forest, 1,000 feet north and 500 feet east of the southwestern corner of sec. 31, T. 5 N., R. 5 E.

O—2 inches to 0; forest litter, some partly decomposed.

A21—0 to 2 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; very weak thick platy structure parting to weak fine granular; soft, very friable; strongly acid; clear smooth boundary.

A22—2 to 8 inches; pinkish gray (7.5YR 6/2) silt loam, brown (7.5YR 4/2) moist; weak fine granular structure; soft, very friable; medium acid; clear wavy boundary.

B2t—8 to 21 inches; light brown (7.5YR 6/4) silty clay, brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium blocky and subangular blocky; very hard, very firm; thin continuous clay films on faces of peds; 10 percent sandstone fragments; slightly acid; gradual wavy boundary.

B3—21 to 29 inches; light brown (7.5YR 6/4) channery silty clay loam, brown (7.5 YR 5/4) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, firm; thin patchy clay films on faces of peds; 20 percent sandstone fragments; neutral; gradual wavy boundary.

C1—29 to 33 inches; light brown (7.5YR 6/4) channery clay loam, brown (7.5YR 5/4) moist; massive; hard, firm; 25 percent sandstone fragments; neutral; gradual wavy boundary.

C2ca—33 to 60 inches; pink (7.5YR 7/4) clay loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable; many fine segregations of lime; strong effervescence; mildly alkaline.

Depth to bedrock ranges from 40 to 60 inches or more. Rock fragments range up to 25 percent, by volume in the solum and up to 60 percent in the C horizon. Depth to free carbonates ranges from 13 to 36 inches. Some pedons have a thin A1 horizon 3 inches or less thick (fig. 9). The A2 horizon is loam or very fine sandy loam in places and ranges from light gray to pink. It is 3 to 12 inches thick. Some pedons have a B&A horizon that ranges up to 6 inches thick. The B2t horizon is clay, clay loam, or silty clay loam in places and ranges from brown to reddish yellow in hue of 7.5YR or 5YR. It is 10 to 24 inches thick. Some pedons lack a B3 horizon, but where present it is silty clay loam, clay loam, or channery clay loam and ranges from brown to reddish yellow. The C horizon commonly is clay loam but in places is loam, silt loam, silty clay loam, or channery clay loam. Segregations of lime in the C horizon range from none to many.

Figure 9.—**This profile of Citadel silt loam in an area of Citadel association, hilly, has a thin A1 horizon about 3 inches thick.**

Citadel soils are near Maitland, Paunsaugunt, and Vanocker soils and are similar to Lakoa soils. They have more clay in the B horizon than Lakoa, Maitland, and Vanocker soils. They are deeper over bedrock than Paunsaugunt soils.

CTE—Citadel association, hilly. These soils are in the Black Hills in irregularly shaped areas that range from 40 to several hundred acres in size. They are mostly

hilly, but some are moderately sloping and some are steep. Citadel soils make up about 70 percent of the areas. The surface layer commonly is silt loam, but in places it is loam or very fine sandy loam. In places the subsoil is more stony or contains less clay than is described as typical.

Maitland and Vanocker soils are the other principal soils in the unit and occupy as much as 30 percent of some areas. Maitland soils are on foot slopes, in swales, and in or near meadow openings on wide ridges. Vanocker soils are on the sides of stony and rocky ridges. These soils are in areas that range from 3 to 40 acres in size.

Included with these soils in mapping are small areas of Marshdale, Paunsaugunt, and Winetti soils. The somewhat poorly drained to poorly drained Marshdale soils are in the lower part of swales and on narrow bottom land. Paunsaugunt soils are shallow over hard limestone. Winetti soils are on bottom land and alluvial fans. Also included in some places are small areas of Rock outcrop.

Runoff is medium to rapid, and the hazard of erosion is severe if the plant cover is removed.

These soils are mostly in ponderosa pine forest and are used for timber production, wildlife, recreation, and limited grazing. Some areas of the Maitland soil are wooded, and some are in native grass. Capability unit VIe-13, woodland group 5r2, not placed in a range site or windbreak group.

Delphill series

The Delphill series consists of moderately deep, well drained, moderately sloping to strongly sloping, loamy soils on uplands. These soils formed in material that weathered from soft siltstone. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is brown loam about 3 inches thick. The underlying material, to a depth of 32 inches, is very pale brown, calcareous loam. Below that, it is light gray, calcareous, soft siltstone.

Delphill soils are low in fertility and in organic-matter content. The available water capacity is low, and permeability is moderate.

Most areas are in native grass and are used for range.

Representative profile of Delphill loam, 6 to 15 percent slopes, in native grass, 800 feet east and 250 feet north of the southwestern corner of sec. 17, T. 7 N., R. 12 E.

A1—0 to 3 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable; mildly alkaline; clear smooth boundary.

C1—3 to 15 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; very weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—15 to 25 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C3—25 to 32 inches; very pale brown (10YR 7/4) loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, friable; strong effervescence; mildly alkaline; gradual wavy boundary.

Cr—32 to 60 inches; light gray (10YR 7/1) soft siltstone that crushes easily to loam, gray (10YR 6/1) moist; strong effervescence; moderately alkaline.

Depth to soft bedrock ranges from 20 to 40 inches. Carbonates are within 8 inches of the surface. The A horizon is loam or light clay loam and ranges from grayish brown to pale brown. It is 2 to 5 inches thick. Some pedons have an AC horizon that is up to 6 inches thick. The C horizon above bedrock ranges from light brownish gray to pale yellow in hue of 10YR or 2.5Y and is loam or clay loam. Some pedons have few or common, fine segregations of lime. The bedrock is silty or sandy shale, siltstone, or weakly-cemented fine grained sandstone.

Delphill soils are near Assinniboine and Cabbart soils. They are shallower over bedrock than Assinniboine soils and are deeper over bedrock than Cabbart soils.

DaD—Delphill loam, 6 to 15 percent slopes. This moderately sloping to strongly sloping soil is on upland ridges and on the sides of entrenched drainageways in irregularly shaped areas that range from 15 to 200 acres in size. In places this soil contains slightly more sand than the soil described as representative of the series. Small stony areas are in some places and are shown on the soil map by a spot symbol.

Included with this soil in mapping are small areas of Assinniboine and Cabbart soils. Assinniboine soils are on foot slopes. Cabbart soils are on the top and upper sides of some ridges and on sharp shoulders of entrenched drainageways. Also included in places are small areas of Rock outcrop, which are shown on the soil map by a spot symbol.

Runoff is medium, and the hazard of erosion is severe. This soil generally is not suited to cultivation because of low fertility, droughtiness, and high susceptibility to erosion and soil blowing.

Most areas are in native grass and are used for range. Thin Upland range site, capability unit VIe–3, windbreak group 10.

Enning series

The Enning series consists of shallow, well drained to somewhat excessively drained, moderately sloping to steep, calcareous, silty soils on uplands. These soils formed in material that weathered from chalky shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is light brownish gray, calcareous silty clay loam about 5 inches thick. The underlying material, to a depth of 14 inches, is white and pale yellow, calcareous silty clay loam. Below that, it is pale yellow, calcareous, chalky shale.

Enning soils are low in fertility and in organic-matter content. The available water capacity is very low, and permeability is moderate.

Most areas are in native grass and are used for range.

Representative profile of Enning silty clay loam in an area of Enning-Rock outcrop complex, 20 to 40 percent slopes, in native grass, 1,700 feet south and 650 feet east of the northwestern corner of sec. 11, T. 4 N., R. 7 E.

A1—0 to 5 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, very friable; many fine and medium roots; strong effervescence (32 percent calcium carbonate); neutral; clear wavy boundary.

C—5 to 14 inches; white (2.5Y 8/2) and pale yellow (2.5Y 8/4) silty clay loam, light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) moist; weak fine and medium granular structure; slightly hard, friable; common fine roots; violent effervescence (72 percent calcium carbonate); mildly alkaline; clear wavy boundary.

Cr—14 to 40 inches; pale yellow (2.5Y 8/4) chalky shale, light yellowish brown (2.5Y 6/4) moist; bedding planes evident; common yellow (10YR 7/6) stains along cracks and bedding planes; easily dug when moist; few fine roots in upper 10 inches; violent effervescence (80 percent calcium carbonate); mildly alkaline.

Depth to soft chalky shale ranges from 10 to 20 inches. Free carbonates commonly are at the surface, but in places the upper 1 or 2 inches is noncalcareous. The horizons above the shale commonly are silt loam or silty clay loam, but some are loam or clay loam. Fragments of soft shale range up to 35 percent, by volume of some pedons. The A horizon ranges from grayish brown to pale yellow in hue of 10YR or 2.5Y. It is 3 to 5 inches thick and is neutral or mildly alkaline. The C horizon above the shale ranges from light brownish gray to pale yellow in hue of 10YR or 2.5Y. It has a calcium carbonate equivalent of 50 to 75 percent and is mildly alkaline or moderately alkaline. The Cr horizon ranges from light gray to pale yellow in hue of 10YR or 2.5Y. In places the chalky shale is interbedded with thin layers of brittle limestone. The shale has a calcium carbonate equivalent of 65 to 85 percent.

Enning soils are mapped with Manvel soils and are similar to Canyon, Midway, and Shingle soils. They contain more carbonates than Canyon, Midway, and Shingle soils. They have less sand than Canyon and Shingle soils and less clay than Midway soils. Enning soils are shallower to bedrock than Manvel soils.

EaD—Enning-Manvel complex, 6 to 20 percent slopes. This mapping unit consists of sloping to moderately steep soils on upland ridges. Areas are irregularly shaped and range from 15 to 75 acres in size. The unit is about 50 percent Enning soils, 40 percent Manvel soils, and 20 percent other soils. Enning soils are on the tops and upper side slopes of ridges and on the sides of entrenched drainageways. Below them are Manvel soils in the mid and lower parts of the landscape.

Included with this complex in mapping are small areas of Blackpipe, Midway, and Savo soils. Blackpipe soils are on foot slopes. Midway soils are in places where the underlying shale is clayey; Savo soils are on foot slopes and in swales. Also included in some places are small areas of Rock outcrop, which are shown on the soil map by a spot symbol.

Runoff is medium to rapid. The hazard of erosion is severe to very severe if the plant cover is removed. These soils generally are not suited to cultivation because of low fertility, shallowness, and high susceptibility to erosion.

Most areas are in native grass and are used for range. Capability unit VIe-11, windbreak group 10; Enning soil is in Shallow range site, Manvel soil is in Thin Upland range site.

EbE—Enning-Rock outcrop complex, 20 to 40 percent slopes. This mapping unit is on escarpments, ridges, and the sides of deeply entrenched drainageways. Areas are irregularly shaped and range from 15 to 150 acres in size. The unit is about 65 percent Enning soils, 25 percent Rock outcrop, and 10 percent other soils. The Enning soil has the profile described as representative of the series. In places channery fragments of brittle limestone are scattered on the surface. The Rock outcrop is in the higher part of the landscape and consists of eroding exposures of soft, chalky shale.

Included with this complex in mapping are small areas of Manvel and Midway soils. Manvel soils are on wide ridgetops and on foot slopes. Midway soils are intermingled with Enning soils.

Runoff is rapid, and the hazard of erosion is very severe. Controlling erosion is the main management concern.

All areas remain in native vegetation and are used for range. The Rock outcrop part of this complex has little or no vegetation. Enning soil is in Shallow range site, capability unit VIIe-4, windbreak group 10; Rock outcrop is in capability unit VIIIs-1, not placed in range site or windbreak group.

Glenberg series

The Glenberg series consists of deep, well drained, nearly level soils on bottom land. These soils formed in alluvium. The native vegetation consisted mainly of a mixture of tall, mid, and short grasses. In places a few native trees and shrubs are scattered along stream channels.

In a representative profile the surface layer is grayish brown fine sandy loam about 6 inches thick. Next is a transitional layer of brown fine sandy loam 5 inches thick. The underlying material, to a depth of 26 inches, is brown, calcareous fine sandy loam. Below this is pale brown, calcareous, stratified fine sandy loam, loamy fine sand, and very fine sandy loam.

Glenberg soils are medium to low in fertility and moderately low in organic-matter content. The available water capacity is low or moderate, and permeability is moderately rapid.

Most areas remain in native grass and are used for range and hay. A few small areas are used for crops.

Representative profile of Glenberg fine sandy loam in an area of Glenberg soils, in native grass, 200 feet south and 50 feet east of the northwestern corner of sec. 11, T. 6 N., R. 8 E.

A1—0 to 6 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular

structure; soft, very friable; neutral; clear smooth boundary.

AC—6 to 11 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, very friable; slight effervescence; mildly alkaline; gradual wavy boundary.

C1—11 to 20 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; massive; soft, very friable; slight effervescence; moderately alkaline; clear smooth boundary.

C2—20 to 26 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; massive; soft, very friable; few yellowish brown concretions; slight effervescence; mildly alkaline; clear smooth boundary.

C3—26 to 60 inches; pale brown (10YR 6/3) stratified fine sandy loam, loamy fine sand and very fine sandy loam, brown (10YR 4/3) moist; massive; soft, very friable; slight effervescence; mildly alkaline.

Free carbonates are at or within 7 inches of the surface. Texture of the profile, to a depth of 40 inches, averages fine sandy loam, but thin lenses of loamy fine sand, loamy very fine sand, very fine sandy loam, loam or clay loam are in some pedons. The A horizon ranges from grayish brown to very pale brown and is 4 to 7 inches thick. The AC horizon ranges from grayish brown to very pale brown in hue of 10YR or 2.5Y, and is 3 to 7 inches thick. The C horizon ranges from grayish brown to very pale yellow in hue of 10YR or 2.5Y.

Glenberg soils are near Altvan, Bankard, Lohmiller, and St. Onge soils. They are more sandy in the upper part of the profile than Altvan soils and differ from those soils by not having a B horizon. Glenberg soils have less sand than Bankard soils and more sand than Lohmiller and St. Onge soils.

Ga—Glenberg soils. These are nearly level soils on bottom land along some of the larger streams. Areas are irregularly shaped and range from 15 to 200 acres in size. The surface layer is commonly fine sandy loam, very fine sandy loam, or loam, but in a few places it is clay loam. Slope is 0 to 2 percent.

Included with these soils in mapping are small areas of Bankard and Lohmiller soils. Bankard soils are intermingled with Glenberg soils in an irregular pattern. Lohmiller soils are in swales that serve as channels for floodwater.

Runoff is slow. This soil is easy to work, but is susceptible to soil blowing if it is farmed. In some years it is subject to stream flooding, but flood damage generally is minor. Controlling soil blowing is the main management concern.

Some areas are cultivated, and a few small tracts are irrigated. Other areas remain in native grass and are used for range and hay. Scattered clumps of trees provide cover for wildlife and winter protection for livestock. Overflow range site, capability unit IVe-6, windbreak group 1.

Grummit series

The Grummit series consists of shallow, well drained, moderately sloping to steep, acid, clayey soils on uplands. These soils formed in material that weathered from the underlying acid shale. The native vegetation consisted mainly of mid and short grasses. A few, short, limby ponderosa pine are in some areas.

In a representative profile the surface layer is gray clay about 4 inches thick. The underlying material, to a depth of 15 inches, is shaly clay that is grayish brown in the upper part and light brownish gray in the lower part. Below that, it is gray, acid shale.

Grummit soils are low in fertility and in organic-matter content. The available water capacity is very low, and permeability is moderate.

All areas are in native grass and are used for range.

Representative profile of Grummit clay, 6 to 15 percent slopes, in native grass, 2,500 feet north and 1,300 feet east of the southwestern corner of sec. 35. T. 6 N., R. 5 E.

A1—0 to 4 inches; gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate fine granular structure; soft, very friable; common fine bits and particles of shale; strongly acid; clear wavy boundary.

C1—4 to 9 inches; grayish brown (10YR 5/2) shaly clay, dark gray (10YR 4/2) moist; very weak coarse subangular blocky structure; hard, friable; many fine fragments of shale; very strongly acid; gradual smooth boundary.

C2—9 to 15 inches; light brownish gray (10YR 6/2) shaly clay, grayish brown (10YR 5/2) moist; common distinct yellowish brown (10YR 5/4) mottles; massive; hard, friable; extremely acid; gradual wavy boundary.

Cr—15 to 60 inches; gray (10YR 6/1) brittle platy shale, dark gray (10YR 4.1) moist; common medium yellowish brown (10 YR 5/4) stains in shale seams; strongly acid.

Depth to shale ranges from 6 to 20 inches. Clay content of the horizons above the shale ranges from 55 to 65 percent. The A1 horizon ranges from gray to light brownish gray in hue of 10YR or 2.5Y and is 2 to 4 inches thick. The C horizon ranges from gray to light olive gray in hue of 10YR, 2.5Y, or 5Y. Weathered shale fragments make up 20 to 50 percent of the C1 and C2 horizons.

Grummit soils are near Kyle and Pierre soils and are similar to Lismas and Samsil soils. They are shallower over shale than Kyle and Pierre soils and are more acid than Lismas and Samsil soils.

GbD—Grummit clay, 6 to 15 percent slopes. This soil is on uplands in irregularly shaped areas that range from 15 to 150 acres in size. It is mostly moderately sloping to strongly sloping, but in some areas it is gently sloping. Moderately steep areas are around the heads of drainageways. This soil has the profile described as representative of the series, but in places the depth to soft shale is slightly more than 20 inches.

Included with this soil in mapping are small areas of Hisle and Pierre soils. Hisle soils are in sags and

swales. Pierre soils commonly are on smooth ridgetops. Small areas of Rock outcrop along gullied drainageways and around the heads of drainageways are also included in most places.

Runoff is medium. This soil is subject to erosion and soil blowing if the plant cover is removed. It generally is not suited to cultivation because of shallowness, erodibility, and low fertility.

All areas remain in native grass and are used for range. In some areas short, limby ponderosa pine grow singly or in clumps. Shallow range site, capability unit VIe-12, windbreak group 10.

GcE—Grummit-Rock outcrop complex, 15 to 40 percent slopes. This mapping unit is on uplands in irregularly shaped areas that range from 15 to 100 acres in size. It is about 20 to 40 percent Grummit soils and 60 to 80 percent Rock outcrop (fig. 10). The Rock outcrop part consists of eroding exposures of soft, acid shale. The Grummit soil is scattered throughout the area in places that have a grass cover. In places it is more than 20 inches deep to soft shale.

Runoff is medium on the Grummit soil and rapid on the Rock outcrop. Active gullies are in the areas, and during dry periods the weathered, fissile shale blows as if it were sand. Controlling erosion and soil blowing is the main management concern.

All areas remain in native vegetation and are used for limited grazing. The Rock outcrop part of this complex is barren except for a few scattered annuals, forbs, bur oak, and stunted ponderosa pine. Grummit soil is in Shallow range site, capability unit VIIe-5, windbreak group 10; Rock outcrop is in capability unit VIIIs-1 and not placed in a range site or windbreak group.

Hisle series

The Hisle series consists of moderately deep, well drained to moderately well drained, nearly level to gently sloping soils that have a claypan subsoil. These soils are on uplands and formed in material that weathered from soft shale. The native vegetation consisted mainly of short grasses.

In a representative profile the surface layer is light brownish gray loam about 2 inches thick. The subsoil is clay about 18 inches thick. It is grayish brown in the upper part and is light brownish gray with spots and streaks of lime and salts in the lower part. The underlying material, to a depth of 34 inches, is light brownish gray shaly clay. Below that, it is light olive gray soft shale.

Hisle soils are low in fertility and in organic-matter content. The available water capacity is very low or low, and permeability is very slow.

Most areas are in native grass and are used for range.

Representative profile of Hisle clay in an area of Hisle-Slickspots complex, 0 to 6 percent slopes, in native grass, 2,600 feet north and 200 feet west of the southeastern corner, sec. 3, T. 6 N., R. 6 E.

A2—0 to 2 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; very weak thin platy structure; soft, very friable; when dry, surface has a ⅛-inch thick crust; mildly alkaline; clear wavy boundary.

B21t—2 to 5 inches; grayish brown (2.5Y 5/2) clay, olive brown (2.5Y 4/3) moist; moderate medium columnar structure part-

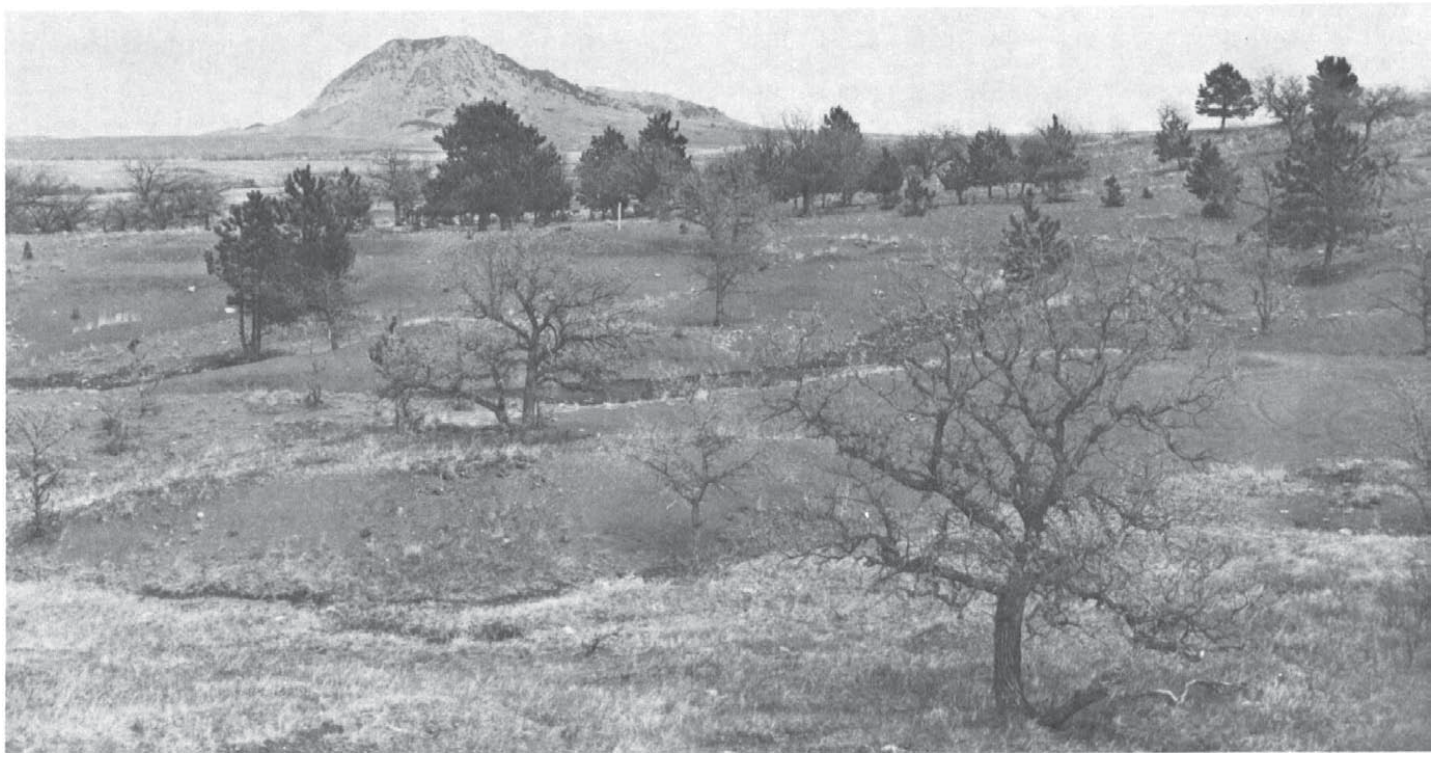


Figure 10.—This area of Grummit-Rock outcrop complex, 15 to 40 percent slopes, consists mainly of barren areas of acid shale bedrock. Grummit soils are in the scattered grassy areas.

ing to strong medium blocky; very hard, very firm, sticky and plastic; tops and upper sides of columns coated with A2 material; thin shiny coatings on faces of peds; mildly alkaline; clear wavy boundary.

B22t—5 to 9 inches; grayish brown (2.5Y 5/2) clay, olive brown (2.5Y 4/3) moist; moderate medium prismatic structure parting to strong medium and coarse blocky; very hard, very firm, sticky and plastic; thin shiny coatings on faces of peds; gradual wavy boundary.

B23tsa—9 to 14 inches; light brownish gray (2.5 Y 6/2) clay, grayish brown (2.5Y 5/2) moist; moderate medium and coarse prismatic structure parting to moderate coarse blocky; very hard, very firm, sticky and plastic; common nests of salts; common fine segregations of lime; slight effervescence; moderately alkaline; gradual wavy boundary.

B3sa—14 to 20 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; very hard, firm, sticky and plastic; common fine fragments of soft shale; common fine threads and seams of lime and salts; slight effervescence; mildly alkaline; clear smooth boundary.

Csa—20 to 34 inches; light brownish gray (2.5Y 6/2) shaly clay, dark grayish brown (2.5Y 4/2) moist; common light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4) mottles, moist; massive; hard, firm; fragments of weathered soft shale about 60 percent of volume; common nests of salts; mildly alkaline; clear smooth boundary.

Cr—34 to 60 inches; light olive gray (5Y 6/2) bedded soft shale, olive gray (5Y 4/2) moist; light yellowish brown (2.5Y 6/4) and light olive brown (2.5Y 4/4) stains in shale seams; mildly alkaline.

Depth to bedded shale ranges from 20 to 40 inches. In places a few pebbles and cobbles are on the surface and throughout the solum. Some pedons have a thin A1 horizon of 2 inches or less. The A2 horizon ranges from gray to white in hue of 10YR or 2.5Y. It is loam or silt loam and is 3 inches or less thick. The B2t horizon ranges from gray to pale yellow in hue of 10YR, 2.5Y, or 5Y. It is 4 to 12 inches thick and is mildly alkaline to strongly alkaline. The B3 and C horizons range from grayish brown to pale yellow in hue of 2.5Y or 5Y. The B3 horizon is 3 to 8 inches thick. The Cr horizon is slightly acid to moderately alkaline.

Hisle soils are near Kyle, Pierre, Swanboy, and Winler soils and are similar to Arvada soils. They are shallower to shale and contain more clay in the B and C horizons that Arvada soils. Hisle soils contain more sodium than Kyle, Pierre, Swanboy, and Winler soils and are shallower to shale than Kyle and Swanboy soils.

HbB—Hisle-Slickspots complex, 0 to 6 percent slopes. These soils are on uplands along drainageways and on flats and gentle rises. They are about 70 percent Hisle soils, 20 percent Slickspots, and 10 percent other soils. Surfaces are uneven. Small mounds and ridges rise 4 to 10 inches above intervening low areas that range from 3 to 100 feet in diameter. Hisle soils are on the mounds or ridges, and Slickspots are in the low areas. Slickspots have a puddled or "slicked-over" surface and commonly have streaks and spots of visible salts within a few inches of the surface.

Included with this complex in mapping are small areas of Kyle, Pierre, Swanboy, and Winler soils. Kyle and Swanboy soils are on foot slopes of slight rises above some of the flats. Pierre and Winler soils are on slight rises. Also included in some places are small seep areas that are shown on the soil map by the symbol for wet spot.

Runoff is slow to medium and commonly ponds on the Slickspots. The soils in this complex absorb water very slowly. They are not suited to cultivation because they have very poor tilth, very slow permeability, low fertility, high content of sodium and other salts, and very low or low available water capacity.

Most areas are in native grass and are used for range. The Slickspots part of this complex has little or no vegetation. Hisle soil is in Thin Claypan range site, capability unit VIs-3, windbreak group 10; Slickspots is in capability unit VIIIs-3 and not placed in a range site or windbreak group.

Hoven series

The Hoven series consists of deep, poorly drained, level soils that have a claypan subsoil. These soils are in closed depressions on uplands and high terraces. They formed in alluvium that washed from adjacent soils. The native vegetation consisted mainly of mid and short grasses and sedges.

In a representative profile the surface layer is gray silt loam about 5 inches thick. The subsoil is about 11 inches thick. It is very firm clay that is grayish brown in the upper part and gray in the lower part. The underlying material is gray, calcareous clay.

Hoven soils are medium to low in fertility and are moderate in organic-matter content. The available water capacity is moderate or high, and permeability is very slow.

Most areas remain in native grass and are used for range and hay. A few of the smaller depressions are cultivated.

Representative profile of Hoven silt loam, in native grass, 1,200 feet north and 600 feet east of the southwestern corner of sec. 30, T. 4 N., R. 14 E.

A2—0 to 5 inches; gray (10YR 6/1) silt loam, dark grayish brown (10YR 4/2) moist; common fine distinct rust-colored mottles; weak thin platy structure parting to weak fine granular; soft, friable; medium acid; clear wavy boundary.

B21t—5 to 8 inches; grayish brown (10YR 5/2) clay, very dark gray (10YR 3/1) moist; few fine faint rust-colored mottles; moderate coarse columnar structure parting to moderate coarse blocky; extremely

hard, very firm, sticky and very plastic; slightly acid; clear wavy boundary.

B22t—8 to 16 inches; gray (10YR 5/1) clay, very dark gray (10YR 3/1) moist; moderate very coarse prismatic structure parting to moderate coarse blocky; extremely hard, very firm, sticky and very plastic; slightly acid; clear wavy boundary.

C1—16 to 44 inches; gray (2.5Y 6/1) clay, dark gray (2.5Y 4/1) moist; massive; extremely hard, very firm, sticky and very plastic; slight effervescence; moderately alkaline; clear wavy boundary.

C2cs—44 to 60 inches; gray (2.5Y 6/1) clay, dark gray (2.5Y 4/1) moist; massive; hard, firm, sticky and plastic; common fine segregations of gypsum and other salts; slight effervescence; moderately alkaline.

Some pedons have a thin, dark colored A1 horizon 2 inches or less thick. The A2 horizon is gray or light gray. It commonly is silt loam but is silty clay loam in places. It is 2 to 6 inches thick and is medium acid to neutral. The B2t horizon ranges from dark gray to grayish brown in hue of 10YR or 2.5Y. It is silty clay loam, silty clay, or clay and has a clay content ranging from 35 to 55 percent. The B2t horizon is 8 to 18 inches thick and is slightly acid to moderately alkaline. Some pedons have a B3 horizon. The B3 and C1 horizons range from dark gray to light brownish gray in hue of 10YR or 2.5Y and are clay or clay loam. The C2cs horizon contains few or common segregations of gypsum and other salts. It is moderately alkaline or strongly alkaline.

Hoven soils are near Arvada, Macken, Mosher, and Onita soils. They are more poorly drained than Arvada, Mosher, and Onita soils. In addition, Hoven soils have a thinner A horizon than Mosher soils and contain more sodium than Onita and Macken soils.

Ho—Hoven silt loam. This is a nearly level soil in closed depressions on uplands and high terraces. Areas are circular to oval-shaped and range from 5 to 30 acres in size. Slope is 0 to 1 percent. Surfaces commonly are uneven. Small mounds rise a few inches above intervening low areas. In a few places the surface layer is slightly thicker than is defined as the range for the Hoven series.

Included with this soil in mapping are small areas of Arvada soils on very slight rises on the edges of the depressions.

Runoff is ponded, and water remains on the surface until it evaporates. The claypan subsoil absorbs water slowly and releases it slowly to plants. Development of plant roots is limited, and the soil is droughty late in summer. This soil generally is not suited to crops because of wetness, poor tilth, sodium content, and droughtiness.

Most areas remain in native grass and are used for range and hay. Closed Depression range site, capability unit VIs-3, windbreak group 10.

Keith series

The Keith series consists of deep, well drained, nearly level to gently sloping, silty soils on uplands and terraces. These soils formed in loess. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is about 27 inches thick. It is silty clay loam that is dark grayish brown in the upper part, brown in the middle part, and light brownish gray in the lower part. The lower part is calcareous and has spots and streaks of soft lime that extend into the underlying material. The underlying material is light brownish gray, calcareous silty clay loam.

Keith soils are medium in fertility and moderate in organic-matter content. The available water capacity is high, and permeability is moderate.

Many areas are cultivated. Some areas are in native grass and are used for range and hay.

Representative profile of Keith silt loam, 0 to 2 percent slopes, in crops 2,350 feet east and 2,350 feet south of the northwestern corner of sec. 16, T. 6 N., R. 7 E.

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

B21t—5 to 9 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) crushing to dark brown (10YR 3/3) moist; weak medium prismatic structure parting to moderate medium and fine subangular blocky; slightly hard, friable; mildly alkaline; clear smooth boundary.

B22t—9 to 17 inches; brown (10YR 5/3) silty clay loam, dark grayish brown (10YR 4/2) moist; weak medium and coarse prismatic structure parting to moderate medium and fine subangular blocky; hard, firm, mildly alkaline; clear smooth boundary.

B3ca—17 to 32 inches; light brownish gray (10 YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate medium subangular blocky structure; hard, firm; common medium segregations of lime; strong effervescence; moderately alkaline; clear smooth boundary.

Cca—32 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 15 to 26 inches. The A horizon is dark grayish brown or grayish brown. It commonly is silt loam but is loam in places. It is 4 to 8 inches thick and is slightly acid to mildly alkaline. The B2t horizon ranges from dark grayish brown to light brown in hue of 10YR or 7.5YR. The lower part is calcareous in some pedons. It is 11 to 18 inches thick and it is neutral or mildly alkaline. The B3ca horizon ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. Segregations of lime are few to many and extend into the C horizon. The Cca horizon is silt loam. In places, it is stratified

with loam, clay loam, or clay at depths of more than 40 inches.

Keith soils are near Altvan, Bridget, Satanta, and Tilford soils. They have more silt in the B horizon than Altvan and Satanta soils. They have more silt and clay and less very fine sand than Bridget soils. Keith soils have colors that are yellower in hue than Tilford soils.

KaA—Keith silt loam, 0 to 2 percent slopes. This nearly level soil is on terraces and uplands. The areas range from 10 to 150 acres in size. This Keith soil has the profile described as representative of the series except the surface layer is loam in a few places.

Included with this soil in mapping are small areas of Hoven and Onita soils. Hoven soils are in small closed depressions, some of which are shown on the soil map by the symbol for wet spot. Onita soils are in shallow swales.

Runoff is slow, and the hazard of erosion is slight. This soil has only slight limitations to use for crops, except for periodic moisture shortages caused by the climate and a moderate risk of soil blowing when the soil is unprotected. Conserving moisture is the main management concern.

Most areas are cultivated. This soil is well suited to all crops commonly grown in the survey area. Silty range site, capability unit IIIc-1, windbreak group 3.

KaB—Keith silt loam, 2 to 6 percent slopes. This gently sloping soil is on terraces and uplands in areas that range from 10 to 100 acres in size. Slopes commonly are long and smooth. This soil has a thinner subsoil and the depth to lime is less than in the soil described as representative of the series. Also, in a few areas the soil is moderately eroded and the surface layer is thinner.

Included with this soil in mapping are small areas of Onita soils in swales.

Runoff is medium, and there are moderate hazards of erosion and soil blowing if the soil is unprotected. Controlling erosion and soil blowing is the main management concern.

Most areas are cultivated. This soil is well suited to all crops commonly grown in the survey area. Some areas remain in native grass and are used for range and hay. Silty range site, capability unit IIIe-1, windbreak group 3.

Kyle series

The Kyle series consists of deep, well drained, nearly level to gently sloping, clayey soils on uplands and terraces. These soils formed in clayey material. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown clay about 3 inches thick. The subsoil is grayish brown clay about 27 inches thick. It is calcareous below a depth of 5 inches. The underlying material is grayish brown, calcareous clay.

Kyle soils are medium in fertility and moderately low in organic-matter content. The available water capacity is low or moderate, and permeability is very slow.

Many areas are in native grass and are used for range and hay. Some areas are cultivated.

Representative profile of Kyle clay, 2 to 6 percent slopes, in cropland, 1,400 feet west and 150 feet north of the southeastern corner of sec. 34, T. 5 N., R. 8 E.

Ap—0 to 3 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; slightly hard, firm, sticky and plastic; mildly alkaline; clear smooth boundary.

B21—3 to 5 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to weak fine subangular blocky; very hard, firm, sticky and plastic; mildly alkaline; gradual wavy boundary.

B22—5 to 17 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate medium and coarse blocky; extremely hard, very firm, sticky and plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

B3—17 to 30 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak very coarse prismatic structure parting to weak medium and coarse blocky; extremely hard; very firm, sticky and plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

Ccs—30 to 60 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; few faint pale yellow mottles; massive; very hard, very firm, sticky and plastic; common fine nests of gypsum crystals; strong effervescence; mildly alkaline.

Depth to free carbonates commonly ranges from 3 to 6 inches, but some pedons are calcareous at the surface. Cracks that are ½ to 1½ inches wide and several feet long extend downward through the solum. The A horizon is 2 to 6 inches thick. It ranges from gray to olive in hue of 2.5Y or 5Y and is clay or silty clay. The B horizon is 8 to 28 inches thick and ranges from gray to pale olive in hue of 2.5Y or 5Y. Some pedons lack a B3 horizon. The C horizon ranges from gray to pale olive in hue of 2.5Y or 5Y. It is mildly alkaline or moderately alkaline. It contains few to many segregations of gypsum and other salts and few or common, fine segregations of lime. Bedded soft shale is at a depth of 40 to 60 inches in places.

Kyle soils are near Hisle, Pierre, Swanboy, and Winler soils. They contain less sodium than Hisle soils and are deeper over shale than Pierre and Winler soils. Kyle soils have a lower salt content above a depth of 15 inches than Swanboy soils.

KbA—Kyle clay, 0 to 2 percent slopes. This nearly level soil is on uplands and terraces in irregularly shaped areas that range from 10 to 150 acres in size. In places near Grummit soils in the western part of the survey area this soil is deeper to lime than is defined as the range of the series.

Included with this soil in mapping are small areas of Hisle, Lohmiller, Macken, Stetter, and Swanboy soils. Hisle soils are in sags, mainly along shallow drainageways. Lohmiller and Stetter soils are on narrow strips

of bottom land along drainageways that cross areas of this soil on valley terraces. Macken soils are in small closed depressions, which are shown on the soil map by the symbol for wet spot. Swanboy soils are on foot slopes and fans between valley terraces and uplands.

Runoff is slow, and the hazard of erosion is slight. This soil absorbs water slowly and releases it slowly to plants. It compacts if farmed when wet and is difficult to work when dry. Excessive tillage pulverizes the soil so that it blows easily. Conserving moisture, improving water absorption, and maintaining tilth are management concerns.

Many areas remain in native grass and are used for range and hay, but some are cultivated. This soil is moderately well suited to most crops in the survey area. Clayey range site, capability unit IVs-3, windbreak group 4.

KbB—Kyle clay, 2 to 6 percent slopes. This gently sloping soil is on uplands and terraces in irregularly shaped areas that range from 10 to 100 acres in size. This soil has the profile described as representative of the series, except it is deeper to lime in places near the Grummit soil in the western part of the survey area. Also, small stony areas are in some places and are shown on the soil map by a spot symbol.

Included with this soil in mapping are small areas of Hisle, Macken, Nunn, and Pierre soils. Hisle soils are on foot slopes and fans along drainageways. Macken soils are in small closed depressions, which are shown on the soil map by the symbol for wet spot. Nunn and Pierre soils are on the tops and upper side slopes of some ridges.

Runoff is medium, and there is a severe hazard of erosion and soil blowing if this soil is farmed. This soil absorbs water slowly and releases it slowly to plants. It compacts if farmed when wet and is difficult to work when dry. Controlling erosion and soil blowing is the main management concern.

Many areas remain in native grass and are used for range and hay, but some are cultivated. This soil is better suited to close-sown crops than to row crops. Clayey range site, capability unit IVe-3, windbreak group 4.

KcB—Kyle soils, 2 to 6 percent slopes, mounded. These gently sloping soils are on uplands in irregularly shaped areas that range from 30 to 90 acres in size. Slopes generally are long, but surfaces are uneven because of low ridges that rise 4 to 10 inches above the intervening troughs. These low ridges, typically 6 to 10 feet apart and 2 to 4 feet wide, are evenly spaced and parallel to each other. They generally extend down the slopes, bending slightly across them in the lower part of the landscape. The soil on the low ridges has a clay surface layer and a profile similar to the one described as representative of the series. The soil in the troughs has a clay loam surface layer that is darker colored and is deeper to lime than is typical for the Kyle series.

Included with these soils in mapping are small areas of Hisle, Nunn, and Pierre soils. Hisle soils are on foot slopes and in swales. Nunn and Pierre soils are in the higher part of the landscape.

Runoff is medium, and there is a severe hazard of erosion and soil blowing if these soils are farmed. These soils absorb water slowly and release it slowly to plants. They compact if farmed when wet and are difficult to work when dry. Controlling erosion and soil blowing is the main management concern.

Most areas remain in native grass and are used for range, but a few are cultivated. Clayey range site, capability unit IVe-3, windbreak group 4.

Lakoa series

The Lakoa series consists of deep, well drained, hilly, loamy soils on uplands. These soils formed in loamy material that weathered from sandstone and shale. The native vegetation consisted mainly of ponderosa pine.

In a representative profile the surface is covered with about 1 inch of forest litter. The surface layer is dark gray loam about 2 inches thick. The subsurface layer is light brownish gray very fine sandy loam about 8 inches thick. The next layer is pale brown heavy loam, about 3 inches thick, that is coated by light brownish gray very fine sand. The subsoil, about 20 inches thick, is light yellowish brown clay loam. The underlying material is very pale brown, calcareous loam.

Lakoa soils are low in fertility and in organic-matter content. The available water capacity is high, and permeability is moderate.

Most areas are in forest and are used for woodland grazing, timber production, wildlife, and recreation.

Representative profile of Lakoa loam in an area of Lakoa-Maitland association, hilly, in ponderosa pine forest with an understory of native grass, 1,750 feet north and 850 feet east of the southwest corner of sec. 11, T. 5 N., R. 5 E.

O—1 inch to 0; forest litter, some partly decomposed; abrupt boundary.

A1—0 to 2 inches; dark gray (10YR 4/2) loam, very dark gray (10YR 3/1) moist; weak fine and medium granular structure; slightly hard, friable; few worm casts; slightly acid; clear wavy boundary.

A2—2 to 10 inches; light brownish gray (10YR 6/2) very fine sandy loam, dark grayish brown (10YR 4/2) moist; moderate thin platy structure parting to weak fine granular; slightly hard, very friable; slightly acid; clear wavy boundary.

B&A—10 to 13 inches; pale brown (10YR 6/3) heavy loam, dark brown (10YR 4/3) moist (B2t); many patches and coats of light brownish gray (10YR 6/2) very fine sand, dark brown (10YR 4/3) moist (A2); weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; neutral; gradual wavy boundary.

B21t—13 to 24 inches; light yellowish brown (10 YR 6/4) clay loam, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure parting to moderate medium blocky and subangular blocky; hard, firm, slightly sticky and sticky and slightly plastic; shiny films on faces of peds; neutral; gradual wavy boundary.

B22t—24 to 33 inches; light yellowish brown (10 YR 6/4) light clay loam, yellowish brown (10YR 5/4) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly sticky and slightly plastic; shiny films on faces of peds; few sandstone fragments; neutral; gradual wavy boundary.

C—33 to 60 inches; very pale brown (10YR 7/3) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; few sandstone fragments; common fine segregations of lime; strong effervescence; mildly alkaline.

The solum is 14 to 41 inches thick. Depth to bedrock ranges from 40 to 60 inches or more. Depth to free carbonates ranges from 30 to 60 inches or more. Coarse fragments make up 5 to 20 percent of the B and C horizons. The A horizon is medium acid to neutral. The A1 horizon, where present, ranges from dark grayish brown to brown and is up to 5 inches thick. The A2 horizon ranges from light brownish gray to very pale brown or pink in hue of 10YR or 7.5YR. It is very fine sandy loam, loam, or silt loam and is 2 to 8 inches thick. The B2t horizon ranges from brown to reddish yellow in hue of 10YR or 7.5YR. It is 12 to 25 inches thick and is medium acid to neutral. The C horizon ranges from light olive brown to pink in hue of 2.5Y to 7.5YR and is loam or clay loam. It is neutral or mildly alkaline.

Lakoa soils are near Butche, Canyon, Keith, and Maitland soils and are similar to Citadel soils. They are deeper over bedrock than Butche and Canyon soils, have less clay in the B horizon than Citadel soils, and have a thinner A1 horizon than Keith and Maitland soils.

LAD—Lakoa-Maitland association, hilly. These soils are on the outer hogback of the Black Hills in irregularly shaped areas that range from 40 to 300 acres in size. Slopes are mostly hilly. Some areas are steep, and some are moderately sloping to strongly sloping. The mapped areas generally are on the north and east sides of the hogback, on wide ridgetops, and in wooded coves. They are about 50 percent Lakoa soils, 30 percent Maitland soils, and 20 percent other soils. Lakoa soils generally are in the middle and higher parts of the landscape. They have a loam surface layer, and in a few places they are slightly less than 40 inches deep to sandstone. Maitland soils generally are on the edges of the timbered areas as they merge into grassed foot slopes, or into parklike openings on broad ridgetops. They have a loam surface layer and their profile is the one described as representative of the Maitland series.

Included with these soils in mapping were small areas of Butche, Canyon, and Keith soils. Butche and Canyon soils are on the crests of some of the ridges. Keith soils are in some of the wider grassed areas on ridgetops where slopes are smooth and face southeast. Also included in some places are small areas of Rock outcrop on the crests of ridges and on canyon walls. These are shown on the soil map by a spot symbol.

Runoff is medium to rapid, and the hazard of erosion is severe if the plant cover is removed. Controlling erosion is the main management concern.

These soils are used for timber production, woodland grazing, wildlife, and recreation. They are in dominantly ponderosa pine and an understory of shrubs and grasses, but include small meadow openings and grassed ridgetops. Capability unit VIe–13, woodland site 5r2, not placed in a range site or windbreak site.

Lismas series

The Lismas series consists of shallow, well drained, moderately sloping to steep, clayey soils on uplands. These soils formed in material that weathered from the underlying soft shale. The native vegetation consisted mainly of a sparse stand of mid grasses.

In a representative profile the surface layer is light brownish gray clay about 2 inches thick. The next layer is grayish brown clay about 3 inches thick. The underlying material, to a depth of 15 inches, is light, brownish gray clay. Below that, it is bedded, soft shale.

Lismas soils are low in fertility and in organic-matter content. The available water capacity is very low, and permeability is slow or very slow.

All areas are in native grass and are used for range.

Representative profile of Lismas clay, 15 to 40 percent slopes, in native grass, 2,400 feet west and 2,000 feet north of the southeastern corner of sec. 5, T. 6 N., R. 10 E.

A1—0 to 2 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; weak fine granular structure; slightly hard, firm, sticky and plastic; neutral; clear smooth boundary.

AC—2 to 5 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; very weak coarse subangular blocky structure parting to weak fine granular; hard, firm, sticky and plastic; mildly alkaline; gradual wavy boundary.

C1—5 to 10 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; very weak coarse subangular blocky structure; very hard, very firm, very sticky and very plastic; mildly alkaline; gradual wavy boundary.

C2—10 to 15 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; massive; very hard, very firm, very sticky and very plastic; few fine segregations of lime; slight effervescence; mildly alkaline; clear wavy boundary.

Cr1—15 to 24 inches; light gray (2.5Y 7/2) shale, light brownish gray (2.5Y 6/2) moist; shale has platy structure; few fine threads of lime and common fine nests of salts in seams and cracks of the shale; mildly alkaline; gradual wavy boundary.

Cr2—24 to 60 inches: light brownish gray (2.5Y 6/2) and white (2.5Y 8/2) shale, dark grayish brown (2.5Y 4/2) and light brownish gray (2.5Y 6/2) moist; neutral.

Depth to shale ranges from 5 to 20 inches. A thin,

soft vesicular crust is at the surface of some pedons. Reaction ranges from neutral to strongly alkaline. Some pedons are calcareous at the surface. Clay content in the horizons above the shale ranges from 55 to 70 percent. The A horizon is grayish brown or light brownish gray in hue of 10YR or 2.5Y and is 1 to 3 inches thick. Some pedons lack an AC horizon. The C horizon above the shale is light brownish gray or light gray in hue of 2.5Y or 5Y. Some pedons lack segregations of lime.

Lismas soils are near Pierre and Winler soils and are similar to Grummit, Midway, and Samsil soils. They have a firmer consistency in the C horizon than Grummit, Midway, and Samsil soils. Lismas soils are more alkaline than Grummit soils, are more clayey than Midway soils, and are shallower over shale than Pierre and Winler soils.

LbE—Lismas clay, 15 to 40 percent slopes. This soil is on uplands on the sides of stream valleys and deeply entrenched drainageways (fig. 11). Areas are irregularly shaped and range from 20 to 500 acres in size. They commonly contain numerous drainageways, many of which are gullied. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Pierre, Swanboy, and Winler soils. Pierre soils are on some of the ridgetops, Swanboy soils are on foot slopes and fans along the larger drainageways, and Winler soils are in the mid and lower parts of the landscape. Also included are small areas of Rock outcrop on sharp shoulders and around the heads of some drainageways, on cutbanks or escarpments, and in slump areas along the larger streams.

Runoff is rapid, and the hazard of erosion is very severe. This soil is not suited to cultivation because of the shallowness, steep slopes, and very severe hazard of erosion. Controlling erosion is the main management concern.

All areas remain in native grass and are used for range. Shallow Dense Clay range site, capability unit VIIe–5, windbreak group 10.

Figure 11.—An area of Lismas clay, 15 to 40 percent slopes, in native grasses used for range.

LCD—Lismas-Winler association, sloping. These moderately sloping to strongly sloping, clayey soils are on uplands in irregularly shaped areas that range from 40 to 200 acres in size. They are about 45 percent Lismas soils, 35 percent Winler soils, and 20 percent other soils. Lismas soils are on the upper side slopes of ridges and on shoulders of drainageways. Winler soils are on some of the wider ridgetops and in the mid and lower parts of the landscape.

Included with these soils in mapping are small areas of Hisle, Pierre, and Swanboy soils. Hisle soils are in sags and swales and on foot slopes along drainageways, Pierre soils are on some ridgetops, and Swanboy soils are on foot slopes and fans along some of the larger drainageways. Small stony areas are in some mapped areas and are shown on the soil map by a spot symbol.

Runoff is medium to rapid, and the hazard of erosion is very severe. These soils are not suited to cultivation because of shallowness, very poor tilth, and their high susceptibility to erosion.

All areas are in native grass and are used for range. Capability unit VIe–12, windbreak group 10; Lismas soil is in Shallow Dense Clay range site, Winler soil is in Dense Clay range site.

Lohmiller series

The Lohmiller series consists of deep, well drained, nearly level soils on bottom land. These soils formed in stratified clayey alluvium. The native vegetation consisted mainly of mid and short grasses. In places native trees and shrubs are scattered along stream channels.

In a representative profile the surface layer is light brownish gray silty clay loam about 7 inches thick. The underlying material also is light brownish gray silty clay loam. All layers are calcareous.

The available water capacity is moderate or high, and permeability is slow or moderately slow. Most areas are subject to stream flooding.

Many areas are in native grass and are used for range and hay. About half the acreage is cultivated, and a few small tracts are irrigated.

Representative profile of Lohmiller silty clay loam, in cropland, 1,000 feet west and 100 feet south of the northeastern corner of sec. 12, T. 7 N., R. 5 E.

Ap—0 to 4 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; slightly hard, friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

A12—4 to 7 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; hard, friable; slight effervescence; moderately alkaline; clear smooth boundary.

C1—7 to 24 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak and coarse subangular blocky; hard, firm; few fine segregations of gypsum crystals; slight

effervescence; moderately alkaline; clear wavy boundary.

C2cs—24 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable; common streaks and nests of gypsum crystals; slight effervescence; moderately alkaline.

The soil, between depths of 10 and 40 inches, commonly is stratified with finer and coarser textures but averages silty clay loam. The A horizon ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y and is 4 to 8 inches thick. The C horizon ranges from grayish brown to pale yellow in hue of 10YR or 2.5Y. Few or common nests of salts and fine seams of segregated lime are in some pedons.

Lohmiller soils are near Glenberg, Savo, and Stetter soils. They have more clay than Glenberg soils, have less clay and are more calcareous than Stetter soils, and differ from Savo soils in not having a B horizon.

Le—Lohmiller silty clay loam. This is a nearly level soil on bottom land. Slope is 0 to 2 percent. The areas range from 10 to 150 acres in size and usually are long and narrow, but some range up to one-half mile in width. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Glenberg, Kyle, and Stetter soils. Glenberg soils generally are in narrow strips along the stream channel, Kyle soils are on low terraces and fans at elevations a few feet above the Lohmiller soils, and Stetter soils generally are in swales and low areas.

Runoff is slow. This soil is subject to stream flooding in some years, but flood damage usually is minor. This soil has few limitations to use for crops. Periodic shortages of moisture are common and conserving moisture is the main management concern.

Some areas are cultivated, and some of these are irrigated. Other areas are in native grass and are used for range and hay. Scattered trees and shrubs along stream channels provide cover for wildlife and winter protection for livestock. Overflow range site, capability unit IIIc–2, windbreak group 1.

Lh—Lohmiller and Glenberg soils, channeled. These soils are on bottom land in long and narrow areas that range from 20 to 80 acres in size. Meandering channels (fig. 12) cut the areas into small tracts. Some areas consist of mostly Lohmiller soils, and some consist of mostly Glenberg soils. The proportion of each soil varies from one area to another. The Lohmiller soil generally has a surface layer of silty clay loam. The Glenberg soil has a surface layer that is commonly fine sandy loam or very fine sandy loam, but in places it is loam or clay loam. Slope is 0 to 2 percent.

Included with these soils in mapping are small areas of Altvan, Arvada, Kyle, Savo, St. Onge, and Stetter soils. Altvan, Arvada, Kyle, and Savo soils are on low terraces and fans on the edges of the areas. St. Onge soils are on some of the bottom lands near the Black Hills. Stetter soils are in low areas.

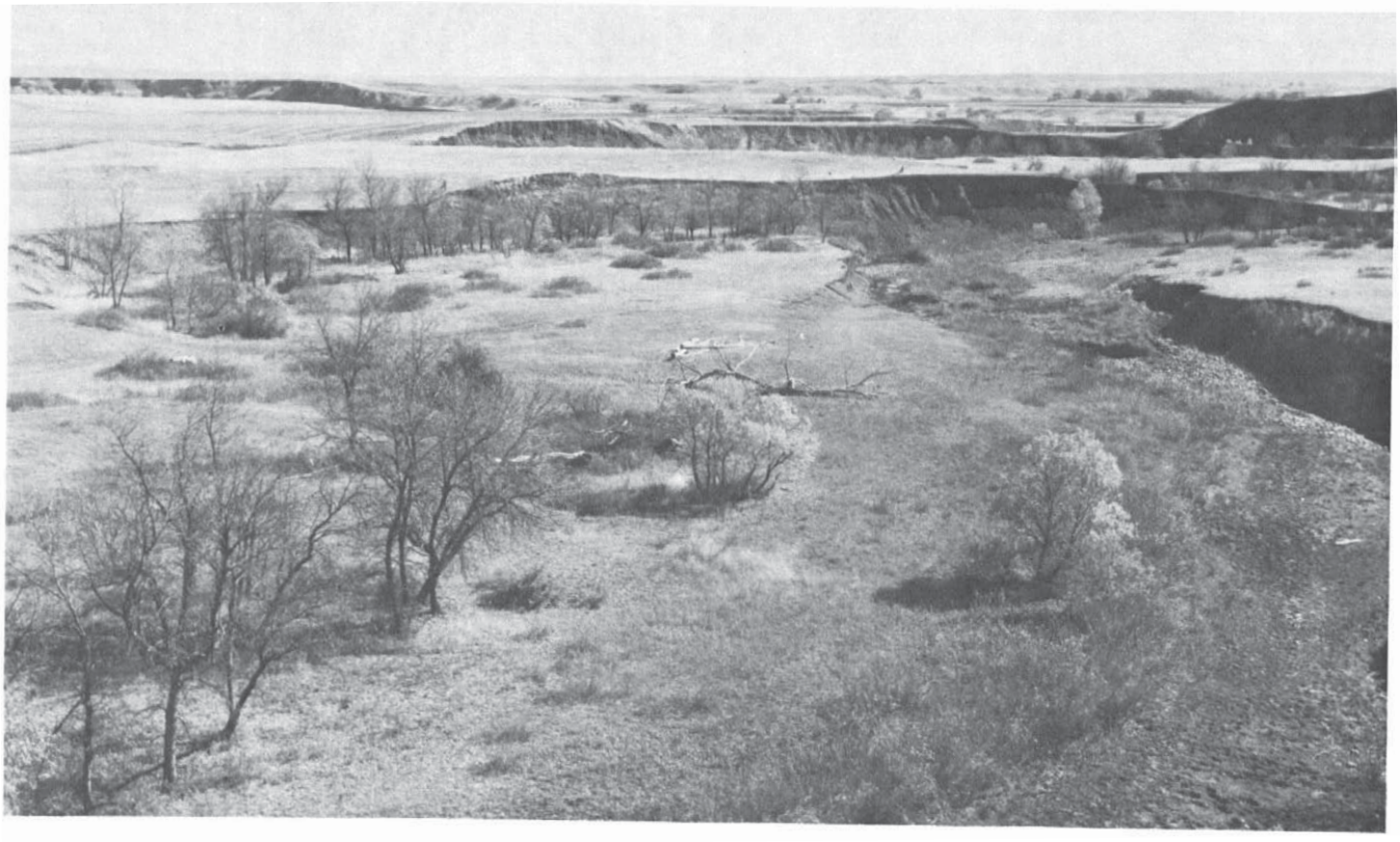


Figure 12.—An area of Lohmiller and Glenberg soils, channeled, along Bear Butte Creek.

Runoff is slow. These soils commonly are subject to stream flooding. They generally are not suited to cultivation because of flooding and the irregular shape and small size of the tracts that are accessible to machinery.

Most areas are in native grass and are used for range and hay. In places these soils can be used as gardens. Scattered trees are in some areas and provide cover for wildlife and winter protection for livestock. Overflow range site, capability unit VIw–1, windbreak group 10.

Macken series

The Macken series consists of deep, poorly drained, level, clayey soils in closed depressions on uplands. These soils formed in alluvium washed from adjacent soils. The native vegetation consisted mainly of mid and short grasses and sedges.

In a representative profile the surface layer is light brownish gray silty clay about 2 inches thick. The subsoil is about 30 inches thick. It is clay that is dark gray in the upper part and gray in the lower part. The underlying material is gray, calcareous clay.

Macken soils are medium in fertility and moderate in organic-matter content. The available water capacity is moderate or high, and permeability is slow. Flooding by ponded runoff is common.

Most areas are in native grass and are used for range and hay.

Representative profile of Macken silty clay, in native grass, 250 feet north and 100 feet west of the southeastern corner of sec. 32, T. 3 N., R. 14 E.

A1—0 to 2 inches; light brownish gray (2.5Y 6/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; medium acid; clear smooth boundary.

B21—2 to 7 inches; dark gray (5Y 4/1) clay, very dark gray (5Y 3/1) moist; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few reddish brown stains; medium acid; gradual wavy boundary.

B22—7 to 32 inches; gray (5Y 5/1) clay, very dark gray (5Y 3/1) moist; very weak coarse prismatic structure parting to moderate medium blocky; extremely hard, extremely firm, very sticky and very plastic; gradual wavy boundary.

Cg—32 to 60 inches; gray (5Y 6/1) clay, gray (5Y 5/1) moist; massive; extremely hard, extremely firm, very sticky and very plastic; slight effervescence; mildly alkaline.

When the soil is dry, cracks that are 1/2 inch to 2 inches wide and several feet long extend downward through the solum. In places a thin layer of organic material is on the surface. The A horizon is silty clay loam or silty clay and is dark gray or gray in hue of 2.5Y or 10YR. It is 2 to 4 inches thick. The B2 horizon is silty clay or clay that has a clay content ranging from 45 to 60 percent. It is dark gray or gray in hue of 2.5Y or 5Y and is 20 to 30 inches thick. Some pedons have a B3 horizon. In places the C horizon is silty clay or silty clay loam.

Macken soils are similar to Hoven soils and are near Onita soils. They contain less sodium than Hoven soils and are more clayey and more poorly drained than Onita soils.

Ma—Macken silty clay. This is a level soil in closed depressions on uplands. The mapped areas are circular to oval in shape and typically range from 3 to 30 acres in size. Slope is 0 to 1 percent.

Included with this soil in mapping are small areas of Hoven and Savo soils. Hoven soils commonly form a rim around the depressions or are on small rises. Savo soils are on the edges of some depressions.

Runoff is ponded and remains on the soil until it evaporates. This soil has poor tilth and is droughty in dry years. It absorbs water slowly and releases it slowly to plants. This soil generally is not suited to cultivation because of spring wetness and poor tilth.

Most areas remain in native grass and are used for range and hay. Closed Depression range site, capability unit Vw–1, windbreak group 10.

Maitland series

The Maitland series consists of deep, well drained, moderately sloping to hilly, loamy soils on uplands. These soils formed in loamy material that weathered from interbedded sandstone and shale. The native vegetation consisted mainly of ponderosa pine and open areas of tall, mid, and short grasses.

In a representative profile the surface is covered with about 1 inch of partly decomposed forest litter. The surface layer is very dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown light loam about 2 inches thick. Below this is about 4 inches of brown loam that is coated with grayish brown silt and very fine sand grains. The subsoil is about 26 inches thick. It is brown clay loam in the upper part, pale brown clay loam in the middle part, and very pale brown heavy loam in the lower part. The underlying material is very pale brown, calcareous loam.

Maitland soils are medium in fertility and moderate in organic-matter content. The available water capacity is high, and permeability is moderate.

Most areas remain in native vegetation and are used for grazing, timber production, wildlife, and recreation. A few small areas are farmed.

Maitland soils are mapped only in association with Lakoa soils and in complex with Marshdale soils.

Representative profile of Maitland loam in an area of Lakoa-Maitland association, hilly, in native grass understory and ponderosa pine, 1,200 feet east and 400 feet south of the northwestern corner of sec. 14, T. 5 N., R. 5 E.

O—1 inch to 0; partly decomposed forest litter; abrupt smooth boundary.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; many worm casts; slightly acid; clear smooth boundary.

A2—7 to 9 inches; grayish brown (10YR 5/2)

light loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, very friable; slightly acid; clear wavy boundary.

B&A—9 to 13 inches; brown (10YR 5/3) loam, dark brown moist (B); faces of peds coated with grayish brown (10YR 5/2) silt and very fine sand grains, dark grayish brown (10YR 4/2) moist (A); weak medium prismatic structure parting to weak fine granular; hard, friable; slightly acid; clear wavy boundary.

B21t—13 to 21 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to moderate medium subangular blocky; hard, firm; medium acid; gradual wavy boundary.

B22t—21 to 30 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; moderate coarse prismatic structure parting to moderate coarse subangular blocky; hard, firm; slightly acid; gradual wavy boundary.

B3—30 to 39 inches; very pale brown (10YR 7/3) heavy loam, brown (10YR 5/3) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly acid; clear wavy boundary.

C—39 to 60 inches; very pale brown (10YR 7/3) loam, brown (10YR 5/3) moist; massive; slightly hard, friable; common medium segregations of lime; strong effervescence; mildly alkaline.

Reaction of the solum is slightly acid to strongly acid. The A1 horizon ranges from dark gray to grayish brown. It is loam or very fine sandy loam and is 5 to 9 inches thick. The A2 horizon ranges from grayish brown to very pale brown. It is fine sandy loam, very fine sandy loam, or loam, and it is 2 to 6 inches thick. The B&A horizon has colors intermediate between those of the A2 and B2 horizons. It is loam or clay loam and is 4 to 7 inches thick. The B2t horizon ranges from brown to reddish yellow in hue of 10YR or 7.5YR. It is clay loam or loam, has a clay content averaging 25 to 35 percent, and is 15 to 30 inches thick. The C horizon is fine sandy loam or loam and is slightly acid to mildly alkaline. Weakly-cemented sandstone or shale is between depths of 40 and 60 inches in places.

In mapping unit McB, these soils are dark colored to a greater depth than is defined as the range of the series, but this difference does not alter the usefulness or behavior of the soils.

Maitland soils are near Butche, Canyon, and Lakoa soils. They are deeper over bedrock than Butche and Canyon soils and have a thicker A1 horizon than Lakoa soils.

Manvel series

The Manvel series consists of deep, well drained, gently sloping to moderately steep, calcareous, silty soils on uplands. These soils formed in material that weathered from calcareous siltstone and chalky shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown silt loam about 3 inches thick. The next layer is brown silt loam about 4 inches thick. The underlying material is very pale brown silt loam. All layers are calcareous.

Manvel soils are low in fertility and in organic-matter content. The available water capacity is high, and permeability is moderate or moderately slow.

Many areas are in native grass and are used for range and hay. Some are cultivated.

Representative profile of Manvel silt loam, 4 to 9 percent slopes, in cropland, 1,350 feet east and 450 feet north of the southwestern corner of sec. 2, T. 4 N., R. 7 E.

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

Ac—3 to 7 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—7 to 16 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; very weak medium subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—16 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; few segregations of lime; violent effervescence; moderately alkaline.

Depth to bedrock is 40 inches or more. Free carbonates are at or within a depth of 4 inches. The A horizon is silt loam or silty clay loam and ranges from olive gray to pink in hue of 5Y to 7.5YR. It is 3 to 5 inches thick. Some pedons lack an AC horizon, but where present it is 2 to 8 inches thick. The C horizon is silt loam or silty clay loam and ranges from light olive gray to pink in hue of 5Y to 7.5YR. Segregations of lime are in the AC or C1 horizon of some pedons. In places soft shale is at a depth of 40 to 60 inches.

Manvel soils are near Blackpipe, Enning, Savo, and Shingle soils. They have less clay below the A horizon and are calcareous at a shallower depth than Blackpipe and Savo soils. Manvel soils are deeper to bedrock than Enning and Shingle soils.

MbB—Manvel silt loam, 4 to 9 percent slopes. This gently sloping to moderately sloping soil is on uplands (fig. 13) in irregularly shaped areas that range from 30 to 60 acres in size. Slopes generally are long and smooth.

Included with this soil in mapping are small areas of Arvada, Blackpipe, Enning, and Savo soils. Arvada, Blackpipe, and Savo soils are in the lower part of the landscape. Enning soils are in the higher part.

Runoff is medium, and the hazard of erosion is severe. This soil also blows easily and is low in fertility

Figure 13.—**An area of Manvel silt loam, 4 to 9 percent slopes. Controlling erosion and soil blowing is the main management concern.**

and in organic-matter content. Controlling erosion and soil blowing is the main management concern.

Many areas remain in native grass and are used for range and hay, and some are cultivated. Close-sown crops, tame grasses, and alfalfa are better suited than row crops. Thin Upland range site, capability unit IVe–8, windbreak group 8.

Marshdale series

The Marshdale series consists of deep, somewhat poorly drained to poorly drained, gently sloping to moderately sloping, loamy soils in swales on uplands. These soils formed in alluvium washed from adjacent soils. The native vegetation consisted mainly of tall grasses and sedges.

In a representative profile the surface layer is loam about 16 inches thick. It is dark gray in the upper part and dark grayish brown in the lower part. The subsoil is dark grayish brown clay loam about 17 inches thick. The underlying material is brown and dark grayish brown, calcareous clay loam.

Marshdale soils are high in fertility and in organic-matter content. The available water capacity is high, and permeability is moderately slow or slow. These soils have a seasonal water table at a depth of 1.5 to 2 feet and are subject to flooding in some years.

Many areas are in native grass and are used for grazing or hay. Some areas are cultivated or are in tame pasture.

Representative profile of Marshdale loam, in an area of Marshdale-Maitland loams, 2 to 9 percent slopes, in native grass, 2,100 feet east and 2,000 feet north of the southeastern corner of sec. 32, T. 4 N., R. 5 E.

A11—0 to 10 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; weak fine granular structure; soft, very friable; slightly acid; gradual wavy boundary.

A12—10 to 16 inches; dark grayish brown (10YR 4/2) loam, very dark gray (10YR 3/1) moist; very weak medium prismatic structure parting to weak fine granular; soft, very friable; slightly acid; gradual wavy boundary.

B2—16 to 27 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; very weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; slightly acid; gradual wavy boundary.

B3—27 to 33 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; very weak medium subangular blocky structure; slightly hard, friable; neutral; clear wavy boundary.

Cgca—33 to 60 inches; brown (10YR 5/3) and dark grayish brown (10YR 4/2) clay loam, dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) moist; common medium distinct olive brown (2.5Y 4/4) mottles, moist, and few medium distinct dark gray (2.5Y 4/0) mottles, moist; massive; hard, firm; common fine segregations of lime; strong effervescence; mildly alkaline.

Depth to free carbonates commonly ranges from 30 to 60 inches or more. Texture between depths of 10 and 40 inches is loam, clay loam, or silt loam, but thin

lenses of fine sandy loam or very fine sandy loam are in some pedons. The A horizon ranges from very dark gray to dark grayish brown. It is 16 to 40 inches thick and is slightly acid or neutral. The B horizon ranges from dark gray to light brownish gray and in places has mottles of brown and yellowish brown. It is 10 to 30 inches thick. The C horizon ranges from dark grayish brown to light yellowish brown and commonly has mottles. It is slightly acid to mildly alkaline. Some pedons lack segregated lime.

Marshdale soils are more poorly drained and have a thicker A1 horizon than the nearby Citadel, Maitland, and Winetti soils. They contain fewer coarse fragments than Winetti soils.

McB—Marshdale-Maitland loams, 2 to 9 percent slopes. These soils are in narrow, mountain valleys in the Black Hills. Areas are long and narrow and range from 30 to 60 acres in size. They are about 50 percent Marshdale soils, 40 percent Maitland soils, and 10 percent other soils. Marshdale soils are in the lower part of the valley; Maitland soils are in the higher part. The Maitland soil generally is dark colored to a greater depth than the soil described as representative of the series.

Included with these soils in mapping are small areas of Citadel, Paunsaugunt, Vanocker, and Winetti soils. The Citadel and Vanocker soils are on convex humps in the higher part of the areas. Paunsaugunt soils are in shallow-to-bedrock rises that extend into some of the valleys. Winetti soils are in small areas along some of the drainageway channels.

Runoff is slow to medium. The Marshdale soil is subject to flooding and has a seasonal high water table. The Maitland soil absorbs water readily and is easy to till, but the hazard of erosion is severe. Wetness of the Marshdale soil and controlling erosion on the Maitland soil are the main management concerns.

Many areas are cultivated, or they are in tame grasses and are used for tame pasture and hay. Others remain in native vegetation and are used for grazing and hay. Choice of crops is limited because of cool night temperatures and a frost-free season of less than 120 days. Marshdale soil is in Subirrigated range site, capability unit IVw–1, windbreak group 2; Maitland soil is in capability unit IIIe–1, and not placed in a range site or windbreak group.

Midway series

The Midway series consists of shallow, well drained, strongly sloping to steep, calcareous, silty soils on uplands. These soils formed in material that weathered from soft shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile (fig. 14) the surface layer is brown silty clay loam about 3 inches thick. The next layer is grayish brown silty clay about 5 inches thick. The underlying material, to a depth of 13 inches, is brown shaly silty clay. Below that it is bedded, soft shale. All layers are calcareous.

Midway soils are low in fertility and in organic-matter content. The available water capacity is very low, and permeability is slow.

All areas are in native grass and are used for range.

Figure 14.—**Representative profile of Midway silty clay loam in an area of Midway-Blackpipe complex, 9 to 40 percent slopes.**

Representative profile of Midway silty clay loam in an area of Midway-Blackpipe complex, 9 to 40 percent slopes, in native grass, 600 feet south and 1,200 feet east of the northwestern corner of sec. 14, T. 5 N., R. 6 E.

A1—0 to 3 inches; brown (10YR 5/3) silty clay loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; clear smooth boundary.

AC—3 to 8 inches; grayish brown (10YR 5/2) light silty clay, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; soft, friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C—8 to 13 inches; brown (10YR 5/3) and gray (10YR 5/1) shaly silty clay, dark brown (10YR 3/3) and dark gray (10YR 4/1) moist; bedding planes evident; slightly hard, firm; strong effervescence; mildly alkaline; gradual wavy boundary.

Cr1—13 to 24 inches; pale brown (10YR 6/3)

and light gray (10YR 6/1) silty and clayey shale, dark brown (10YR 4/3) and dark gray (10YR 4/1) moist; bedded shale has thin platy structure; strong effervescence; mildly alkaline; clear smooth boundary.

Cr2—24 to 60 inches; yellowish brown (10YR 6/4) and light gray (10YR 6/1) platy silty and clayey shale, dark brown (10YR 4/3) moist; slight effervescence; mildly alkaline.

Depth to bedded soft shale ranges from 6 to 20 inches. Free carbonates are at or within 7 inches of the surface. The A horizon is silty clay in places. It is 2 to 7 inches thick and ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. Some pedons lack an AC horizon but, where present, it is silty clay loam, silty clay, or light clay and is 2 to 6 inches thick. The C1 horizon ranges from grayish brown to pale yellow in hue of 10YR or 2.5Y and is mildly alkaline to strongly alkaline. In places the soft shale in the Cr horizon is interbedded with thin layers of brittle limestone.

Midway soils are mapped with Blackpipe soils and are similar to Enning, Samsil, and Shingle soils. They are shallower to shale than Blackpipe soils, are more clayey than Enning and Shingle soils, and are less clayey than Samsil soils.

MdD—Midway-Blackpipe complex, 9 to 40 percent slopes. These soils are on uplands on low escarpments and on the sides of entrenched drainageways. Areas are irregularly shaped and range from 30 to 80 acres in size. They are about 50 percent Midway soils, 30 percent Blackpipe soils, and 20 percent other soils. Midway soils are in the higher part of the landscape and have a surface layer of silty clay loam. Blackpipe soils are in the mid and lower parts of the landscape and generally are less steep than Midway soils. They have a profile in which the silt loam surface layer is thinner than in the profile described as representative of the series. Small stony areas are in some places and are shown on the soil map by a spot symbol.

Included with these soils in mapping are small areas of Enning, Manvel, and Savo soils. Enning soils are on some of the ridges that are underlain by chalky shale. Manvel soils are in the mid and lower parts of the landscape with Blackpipe soils. Savo soils are in swales and on concave foot slopes in the lower part of the landscape. Also included in some places are small areas of Rock outcrop around the heads of gullied drainageways.

Runoff is medium to rapid, and the hazard of erosion is severe. These soils generally are not suited to cultivation because of shallowness, irregular and steep slopes, and high susceptibility to erosion.

All areas are in native grass and are used for range. Windbreak group 10; Midway soil is in Shallow range site, capability unit VIIe–5; Blackpipe soil is in Silty range site, capability unit VIe–1.

Mosher series

The Mosher series consists of deep, moderately well drained, nearly level, loamy soils that have a claypan subsoil and are on terraces and uplands. These soils formed in alluvium.

In a representative profile the surface layer, about 7 inches thick, is loam that is grayish brown in the upper part and dark grayish brown in the lower part. The subsurface layer is light brownish gray loam about 4 inches thick. The subsoil, about 17 inches thick, is clay loam that is brown in the upper part and grayish brown and calcareous in the lower part. The underlying material is grayish brown, calcareous clay loam that contains spots and streaks of lime and salts.

Mosher soils are medium in fertility and moderate in organic-matter content. The available water capacity is moderate or high, and permeability is very slow. In places this soil has a seasonal water table at a depth of 3 to 6 feet.

Most areas are in native grass and are used for grazing, but some are cultivated.

Mosher soils are mapped only in complex with Satanta soils.

Representative profile of Mosher loam in an area of Satanta-Mosher loams, 0 to 3 percent slopes, in native grass, 1,400 feet south and 100 feet east of the northwestern corner of sec. 30, T. 4 N., R. 14 E.

A11—0 to 4 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear smooth boundary.

A12—4 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; slightly acid; clear wavy boundary.

A2—7 to 11 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; weak thick platy structure parting to weak fine and medium subangular blocky; soft, very friable; slightly acid; clear wavy boundary.

B21t—11 to 15 inches; brown (10YR 5/3) heavy clay loam, dark brown (10YR 4/3) moist; moderate medium and coarse columnar structure parting to strong medium and coarse blocky; extremely hard, very firm, sticky and plastic; column tops thinly coated with light brownish gray (10YR 6/2) silt and very fine sand grains; thin shiny coats on faces of peds; mildly alkaline; clear wavy boundary.

B22t—15 to 22 inches; brown (10YR 5/3) heavy clay loam, dark brown (10YR 4/3) moist; moderate medium and coarse prismatic structure parting to strong medium and coarse blocky; very hard, very firm, sticky and plastic; thin shiny coatings on faces of peds; mildly alkaline; clear wavy boundary.

B3—22 to 28 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate coarse blocky; very hard, very firm, sticky and plastic; slight effervescence; moderately alkline; clear wavy boundary.

C1casa—28 to 40 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak very coarse prismatic structure; hard, firm, sticky and plastic; common nests of salts; common fine segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2sa—40 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm sticky and plastic; common nests of salts; slight effervescence; moderately alkaline.

The solum is 18 to 42 inches thick. Depth to free carbonates ranges from 15 to 32 inches. The A1 horizon ranges from dark gray to grayish brown and is loam or silt loam. It is 3 to 8 inches thick and is slightly acid to mildly alkaline. The A2 horizon is loam or silt loam and ranges from gray to light brownish gray. It is 2 to 6 inches thick and is slightly acid to mildly alkaline. The B2t horizon is clay loam or light clay and ranges from dark gray to light yellowish brown in hue of 10YR or 2.5Y. It is 7 to 18 inches thick and is mildly alkaline or moderately alkaline. In places the B3 horizon is noncalcareous. The C horizon ranges from grayish brown to light yellowish brown and commonly is stratified with lenses of finer and coarser material. It is moderately or strongly alkaline.

Mosher soils have a dryer moisture regime than is defined as the range for the series, but this does not significantly alter their usefulness or behavior.

Mosher soils are near Assinniboine, Nunn, Onita, and Satanta soils and are similar to Arvada soils. They have a thicker A horizon than Arvada soils and have more clay and more sodium in the B horizon than Assinniboine and Satanta soils. Mosher soils contain more sodium in the B horizon than Nunn and Onita soils.

Nevee series

The Nevee series consists of deep, well drained, moderately sloping to strongly sloping, calcareous silty soils on uplands. These soils formed in material that weathered from reddish colored siltstone or shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is reddish brown silt loam about 8 inches thick. The underlying material is reddish yellow silt loam. All layers are calcareous.

Nevee soils are low in fertility and moderately low in organic-matter content. The available water capacity is moderate or high, and permeability is moderate.

Most areas are in native grass and are used for range and hay, but a few are cultivated or in tame pasture.

Representative profile of Nevee silt loam in an area of Nevee-Spearfish complex, 6 to 15 percent slopes, in native grass, 1,700 feet east and 1,000 feet north of the southwestern corner of sec. 31, T. 3 N., R. 7 E.

A11—0 to 3 inches; reddish brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/3) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; clear wavy boundary.

A12—3 to 8 inches; reddish brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C1—8 to 17 inches; reddish yellow (5YR 6/6) silt loam, yellowish red (5YR 4/6) moist; massive; slightly hard, friable; common segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2ca—17 to 35 inches; reddish yellow (5YR 6/6) silt loam, yellowish red (5YR 4/6) moist; massive; slightly hard, friable; common segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—35 to 60 inches; reddish yellow (5YR 6/6) silt loam, yellowish red (5YR 4/6) moist; massive; slightly hard, friable; slight effervescence; moderately alkaline.

Free carbonates are at or within 10 inches of the surface. Texture throughout the profile is silt loam, very fine sandy loam, or loam. The clay content between depths of 10 and 40 inches averages 10 to 18 percent, and the content of fine or coarser sand is less than 15 percent. The A horizon ranges from dark grayish brown to light reddish brown in hue of 10YR to 5YR. It is 4 to 10 inches thick and is neutral or mildly alkaline. The C horizon ranges from brown to reddish yellow in hue of 7.5YR or 5YR. It is mildly alkaline to strongly alkaline and in places lacks segregations of lime. In places bedded soft shale, siltstone, or sandstone is at some depth between 40 and 60 inches.

Nevee soils are similar to Bridget soils and are near Spearfish and Tilford soils. They have redder colors than Bridget soils, are deeper to bedrock than Spearfish soils, and have a redder A horizon and contain less organic matter than Tilford soils.

NaD—Nevee-Spearfish complex, 6 to 15 percent slopes. These moderately sloping to strongly sloping soils are on uplands in irregularly shaped areas that range from 30 to 70 acres in size. They are about 60 percent Nevee soils, 25 percent Spearfish soils, and 15 percent other soils. Nevee soils have a silt loam surface layer and are in the middle and lower parts of the landscape where slopes generally are plane to slightly convex. Spearfish soils have a loam surface layer and are on the tops and upper side slopes of ridges and knolls where slopes are short and convex.

Included with these soils in mapping are small areas of Nihill, St. Onge, Tilford, and Winetti soils. Nihill soils are on rounded ridgetops. St. Onge and Winetti soils are on narrow strips of bottom land and alluvial fans. Tilford soils are on broad ridgetops, on foot slopes, and in swales.

Runoff is medium, and the hazard of erosion is severe. These soils generally are not suited to cultivation

because of low fertility, high susceptibility to erosion, and because of the shallowness of the Spearfish soils.

Most areas remain in native vegetation and are used for range and hay. In places, small areas of the Nevee soil are farmed. Capability unit VIe–3, windbreak group 10; Nevee soil is in Thin Upland range site, Spearfish soil is in Shallow range site.

Nihill series

The Nihill series consists of deep, excessively drained, sloping to steep, gravelly soils on uplands and terrace escarpments. These soils formed in gravelly alluvium. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown gravelly loam about 6 inches thick. The underlying material is pale brown, calcareous gravelly loam and very gravelly loam.

Nihill soils are low in fertility and in organic-matter content. The available water capacity is low, and permeability is moderately rapid.

Most areas are in native grass and used for range.

Representative profile of Nihill gravelly loam, 9 to 40 percent slopes, in native grass, 2,450 feet north and 150 feet east of the southwestern corner of sec. 27, T. 5 N., R. 10 E.

A1—0 to 6 inches; grayish brown (10YR 5/2) gravelly loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; 15 percent gravel; mildly alkaline; gradual wavy boundary.

C1ca—6 to 24 inches; pale brown (10YR 6/3) gravelly loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; 45 percent gravel; coatings of lime on undersides of pebbles; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—24 to 60 inches; pale brown (10YR 6/3) very gravelly loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; 55 percent gravel; strong effervescence; mildly alkaline.

Free carbonates are at or within 9 inches of the surface. The A horizon commonly is gravelly loam but in places is loam, sandy loam, or gravelly sandy loam. It ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is 6 to 9 inches thick and is neutral or mildly alkaline. The C horizon contains 35 to 70 percent gravel and in places is very gravelly sandy loam or very gravelly clay loam. It ranges from light brownish gray to pale yellow in hue of 10YR or 2.5Y and is neutral to moderately alkaline.

Nihill soils are near Altvan, Nunn, Satanta, and Zigweid soils. They are gravelly at a shallower depth than Altvan soils. They differ from Nunn, Satanta, and Zigweid soils in not having a B horizon and in being more gravelly.

NbE—Nihill gravelly loam, 9 to 40 percent slopes. This strongly sloping to steep soil is on upland ridges and terrace escarpments in irregularly shaped areas that range from 10 to 50 acres in size. Slopes typically are short and convex. This soil has the profile described as representative of the series. In places stones and cobbles are scattered on the surface.

Included with this soil in mapping are small areas of Altvan, Arvada, Nunn, Satanta, and Zigweid soils. Altvan, Nunn, and Satanta soils are on narrow, flattened ridgetops above the Nihill soil. Arvada soils are on foot slopes and in swales. Zigweid soils typically are immediately below the Nihill soil. These included soils occupy as much as 25 percent of some mapped areas.

Runoff is medium to rapid, and the hazard of erosion is severe if the plant cover is removed. This soil generally is not suited to farming because of steep slopes, droughtiness, low fertility, and high susceptibility to erosion.

Most areas remain in native grass and are used for range. Thin Upland range site, capability unit VIIe–1, windbreak group 10.

Nunn series

The Nunn series consists of deep, well drained, nearly level to moderately sloping, loamy soils on terraces and uplands. These soils formed in alluvium. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is dark grayish brown clay loam about 7 inches thick. The subsoil about 25 inches thick, is brown clay and clay loam in the upper part and light brownish gray, calcareous, silty clay loam in the lower part. Spots and streaks of soft lime are in the lower part. The underlying material is grayish brown, calcareous clay loam.

Nunn soils are medium in fertility and moderate in organic-matter content. The available water capacity is moderate or high, and permeability is moderately slow.

Many areas are cultivated, and some are in native grass and are used for range and hay.

Representative profile of Nunn clay loam, 0 to 2 percent slopes, in cropland, 2,550 feet south and 150 feet west of the northeastern corner of sec. 5, T. 5 N., R. 7 E.

Ap—0 to 4 inches; dark grayish brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; mildly alkaline; abrupt smooth boundary.

A12—4 to 7 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium prismatic structure parting to weak fine granular; slightly hard, friable; neutral; clear wavy boundary.

B21t—7 to 14 inches; brown (10YR 5/3) clay, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to strong medium blocky and subangular blocky; very hard, firm; thin shiny coatings on faces of peds; neutral; gradual wavy boundary.

B22t—14 to 23 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium and coarse prismatic

structure parting to moderate medium blocky; very hard, firm; thin shiny coatings on faces of peds; slight effervescence; neutral; clear wavy boundary.

B3ca—23 to 32 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; weak very coarse prismatic structure parting to weak coarse subangular blocky; hard, friable; common medium segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—32 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable; few segregations of lime; slight effervescence; moderately alkaline.

Depth to free carbonates ranges from 11 to 24 inches. The A horizon is dark grayish brown or grayish brown loam or clay loam. It is 4 to 8 inches thick. The B2t horizon ranges from dark brown to light yellowish brown in hue of 7.5YR to 2.5Y. It is 7 to 16 inches thick and is neutral or mildly alkaline. In places the B22t horizon is noncalcareous. The B3ca and C horizons range from brown to light yellowish brown in hue of 7.5YR to 2.5Y. They commonly are loam, clay loam, or clay and are stratified with lenses of coarser material and with layers of silty material up to 15 inches in thickness. Segregations of lime in the B3ca horizon and the C1ca horizon, where present, are common or many and fine to coarse. Reaction is mildly alkaline or moderately alkaline. In places gravelly sand or bedded soft shale is at a depth of 40 to 60 inches.

Nunn soils are near Altvan, Onita, Satanta, and Zigweid soils and are similar to Savo soils. They have a more clayey B horizon than Altvan, Satanta, and Zigweid soils; they are deeper over gravelly sand than Altvan soils; and they are deeper to free carbonates than Zigweid soils. Nunn soils have a thinner A horizon than Onita soils and contain slightly more fine sand in the B horizon than Savo soils.

NcA—Nunn clay loam, 0 to 2 percent slopes. This nearly level soil typically is on high terraces and broad tables east of the Black Hills in areas that range from 10 to 500 acres in size. It has the profile described as representative of the series.

Included with this soil in mapping are small areas of Altvan, Hoven, Mosher, Onita, and Satanta soils. Altvan and Satanta soils are on very slight rises in some areas. Hoven soils are in closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Mosher and Onita soils are in shallow swales along ill-defined drainageways.

Runoff is slow, and the hazard of erosion is slight. There are few limitations to use of this soil for crops other than moisture shortages caused by the climate. Conserving moisture is the main management concern.

Most areas are cultivated. This soil is well suited to most crops common to the survey area. Clayey range site, capability unit IIIc–1, windbreak group 3.

NcB—Nunn clay loam, 2 to 6 percent slopes. This gently sloping soil is on high terraces and broad upland tables in areas that range from 10 to 300 acres in size. Slopes are long and smooth.

Included with this soil in mapping are small areas of Altvan, Hoven, Onita, and Satanta soils. Altvan soils are in places that are underlain by gravelly sand within a depth of 40 inches. Hoven soils are in closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Onita soils are in swales. Satanta soils are intermingled with Nunn soils in an erratic pattern.

Runoff is medium, and the hazard of erosion is moderate. This soil is subject to soil blowing when it is farmed. Controlling erosion and soil blowing is the main management concern.

Many areas are cultivated but some are in native grass and are used for range and hay. This soil is well suited to most crops grown in the survey area. Clayey range site, capability unit IIIe–1, windbreak group 3.

NcC—Nunn clay loam, 6 to 9 percent slopes. This moderately sloping soil is on terrace fronts and uplands in irregularly shaped areas that range from 10 to 60 acres in size. Slopes typically are long and smooth. This soil generally has a thinner surface layer and subsoil than those in the soil described as representative of the series. In places the surface layer is gravelly.

Included with this soil in mapping are small areas of Nihill, Onita, and Zigweid soils. Nihill and Zigweid soils are on the tops and upper side slopes of some ridges and on shoulders of drainageways. Onita soils are in swales.

Runoff is medium, and the hazard of erosion is severe. This soil is also subject to soil blowing. Controlling erosion and soil blowing is the main management concern.

Many areas are in native grass and are used for range and hay. Some areas are farmed. This soil is better suited to close-sown crops than to row crops because of the hazard of erosion. Clayey range site, capability unit IVe–1, windbreak group 3.

Onita series

The Onita series consists of deep, moderately well drained to well drained, nearly level to gently sloping, loamy soils on foot slopes and in swales on uplands and terraces. These soils formed in alluvium that washed from adjacent soils. The native vegetation consisted of a mixture of tall, mid, and short grasses.

In a representative profile the surface layer is grayish brown clay loam about 11 inches thick. The subsoil, about 16 inches thick, is silty clay that is dark brown in the upper part and brown in the lower part. The underlying material is light brownish gray, calcareous, silty clay loam.

Onita soils are high in fertility and in organic-matter content. The available water capacity is high, and permeability is moderately slow. Most areas receive runoff from adjacent soils.

Many areas are cultivated. Other areas are in native grass and are used for range and hay.

Representative profile of Onita clay loam, 0 to 4 percent slopes, in cropland, 550 feet north and 175 feet west of the southeastern corner of sec. 14, T. 7 N., R. 6 E.

Ap—0 to 5 inches; grayish brown (10YR 5/2) light clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular

structure; soft, very friable; neutral; clear smooth boundary.

A12—5 to 11 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to weak fine granular; slightly hard, friable; neutral; clear wavy boundary.

B21t—11 to 21 inches; dark brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate medium and coarse prismatic structure parting to moderate medium blocky; hard, firm; thin shiny coatings on faces of peds; neutral; gradual wavy boundary.

B22t—21 to 27 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to moderate coarse subangular blocky; hard, firm; thin shiny coatings on faces of peds; neutral; gradual wavy boundary.

C1ca—27 to 40 inches; light brownish gray (2.5Y 6/2) silty clay loam, light olive brown (2.5Y 5/3) moist; very weak, coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, friable; common fine segregations of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—40 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable; few medium segregations of lime and gypsum; strong effervescence; moderately alkaline.

Depth to free carbonates ranges from 20 to 37 inches. The A horizon ranges from very dark gray to grayish brown and is clay loam, silt loam, or loam. It is 8 to 12 inches thick and is medium acid to neutral. The B2t horizon ranges from very dark gray to brown in hue of 10YR or 2.5Y and in places is heavy silty clay loam or heavy clay loam. It is 12 to 25 inches thick and is slightly acid or neutral. Some pedons have a B3 or B3ca horizon. The C horizon ranges from grayish brown to pale yellow in hue of 10YR or 2.5Y and in places is stratified with thin layers of coarser or finer material. Some pedons have a buried A horizon within the C horizon.

Onita soils are near and have a thicker A1 horizon than Blackpipe, Keith, Mosher, Nunn, Satanta, and Tilford soils. Onita soils have more clay in the B horizon than Keith, Satanta, and Tilford soils and contain less sodium in the B horizon than Mosher soils.

OaA—Onita clay loam, 0 to 4 percent slopes. This soil is on uplands and high terraces in swales and on foot slopes in long and narrow areas that range from 5 to 25 acres in size.

Included with this soil in mapping are small areas of Nunn, Satanta, and Tilford soils on convex rises on the edges of some areas.

Runoff is slow to medium. Most areas receive additional moisture in the form of runoff from adjacent soils. This additional moisture generally is beneficial but there is a moderate hazard of erosion where slopes exceed 2 percent. Controlling erosion is the main management concern.

Most areas are farmed, but some are in native grass and are used for range and hay. This soil is well suited to all crops commonly grown in the survey area. Silty range site, capability unit IIIe–2, windbreak group 1.

Paunsaugunt series

The Paunsaugunt series consists of shallow, well drained to somewhat excessively drained, gently sloping to steep soils on uplands. These soils formed in material that weathered from the underlying limestone. The native vegetation consisted of ponderosa pine and open areas of mid and short grasses.

In a representative profile the surface layer, about 8 inches thick, is gravelly loam that is dark grayish brown in the upper part and brown in the lower part. The underlying material is a thin layer of brown, calcareous, gravelly loam and a thin layer of light brownish gray, calcareous, very channery loam. Fractured limestone is at a depth of 15 inches.

Paunsaugunt soils are medium in fertility and moderate in organic-matter content. The available water capacity is very low, and permeability is moderate above the limestone.

All areas are in native vegetation and are used mainly for grazing, wildlife, and recreation. Timber production is limited mostly to posts and poles, but saw logs are harvested in places.

Representative profile of Paunsaugunt gravelly loam in an area of Paunsaugunt-Rock outcrop complex, 3 to 40 percent slopes, in native grass and scattered pine, 200 feet east and 150 feet south of the northwestern corner of sec. 30, T. 4 N., R. 6 E.

A11—0 to 3 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine, granular structure; soft, very friable; 15 percent fragments of limestone; mildly alkaline; clear wavy boundary.

A12—3 to 8 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; very weak, coarse prismatic structure parting to weak fine granular; soft, very friable; 20 percent fragments of limestone; slight effervescence; mildly alkaline; clear wavy boundary.

C1—8 to 12 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; very weak, very coarse prismatic structure; slightly hard, friable; 35 percent fragments of limestone; few fine segregations of lime; strong effervescence; moderately alkaline; clear broken boundary.

C2—12 to 15 inches; light brownish gray (10YR 6/2) very channery loam, dark brown (10YR 4/3) moist; banded white (10YR 8/1), and very pale brown (10YR 8/4) fractured limestone; massive; slightly hard, friable; 60 percent fragments of limestone; strong effervescence; mildly alkaline; clear broken boundary.

R—15 to 18 inches; fractured limestone.

Depth to bedrock ranges from 10 to 20 inches. The A horizon is loam or gravelly loam 5 to 12 inches thick. It ranges from dark gray to brown and is noncalcareous in places. Some pedons have an AC horizon that is intermediate in color between the A and C horizons. The C horizon is grayish brown to very pale brown gravelly, very gravelly, very cobbly, or very channery loam or silt loam.

Paunsaugunt soils are near Citadel, Nevee, Spearfish, and Vanocker soils and are similar to Butche soils. They are more calcareous than Butche soils; are shallower to bedrock than Citadel, Nevee, and Vanocker soils; and are underlain by harder bedrock than Spearfish soils.

PaE—Paunsaugunt-Rock outcrop complex, 3 to 40 percent slopes. These soils are on uplands in the Black Hills on gentle rises, ridges, and steep canyon walls in irregularly shaped areas that range from 20 to 200 acres in size. They are about 45 percent Paunsaugunt soils, 30 percent Rock outcrop, and 25 percent other soils. Paunsaugunt soils and Rock outcrop are so closely intermingled (fig. 15) that separate mapping is not feasible. The Paunsaugunt soil has a gravelly loam surface layer and in a few places is slightly more than 20 inches deep to limestone. The Rock outcrop consists of fractured limestone that is exposed flush with the surface in some areas and that consists of almost vertical cliffs on the sides of ridges and canyon walls in other areas.

Included with this complex in mapping are small areas of Citadel, Nevee, Tilford, Vanocker, and Winetti soils. Citadel soils are on the well timbered sides of some ridges. Nevee and Tilford soils are in sags and swales in the foot slope areas of the Black Hills. Vanocker soils are on the sides of some ridges below outcrops of limestone. Winetti soils are on narrow strips of bottom land in canyons.

Runoff is rapid, and the hazard of erosion is very severe if the plant cover is removed. The Paunsaugunt soils are not suited to cultivation because they are shallow to limestone, steep, and are closely intermingled with Rock outcrop.

All areas remain in native vegetation and are used for woodland grazing, wildlife, and recreation. Timber production is limited mostly to posts and poles, but some areas produce saw logs. The Rock outcrop part of this complex has little or no plant cover. Paunsaugunt soil is in capability unit VIIs–1, woodland group 6d0, and not placed in a range site or windbreak group; Rock outcrop is in capability unit VIIIs–1 and not placed in a range site or windbreak group.

Figure 15.—**An area of Paunsaugunt-Rock outcrop complex, 3 to 40 percent slopes. In the foreground are exposures of fractured limestone bedrock. The trees are ponderosa pine.**

Pierre series

The Pierre series consists of moderately deep, well drained, gently sloping to strongly sloping, clayey soils on uplands. These soils formed in material that weathered from the underlying soft shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown clay about 4 inches thick. The subsoil, about 20 inches thick, is grayish brown, calcareous clay. The underlying material, to a depth of 34 inches, is light olive brown, calcareous clay. Below that, it is grayish brown, soft shale.

Pierre soils are medium in fertility and moderately low in organic-matter content. The available water capacity is low, and permeability is very slow.

Most areas are in native grass and are used for range. Some areas are cultivated.

Representative profile of Pierre clay, 6 to 15 percent slopes, in native grass, 1,850 feet west and 1,000 feet south of the northeastern corner of sec. 10 T. 4 N., R. 8 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, friable, sticky and plastic; neutral; clear smooth boundary.

B2—4 to 16 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (10YR 4/2) moist; weak medium and coarse pris-

matic structure parting to moderate medium and coarse blocky; very hard, firm, sticky and plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

B3ca—16 to 24 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to moderate coarse blocky; very hard, very firm, sticky and plastic; common fine segregations of lime; moderately alkaline; gradual wavy boundary.

C—24 to 34 inches; light olive brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) moist; massive; very hard, firm, sticky and plastic; common fine fragments of soft shale; few nests of gypsum crystals; slight effervescence; mildly alkaline; clear smooth boundary.

Cr—34 to 60 inches; grayish brown (2.5Y 5/2) soft shale, dark grayish brown (2.5Y 4/2) moist; bedded, shale has platy structure; common nests of gypsum crystals in seams and cracks; mildly alkaline.

The solum ranges from 15 to 31 inches thick. Depth to bedded soft shale ranges from 20 to 40 inches. When the soil is dry, cracks that are ½ to 2 inches wide and several feet long extend downward through the solum. The A horizon ranges from gray to olive in hue of 10YR to 5Y. It is clay or silty clay and in places is calcareous. This horizon is 3 to 6 inches thick and is slightly acid and neutral. In places it includes a light gray crust that is ¼ to 1 inch thick. The B2 horizon ranges from gray to pale olive in hue of 2.5Y or 5Y. It is 12 to 22 inches thick and is neutral to moderately alkaline. Some pedons lack a B3 horizon. The C horizon ranges from gray to pale yellow in hue of 2.5Y or 5Y and is mildly alkaline or moderately alkaline.

Pierre soils are near Hisle, Kyle, Lismas, and Samsil soils and are similar to Winler soils. They contain less sodium than Hisle soils, and are shallower over shale than Kyle soils, are deeper over shale than Lismas and Samsil soils, and have a lower salt content above a depth of 20 inches than Winler soils.

PbB—Pierre clay, 2 to 6 percent slopes. This gently sloping soil is on uplands in irregularly shaped areas that range from 20 to 80 acres in size. The slopes are convex and mostly long and smooth. In places the depth to soft shale is slightly more than 40 inches and in a few places the surface layer is clay loam.

Included with this soil in mapping are small areas of Hisle and Nunn soils. Hisle soils are in sags and on foot slopes. Nunn soils are on the tops of some ridges.

Runoff is medium, and the hazard of erosion is severe. This soil loses its tilth and blows easily when it is farmed. It absorbs water slowly and releases it slowly to plants. Controlling erosion and soil blowing is the main management concern.

Many areas are in native grass and are used for range and hay. Some areas are farmed. Clayey range site, capability unit IVe–3, windbreak group 4.

PbC—Pierre clay, 6 to 15 percent slopes. This moderately sloping to strongly sloping soil is on uplands in irregularly shaped areas that range from 10 to 300 acres in size. The areas typically consist of ridges and entrenched drainageways. This soil has the profile described as representative of the series, except in places the depth to soft shale is slightly more than 40 inches. Where this soil is near Grummit soils in the western part of the survey area, the underlying soft shale is acid.

Included with this soil in mapping are small areas of Hisle, Nunn, Lismas, and Samsil soils. Hisle soils are in sags and on foot slopes and fans along drainageways. Nunn soils are on flattened ridgetops. Lismas and Samsil soils are on the tops and upper side slopes of some ridges and on sharp shoulders of entrenched drainageways. In places stones and cobbles are on the surface and are shown on the soil map by the spot symbol for stony areas.

Runoff is medium. This soil absorbs water slowly and releases it slowly to plants. It generally is not suited to cultivation because of slope and high susceptibility to erosion.

Most areas remain in native grass and are used for range. Clayey range site, capability unit VIe–4, windbreak group 10.

Samsil series

The Samsil series consists of shallow, well drained to excessively drained, moderately sloping to steep, clayey soils on uplands. These soils formed in material that weathered from the underlying soft shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown clay about 2 inches thick. The next layer is grayish brown calcareous clay about 6 inches thick. The underlying material, to a depth of 14 inches, is light brownish gray, calcareous shaly clay. Bedded soft shale is at a depth of 14 inches.

Samsil soils are low in fertility and organic-matter content. The available water capacity is very low, and permeability is slow.

All areas are in native grass and are used for range.

Representative profile of Samsil clay, 15 to 40 percent slopes, in native grass, 1,900 feet east and 1,000 feet south of the northwestern corner of sec. 27, T. 3 N., R. 14 E.

A1—0 to 2 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; slightly hard, friable, sticky and plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

AC—2 to 8 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; hard, friable, sticky and plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

C—8 to 14 inches; light brownish gray (2.5Y 6/2) shaly clay, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable, sticky and plastic; 35 percent fine fragments of soft shale; slight effervescence; moderately alkaline; gradual wavy boundary.

Cr1cs—14 to 36 inches; light brownish gray (2.5Y 6/2) bedded soft shale, dark grayish brown (2.5Y 4/2) moist; platy bedrock structure; many light yellowish brown and olive brown stains; common nests of gypsum crystals in seams; slight effervescence; mildly alkaline; gradual wavy boundary.

Cr2—36 to 60 inches; light brownish gray (2.5Y 6/2) bedded soft shale, grayish brown (2.5Y 5/2) moist; platy bedrock structure; slight effervescence; mildly alkaline.

Depth to bedded soft shale ranges from 4 to 20 inches. Clay content in horizons above the Cr horizon ranges from 45 to 65 percent. The A horizon is clay or silty clay and ranges from grayish brown to pale yellow in hue of 10YR, 2.5Y, or 5Y. It is 2 to 4 inches thick and when dry includes a light gray crust about ½ inch thick. Some pedons lack an AC horizon. The C and Cr horizons range from gray to pale yellow in hue of 10YR, 2.5Y, or 5Y. Fine fragments of soft shale in the C horizon make up 5 to 70 percent of the volume. The C horizon is mildly alkaline or moderately alkaline. The Cr horizon is medium acid to moderately alkaline.

Samsil soils are near Hisle, Kyle, and Pierre soils and are similar to Grummit, Lismas, and Midway soils. They are more alkaline than Grummit soils and are shallower to shale than Hisle, Kyle, and Pierre soils. Samsil soils are more friable than Lismas soils and are more clayey than Midway soils.

SaE—Samsil clay, 15 to 40 percent slopes. This moderately steep to steep soil is mainly in breaks of the Belle Fourche and Cheyenne Rivers. Typically, the mapped areas are laced with numerous short drainageways, many of which are gullied. The areas are irregular in shape and range from 40 to 1,000 acres or more in size. This Samsil soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Kyle, Nihill, Pierre, Stetter, and Zigweid soils. Kyle and Pierre soils generally are in the lower part of the landscape. Nihill and Zigweid soils are in the higher part that borders high terraces or tablelands. Stetter soils are on narrow bottom lands along major drainageways. Also included are some small areas of Rock outcrop around the heads of gullied drainageways.

Runoff is rapid. This soil is not suited to cultivation because of shallowness, steep slopes, low fertility, and high susceptibility to erosion.

All areas are in native grass and are used for range. Native cedar trees commonly are scattered on north-facing slopes. Shallow range site, capability unit VIIe–5, windbreak group 10.

SBD—Samsil-Pierre association, sloping. This mapping unit is on uplands—typically in the lower part of the Cheyenne River breaks, on ridges, and on valley sides along creeks and major drainageways. Slopes are 6 to 15 percent. The areas are irregularly shaped and range from 40 to 150 acres in size.

This mapping unit is about 45 percent Samsil soils, 30 percent Pierre soils, and 25 percent other soils. Samsil soils are in the higher part of the landscape. Most of the Pierre soils are in the lower part, but some are on smooth ridgetops.

Included with these soils in mapping are small areas of Hisle, Kyle, and Swanboy soils on foot slopes and fans and along drainageways.

Runoff is medium to rapid, and the hazard of erosion is severe if the soils are farmed. Controlling erosion is the main management concern.

Almost all areas are in native grass and are used for range. Capability unit VIe–12, windbreak group 10; Samsil soil is in Shallow range site; Pierre soil is in Clayey range site.

SCE—Samsil-Rock outcrop association, steep. This mapping unit is mainly in breaks of the Belle Fourche and Cheyenne Rivers. Slopes are mostly steep and broken and exceed 40 percent in places. The mapped areas range from 40 to several hundred acres in size.

This mapping unit is about 50 percent Samsil soils, 30 percent Rock outcrop, and 20 percent other soils. The Samsil soil is shallow and has a clay surface layer. Rock outcrop is on rounded knolls and on almost vertical cut banks or escarpments and around the head of drainageways. It is made up of eroding exposures of soft, clayey shale.

Included in mapping are small areas of Hisle, Kyle, Nihill, Pierre, Stetter, and Swanboy soils. Hisle, Kyle, and Swanboy soils are on foot slopes and fans in the lower part of the landscape. Nihill soils are on gravelly ridges. Pierre soils are on smooth ridgetops and in the lower part of the landscape. Stetter soils are on bottoms of the larger draws.

Runoff is rapid to very rapid, and the hazard of erosion is very severe. Controlling erosion is the main management concern.

All areas are used for range. The Rock outcrop part of this mapping unit has little or no vegetation. Samsil soil is in Shallow range site, capability unit VIIe–5, windbreak group 10; Rock outcrop is in capability unit VIIIs–1 and not placed in a range site or windbreak group.

Satanta series

The Satanta series consists of deep, well drained, nearly level to moderately sloping, loamy soils that formed in alluvium. These soils are on terraces and uplands. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown loam about 6 inches thick. The subsoil is about 25 inches thick. It is dark grayish brown heavy loam in the upper part, brown clay loam in the middle, and pale brown calcareous loam in the lower part. Spots and streaks of soft lime are in the lower part and extend into the underlying material. The underlying material to a depth of 40 inches is pale brown calcareous loam. Below that it is pale brown calcareous loam stratified with thin layers of silt loam and fine sandy loam.

Satanta soils are medium in fertility and moderate in organic-matter content. The available water capacity is high, and permeability is moderate.

Many areas are cultivated. Some areas are in native grass and are used for range and hay.

Representative profile of Satanta loam, 2 to 6 per-

cent slopes, in a cultivated area, 350 feet east and 85 feet north of the southwestern corner of sec. 15, T. 5 N., R. 10 E.

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

B1—6 to 9 inches; dark grayish brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) moist; weak coarse prismatic structure parting to moderate medium and coarse subangular blocky; slightly hard, friable; neutral; gradual wavy boundary.

B2t—9 to 21 inches; brown (10YR 5/3) clay loam, brown (10YR 4/3) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm; thin shiny coatings on ped faces; neutral; gradual wavy boundary.

B3ca—21 to 31 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; weak very coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; common fine threads and seams of segregated lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C1ca—31 to 40 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; slightly hard, friable; common fine threads and seams of segregated lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—40 to 60 inches; pale brown (10YR 6/3) loam stratified with thin layers of silt loam and fine sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline.

The solum is 16 to 40 inches thick. Depth to free carbonates ranges from 15 to 31 inches. The A horizon is dark grayish brown to brown loam or fine sandy loam. It is 5 to 10 inches thick and is slightly acid to mildly alkaline. Some pedons lack a B1 horizon. The B2t horizon is loam, clay loam, or sandy clay loam and ranges from dark grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is 6 to 18 inches thick and is neutral to moderately alkaline. The B3 and C horizons commonly are loam, light clay loam, or sandy clay loam and range from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. In some places, gravelly sand is at a depth of 40 to 60 inches.

Satanta soils are near Altvan, Assinniboine, Mosher, and Nunn soils, and they are similar to Keith soils. In contrast to Altvan soils, Satanta soils lack gravelly sand within a depth of 40 inches. The contain less fine sand or coarser sand in the B horizon than Assinniboine soils and contain more sand in the B horizon than Keith soils. Satanta soils contain less clay in the B horizon than Mosher and Nunn soils.

SdA—Satanta loam, 0 to 2 percent slopes. This nearly level soil is on terraces and uplands in irregularly shaped areas that range from 10 to 200 acres in size.

Included with this soil in mapping are small areas of Altvan, Hoven, Mosher, Nunn, and Onita soils. Altvan soils are on the edge of some areas where depth to gravelly sand is less than 40 inches. Hoven soils are in small closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Mosher and Onita soils are in shallow swales. Nunn soils are on foot slopes bordering swales and closed depressions.

Runoff is slow. This soil is easy to work, and its use for crops is limited only by periodic moisture shortages caused by the climate. Conserving moisture is the main management concern.

Most areas are cultivated. Some areas remain in native grass and are used for range and hay. Silty range site, capability unit IIIc–1, windbreak group 3.

SdB—Satanta loam, 2 to 6 percent slopes. This gently sloping soil is on terraces and uplands in irregularly shaped areas that range from 10 to 200 acres in size. This soil has a profile similar to the one described as representative of the series, except that in a few places it has a surface layer of fine sandy loam and a subsoil of sandy clay loam.

Included with this soil in mapping are small areas of Altvan, Hoven, Mosher, and Onita soils. Altvan soils are in places where gravelly sand is at a depth of less than 40 inches, Hoven soils are in small, closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Mosher soils are in sags and along drainageways. Onita soils are in swales.

Runoff is medium, and the hazard of erosion is moderate. Controlling erosion is the main management concern.

This soil is well suited to crops, and many areas are cultivated. Some areas are used for range and hay. Silty range site, capability unit IIIe–1, windbreak group 3.

SdC—Satanta loam, 6 to 9 percent slopes. This moderately sloping soil is on terrace fronts and uplands in irregularly shaped areas that range from 10 to 40 acres in size. This soil has a thinner surface layer and in places is shallower to lime than the soil described as representative of the series. In a few places pebbles and cobbles are scattered on the surface and throughout the soil.

Included with this soil in mapping are small areas of Altvan, Nihill, Onita, and Zigweid soils. Altvan and Nihill soils are on gravelly ridges, Onita soils are in swales, and Zigweid soils are commonly immediately below Nihill soils.

Runoff is medium, and the hazard of erosion is severe. Controlling erosion is the main management concern.

Most areas remain in native grass and are used for range and hay. Some areas are cultivated. This soil is better suited to close-sown crops than to row crops because of the hazard of erosion. Silty range site, capability unit IVe–1, windbreak group 3.

SeA—Satanta-Mosher loams, 0 to 3 percent slopes. These nearly level soils are mostly on terraces and tablelands in irregularly shaped areas that range from 5 to 40 acres in size. This mapping unit is about 55 percent Satanta soils, 30 percent Mosher soils, and 15 percent other soils. Satanta soils are on very slight

rises, and Mosher soils are in the lower part of the landscape along poorly defined drainageways.

Included with these soils in mapping are small areas of Arvada, Hoven, and Nunn soils. Arvada soils are intermingled with Mosher soils. Hoven soils are in small, closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Nunn soils are on some very slight rises.

Runoff is slow. Except for moisture shortages caused by the climate, use of the Satanta soil for crops is only slightly limited. The Mosher soil is slow to dry in spring but is droughty late in summer. Its claypan subsoil takes in water slowly and releases moisture slowly to plants. The Mosher soil compacts and loses tilth if farmed when wet. Conserving moisture, improving water intake in the Mosher soil, and maintaining tilth are the main concerns of management.

Some areas are farmed. Crop growth is uneven because of the sodium in Mosher soil. Other areas are in native grass and are used for range and hay. Satanta soil is in Silty range site, capability unit IIIc–1, windbreak group 3. Mosher soil is in Claypan range site, capability unit IVs–2, windbreak group 9.

Savo series

The Savo series consists of deep, well drained, nearly level to gently sloping, silty soils on terraces and uplands. These soils formed in silty alluvium that derived in part from silty shale.

In a representative profile the surface layer is grayish brown silty clay loam about 4 inches thick. The subsoil is about 25 inches thick. It is dark grayish brown heavy silty clay loam in the upper part, grayish brown, calcareous silty clay in the middle part, and grayish brown, calcareous heavy silty clay loam in the lower part. Spots and streaks of soft lime are in the lower part and in the underlying material. The underlying material is light brownish gray, calcareous silty clay loam.

Savo soils are medium in fertility and moderate in organic-matter content. The available water capacity is high, and permeability is moderately slow.

Many areas are cultivated. Some areas are in native grass and are used for range and hay.

Representative profile of Savo silty clay loam, 0 to 2 percent slopes, in native grass, 850 feet east and 75 feet north of the southwestern corner of sec. 31, T. 3 N., R. 14 E.

A1—0 to 4 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; neutral; clear wavy boundary.

B21t—4 to 13 inches; dark grayish brown (10YR 4/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, firm, sticky and plastic; mildly alkaline; gradual wavy boundary.

B22t—13 to 22 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate medium and coarse prismatic structure parting to moderate medium and coarse subangular blocky; very hard, very firm, sticky and plastic; thin shiny coatings on faces of peds; slight effervescence; mildly alkaline; gradual wavy boundary.

B3ca—22 to 29 inches; grayish brown (2.5Y 5/2) heavy silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak very coarse prismatic structure parting to weak coarse subangular blocky; hard, firm, sticky and plastic; common segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2cacs—29 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable; common nests of gypsum; many segregations of lime; strong effervescence; moderately alkaline.

The solum is 17 to 33 inches thick. Depth to free carbonates ranges from 12 to 20 inches. The A horizon is dark grayish brown or grayish brown silty clay loam or silt loam. It is 3 to 5 inches thick and is slightly acid or neutral. The B2t horizon ranges from dark grayish brown to brown or light olive brown, and in places the lower part is noncalcareous. It is 11 to 18 inches thick and is neutral or mildly alkaline. The B3 and C horizons range from grayish brown to pale yellow and are mildly alkaline or moderately alkaline. In places gravelly sand or bedded soft shale is between depths of 40 and 60 inches.

Savo soils are near Blackpipe and Onita soils and are similar to Keith, Nunn, and Satanta soils. Unlike Blackpipe soils, Savo soils lack bedded soft shale within a depth of 40 inches. They have more clay in the B horizon than Keith and Satanta soils. Savo soils contain more silt and less fine sand in the B horizon than Nunn soils and have a thinner A horizon than Onita soils.

ShA—Savo silty clay loam, 0 to 2 percent slopes. This nearly level soil is on terraces and uplands in irregularly shaped areas that range from 10 to 60 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Arvada, Blackpipe, Hoven, and Onita soils. Arvada soils are in sags and along ill-defined drainageways. Blackpipe soils are on some of the slight rises. Hoven soils are in small, closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Onita soils are in shallow swales.

Runoff is slow. The use of this soil for crops is only slightly limited except for periods of moisture shortages caused by the climate. Conserving moisture is the main management concern.

Many areas are cultivated. Other areas remain in native grass and are used for range and hay. Silty range site, capability unit IIIc–1, windbreak group 3.

SkB—Savo and Blackpipe soils, 2 to 6 percent slopes. These gently sloping soils are on uplands in irregularly shaped areas that range from 20 to 80 acres in size. Slopes are long and smooth. Some areas are mostly Savo soils and some are mostly Blackpipe soils. In

areas containing both soils, Blackpipe soils generally are in the higher part of the landscape. This Savo soil has a surface layer of silty clay loam. This Blackpipe soil has a surface layer of silt loam and has the profile described as representative of the Blackpipe series.

Included with these soils in mapping are small areas of Arvada, Hoven, Manvel, Nunn, and Onita soils. Arvada soils are in sags and on foot slopes. Hoven soils are in small, closed depressions, some of which are shown on the soil map by the symbol for a wet spot. Manvel soils are on the higher part of the landscape in some areas. Nunn soils are on flattened ridgetops. Onita soils are in swales.

Runoff is medium, and the hazard of erosion is moderate. These soils are well suited to the crops commonly grown in the survey area although the Blackpipe soil is somewhat droughty. Controlling erosion is the main management concern.

Many areas are in native grass and are used for range and hay. Some areas are used for crops. Silty range site, capability unit IIIe–1, windbreak group 3.

Shingle series

The Shingle series consists of shallow, well drained, moderately sloping to strongly sloping, calcareous, loamy soils on uplands. These soils formed in material that weathered from the underlying soft shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is grayish brown loam about 3 inches thick. The next layer is light brownish gray light clay loam about 5 inches thick. The underlying material, to a depth of 17 inches, is light gray loam. Below that, it is light gray, soft shale. All layers are calcareous.

Shingle soils are low in fertility and organic-matter content. The available water capacity is low, and permeability is moderate.

Most areas are in native grass and are used for range; some small areas are cultivated.

Shingle soils are mapped only in complex with Blackpipe soils.

Representative profile of Shingle loam in an area of Blackpipe-Shingle complex, 6 to 15 percent slopes, in native grass, 900 feet north and 80 feet west of the southeastern corner of sec. 32, T. 3 N., R. 14 E.

A1—0 to 3 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable; slight effervescence; mildly alkaline; clear smooth boundary.

AC—3 to 8 inches; light brownish gray (10YR 6/2) light clay loam, dark grayish brown (10YR 4/2) moist; few medium distinct brownish yellow (10YR 6/6) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; strong effervescence; moderately alkaline; gradual wavy boundary.

C—8 to 17 inches; light gray (10YR 7/2) loam, light brownish gray (10YR 6/2) moist; very weak, coarse prismatic structure; slightly hard, friable; strong effervescence; moderately alkaline; clear smooth boundary.

Cr—17 to 60 inches; light gray (2.5Y 7/2) soft shale, light brownish gray (10YR 6/2) moist; platy bedrock structure; slightly hard, friable; common reddish yellow (7.5YR 6/6) stains in seams and fractures; slight effervescence; moderately alkaline.

Depth to bedded soft shale ranges from 10 to 20 inches. Free carbonates are at or within 6 inches of the surface. The horizons above the bedded shale contain more than 15 percent fine sand or coarser sand. The A horizon is loam or clay loam and ranges from gray to pale yellow in hue of 7/5YR to 5Y. It is 3 to 6 inches thick and is mildly alkaline to strongly alkaline. The AC and C horizons range from gray to pale yellow in hue of 7.5YR to 5Y and are moderately alkaline or strongly alkaline. The AC horizon is 3 to 5 inches thick. Fine fragments of soft shale commonly are in the C horizon and make up to 50 percent of the horizon in some pedons.

Shingle soils are near Blackpipe and Savo soils and are similar to Cabbart, Canyon, Enning, and Midway soils. They are shallower to soft shale than Blackpipe and Savo soils, have warmer temperatures than Cabbart soils, contain more fine sand or coarser sand than Canyon soils, are less calcareous than Enning soils, and have less clay than Midway soils.

Spearfish series

The Spearfish series consists of shallow, well drained to excessively drained, moderately sloping to steep, calcareous, loamy soils on uplands. These soils formed in material that weathered from the underlying reddish-colored silt-stone, sandstone, or shale. The native vegetation consisted mainly of mid and short grasses, but a few short, limby ponderosa pine are scattered throughout some areas.

In a representative profile the surface layer is reddish brown loam about 3 inches thick. The next layer is reddish brown loam about 5 inches thick. The underlying material, to a depth of 16 inches, is yellowish red loam. Below that, it is reddish yellow siltstone. All layers are calcareous.

Spearfish soils are low in fertility and in organic-matter content. The available water capacity is very low or low, and permeability is moderate.

Most areas are in native grass and are used for range.

Representative profile of Spearfish loam in an area of Spearfish-Rock outcrop complex, 15 to 40 percent slopes, in native grass, 2,300 feet east and 1,000 feet north of the southwestern corner of sec. 15, T. 5 N., R. 5 E.

A1—0 to 3 inches; reddish brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) moist; weak fine granular structure; soft, very friable; many roots; slight effervescence; mildly alkaline; clear smooth boundary.

AC—3 to 8 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure;

soft, very friable; many fine roots; strong effervescence; moderately alkaline; gradual wavy boundary.

C—8 to 16 inches; yellowish red (5YR 5/6) loam; dark red (2.5YR 3/6) moist; massive; soft, very friable; few fine roots; common fragments of soft siltstone; common fine nests of gypsum crystals; strong effervescence; moderately alkaline; clear smooth boundary.

Cr—16 to 60 inches; reddish yellow (5YR 6/6) bedded siltstone, reddish brown (5YR 5/4) moist; common thin layers and nests of gypsum between bedding planes; strong effervescence; mildly alkaline.

Depth to soft bedrock ranges from 6 to 20 inches. The horizons above the bedrock commonly are loam, but in places they are very fine sandy loam, silt loam, or silty clay loam. The A horizon ranges from dark grayish brown to light reddish brown in hue of 10YR to 5YR. It is 2 to 5 inches thick and is neutral to moderately alkaline. The AC and C horizons range from brown to light red in hue of 7.5YR to 2.5YR. They are mildly alkaline or moderately alkaline. Some pedons lack an AC horizon, but where present, it ranges up to 5 inches thick. The Cr horizon is bedded siltstone, sandstone, or shale. It is soft and easily penetrated.

Spearfish soils are near Canyon, Nevee, Paunsaugunt, and Tilford soils. They have redder colors than Canyon soils, are shallower to bedrock than Nevee and Tilford soils, and are underlain by softer bedrock than Paunsaugunt soils.

S1E—Spearfish-Rock outcrop complex, 15 to 40 percent slopes. This complex is on the tops and upper side slopes of upland ridges and on shoulders of entrenched drainageways. Areas are irregularly shaped and range from 15 to 40 acres in size. They are about 55 percent Spearfish soils, 20 percent Rock outcrop, and 25 percent other soils. The Spearfish soil has a loam surface layer and the profile described as representative of the series. The Rock outcrop part generally is on the upper side slopes of ridges and knolls, around the heads of drainageways, and along eroding drainageways. It consists of eroding exposures of reddish-colored soft sandstone, siltstone, or shale that contains seams of gypsum rock in places. In some areas, outcrops of the gypsum rock are on the tops of knolls.

Included with this complex in mapping are small areas of Nevee, Nihill, Tilford, and Winetti soils. Nevee and Tilford soils are in the mid and lower parts of the landscape below Spearfish soils. Nihill soils are on gravel-capped ridgetops. Winetti soils are on the bottom of drainageways flowing out of the adjacent Black Hills.

Runoff is rapid, and the hazard of erosion is very severe. The Spearfish soil is not suited to cultivation because it is shallow, steep, low in fertility, and highly susceptible to erosion.

All areas remain in native vegetation and are used for range. Spearfish soil is in Shallow range site, capability unit VIIe–4, windbreak group 10; Rock outcrop is in capability unit VIIIs–1 and not placed in a range site or windbreak group.

St. Onge series

The St. Onge series consists of deep, moderately well drained to well drained, nearly level, loamy soils on bottom land. These soils formed in alluvium. The native vegetation consisted mainly of tall and mid grasses, but native trees and shrubs commonly are in a narrow belt along stream channels.

In a representative profile the surface layer is dark grayish brown and dark gray loam about 29 inches thick. The underlying material is pinkish gray loam. All layers are calcareous.

St. Onge soils are high in fertility and in organic-matter content. The available water capacity is high, and permeability is moderate. These soils are subject to flooding in some years.

Many areas are cultivated. Some are in native grass and are used for grazing and hay.

Representative profile of St. Onge loam, in cropland, 2,500 feet south and 100 feet east of the northwestern corner of sec. 33, T. 6 N., R. 6 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable; slight effervescence; neutral; clear smooth boundary.

A12—6 to 20 inches; dark gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; very weak, coarse prismatic structure parting to weak fine granular; slightly hard, friable; slight effervescence; neutral; gradual wavy boundary.

A13—20 to 29 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable; slight effervescence; neutral; gradual wavy boundary.

C—29 to 60 inches; pinkish gray (7.5YR 6/2) loam, dark brown (7.5YR 4/2) moist; common medium faint, light gray, reddish yellow and yellowish brown mottles; massive; slgihtly hard, friable; slight effervescence; neutral.

Free carbonates are at or within 15 inches of the surface. Some pedons have a buried A horizon at a depth below 20 inches. The A horizon ranges from very dark gray to brown and commonly is loam, but in places it is silt loam or very fine sandy loam. It is 20 to 48 inches thick and is neutral or mildly alkaline. The C horizon ranges from grayish brown to light reddish brown in hue of 10YR to 5YR. It is loam in most places but commonly is stratified with thin layers of fine sandy loam, very fine sandy loam, silt loam, or clay loam. In places this horizon has few to many segregations of lime. It is neutral to moderately alkaline.

St. Onge soils are near Glenberg, Lohmiller, and Tilford soils and are similar to Onita soils. They have a thicker A horizon than Glenberg, Lohmiller, and Tilford soils. They have less sand than Glenberg soils and less clay than Lohmiller and Onita soils.

So—St. Onge loam. This is a nearly level soil on bottom land along streams flowing out of the Black

Hills. Areas range from 10 to 200 acres in size. Some areas are long and narrow and are dissected into small tracts by stream channels, but some range up to one-half mile or more in width. Slope is 0 to 2 percent.

Included with this soil in mapping are small areas of Altvan, Glenberg, Keith, Satanta, and Tilford soils. Altvan, Keith, Satanta, and Tilford soils are on remnants of valley terraces. Glenberg soils are along the stream channel.

Runoff is slow, and the hazard of erosion is slight. Areas near stream channels are subject to flooding in some years, but some areas rarely are flooded. The use of this soil for crops is only slightly limited except by periodic moisture shortages resulting from the climate. Conserving moisture is the main management concern.

Most areas are used for crops. A few areas remain in native vegetation and are used for range and hay. Native trees and shrubs along stream channels provide cover for wildlife and winter protection for livestock. Overflow range site, capability unit IIIc–3, windbreak group 1.

Stetter series

The Stetter series consists of deep, well drained, nearly level, clayey soils on bottom land. These soils formed in alluvium. The native vegetation consisted mainly of mid and tall grasses, but in places native trees and shrubs are scattered along stream channels.

In a representative profile the surface layer is grayish brown clay about 3 inches thick. The underlying material is clay that is grayish brown to a depth of 30 inches. Below that, it is light brownish gray.

Stetter soils are medium in fertility and moderately low in organic-matter content. The available water capacity is low or moderate, and permeability is slow or very slow. Most areas are subject to stream flooding.

Most areas are in native grass and are used for range and hay, but a few are cultivated.

Representative profile of Stetter clay, in native grass, 1,700 feet west and 1,500 feet south of the northeastern corner of sec. 17, T. 5 N., R. 11 E.

A11—0 to 1 inch; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium platy structure parting to weak fine granular; slightly hard, friable; mildly alkaline; clear smooth boundary.

A12—1 to 3 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; hard, firm, sticky and plastic; mildly alkaline; clear smooth boundary.

C1—3 to 10 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; very hard, very firm, sticky and plastic; moderately alkaline; gradual wavy boundary.

C2—10 to 30 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, very firm, sticky and plastic; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; light brownish gray (2.5Y 6/2) clay, grayish brown (2.5Y 5/2) moist; massive; extremely hard, very firm, sticky and plastic; stratified with thin lenses of coarser material; few fine segregations of lime; noncalcareous matrix; mildly alkaline.

Stetter soils generally lack free carbonates, but some pedons have thin layers that are calcareous. Reaction ranges from neutral to moderately alkaline throughout the profile. When the soil is dry, cracks that are ½ to 2 inches wide and several feet long extend downward 4 feet or more. The A horizon ranges from dark gray to light brownish gray in hue of 2.5Y or 10YR and is 2 to 6 inches thick. The C horizon commonly has horizontal bedding planes. The material below a depth of 40 inches ranges from loamy sand to clay. In places bedded soft shale is at a depth between 40 and 60 inches.

Stetter soils are near Kyle, Lohmiller, and Swanboy soils. They have less clay than Kyle and Swanboy soils and have more clay and are less calcareous than Lohmiller soils.

St—Stetter clay. This is a nearly level soil on bottom land in areas ranging from 10 to 200 acres in size. Some areas are long and narrow and are dissected into small tracts by stream channels, but some range up to a quarter mile in width. In a few places this soil is slightly wetter than is defined as the range for the series. Slope is 0 to 2 percent.

Included with this soil in mapping are small areas of Hisle, Kyle, Lohmiller, and Swanboy soils. Hisle, Kyle, and Swanboy soils are on remnants of terraces within some areas or on foot slopes and fans on the edges of the areas. Lohmiller soils generally are in narrow strips along the stream channel.

Runoff is slow, and most areas are subject to stream flooding. This soil is difficult to work and loses its tilth if farmed when wet. It absorbs water slowly and releases it slowly to plants. Improving water absorption and maintaining tilth are the main management concerns if this soil is farmed.

Most areas remain in native vegetation and are used for range and hay. Only a few areas are used for crops. Scattered native trees provide cover for wildlife and winter protection for livestock. Overflow range site, capability unit IVs–3, windbreak group 4.

Swanboy series

The Swanboy series consists of deep, moderately well drained to well drained, nearly level to gently sloping, clayey soils on stream terraces and uplands. These soils formed in alluvium. The native vegetation consisted mainly of a sparse stand of mid grasses.

In a representative profile the surface layer is light brownish gray clay about 1 inch thick. The subsoil, about 19 inches thick, is light brownish gray clay that has visible salts in the lower part. The underlying material is light brownish gray clay. All layers are calcareous.

Swanboy soils are low in fertility and in organic-matter content. The available water capacity is low or moderate, and permeability is very slow.

All areas are in native grass and are used for range.

Representative profile of Swanboy clay, in an area

of Swanboy-Slickspots complex, 0 to 6 percent slopes, in native grass, 1,900 feet east and 300 feet south of the northwestern corner of sec. 6, T. 4 N., R. 11 E.

A1—0 to 1 inch; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; hard, friable; light gray vesicular crust in upper ¼ inch; slight effervescence; moderately alkaline; clear smooth boundary.

B21—1 to 7 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; weak fine blocky structure; extremely hard, very firm, sticky and very plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

B22—7 to 20 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate medium blocky structure; extremely hard, very firm, sticky and very plastic; common nests of salt crystals; slight effervescence; mildly alkaline; gradual wavy boundary.

C1—20 to 36 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; massive; extremely hard, very firm, sticky and plastic; common nests of salt crystals; slight effervescence; mildly alkaline; gradual wavy boundary.

C2—36 to 60 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; common medium distinct white and light gray mottles; massive; extremely hard, very firm, sticky and plastic; common nests of gypsum and other salts; slight effervescence; mildly alkaline.

The solum is 9 to 24 inches thick. Some pedons are noncalcareous. Reaction throughout the profile ranges from neutral to strongly alkaline. Visible segregations of salts are within 15 inches of the surface. When the soil is dry, cracks that range up to 2 inches wide and several feet long extend downward to a depth of 20 inches or more. The A horizon is clay or silty clay and 1 or 2 inches thick, and ranges from gray to light olive gray in hue of 10YR to 5Y. The B and C horizons range from grayish brown to pale yellow in hue of 2.5Y or 5Y and have a clay content of 60 to 75 percent.

Swanboy soils are near Hisle, Kyle, Pierre, and Winler soils. They contain less sodium than Hisle soils and have visible salts at a shallower depth than Kyle soils. Swanboy soils are deeper to shale than Pierre and Winler soils.

SwB—Swanboy clay, 2 to 6 percent slopes. This gently sloping soil is on foot slopes and fans below steeper clayey soils in areas that range from 10 to 100 acres in size. Slopes are slightly convex to slightly concave.

Included with this soil in mapping are small areas of Hisle, Kyle, and Winler soils. Hisle soils are intermingled with the Swanboy soil in an erratic pattern in some areas. Kyle and Winler soils are on convex rises in some areas. Also included in some places are small areas of Slickspots.

Runoff is rapid, and the hazard of erosion is severe. This soil has very poor tilth and is difficult to work. It absorbs water very slowly and releases it slowly to plants. This soil generally is not suited to cultivation because it has very poor tilth, low fertility, and salts at a shallow depth.

All areas remain in native grass and are used for range. Dense Clay range site, capability unit VIs–6, windbreak group 10.

SyB—Swanboy-Slickspots complex, 0 to 6 percent slopes. These soils are on foot slopes and fans below steeper clayey soils in irregularly shaped areas that range from 10 to 50 acres in size. The areas are about 60 percent Swanboy soils and 40 percent Slickspots. The Slickspots generally are scattered throughout the areas and range from 3 to 100 feet or more in width. They consist of massive clay that has a "slicked-over" crust and generally contains visible salts within a depth of 6 inches. This Swanboy soil has the profile described as representative of the series.

Included with this complex in mapping are small areas of Kyle and Stetter soils. Kyle soils are on some of the rises. Stetter soils are in narrow strips along some drainageways.

Runoff is medium to rapid, and in places it ponds on Slickspots. These soils are not suited to cultivation because they have very poor tilth, low fertility, and salts at a shallow depth.

All areas are in native vegetation and are used for range. The Slickspots part of this unit generally has little or no vegetation. Swanboy soil is in Dense Clay range site, capability unit VIs–6, windbreak group 10; Slickspots is in capability unit VIIIs–3 and not placed in a range site or windbreak group.

Tilford series

The Tilford series consists of deep, well drained, nearly level to gently sloping, silty soils on uplands, terraces, and alluvial fans. These soils formed in material that weathered from reddish-colored siltstone or shale. The native vegetation consisted mainly of mid and short grasses.

In a representative profile the surface layer is dark brown silt loam about 5 inches thick. The subsoil is about 21 inches thick. It is dark reddish gray, calcareous silt loam in the upper part; reddish brown, calcareous silt loam in the middle part; and reddish yellow, calcareous loam in the lower part. The underlying material is light reddish brown, calcareous loam.

Tilford soils are medium in fertility and moderate in organic-matter content. The available water capacity is high, and permeability is moderate.

Many areas are cultivated. Some areas are in native grass and are used for grazing and hay.

Representative profile of Tilford silt loam, 2 to 6 percent slopes, in native grass, 1,400 feet south and 400 feet west of the northeastern corner of sec. 15, T. 3 N., R. 6 E.

A1—0 to 5 inches; dark brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; clear wavy boundary.

B21—5 to 9 inches; dark reddish gray (5YR 4/2) silt loam, dark reddish brown (5YR 3/2) moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few siltstone fragments; slight effervescence; neutral; gradual wavy boundary.

B22—9 to 16 inches; reddish brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

B3—16 to 26 inches; reddish yellow (5YR 6/6) loam, yellowish red (5YR 4/6) moist; weak coarse prismatic structure parting to weak coarse blocky; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; moderately alkaline; gradual wavy boundary.

C—26 to 60 inches; light reddish brown (2.5YR 6/4) loam, red (2.5YR 4/6) moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; common nests of gypsum crystals; few pebbles coated with lime; few threads of segregated lime; strong effervescence; moderately alkaline.

The solum is 13 to 31 inches thick. Free carbonates are at or within 10 inches of the surface. The A horizon is silt loam or loam that ranges from very dark grayish brown to brown in hue of 10YR or 7.5YR. It is 3 to 6 inches thick and is neutral or mildly alkaline. The B2 horizon commonly is silt loam but in places is silty clay loam or loam. It ranges from dark brown to light red in hue of 7.5YR to 2.5YR. It is 7 to 15 inches thick. The B3 and C horizons are loam, silt loam, or silty clay loam that range from brown to light red in hue of 7.5YR to 2.5YR. They are mildly alkaline or moderately alkaline. The B3 horizon is 3 to 10 inches thick. Some pedons have a Cr horizon of bedded soft shale at a depth of 40 to 60 inches.

Tilford soils are near Bridget, Keith, Nevee, and Spearfish soils. They have redder colors than Bridget and Keith soils and are deeper over bedrock than Spearfish soils. Tilford soils have a higher organic-matter content and, when moist, have dark colors to a greater depth than Nevee soils.

TaA—Tilford silt loam, 0 to 2 percent slopes. This nearly level soil is on stream terraces and in upland swales in areas that range from 10 to 80 acres in size. It has a profile similar to the one described as representative of the series, but in places the subsoil is silty clay loam, and the depth to lime is slightly greater.

Included with this soil in mapping are small areas of Onita, St. Onge, and Winetti soils. Onita soils are in the lower part of some areas. St. Onge and Winetti soils are on narrow strips of bottom land.

Runoff is slow, and the hazard of erosion is slight. The use of this soil for crops is only slightly limited except by periodic shortages of moisture resulting from the climate. Conserving moisture is the main management concern.

Most areas are cultivated. Some areas are in native grass and are used for range and hay. Silty range site, capability unit IIIc–1, windbreak group 3.

TaB—Tilford silt loam, 2 to 6 percent slopes. This gently sloping soil is on uplands in irregularly shaped areas that range from 10 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Nevee, Spearfish, St. Onge, and Winetti soils. Nevee and Spearfish soils are on ridges and knolls in the higher part of the landscape. St. Onge soils are in some swales and on narrow strips of bottom land. Winetti soils are on gravelly fans and bottom land.

Runoff is medium, and the hazard of erosion is moderate. Controlling erosion is the main management concern.

Many areas are cultivated. Some areas are in native grass and are used for range and hay. This soil is well suited to the crops commonly grown in the survey area. Silty range site, capability unit IIIe–1, windbreak group 3.

Vanocker series

The Vanocker series consists of deep, well drained, steep to very steep, loamy soils on uplands. These soils formed in material that weathered mainly from sandstone, limestone, and shale. The native vegetation consisted mainly of ponderosa pine and an understory of mid and short grasses. Open areas of tall, mid, and short grasses are in places.

In a representative profile about 2 inches of forest litter is on the surface. The surface layer is dark grayish brown channery loam about 2 inches thick. The subsoil is about 14 inches thick. It is brown channery clay loam in the upper part and light brown very channery clay loam in the lower part. The underlying material is pale brown very channery clay loam.

Vanocker soils are low in fertility and in organic-matter content. The available water capacity is low or moderate, and permeability is moderate.

All areas are in native woodland and native grass. These soils are used for limited grazing, timber production, wildlife, and recreation.

Representative profile of Vanocker channery loam in an area of Vanocker-Citadel association, steep, in ponderosa pine forest, 1,500 feet east and 100 feet south of the northwestern corner of sec. 5, T. 4 N., R. 5 E.

O—2 inches to 0; forest litter, some partly decomposed; abrupt boundary.

A1—0 to 2 inches; dark grayish brown (10YR 4/2) channery loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; 20 percent coarse fragments; neutral; clear wavy boundary.

B21—2 to 6 inches; brown (7.5YR 5/4) channery clay loam, dark brown (7.5YR 4/2) moist; weak coarse prismatic structure parting to weak fine and medium subangular blocky; hard, firm; 40 percent

coarse fragments; neutral; gradual wavy boundary.

B22—6 to 16 inches; light brown (7.5YR 6/4) very channery clay loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; slightly hard, friable; 50 percent coarse fragments; mildly alkaline; gradual wavy boundary.

Cca—16 to 60 inches; pale brown (10YR 6/3) very channery clay loam, brown (10YR 5/3) moist; massive; slightly hard, friable; 60 percent coarse fragments; common fine segregations of lime; strong effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 10 to 25 inches. Depth to bedrock is 40 to 60 inches or more. Coarse fragments of limestone or sandstone range from 10 to 20 percent in the A horizon and from 40 to 80 percent in the B and C horizons. The A horizon is loam, gravelly loam, or channery loam that ranges from dark gray to reddish brown in hue of 10YR or 7.5YR. It commonly is 1 to 4 inches thick and is slightly acid or neutral. The B2 horizon ranges from brown to reddish yellow in hue of 7.5YR or 5YR and in places is gravelly loam or channery loam. It is 9 to 21 inches thick and is slightly acid to mildly alkaline.

Vanocker soils are mapped with Citadel soils and are near Paunsaugunt soils. They are less clayey in the B horizon than Citadel soils and are deeper to bedrock than Paunsaugunt soils.

VAE—Vanocker-Citadel association, steep. These soils are in the Black Hills on the sides of ridges and on the valley sides of canyons and deeply entrenched streams and drainageways. Areas are irregularly shaped and range from 40 to several hundred acres in size. They are about 40 percent Vanocker soils, 35 percent Citadel soils, and 25 percent other soils. Slopes are mostly steep, but within the areas they range from moderately sloping to very steep.

Vanocker soils generally are in the higher part of the landscape and commonly are near and below Rock outcrop. They have a surface layer of channery loam and generally have the profile described as representative of the series, but in places the depth to bedrock is slightly less than 40 inches. Citadel soils are in the mid and lower parts of the landscape and on broad ridgetops. In places they have a higher content of stones and cobbles than the soil described as representative of the Citadel series.

Included with these soils in mapping are areas of Maitland, Marshdale, Paunsaugunt, and Winetti soils. Maitland soils are in the lower part of the landscape below Citadel soils, and on the edges of and in grassed openings. Small areas of Marshdale soils are in the lowest part of grassed valleys and swales. Paunsaugunt soils are on limestone-capped ridgetops. Winetti soils are on narrow strips of bottom land in canyons. Also included in some places are small areas of Rock outcrop on the upper part of canyon walls.

Runoff is medium to rapid if the plant cover is removed. Most of these soils are not suited to cultivation because they are steep, stony, and highly susceptible to erosion. Controlling erosion is the main management concern.

All areas are dominantly ponderosa pine forest and are used for timber production, woodland grazing, wildlife, and recreation. Some of the small grassed valleys and meadow openings are used for native or tame hay, and a few are used for crops. Capability unit VIIe–9; Vanocker soil is in woodland group 5f3; Citadel soil is in woodland group 5r3 and not placed in a range site or windbreak group.

Winetti series

The Winetti series consists of deep, somewhat excessively drained, nearly level to gently sloping, loamy soils on bottom land, low terraces, and alluvial fans. These soils formed in gravelly to stony alluvium. The native vegetation consisted mainly of tall, mid, and short grasses, but ponderosa pine, bur oak, and quaking aspen are in some areas.

In a representative profile the surface layer is dark grayish brown gravelly loam about 3 inches thick. The underlying material is brown gravelly sandy loam and very gravelly sandy loam.

Winetti soils are low in fertility and moderately low in organic-matter content. The available water capacity is low, and permeability is moderately rapid. Most areas are subject to flooding.

All areas are in native vegetation and are used for grazing, wildlife, and recreation.

Representative profile of Winetti gravelly loam, in native grass, 2,400 feet east and 500 feet north of the southwestern corner of sec. 5, T. 5 N., R. 5 E.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; 20 percent gravel and cobbles; slight effervescence; mildly alkaline; clear smooth boundary.

C1—3 to 12 inches; brown (7.5YR 5/2) gravelly sandy loam, dark brown (7.5YR 4/2) moist; massive; slightly hard, friable; 45 percent gravel and cobbles; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—12 to 60 inches; brown (7.5YR 5/2) very gravelly sandy loam, dark brown (7.5YR 4/2) moist; massive; slightly hard, very friable; many thin layers of gravelly loamy sand; 60 percent gravel and cobbles; strong effervescence; mildly alkaline.

Free carbonates are at or within 6 inches of the surface. A few stones commonly are scattered over the surface. Coarse fragments, mainly gravel and cobble size, make up 35 to 60 percent of the horizons between depths of 10 and 40 inches. A buried A horizon is in some pedons at a depth below 10 inches. The A horizon is gravelly loam, gravelly sandy loam, loam, or sandy loam that ranges from dark grayish brown to light reddish brown in hue of 10YR to 5YR. It is 1 to 6 inches thick. The C horizon ranges from grayish brown to reddish yellow in hue of 10YR to 5YR and is mildly

alkaline or moderately alkaline. It is gravelly and very gravelly sandy loam or gravelly and very gravelly loam, and commonly is stratified with thin layers of gravelly or very gravelly loamy sand, loamy sand, and sandy loam.

Winetti soils contain more gravel and cobbles than Glenberg and St. Onge soils, which also formed in alluvium further downstream and away from the Black Hills. They are similar to Nihill soils, but are subject to flooding and generally have a more irregular decrease in organic-matter content with increasing depth.

Wa—Winetti gravelly loam. This is a nearly level to gently sloping soil on bottom land, low terraces, and alluvial fans in and near the Black Hills. The long and narrow areas range from 10 to 100 acres or more in size and commonly are dissected by stream channels. Slopes are mostly 2 to 6 percent in the mapped areas in the Black Hills, but they range from 0 to 6 percent. In places the surface is stony or cobbly.

Included with this soil in mapping are small areas of Altvan, Bankard, Glenberg, Nihill, and St. Onge soils. Altvan and Nihill soils are on small terrace remnants. Bankard, Glenberg, and St. Onge soils are intermingled with the Winetti soil in places.

Runoff is slow to medium. Most areas are subject to flooding and the channels are subject to streambank erosion. This soil is not suited to cultivation because of the flooding and because the narrow areas generally are cut into small tracts by stream channels. Some areas are too stony for cultivation.

Most areas are in native vegetation and are used for grazing. Parts of some areas are suited to small gardens. Native trees and shrubs provide cover for wildlife and winter protection for livestock. Overflow range site, capability unit VIw–1, windbreak group 10.

Figure 16.—**Bedded soft shale is below a depth of 21 inches in this profile of Winler clay in an area of Lismas-Winler association, sloping.**

Winler series

The Winler series consists of moderately deep, well drained, nearly level to moderately sloping, clayey soils on uplands. These soils formed in material that weathered from the underlying soft shale. The native vegetation consisted mainly of a sparse stand of mid grasses.

In a representative profile the surface layer is grayish brown clay about 3 inches thick. The subsoil, about 12 inches thick, is grayish brown clay that is calcareous and contains spots and streaks of salts in the lower part. The underlying material, to a depth of 21 inches, is olive gray, calcareous clay. Below that it is olive gray, soft shale (fig. 16).

Winler soils are low in fertility and in organic-matter content. The available water capacity is very low, and permeability is very slow.

Almost all areas are in native grass and are used for range.

Representative profile of Winler clay, 2 to 9 percent slopes, in native grass, 1,600 feet south and 1,200 feet east of the northwestern corner of sec. 4, T. 6 N., R. 10 E.

A1—0 to 3 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak thin platy structure in top ½ inch vesicular crust; weak fine granular structure in lower part; hard, firm, sticky and plastic; neutral; clear smooth boundary.

B2—3 to 10 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; weak, very coarse and coarse blocky and subangular blocky structure; extremely hard, very firm, sticky and very plastic; common pressure faces; neutral; clear smooth boundary.

B3sacs—10 to 15 inches; grayish brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; very weak, very coarse and coarse subangular blocky structure; extremely hard, very firm, sticky and plastic; common pressure faces; common fine segregations of salt and gypsum; slight effervescence; mildly alkaline; clear smooth boundary.

C1sacs—15 to 18 inches; olive gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; common fine olive and light olive gray mottles; massive; very hard, very firm, sticky and plastic; common fine nests and striations of gypsum and other salts;

slight effervescence; moderately alkaline; clear smooth boundary.

C2—18 to 21 inches; olive gray (5Y 5/2) clay, olive gray (5Y 4/2) moist; massive; very hard, very firm, sticky and plastic; many fine fragments of soft shale; few nests of salts; few segregations of lime; slight effervescence; moderately alkaline; clear smooth boundary.

Cr—21 to 60 inches; olive gray (5Y 5/2) bedded soft shale, olive gray (5Y 4/2) moist; common olive and strong brown mottles; platy bedrock structure; slightly acid.

Depth to bedded shale ranges from 20 to 40 inches. Depth to accumulations of visible salts and gypsum ranges from 8 to 20 inches. When the soil is dry, cracks that are ½ inch to 2 inches wide and several feet long extend downward through the solum. The A horizon ranges from dark grayish brown to pale olive in hue of 2.5Y or 5Y and is 2 to 5 inches thick. The B and C horizons range from grayish brown to pale olive in hue of 2.5Y or 5Y and have a clay content ranging from 60 to 72 percent. The B3 and C horizons lack free carbonates in some pedons. Reaction in the B and C horizons ranges from medium acid to moderately alkaline. The B2 horizon is 6 to 12 inches thick, and the B3 horizon is 5 to 10 inches thick.

Winler soils are near Lismas and Swanboy soils and are similar to Pierre soils. They are deeper over shale than Lismas soils and are shallower over shale than Swanboy soils. Winler soils have a harder consistency and a higher salt content than Pierre soils.

WbC—Winler clay, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on uplands in irregularly shaped areas that range from 30 to 150 acres in size. Slopes are long and smooth. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Hisle, Lismas, Pierre, and Swanboy soils. Hisle soils are in sags and on foot slopes. Lismas soils are on ridges and on shoulders of drainageways. Pierre soils are on some knolls and ridges. Swanboy soils are on foot slopes and fans in the lower part of the landscape. Also included in some places are small areas of Slickspots. In some areas stones unrelated to the underlying soft shale are on the surface, and these areas are shown on the soil map by a spot symbol.

Runoff is medium to rapid. This soil absorbs water very slowly and releases it slowly to plants. It generally is not suited to cultivation because it is very poor in tilth, low in fertility, and droughty. This soil is susceptible to erosion and soil blowing if it is farmed.

Almost all areas are in native grass and are used for range. Dense Clay range site, capability unit VIs–6, windbreak group 10.

WcB—Winler-Swanboy clays, 0 to 6 percent slopes. These nearly level to gently sloping soils are on uplands in irregularly shaped areas that range from 20 to 80 acres in size. The areas are about 60 percent Winler soils and 40 percent Swanboy soils. Winler soils generally are in the higher part of the landscape. Swanboy soils are on foot slopes and fans in the lower part of the areas.

Included with these soils in mapping are small areas of Hisle soils and Slickspots. Hisle soils are on foot slopes and along drainageways. Slickspots are intermingled with Swanboy soils in some areas.

Runoff is medium to rapid. These soils absorb water slowly and release it slowly to plants. They generally are not suited to cultivation because they are very poor in tilth, low in fertility, and droughty. These soils are also susceptible to erosion and soil blowing if they are farmed.

All areas are in native grass and are used for range. Dense Clay range site, capability unit VIs–6, windbreak group 10.

Zigweid series

The Zigweid series consists of deep, well drained, moderately sloping to strongly sloping, loamy soils on uplands and terrace fronts. These soils formed in alluvium. The native vegetation consisted mainly of mid and short grasses.

In a representative profile (fig. 17) the surface layer is grayish brown clay loam about 4 inches thick. The subsoil is about 19 inches thick. It is calcareous clay loam that is grayish brown in the upper part and light brownish gray in the lower part. The underlying material is light brownish gray, calcareous clay loam that is stratified with thin layers of loam.

Zigweid soils are low in fertility and moderately low

Figure 17.—**Representative profile of Zigweid clay loam in an area of Zigweid-Nihill complex, 6 to 15 percent slopes.**

in organic-matter content. The available water capacity is high, and permeability is moderate.

Most areas are in native grass and are used for range, but a few areas are cultivated.

Representative profile of Zigweid clay loam in an area of Zigweid-Nihill complex, 6 to 15 percent slopes, in native grass, 2,500 feet west and 600 feet north of the southeastern corner of sec. 9, T. 5 N., R. 11 E.

A1—0 to 4 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak fine granular structure; soft, very friable; mildly alkaline; clear wavy boundary.

B2—4 to 16 inches; grayish brown (2/5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm; few fine segregations of lime; slight effervescence; moderately alkaline; gradual wavy boundary.

B3ca—16 to 23 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, firm; common medium segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1ca—23 to 28 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak very coarse prismatic structure; hard, firm; few medium segregations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—28 to 60 inches; light brownish gray (2.5Y 6/2) clay loam stratified with thin layers of loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The solum is 15 to 28 inches thick. Free carbonates are at or within 6 inches of the surface. In some pedons, coarse fragments that are mainly rounded, quartzitic gravel and cobbles, are throughout the profile and are less than 5 to 15 percent of the horizon. The A horizon ranges from grayish brown to light yellowish brown in hue of 10YR or 2.5Y. It is clay loam, loam, or gravelly loam and is 3 to 7 inches thick. The B2 horizon ranges from grayish brown to pale olive in hue of 10YR to 5Y. It is clay loam or loam and is 5 to 14 inches thick. The B3 and C horizons range from light brownish gray to pale yellow in hue of 10YR to 5Y. They are clay loam or loam that is commonly stratified with thin layers of finer or coarser material. In places bedded soft shale is at a depth of 40 to 60 inches.

Zigweid soils are mapped with Nihill soils and are near Nunn and Satanta soils. They are less gravelly than Nihill soils and are calcareous closer to the surface than Nunn and Satanta soils.

ZaD—Zigweid-Nihill complex, 6 to 15 percent slopes. These moderately sloping to strongly sloping soils are on uplands on ridges, on sides of entrenched drainageways, and on sides of broad tablelands. Areas are irregularly shaped and range from 10 to 80 acres in size. They are about 55 percent Zigweid soils, 20 percent Nihill soils, and 25 percent other soils. Zigweid soils commonly are in the middle part of the landscape. Nihill soils generally are in the higher part on the rounded tops of ridges and knolls.

Included with these soils in mapping are small areas of Altvan, Kyle, Lismas, Nunn, Pierre, Samsil, and Satanta soils. Altvan soils are in the higher part of the landscape near Nihill soils. Kyle and Pierre soils are in the lower part below Zigweid soils. Lismas and Samsil soils are on the sides of entrenched drainageways that cut back into the lower part of the areas. Nunn and Satanta soils are on flattened ridgetops that extend into some of the areas.

Runoff is medium to rapid, and the hazard of erosion is severe. The available water capacity is high in the Zigweid soil and low in the Nihill soil. These soils generally are not suited to cultivation because of slope, low fertility, droughtiness of the Nihill soil, and the hazard of erosion.

Most areas are in native grass and are used for range. Thin Upland range site, capability unit VIe–3, windbreak group 10.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of

the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Range[3]

Prior to settlement most of the survey area was covered with mixed prairie vegetation. Except for woodland in the Black Hills in the southwestern part of the county and trees along the Belle Fourche and Cheyenne Rivers, the vegetation was dominantly grass.

As the area was settled, the soils having the fewest limitations were plowed and farmed. These included the Nunn and Satanta soils on high terraces and uplands, and many of the deep, nearly level soils in the broad stream valleys. About 14 percent of the survey area is now cultivated.

About 910,000 acres, or 79 percent, of the survey area is now range, which is grazed by cattle and sheep and has a valuable secondary use for wildlife. White-tailed deer and wild turkey are common in the Black Hills. Pronghorn antelope, white-tailed deer, and mule deer are important users of range.

Most of the range in the survey area has been grazed by domestic livestock for a long time. This has changed the plant cover, making it difficult to appraise the productive potential of the range unless range site and range condition techniques are used.

Range sites and condition classes

A *range site* is a distinctive kind of range that differs from other kinds of range in its potential to produce native plants. A range site is the product of all environmental factors responsible for its development. If there is no abnormal disturbance and physical site deterioration, it supports a plant community that differs from that of other range sites in the kind or proportion of plants or in total annual yield. Boundaries of range sites can be determined directly from the detailed soil maps in this survey.

Range condition is the present state of vegetation of a range site in relation to the climax plant community for that site. The terms "climax" and "natural potential" are synonymous.

Range condition classes represent the degree to which the present composition, expressed in percent, has departed from that of the climax plant community of a range site. There are four classes: excellent, good, fair, and poor. A range site is in *excellent* condition if 76 to 100 percent of the present vegetation is the climax vegetation for that site. It is in *good* condition if the percentage is 51 through 75; in *fair* condition if the percentage is 25 through 50; and in *poor* condition if the percentage is 25 or less.

Determining range condition provides an approximate measure of changes that have taken place in the plant cover. This forms a basis for predicting the nature and direction of changes in plant community that can be expected from management and treatment.

A range condition guide for each site helps determine the condition of a range. Range plants on each site are classified according to their response to grazing as decreasers, increasers, or invaders.

Decreasers are plants in the climax plant community that decrease in relative abundance when the site is subjected to continued excessive grazing. Increasers are plants in the climax plant community that increase when the site is subjected to continued excessive grazing. Invaders are not members of the climax plant community for the site, but they invade the plant community because of various kinds of disturbance.

Range sites

The soils of Meade County, Southern Part, are grouped into 13 range sites, which are described in this section. In each description are given important soil characteristics, the principal plants, and estimates of yields. When the sites are in excellent condition, the kinds of grass that provide the major source of forage make up 70 to 90 percent of the total annual yield. To find the range site in which a given soil is placed, refer to the "Guide to Mapping Units" at the back of this survey.

Subirrigated range site

The Marshdale part of Marshdale-Maitland loams, 2 to 9 percent slopes, is the only soil in this range site. It is a somewhat poorly drained to poorly drained soil in upland swales or valleys in the Black Hills. It has a water table at a depth of about 2 feet. The available water capacity is high. Fertility is high. Because moisture is abundant, this site has the potential to produce a luxuriant stand of tall grasses.

Big bluestem is dominant in the climax plant community and makes up 75 percent of the vegetation in places. Indiangrass and prairie cordgrass are tall grasses that occur in lesser amounts. The understory includes Kentucky bluegrass. Sedges and forbs are also on this site. Trees and shrubs are in some areas but are not abundant.

If this range site is continuously overgrazed, the stand of tall grasses loses vigor and thins out. Bluegrasses then increase and production declines.

If this site is in excellent condition, the total annual yield of air-dry herbage is 4,200 pounds per acre in a typical year. It ranges from 3,360 pounds per acre in an unfavorable year to 4,600 per acre in a favorable year.

Overflow range site

This range site consists of deep, moderately well drained to somewhat excessively drained soils on bottom land, low terraces, and alluvial fans. The water table is generally at a depth of more than 5 feet. The available water capacity is low to high, but additional

[3] By C. M. SCHUMACHER, range conservationist, Soil Conservation Service.

moisture is received as stream overflow or as runoff from adjacent soils.

The climax plant cover consists mainly of tall and mid prairie grasses. Big bluestem is dominant and makes up as much as 65 percent of the vegetation in places. Other important grasses are green needlegrass, prairie sandreed, and switchgrass. Western wheatgrass, sideoats grama, and blue grama are the principal increasers. The understory generally includes Kentucky bluegrass. Significant amounts of sedges and forbs are also present. Trees and shrubs are not abundant, but in places there are scattered western snowberry and rose plants.

If this site is continuously overgrazed, the climax grasses lose vigor and thin out. Western wheatgrass, sideoats grama, blue grama, and Kentucky bluegrass then increase. With further overgrazing, Kentucky bluegrass becomes the principal grass, especially in and near the Black Hills area.

This site is well suited to the installation of water-spreading structures to increase native hay production.

If this range site is in excellent condition, the total annual yield of air-dry herbage is 2,800 pounds per acre in a typical year. It ranges from 1,960 pounds per acre in an unfavorable year to 3,360 pounds per acre in a favorable year.

Closed depression range site

This range site consists of deep, poorly drained soils in closed depressions. These soils are wet from ponded runoff in most years but are droughty during dry years. Permeability is slow to very slow in the clay subsoil. The available water capacity is moderate or high. The lack of surface drainage is a distinctive feature of this site.

The potential plant cover lacks the stability generally associated with climax plant cover because of the seasonal wetness or dryness. The best potential plant cover here is a stand of western and Montana wheatgrass. The understory generally consists of rushes and sedges.

If this range site is overgrazed, rushes and such weeds as knotweed increase. This overgrazing, especially when the soil is wet, aggravates the poor drainage and poor tilth of the soils and accelerates the deterioration of the site. The kinds of invading weeds differ according to the current wetness of the disturbed site.

If this site is in excellent condition, the total annual yield of air-dry herbage is 3,000 pounds per acre in a normal year. It ranges from 2,100 pounds per acre in an unfavorable year to 3,300 pounds per acre in a favorable year.

Sands range site

Bankard soils are the only soils in this range site. They are well drained to somewhat excessively drained, nearly level soils on bottom land. The surface layer commonly ranges from loamy fine sand to very fine sandy loam or loam but is clay loam or clay in places. The soils are underlain by sandy alluvium. The available water capacity is low, and permeability is rapid.

The climax plant community consists mainly of a mixture of tall and mid warm-season grasses. Although no single species dominates the site, prairie sandreed, sand bluestem, and little bluestem are the principal species. Cool-season grasses usually are not abundant, but needleandthread occurs in places. Woody plants such as leadplant, rose, and sandcherry occur in places and are important browse plants. Native trees, mainly cottonwood and willow, are in some areas.

If this range site is continuously overgrazed, the tall grasses decrease and are replaced by sand dropseed and blue grama. With further overuse, these grasses thin out and soil blowing becomes a serious problem.

If this site is in excellent condition, the total annual yield of air-dry herbage is 2,000 pounds per acre during a normal year. It ranges from 1,400 pounds per acre in an unfavorable year to 2,400 pounds per acre in a favorable year.

Sandy range site

Assinniboine fine sandy loam, 2 to 9 percent slopes, is the only soil in this range site. It is a deep, well drained soil on uplands. The available water capacity is moderate, and permeability is moderate in the subsoil.

The climax plant cover consists mainly of a mixture of mid and tall warm-season grasses. Prairie sandreed, little bluestem and sand bluestem or big bluestem are the main grasses. The principal increasers are the cool-season grasses, needleandthread, and western wheatgrass. Blue grama and sideoats grama are also on this site.

If this range site is overgrazed, the bluestems and prairie sandreed decrease and are replaced by needleandthread, western wheatgrass, and sideoats grama. With further overuse, those species decrease and are replaced by sand dropseed, threadleaf sedge, and blue grama.

If this site is in excellent condition, the total annual yield of air-dry herbage is 2,000 pounds per acre during a normal year. It ranges from 1,400 pounds per acre in an unfavorable year to 2,400 pounds per acre in a favorable year.

Silty range site

This range site consists of deep and moderately deep, well drained to moderately well drained, silty and loamy soils on uplands and terraces. The available water capacity is low to high. Permeability in the subsoil is moderate or moderately slow. Fertility is medium.

The climax plant cover is a mixture characteristic of the mixed prairie. Western wheatgrass and green needlegrass are of major importance. Needleandthread, sideoats grama, and blue grama are the principal increasers. Forbs and woody plants, such as leadplant, generally are not abundant but are an important part of the climax plant cover.

If this range site is continuously overgrazed, the mid grasses decrease and are replaced by blue grama and threadleaf sedge. Further overuse results in a broken cover of short grasses interspersed with annuals.

If this site is in excellent condition, the total annual yield of air-dry herbage outside the Black Hills is 2,000

pounds per acre during a normal year and ranges from 1,300 pounds per acre in an unfavorable year to 2,400 pounds per acre in a favorable year. In the Canyon-Lakoa-Maitland and Tilford-Nevee soil associations, the total yield of air-dry herbage is about 2,400 pounds per acre during a normal year and ranges from 1,500 pounds per acre in an unfavorable year to 3,000 pounds per acre in a favorable year.

Clayey range site

This range site consists of deep and moderately deep, well drained soils on uplands and terraces. They have a clayey subsoil and a surface layer of clay or clay loam. The available water capacity is low or moderate in most of the soils, but it is high in some. Permeability is moderately slow to very slow.

The climax plant cover is a mixture characteristic of the mixed prairie. Western wheatgrass and green needlegrass are the major grasses. The understory consists of short grasses.

If this range site is continuously overgrazed, the green needlegrass and western wheatgrass decrease and are replaced by blue grama and buffalograss.

This site usually is well suited to range improvement by such methods as contour furrowing, pitting, and range interseeding.

If this site is in excellent condition, the total annual yield of air-dry herbage is 1,800 pounds per acre during a normal year. It ranges from 1,260 pounds per acre in an unfavorable year to 2,160 pounds per acre in a favorable year.

Thin upland range site

This range site consists of deep and moderately deep, well drained to excessively drained soils on uplands. These soils have a thin surface layer of loam, silt loam, clay loam, or gravelly loam, and they are calcareous at or near the surface. Fertility is low. The available water capacity is low to high, and permeability is moderately slow to moderately rapid.

Needleandthread is a major grass in the climax plant cover. Other major grasses are western wheatgrass and green needlegrass. Sideoats grama, blue grama, and sedges are important increasers. Forbs and shrubs such as leadplant are important in places.

If this site is continually overused, the mid grasses are replaced by blue grama and threadleaf sedge.

If this range site is in excellent condition, the total annual yield of air-dry herbage is 1,500 pounds per acre during a normal year. It ranges from 1,000 pounds per acre in an unfavorable year to 1,900 pounds per acre in a favorable year.

Shallow range site

This range site consists of shallow, well drained to excessively drained, loamy, silty, and clayey soils on uplands. These soils are underlain by sandstone, siltstone, or shale at a depth of less than 20 inches. They have very low to low available water capacity. Permeability is moderate to slow. Runoff is rapid on most of these soils.

Little bluestem and sideoats grama are dominant in the climax plant cover. Needleandthread is the principal cool-season grass on the loamy soils, and western wheatgrass is the principal grass on the clayey soils. The understory consists of blue grama, hairy grama, and sedges. Forbs, such as black samson, and shrubs, such as leadplant and rose, are also on this site.

If this range site is overgrazed, little bluestem decreases and is replaced by sideoats grama. Further overuse results in a sparse cover of short grass and threadleaf sedge. The site then becomes bare and subject to erosion.

If this range site, excluding the Black Hills, is in excellent condition, the total annual yield of air-dry herbage is about 1,400 pounds per acre during a normal year, and it ranges from 980 pounds per acre in an unfavorable year to 1,700 pounds per acre in a favorable year. In the Canyon-Lakoa-Maitland and Tilford-Nevee soils associations, the total annual air-dry yield is about 1,800 pounds per acre during a normal year, and it ranges from 1,100 pounds per acre in an unfavorable year to 2,500 pounds per acre in a favorable year.

Dense clay range site

This range site consists of deep and moderately deep, well drained to moderately well drained soils on uplands and stream terraces. They have a clay surface layer and a heavy clay subsoil. The available water capacity is very low to moderate, and permeability is very slow. The dense clayey subsoil severely restricts the growth of plant roots.

The climax plant cover consists of western wheatgrass, green needlegrass, Montana wheatgrass, sedges, and wild onion and other forbs. This site lacks an understory of short grasses.

If this range site is continuously overgrazed, green needlegrass and western wheatgrass thin out and are replaced by annual forbs. If overused during dry years, the soil is bare or nearly bare.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,300 pounds per acre during a normal year. It ranges from 780 pounds per acre in an unfavorable year to 1,690 pounds per acre in a favorable year.

Claypan range site

The Mosher part of Satanta-Mosher loams, 0 to 3 percent slopes, is the only soil in this range site. It is a deep, moderately well drained soil that has a loam surface layer and a claypan subsoil. This soil is moderately alkaline to strongly alkaline in some part of the subsoil or underlying material. The available water capacity is moderate or high, and permeability is very slow.

The climax plant cover is dominantly western wheatgrass and blue grama with lesser amounts of green needlegrass, needleandthread, and buffalograss. Sedges and perennial forbs usually are on this site.

If this range site is continuously overgrazed, the western wheatgrass and green needlegrass are replaced by blue grama, buffalograss, and sedges. Further overuse results in the appearance of annual weeds and bare ground.

If this site is in excellent condition, the total annual yield of air-dry herbage is 1,200 pounds per acre during a normal year. It ranges from 840 pounds per acre

in an unfavorable year to 1,440 pounds per acre in a favorable year.

Shallow dense clay range site

This range site consists of shallow, well drained, clayey soils on uplands. Soft clay shale is at a depth of less than 20 inches. The available water capacity is very low, and permeability is slow to very slow.

The climax plant cover is dominantly western wheatgrass and Montana wheatgrass with lesser amounts of green needlegrass and plains muhly. Forbs are common, and the shrub, nuttall saltbush, occurs in places.

If this range site is continuously overgrazed, the green needlegrass and wheatgrasses thin out and much of the site is bare.

If this soil is in excellent condition, the total annual yield of air-dry herbage is 1,000 pounds per acre during a normal year. It ranges from 600 pounds per acre in an unfavorable year to 1,300 pounds per acre in a favorable year.

Thin claypan range site

This range site consists of deep and moderately deep, well drained to moderately well drained soils that have a thin surface layer of silt loam or loam and a claypan subsoil. These soils have a high content of sodium in some part of the subsoil or underlying material. They usually are moderately alkaline or strongly alkaline within 20 inches of the surface. The available water capacity is very low to moderate, and permeability is very slow. The dense claypan subsoil restricts the growth of plant roots.

The climax plant cover is dominantly short grasses in a mixture of mid and short grasses. Western wheatgrass, the principal decreaser, and blue grama and buffalograss, the increasers, are of major importance. Small amounts of needleandthread, saltgrass, and sedges also are in the climax plant community. Forbs are generally not present in significant amounts, but small amounts of pricklypear are common on this site.

If this range site is continuously overgrazed, the mid grasses are replaced by blue grama, buffalograss, and saltgrass. Further overuse results in bare ground during dry cycles and abundant weeds during wet cycles.

If this soil is in excellent condition, the total annual yield of air-dry herbage is 700 pounds per acre during a normal year. It ranges from 500 pounds per acre in an unfavorable year to 900 pounds per acre in a favorable year.

Cropland[4]

Cropland makes up about 14 percent of the survey area. Most of the cropland is in the Nunn-Satanta-Zigweid, Blackpipe-Savo-Manvel, and St. Onge-Keith soil associations, but scattered cropped fields are in most of the other parts of the survey area. Winter wheat, oats, and alfalfa are the main crops. Corn, sorghum, spring wheat, barley, and rye are also grown. Winter wheat and some spring wheat generally are planted on soils that have been left fallow in summer.

Successful long-term cultivation of any soil depends on managing the soil according to its capabilities and limitations. These objectives can be accomplished by conserving moisture, controlling erosion and soil blowing, and maintaining fertility and tilth.

Basic management should include a sound conservation cropping system tailored to the properties of each soil or group of soils. Some soils can be used for a single crop for many years without damage to their physical condition. Other soils deteriorate rapidly when used continuously for one crop, especially if the crop produces little residue. A cropping system based on properties of the soil will help to maintain tilth; reduce insect, disease, and weed infestations; and control erosion and soil blowing. In addition, such a cropping system generally helps to conserve moisture and maintain fertility.

Conserving moisture in the southern part of Meade County generally means evenly distributing snow, reducing evaporation, limiting runoff, and controlling weeds. Some effective measures are minimum tillage, stubble mulching, returning crop residue to the soil, wind stripcropping, using field windbreaks or barriers, contour farming, terracing, and timely tillage. Subsoiling, or chiseling, helps to improve water absorption in clayey soils and soils that have a claypan subsoil. All of these practices also help to control erosion and soil blowing. Grassed waterways and diversions also help to control water erosion. Emergency tillage helps to control soil blowing until permanent measures are established. Generally a combination of practices is needed.

Measures that help to maintain soil tilth include stubble mulching, proper use of crop residue, minimum tillage, timely tillage, growing green manure crops, and using grasses and legumes in the cropping system. These measures, plus the application of manure and chemical fertilizers and controlling erosion and soil blowing help to maintain fertility.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are 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 rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

[4] By PAUL BODEN, conservation agronomist, Soil Conservation Service.

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

Class I soils have 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, or that require special conservation practices, or both.
Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.
Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.
Class VI soils have severe limitations that make them generally unsuitable for cultivation.
Class VII soils have very severe limitations that make them unsuitable for cultivation.
Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

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

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

The capability unit is identified in the description of each soil mapping unit in the section "Descriptions of the Soils." 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 (*7*). 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, IIIe–1 or IVs–3.

Management by capability units

In the following pages, each of the capability units in the survey area is described, and suggestions for the use and management of each capability unit are given. The capability units within a capability subclass are not numbered consecutively because not all of the units in the statewide system are in the survey area. To find the capability classification of a given soil in this survey area, refer to the "Guide to Mapping Units" at the back of this survey.

Capability unit IIIe–1

This unit consists of deep and moderately deep, well drained, loamy and silty soils on uplands and terraces. These soils are gently sloping except for one soil in the Black Hills which is gently sloping to moderately sloping. These soils have a surface layer of loam, silt loam, clay loam, or silty clay loam.

These soils are medium in fertility, have good tilth, and are easy to work. Permeability in the subsoil is moderate or moderately slow. The available water capacity is high in most of the soils but is low or moderate in a moderately deep soil in this unit. Runoff is medium. Controlling erosion is the main concern if these soils are farmed. Controlling soil blowing, conserving moisture, and maintaining fertility and tilth are other concerns of management.

About half the acreage is cultivated. Winter wheat, oats, and alfalfa are the main crops on the gently sloping soils. Barley, corn, spring wheat, and sorghum also are grown. Potatoes, oats, and tame grasses and legumes are the main crops on the soil in the Black Hills. The soils in this unit are well suited to dryfarming. Many areas remain in native grass and are used for range and hay.

Stubble mulching, returning crop residue to the soil, contour farming, and terracing are among the practices that help control erosion and conserve moisture. If slopes are too short and irregular for contour farming and terracing, including close-sown crops, grasses, and legumes in the cropping system is an alternative means of controlling erosion and helping to maintain fertility and tilth. Grassed waterways help prevent the formation of gullies. Wind stripcropping (fig. 18) and field windbreaks help to control soil blowing.

Capability unit IIIe–2

Onita clay loam, 0 to 4 percent slopes, is the only soil in this unit. It is on foot slopes and in swales on uplands and high terraces.

This soil is high in fertility. Tilth is good. The available water capacity is high, and permeability is moderately slow. Runoff is slow to medium. Most areas receive runoff from adjacent areas, and in most years this additional moisture is beneficial. Controlling erosion is the main management concern. Conserving moisture and maintaining tilth and fertility also are important.

Most areas are farmed. Winter wheat, oats, corn, and alfalfa are the main crops. This soil is well suited to dryfarming. Some areas remain in native grass and are used for range and hay.

Stubble mulching, utilizing crop residue, contour farming, and terracing help to control erosion and conserve moisture. If slopes are too short or irregular for contour farming and terracing, including close-sown crops, grasses, and legumes in the cropping system is an alternative means of controlling erosion.

Figure 18.—**Wind stripcropping and the use of crop residue help to control soil blowing and conserve moisture in this area of Nunn clay loam, 2 to 6 percent slopes.**

Grassed waterways help to prevent the formation of gullies.

Capability unit IIIc–1

This unit consists of deep, well drained, nearly level, silty and loamy soils on terraces and uplands. These soils have a surface layer of silt loam, silty clay loam, or loam.

These soils are medium in fertility, easy to work, and have high or moderate available water capacity. Permeability is moderate or moderately slow. Runoff is slow. Conserving moisture is the main management concern. Controlling soil blowing and maintaining fertility and tilth are also important.

About 75 percent of the acreage is cultivated. Winter wheat, oats, corn, and alfalfa are the main crops. Spring wheat, barley, and sorghum are also grown. The soils in this unit are well suited to all crops grown in the county. Some areas remain in native grass and are used for range and hay.

Stubble mulching and returning crop residue to the soil help to conserve moisture and control soil blowing. Wind stripcropping and field windbreaks also help to control soil blowing.

Capability unit IIIc–2

Lohmiller silty clay loam is the only soil in this unit. It is a deep, well drained, nearly level soil on bottom land.

This soil is medium in fertility and has moderate or high available water capacity, but it is moderately low in organic-matter content. Permeability is moderately slow or slow. Runoff is slow, and most areas are subject to stream flooding in some years. Generally, flood damage is slight and the additional moisture is beneficial. Wetness delays spring planting in some years. Conserving moisture is the main management concern. Controlling soil blowing and maintaining tilth, fertility, and organic-matter content are also important.

Some areas are cultivated, but other areas remain in native grass and are used for range and hay. Alfalfa and oats are the main crops. Barley, corn, spring wheat, and winter wheat are also grown. The soil in this unit is moderately well suited to all crops grown in the survey area.

Returning crop residue to the soil and stubble mulching help to conserve moisture, control soil blowing, and maintain tilth and fertility. The application of manure helps to increase fertility and organic-matter content and improve tilth.

Capability unit IIIc–3

St. Onge loam is the only soil in this unit. It is a deep, moderately well drained to well drained, nearly level soil on bottom land.

This soil is high in fertility, is easy to work, and has high available water capacity. Permeability is moderate, and runoff is slow. This soil is subject to stream flooding in some years, but generally the additional moisture is beneficial and flood damage is slight. Conserving moisture is the main management concern. Controlling soil blowing and maintaining fertility and tilth are also important.

Most areas are cultivated. Corn, oats, winter wheat, and alfalfa are the main crops. Barley, spring wheat, and sorghum are also grown. This soil is well suited to dryfarming and responds well to irrigation. A few areas remain in native grass and are used for range and hay.

Returning crop residue to the soil and stubble mulch-

ing help to conserve moisture, control soil blowing, and maintain fertility and tilth. Wind stripcropping and field windbreaks help control soil blowing in the larger areas of this soil.

Capability unit IVe–1

This unit consists of deep and moderately deep, well drained soils on uplands and high terraces. These soils are mostly moderately sloping, but some are strongly sloping. These soils have a surface layer of loam, silt loam, or clay loam.

These soils are medium in fertility and generally are easy to work. The available water capacity is moderate or high in most of the soils. Permeability is moderate or moderately slow. Runoff is medium. Controlling erosion is the main management concern. Controlling soil blowing, conserving moisture, and maintaining tilth and fertility are also important.

Most areas remain in native grass and are used for range and hay, but some are farmed. Winter wheat, oats, alfalfa, and tame grasses are the main crops. The soils in this unit are moderately well suited to crops. Because of the severe hazard of erosion, close-sown crops are better suited than row crops.

Stubble mulching, returning crop residue to the soil, contour farming, terracing, and grassed waterways help to control erosion. Where the slopes are too short and irregular for mechanical practices such as terracing, the use of close-sown crops will help to control erosion and soil blowing. The use of grasses and legumes in the cropping system helps to maintain fertility and tilth.

Capability unit IVe–2

Altvan loam, 2 to 6 percent slopes, is the only soil in this unit. It is a well drained, gently sloping soil that is moderately deep over gravelly sand on terraces and alluvial fans.

This soil is medium in fertility and easy to work, but it is somewhat droughty. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. Runoff is medium. Controlling erosion and soil blowing and conserving moisture are the main management concerns. Maintaining fertility and tilth also are important.

Some areas are used for crops, but many areas remain in native grass and are used for range. Winter wheat, barley, oats, and alfalfa are the main crops. This soil is better suited to early-maturing small grain than to late-maturing row crops.

Stubble mulching and returning crop residue to the soil, used in combination with contour farming or contour stripcropping, help to control erosion and soil blowing and conserve moisture. Terracing generally is not satisfactory because of the moderate depth to gravelly sand. Where slopes are too irregular for contour farming, the use of close-sown crops and tame grasses helps to minimize soil losses. Applying manure and chemical fertilizer helps to maintain fertility and organic-matter content.

Capability unit IVe–3

This unit consists of deep and moderately deep, well drained, gently sloping, clayey soils on uplands and terraces. The moderately deep soils are underlain by soft shale at a depth of 20 to 40 inches.

These soils are medium in fertility and moderately low in organic-matter content. They have poor tilth and are difficult to work. Permeability is very slow, and the available water capacity is low to moderate. Runoff is medium. Controlling erosion and soil blowing is the main management concern. Conserving moisture, improving water absorption and tilth, and maintaining fertility and organic-matter content are also important.

Many areas remain in native grass and are used for range and hay, but some areas are farmed. Small grain and alfalfa are the main crops. Corn and sorghum also are grown. The soils in this unit are better suited to small grain than to row crops.

Stubble mulching and returning crop residue to the soil, used in combination with contour farming and terracing, help to control erosion, conserve moisture, and maintain fertility and tilth. Stubble mulching and wind stripcropping help to control soil blowing. Chiseling, or subsoiling, helps to improve water absorption. Timely tillage helps to maintain tilth.

Capability unit IVe–6

Glenberg soils is the only mapping unit in this capability unit. They are deep, well drained, nearly level soils on bottom land. These soils have a surface layer of fine sandy loam, very fine sandy loam, loam, or clay loam. They are underlain by alluvium that is mainly fine sandy loam.

These soils are medium to low in fertility and moderately low in organic-matter content. They are easy to work but blow easily if the plant cover is removed. The available water capacity is low to moderate. Permeability is moderately rapid, and runoff is slow. These soils are subject to stream flooding in some years, but flood damage is generally slight. Controlling soil blowing is the main management concern, but conserving moisture and improving fertility and organic-matter content are also important.

Many areas remain in native grass and are used for range and hay, but some are used for crops and a few are irrigated. Oats, sorghum, and alfalfa are the main crops.

Stubble mulching, returning crop residue to the soil, wind stripcropping, field windbreaks, and the use of close-sown crops help to control soil blowing and conserve moisture. Use of grasses and legumes in the cropping system, use of green manure crops, and applying manure and chemical fertilizer help to improve fertility and organic-matter content.

Capability unit IVe–7

Assinniboine fine sandy loam, 2 to 9 percent slopes, is the only soil in this unit. It is a deep, well drained, gently sloping to moderately sloping soil on uplands.

This soil is medium in fertility and easy to work. The available water capacity is moderate. Permeability is moderate in the subsoil, and runoff is medium. Controlling erosion and soil blowing is the main management concern. Conserving moisture and maintaining fertility are also important.

About half the acreage is farmed. Small grain, sorghum, and alfalfa are the main crops.

Stubble mulching, returning crop residue to the soil, contour farming, terracing, and grassed waterways help to control erosion and conserve moisture. Wind stripcropping, field windbreaks, minimum tillage, and use of close-sown crops help to control soil blowing. Using grasses and legumes in the cropping system and applying manure and chemical fertilizer help to maintain fertility.

Capability unit IVe–8

Manvel silt loam, 4 to 9 percent slopes, is the only soil in this unit. It is a deep, well drained, gently sloping to moderately sloping soil on uplands.

This soil is low in fertility and easy to work. The available water capacity is high. The high content of lime in this soil causes it to erode and blow easily. Permeability is moderate or moderately slow, and runoff is medium. Controlling erosion and soil blowing is the main management concern. Conserving moisture, maintaining tilth, and improving fertility and organic-matter content are also important.

Many areas remain in native grass and are used for range and hay. Small grain, tame grasses, and alfalfa are the main crops, and they are better suited than row crops.

Stubble mulching, returning crop residue to the soil, contour farming, terracing, grassed waterways, and minimum tillage help to control erosion and conserve moisture. Stubble mulching, use of close-sown crops, and wind stripcropping help to control soil blowing. Using grasses and legumes in the cropping system and applying manure help to improve fertility and organic-matter content.

Capability unit IVw–1

The Marshdale part of Marshdale-Maitland loams, 2 to 9 percent slopes, is the only soil in this unit. It is a deep, somewhat poorly drained to poorly drained, gently sloping to moderately sloping soil in upland valleys in the Black Hills.

This soil is high in fertility, is easy to work, and has high available water capacity. Soil wetness caused by a high water table makes using this soil for crops difficult in most years. Permeability is moderately slow or slow. Runoff is slow, and water ponds in low areas. Wetness is the main management concern. Maintaining fertility is also important.

Most areas are in tame or native grasses, and a few areas are cultivated. Potatoes, alsike clover, and timothy are the main crops. Oats is also grown in some areas. Wetness, cool nights, and a short growing season limit the choice of crops.

Surface and subsurface drains help to control wetness. Returning crop residue to the soil and applying chemical fertilizer help to maintain fertility.

Capability unit IVs–1

Altvan loam, 0 to 2 percent slopes, is the only soil in this unit. It is a well drained, nearly level soil that is moderately deep over gravelly sand on terraces and alluvial fans.

This soil is medium in fertility and easy to work, but it is somewhat droughty. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. Runoff is slow. Conserving moisture is the main management concern. Controlling soil blowing and maintaining fertility and tilth are also important.

Over half the acreage is farmed. Oats, corn, sorghum, and aflalfa are the main crops. Some wheat and barley are also grown. This soil is better suited to early-maturing small grain crops than to late-maturing row crops.

Stubble mulching, returning crop residue to the soil, wind stripcropping, and use of close-sown crops help to conserve moisture and control soil blowing. Use of grasses and legumes in the cropping system and applying manure and chemical fertilizer help to maintain fertility and tilth.

Capability unit IVs–2

The Mosher part of Satanta-Mosher loams, 0 to 3 percent slopes, is the only soil in this unit. It is a deep, moderately well drained, nearly level soil that has a claypan subsoil.

This soil is medium in fertility and has moderate or high available water capacity, but its claypan subsoil absorbs water slowly and releases it slowly to plants. The claypan subsoil restricts the development of plant roots, and its sodium content affects crop growth. This soil compacts easily and loses its tilth if farmed when wet. Conserving moisture, improving water absorption, and maintaining tilth are the main management concerns. Controlling soil blowing and maintaining fertility are also important.

Many areas remain in native grass and are used for range and hay, but some are farmed. Winter wheat, oats, corn, and alfalfa are the main crops. Small grain is better suited than late-maturing crops such as corn and sorghum.

Stubble mulching, returning crop residue to the soil, and wind stripcropping help to conserve moisture and control soil blowing. Subsoiling, or chiseling, and use of grasses and legumes in the cropping system help to improve water absorption. Timely tillage, use of green manure crops, and applying manure and chemical fertilizer help maintain fertility and tilth.

Capability unit IVs–3

This unit consists of deep, well drained, nearly level clayey soils on uplands, terraces, and bottom land.

These soils are medium in fertility and moderately low in organic-matter content. The available water capacity is low or moderate. These soils are difficult to work, and they absorb water slowly and release it slowly to plants. They lose their tilth and blow easily if farmed. Runoff is slow, and the soil on bottom land is subject to flooding. Conserving moisture, improving water absorption, and maintaining tilth are the main management concerns. Controlling soil blowing and maintaining fertility are also important.

Many areas remain in native grass and are used for range and hay, but some are farmed. Wheat, oats, and alfalfa are the main crops. Corn and sorghum also are grown.

Stubble mulching, returning crop residue to the soil, and wind stripcropping help to conserve moisture and control soil blowing. Subsoiling, or chiseling, timely tillage, and use of grasses and legumes in the cropping

system help to improve water absorption and maintain tilth and fertility.

Capability unit Vw–1

Macken silty clay is the only soil in this unit. It is a deep, poorly drained, level soil in closed depressions on uplands.

This soil is medium in fertility. It dries slowly and is difficult to work. The available water capacity is moderate or high. This soil is too wet for satisfactory cultivation.

Most areas remain in native grass and are used for range and hay. Proper range use helps to maintain a cover of desirable grasses.

Capability unit VIe–1

The Blackpipe part of Midway-Blackpipe complex, 9 to 40 percent slopes, is the only soil in this unit. It is a moderately deep, well drained, strongly sloping to moderately steep, silty soil on uplands. Soft shale is at a depth of 20 to 40 inches.

This soil is medium in fertility. The available water capacity is low or moderate. Permeability is moderately slow, and runoff is medium. This soil generally is not suited to cultivation because of steep slopes and because it has a high susceptibility to erosion.

All areas remain in native grass and are used for range. Proper range use helps to control erosion.

Capability unit VIe–3

This unit consists mainly of moderately deep and deep, well drained to excessively drained, moderately sloping to strongly sloping, calcareous soils on uplands. Also in this unit is a shallow soil that is mapped with one of the deep soils. These soils have a surface layer of loam, gravelly loam, silt loam, or clay loam.

These soils have a high content of lime. They are low in fertility and low or moderately low in organic-matter content. The available water capacity ranges from low in the moderately deep and shallow soils to high in the deep soils. Permeability is moderate or moderately rapid, and runoff is medium. These soils generally are too erodible for cultivation.

Most areas remain in native grass and are used for range. Small grain, alfalfa, and tame grasses are the main crops in the few areas that are cultivated. Proper range use helps to control erosion in the areas in native grass. Seeding to native grass is the most effective method of controlling erosion in cultivated areas.

Capability unit VIe–4

Pierre clay, 6 to 15 percent slopes, is the only soil in this unit. It is a moderately deep, well drained, moderately sloping to strongly sloping soil on uplands. It is underlain by soft shale at a depth of 20 to 40 inches.

This soil is medium in fertility and moderately low in organic-matter content. It is difficult to work and absorbs water slowly. The available water capacity is low, and runoff is medium. This soil generally is not suited to cultivation because of slope and because it has a high susceptibility to erosion and soil blowing.

Most areas remain in native grass and are used for range. Wheat and oats are the main crops in the few areas that are farmed. Proper range use helps to control erosion. Seeding to native grass is the best means of controlling erosion in cultivated areas.

Capability unit VIe–8

Bankard soils is the only mapping unit in this capability unit. They are deep, well drained to somewhat excessively drained, nearly level soils on bottom land. These soils mostly have a surface layer of very fine sandy loam, loam, fine sandy loam, or loamy fine sand. They are underlain by sandy alluvium.

These soils are low in fertility and organic-matter content. The available water capacity is low, and permeability is rapid. Runoff is slow, and most areas are subject to stream flooding. These soils generally are not suited to dryfarming because of their high susceptibility to soil blowing.

Most areas are in native grass and are used for range. Proper range use helps to control soil blowing. Seeding to native grasses is the best means of controlling soil blowing in the few areas that are cultivated.

Capability unit VIe–11

This unit consists mainly of shallow, well drained to excessively drained, moderately sloping to moderately steep, calcareous, loamy and silty soils on uplands. Also in this unit is a deep soil that is mapped with one of the shallow soils. These soils have a surface layer of loam, silt loam, and silty clay loam.

These soils are low in fertility and organic-matter content. In the shallow soils, the available water capacity is low or very low and permeability is moderate above the soft bedrock. Runoff is medium to rapid. These soils generally are not suited to cultivation because of shallowness and slope and because they are highly susceptible to erosion.

Most areas remain in native grass and are used for range. Proper range use helps to control erosion and conserve moisture.

Capability unit VIe–12

This unit consists mainly of shallow, well drained to excessively drained, moderately sloping to strongly sloping, clayey soils on uplands. Also in this unit are moderately deep clayey soils that are mapped with these shallow soils.

In the shallow soils, fertility and the organic-matter content are low and the available water capacity is very low. Permeability typically is slow or very slow, but it is moderate in the soil that is underlain by acid shale. Runoff is medium to rapid. These soils generally are not suited to cultivation because of shallowness and slope and because they are highly susceptible to erosion and soil blowing.

Most areas remain in native grass and are used for range. Proper range use helps to control erosion and soil blowing and conserve moisture.

Capability unit VIe–13

This unit consists of deep, well drained, hilly soils in the Black Hills. These soils have a surface layer of loam, silt loam, or very fine sandy loam, and in places

the surface is stony. These soils are underlain by sandstone, limestone, or shale.

These soils are low to medium in fertility. The available water capacity is high. Permeability in the subsoil is moderate or moderately slow. Runoff is medium to rapid. These soils generally are not suited to cultivation because of slope and because they are highly susceptible to erosion if the plant cover is removed.

Most areas are in ponderosa pine forest and are used for timber production, woodland grazing, recreation, and wildlife. Maintaining an adequate plant cover and protecting the forest litter from disturbance will help to control erosion.

Capability unit VIw–1

This unit consists of deep, well drained to somewhat excessively drained, nearly level to gently sloping soils on bottom land, low terraces, and alluvial fans. These soils have a surface layer that ranges from fine sandy loam to clay loam or silty clay loam, and in places is gravelly, cobbly, or stony.

These soils are low to medium in fertility. The available water capacity is low to high. Permeability is slow to moderately rapid. Runoff is slow to medium. These soils are subject to flooding. Farming is impractical, because most of the narrow areas are dissected by meandering channels.

Most areas remain in native vegetation and are used for grazing and hay. Scattered trees and shrubs provide cover for wildlife and winter protection for livestock. In places the soils in this unit have potential for small gardens.

Capability unit VIs–3

This unit consists of deep and moderately deep, well drained to poorly drained, level to gently sloping soils. These soils have a thin surface layer of loam or silt loam and a claypan subsoil.

These soils are low to medium in fertility. The available water capacity is very low to high. Permeability is very slow, and runoff is medium to ponded. The soils in this unit generally are not suited to cultivation because they have very poor tilth, very slow permeability in the claypan subsoil, and a high sodium content. In addition, they are wet in the early part of the growing season and droughty late in summer.

Most areas remain in native grass and are used for range and hay. Proper range use helps to control soil blowing and conserve moisture.

Capability unit VIs–6

This unit consists of deep and moderately deep, well drained to moderately well drained, nearly level to moderately sloping, clayey soils on uplands, terraces, and alluvial fans. These soils are very high in clay content and generally have spots and streaks of salts above a depth of 15 inches.

These soils are low in fertility and organic-matter content. The available water capacity is very low to moderate. Runoff is medium to rapid. These soils generally are not suited to cultivation because they have a very poor tilth, high salt content, and low fertility.

Most areas remain in native grass and are used for range. Proper range use helps to conserve moisture and to control erosion and soil blowing.

Capability unit VIIe–1

Nihill gravelly loam, 9 to 40 percent slopes, is the only soil in this unit. It is a deep, excessively drained, strongly sloping to steep, gravelly soil on uplands and terrace escarpments.

This soil is low in fertility and organic-matter content. The available water capacity is low. Permeability is moderately rapid, and runoff is medium to rapid. This soil is not suited to cultivation because it is steep and highly susceptible to erosion.

Most areas remain in native grass and are used for range. Proper range use helps to control erosion.

Capability unit VIIe–4

This unit consists of shallow, well drained to excessively drained, moderately steep and steep, loamy soils on uplands. Sandstone, siltstone, or shale is at a depth of less than 20 inches.

These soils are low in fertility and organic-matter content. The available water capacity is very low to low. Permeability is moderate, and runoff is rapid. These soils are not suited to cultivation because they are steep, shallow, and highly susceptible to erosion.

All areas remain in native grass and are used for range. Proper range use helps to control erosion and conserve moisture.

Capability unit VIIe–5

This unit consists of shallow, well drained to excessively drained, strongly sloping to steep, clayey soils on uplands. Soft clayey shale is at a depth of less than 20 inches.

These soils are low in fertility and organic-matter content. The available water capacity is very low. Permeability is very slow to moderate, and runoff is rapid. These soils are not suited to cultivation because they are steep, shallow, and highly susceptible to erosion and soil blowing.

All areas remain in native grass and are used for range. Proper range use helps to control erosion and soil blowing and to conserve moisture.

Capability unit VIIe–9

Vanocker-Citadel association, steep, is the only mapping unit in this capability unit. These are mostly deep, well drained, steep soils in the Black Hills. These soils have a surface layer of silt loam, very fine sandy loam, loam, and channery loam. In places they are stony.

These soils are medium to low in fertility. The available water capacity is low to high. Permeability is moderate or moderately slow, and runoff is medium to rapid. The soils in this unit are not suited to cultivation because they are steep, stony, and highly susceptible to erosion if the plant cover is removed.

Most areas are in ponderosa pine forest and are used for timber production, woodland grazing, recreation, and wildlife habitat. Maintaining the plant cover and protecting forest litter from disturbance help to control erosion.

Capability unit VIIs–1

The Paunsaugunt part of Paunsaugunt-Rock outcrop, 3 to 40 percent slopes, is the only soil in this unit. It is a shallow, well drained to somewhat excessively drained, gently sloping to steep soil on uplands in the Black Hills. This soil has a surface layer of gravelly loam, and fragments of limestone are throughout the soil above the hard limestone bedrock.

This soil is medium in fertility. The available water capacity is very low, and runoff is rapid. This soil is not suited to cultivation because of slopes, shallowness, and stoniness.

All areas are in ponderosa pine forest or in native grasses. This soil is used mainly for woodland grazing, recreation, and wildlife habitat. Posts, poles, and a few saw logs are harvested from the timber stand. Maintaining an adequate plant cover helps conserve moisture and control erosion.

Capability unit VIIIs–1

This unit consists of the Rock outcrop parts of several mapping units. Rock outcrop consists of limestone, sandstone, siltstone, or shale that is at the surface. Most areas of Rock outcrop support little or no vegetation and have little or no value for grazing domestic livestock. The main uses are for recreation and wildlife habitat.

Capability unit VIIIs–3

This unit consists of the Slickspots parts of several mapping units. These small spots, which are scattered throughout the landscape, have a puddled or "slicked-over" surface and commonly have spots and streaks of salts within a few inches of the surface. They support little or no vegetation and have little or no value for grazing domestic livestock. Weeds and forbs that grow on some of the Slickspots provide a limited amount of browse for wildlife.

Tame pastures [5]

Tame pasture is a practical, economically feasible land use for many soils in this survey area. The acreage in permanent tame pasture is relatively small, but it is an important supplement to native range because it provides grazing early in the season when the native range is still dormant. In addition to areas in permanent tame pasture, some of the cropland periodically is seeded to tame grasses for use as rotation pasture and hay.

The primary objective of pasture management is to maintain vigorous stands of palatable, well adapted forage that will improve the soil and control erosion and soil blowing. Management that includes proper grazing use, maintaining adequate fertility, clipping, and weed control helps to meet this objective.

Proper grazing use includes delaying grazing until vegetation has a good start in the spring, avoiding grazing too closely, rotation grazing, grazing at the optimum stage of plant growth, and periodic resting. A good fertility program includes applying fertilizer when needed and maintaining an adequate supply of all plant nutrients. Clipping of some grasses helps to distribute grazing and stimulate even regrowth. Where stands are thin, control of weeds by mowing or spraying increases the moisture and plant nutrients available for use by desirable plant species.

The soils in this survey area that are suitable for tame pasture are placed in pasture suitability groups. The soils in each group have the potential for producing similar kinds and amounts of tame grasses and legumes. To find the pasture group of a given soil, refer to the "Guide to Mapping Units" at the back of this survey. The pasture groups described in the following paragraphs are not consecutive alphabetically because not all of the groups in the statewide system occur in this survey area.

Pasture group B

This group consists of deep, poorly drained soils in upland depressions and a deep, somewhat poorly drained and poorly drained soil in upland valleys in the Black Hills. The soils in depressions receive runoff from adjacent areas, and water ponds on them for short periods in most years. The soil in the Black Hills has a water table that is within the root zone of pasture plants throughout the growing season. In most areas, artificial drainage of the soils in this group is not feasible. The excess moisture limits the choice of plants to water-tolerant species.

Western wheatgrass is the pasture plant best suited to the soils in this group that are in depressions. Creeping foxtail and reed canarygrass are suitable pasture plants for the soil that is in the Black Hills.

Pasture group C

The Mosher part of Satanta-Mosher loams, 0 to 3 percent slopes, is the only soil in this group. It is a deep, moderately well drained soil that has a claypan subsoil. The claypan subsoil absorbs water slowly and limits the growth of plant roots. The choice of plants and the yield of forage are limited by the relatively high sodium content in the subsoil or underlying material.

Crested wheatgrass and western wheatgrass are the pasture plants best suited to this soil.

Pasture group D

This group consists of well drained, nearly level and gently sloping, loamy soils that are moderately deep over gravelly sand. These soils are somewhat droughty because of the underlying gravelly sand.

Alfalfa, crested wheatgrass, and pubescent wheatgrass are the pasture plants best suited to the soils in this group.

Pasture group F

This group consists of deep and moderately deep, well drained, nearly level to hilly, loamy and silty soils. In most of these soils, permeability is moderate or moderately slow and the available water capacity is moderate or high. The soils in this group are well suited to all climatically adapted pasture plants; however, bunchtype species planted alone are not recom-

[5] By PAUL M. BODEN, conservation agronomist, Soil Conservation Service.

mended for soils that have slopes of more than 6 percent.

Alfalfa, crested wheatgrass, green needlegrass, intermediate wheatgrass, and pubescent wheatgrass are the pasture plants best suited to the soils in this group. Smooth bromegrass and these pasture plants are suited to the soils of this group that are in the Canyon-Lakoa-Maitland and Tilford-Nevee soil associations. Big bluestem, birdsfoot trefoil, indiangrass, Kentucky bluegrass, orchardgrass, smooth bromegrass, and tall fescue are suited to the soils that are in the Citadel-Vanocker soil association.

Pasture group G

This group consists of deep and moderately deep, well drained, gently sloping to strongly sloping, loamy and silty soils that are calcareous at or within 10 inches of the surface. The choice of plants and the yield of forage are limited because these soils are low in fertility, have a high lime content, and are highly susceptible to erosion and soil blowing.

Alfalfa, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are the pasture plants best suited to the soils in this group.

Pasture group H

This group consists of deep, well drained, nearly level to moderately sloping soils that formed in moderately sandy material. Most of these soils have a surface layer of fine sandy loam, but some have a surface layer of very fine sandy loam, loam, or clay loam. These soils absorb water readily, have low or moderate available water capacity, and are susceptible to soil blowing.

Alfalfa, crested wheatgrass, intermediate wheatgrass, and pubescent wheatgrass are the pasture plants best suited to the soils in this group.

Pasture group I

This group consists of deep and moderately deep, well drained, nearly level to strongly sloping clayey soils. These soils have very slow or slow permeability and a clayey subsoil that releases moisture slowly to plants. The available water capacity is low or moderate. Tilth is poor, and the soils crack when dry.

Alfalfa, crested wheatgrass, green needlegrass, pubescent wheatgrass, and western wheatgrass are the pasture plants best suited to the soils in this group.

Pasture group K

This group consists of deep, well drained and moderately well drained, nearly level and gently sloping, loamy soils that receive extra moisture from runoff from adjacent soils or from stream overflow. These soils are high in fertility and have high available water capacity. The additional moisture available to pasture plants results in yields of forage that are higher than on adjacent uplands.

Alfalfa, green needlegrass, intermediate wheatgrass, smooth bromegrass, pubescent wheatgrass, and western wheatgrass are the pasture plants best suited to the soils in this group.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

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

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

Crops other than those shown in table 2 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. Also, the yields shown in table 2 are for dryfarmed crops only. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for other dryfarmed crops and for crops under irrigation.

Windbreaks[6]

Windbreaks have been planted in the survey area since the time of early settlement. Most of the early plantings were for farmstead and livestock protection, and many farmsteads and ranch headquarters still need this kind of planting. In recent years, field windbreaks have been planted to help control soil blowing

[6] By DAVID L. HINTZ, forester, Soil Conservation Service.

TABLE 2.—*Yields per acre of crops and pasture*

[All yields were estimated for a high level of management in 1975. Dashes indicate that the crop is seldom grown or is not suited. Only soils suitable for crops are listed]

Soil series and map symbols	Corn	Oats	Winter wheat	Grain sorghum	Alfalfa hay	Cool season grass
	Bu	*Bu*	*Bu*	*Bu*	*Ton*	*AUM* [1]
Altvan:						
AlA	18	28	24		1.1	1.8
AlB	17	27	20		0.9	1.5
Assinniboine:						
AsB		38	30		1.4	2.3
Blackpipe:						
BlD	25	33	25		1.3	2.2
Glenberg:						
Ga		36	20	29	1.4	2.3
Keith:						
KaA	31	41	36	38	1.6	2.7
KaB	29	39	32	34	1.5	2.5
Kyle:						
KbA	22	33	28	30	1.3	2.2
KbB, KcB [2]	19	32	27	28	1.2	2.0
Lohmiller:						
Le		38	30		1.6	2.7
Manvel:						
MbB		28	24		1.0	1.7
Marshdale:						
McB [2]						4.5
Nunn:						
NcA	31	40	35	35	1.6	2.7
NcB	29	37	32	33	1.5	2.4
NcC		33	28		1.3	2.2
Onita:						
OaA	38	45	41		2.0	3.3
Pierre:						
PbB	17	30	24		0.9	1.5
Satanta:						
SdA	31	40	33	33	1.6	2.7
SdB	29	38	32	31	1.5	2.5
SdC		35	29		1.3	2.2
SeA [2]		27	26		1.3	2.2
Savo:						
ShA		40	32	30	1.5	2.5
SkB [2]		36	30	28	1.4	2.3
St. Onge:						
So	40	47	41		2.2	3.7
Stetter:						
St					1.4	2.3
Tilford:						
TaA	33	43	39		2.1	3.5
TaB	31	41	36		2.0	3.3

[1] Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

[2] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

and conserve moisture, but thousands of acres in the survey area still need some form of wind protection.

Windbreaks help distribute and hold snow, thus preventing the snow from drifting against the farmstead. They help protect the house and livestock from winter winds, reducing fuel and feed costs. They protect field crops, gardens, and orchards from damaging winds. They reduce evaporation of moisture and help control soil blowing. In addition, windbreaks provide suitable habitat for birds and other wildlife.

In planting a windbreak, the purpose of the planting, suitability of the soils, the adaptability of trees and shrubs to the site, and the location of the windbreak should be considered.

The establishment of a windbreak and the continued growth of the trees depend upon the careful selection of the site and of the trees and shrubs to be planted, adequate site preparation, and adequate maintenance of planted trees or seedlings. Grasses and weeds should be controlled before trees are planted, and regrowth of ground cover should be controlled during the life of the windbreak. Some replanting is generally needed after the first or second year.

The soils in this survey area are placed in windbreak suitability groups. The growth response of adapted trees and shrubs generally is the same within a group if good management practices are used. The most critical factor that determines placement of soils into windbreak groups is the amount and seasonal availability of soil moisture to trees. Slope and texture are also important, because they affect the susceptibility of the soil to erosion and soil blowing.

Water conservation generally is needed to ensure satisfactory tree growth on soils that have slopes of more than 6 percent. Special site preparation and special practices for planting and cultivation generally are necessary to successfully establish and maintain tree plantings on soils that have a hazard of erosion or soil blowing. The water table generally is below the depth to which tree roots extend in all the soils in windbreak groups 3 through 9 and in almost all the soils in group 10.

Table 3 can be used as a guide in planning a windbreak. It lists, by height class, the main tree and shrub species that are suitable for the soils in each windbreak group in the survey area except those in windbreak group 10. The height classes given in table 3 are based on measurements and observations made on windbreaks of 20 years of age that have been adequately managed. Soils in group 10 are not suited to windbreaks. Onsite investigations are necessary to determine which species are suited to specialized plantings on the soils of this group because of the wide range of soil characteristics and site conditions.

In the following paragraphs, the windbreak groups in this survey area are described. To find the windbreak group of a given soil, refer to the "Guide to Mapping Units" at the back of this survey.

Windbreak group 1

This group consists of deep, well drained and moderately well drained, nearly level to gently sloping soils on bottom land and in upland swales. These soils have a surface layer that ranges from fine sandy loam to clay loam and silty clay loam. These soils receive additional moisture from stream flooding or as runoff from adjacent soils. The available water capacity is moderate or high in most of the soils. Susceptibility to erosion and to soil blowing is slight or moderate.

The soils in this group are well suited to all kinds of windbreaks and other types of woody plantings. All climatically adapted trees and shrubs have the potential to grow well.

Windbreak group 2

The Marshdale part of Marshdale-Maitland loams, 2 to 9 percent slopes, is the only soil in this group. It is a deep, somewhat poorly drained to poorly drained soil in upland valleys in the Black Hills. This soil is high in fertility and has a water table within a depth of 2 feet from the surface during much of the growing season. The available water capacity is moderate or high. Susceptibility to erosion and to soil blowing is slight.

This soil is well suited to all kinds of woody plantings if drainage is provided. However, there is generally little or no need for windbreak plantings in areas of this soil. All climatically adapted species have the potential to grow well.

Windbreak group 3

This group consists of deep and moderately deep, well drained, nearly level to strongly sloping, loamy and silty soils on uplands. Permeability is moderate or moderately slow in most of these soils. The available water capacity is moderate or high in most of the soils in this group, but it is low or moderate in the moderately deep soil. Susceptibility to erosion is slight to severe, and the hazard of soil blowing is slight or moderate.

The soils in this group are well suited to windbreaks and other types of woody plantings. All climatically adapted species have the potential to grow well except those species that have a high moisture requirement. Planting on the contour helps to control water erosion and conserve moisture.

Windbreak group 4

This group consists of deep and moderately deep, well drained, nearly level and gently sloping clayey soils on uplands, terraces, and bottom land. Permeability is very slow or slow, and the available water capacity is low or moderate. Susceptibility to erosion and to soil blowing is slight to severe.

The soils in this group are moderately well suited to windbreaks and other types of woody plantings. Most of the climatically adapted species of trees and shrubs have the potential to grow well.

Windbreak group 5

Assinniboine fine sandy loam, 2 to 9 percent slopes, is the only soil in this group. It is a deep, well drained soil on uplands. Permeability is moderate in the subsoil and moderately rapid in the underlying material. The available water capacity is moderate. Susceptibility to erosion is moderate or severe, and this soil is susceptible to soil blowing.

TABLE 3.—*Windbreaks and environmental plantings*

[Absence of an entry means that trees of the specified height class normally do not grow on the soils in the specified windbreak group]

Windbreak group and soil map symbols	Trees and shrubs having a predicted 20-year average height of—				
	Less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Group 1: Ga, Le, OaA, So.	American plum, golden currant, late lilac, lilac, Nanking cherry, Peking cotoneaster, redosier dogwood, Saskatoon serviceberry, silver buffaloberry, skunkbush sumac, Tatarian honeysuckle, and western sandcherry.	Amur maple, common chokecherry, eastern redcedar, Harbin pear, Manchurian apricot, Manchurian crabapple, Missouri River willow, Rocky Mountain juniper, Russian-olive, Siberian apricot, Siberian crabapple, and Siberian peashrub.	Black Hills spruce, blue spruce, boxelder, bur oak, green ash, hackberry, laurel willow, ponderosa pine, Scotch pine, and Siberian larch.	Carolina poplar, Chinkota elm, dropmore elm, eastern cottonwood, golden willow, plains cottonwood, robusta poplar, Siberian elm, Siouxland cottonwood, and white willow.	Northwest poplar.
Group 2: Marshdale part of McB.	American plum, golden currant, late lilac, lilac, Nanking cherry, Peking cotoneaster, redosier dogwood, Saskatoon serviceberry, Siberian peashrub, silver buffaloberry, skunkbush sumac, Tatarian honeysuckle, and western sandcherry.	Amur maple, boxelder, common chokecherry, eastern redcedar, hackberry, Harbin pear, Manchurian apricot, Manchurian crabapple, Missouri River willow, Rocky Mountain juniper, Russian-olive, Siberian apricot, and Siberian crabapple.	Black Hills spruce, blue spruce, bur oak, golden willow, green ash, laurel willow, ponderosa pine, Scotch pine, Siberian larch, and white willow.	Carolina poplar, eastern cottonwood, northwest poplar, plains cottonwood, robusta poplar, and Siouxland cottonwood.	----------
Group 3: BlD, KaA, KaB, NcA, NcB, NcC, SdA, SdB, SdC, ShA, SkB, TaA, TaB; Blackpipe part of BsD, Bridget part of CbD, and Satanta part of SeA.	American plum, Amur maple, golden currant, late lilac, lilac, Nanking cherry, Peking cotoneaster, redosier dogwood, silver buffaloberry, skunkbush sumac, Tatarian honeysuckle, and western sandcherry.	Bur oak, common chokecherry, eastern redcedar, green ash, hackberry, Harbin pear, Manchurian apricot, Manchurian crabapple, Rocky Mountain juniper, Siberian apricot, Siberian crabapple, and Siberian peashrub.	Black Hills spruce, blue spruce, boxelder, Chinkota elm, dropmore elm, ponderosa pine, Russian-olive, Scotch pine, Siberian elm, and Siberian larch.	----------	----------
Group 4: KbA, KbB, KcB, PbB, St.	American plum, golden currant, lilac, Nanking cherry, Peking cotoneaster, Siberian peashrub, silver buffaloberry, skunkbush sumac, and Tatarian honeysuckle.	Common chokecherry, eastern redcedar, green ash, hackberry, Harbin pear, Manchurian apricot, Manchurian crabapple, Rocky Mountain juniper, Russian-olive, Siberian apricot, and Siberian crabapple.	Chinkota elm, dropmore elm, ponderosa pine, and Siberian elm.	----------	----------
Group 5: AsB ----------	American plum, golden currant, lilac, Peking cotoneaster, silver buffaloberry, skunkbush sumac, Tatarian honeysuckle, and western sandcherry.	Common chokecherry, eastern redcedar, green ash, Harbin pear, Manchurian apricot, Manchurian crabapple, Rocky Mountain juniper, Siberian apricot, Siberian crabapple, and Siberian peashrub.	Bur oak, Chinkota elm, dropmore elm, hackberry, ponderosa pine, Russian-olive, and Siberian elm.	----------	----------

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Windbreak group and soil map symbols	Trees and shrubs having a predicted 20-year average height of—				
	Less than 8 feet	8 to 15 feet	16 to 25 feet	26 to 35 feet	More than 35 feet
Group 6: AlA, AlB	Eastern redcedar, lilac, Rocky Mountain juniper, Russian-olive, and Siberian peashrub.	Chinkota elm, dropmore elm, green ash, hackberry, ponderosa pine, and Siberian elm.			
Group 7: Ba		Eastern redcedar, ponderosa pine, and Rocky Mountain juniper.			
Group 8: MbB	Eastern redcedar, Harbin pear, lilac, Rocky Mountain juniper, Siberian peashrub, and silver buffaloberry.	Chinkota elm, dropmore elm, green ash, ponderosa pine, Russian-olive, and Siberian elm.			
Group 9: Mosher part of SeA	Eastern redcedar, Harbin pear, lilac, Rocky Mountain juniper, Siberian peashrub, and silver buffaloberry.	Chinkota elm, dropmore elm, green ash, ponderosa pine, Russian-olive, and Siberian elm.			

This soil is well suited to windbreaks and other types of woody plantings. It is well suited to most climatically adapted species but not to those trees and shrubs that have a high moisture requirement. Management that controls soil blowing before and after planting is generally needed.

Windbreak group 6

This group consists of well drained, nearly level to gently sloping, loamy soils that are moderately deep over gravelly sand. Permeability is moderate in the subsoil and rapid in the underlying gravelly sand. The available water capacity is moderate, but the soils are droughty because of the underlying gravelly sand. Susceptibility to erosion and to soil blowing is slight or moderate.

The soils in this group are poorly suited to windbreaks and other types of woody plantings. Trees and shrubs grow poorly, but some plantings can be established if optimum survival, growth, and vigor are not required or expected. Field windbreaks generally are not recommended. Survival and vigor are poor during dry years.

Windbreak group 7

Bankard soils is the only mapping unit in this group. These are deep, well drained to somewhat excessively drained soils on bottom land. They formed in alluvium. The surface layer commonly is loamy fine sandy loam, fine sandy loam, very fine sandy loam, or loam. Permeability is rapid, and the available water capacity is low. Susceptibility to erosion is slight, but the hazard of soil blowing is very severe.

These soils are poorly suited to windbreaks and other types of woody plantings. If optimum survival, growth, and vigor are not required or expected, however, plantings can be established by using selected adapted species. Field windbreaks are not recommended. The control of soil blowing is necessary before and after planting.

Windbreak group 8

Manvel silt loam, 4 to 9 percent slopes, is the only soil in this group. It is a deep, well drained, calcareous soil on uplands. Permeability is moderate or moderately slow, and the available water capacity is high. This soil is low in fertility, and its high lime content causes it to blow easily. Susceptibility to erosion is severe.

This soil is poorly suited to windbreaks and other types of woody plantings. If optimum survival, growth, and vigor are not required or expected, however, plantings can be established by using selected adapted species. Field windbreaks are not recommended. Planting on the contour helps to control erosion and conserve moisture.

Windbreak group 9

The Mosher part of Satanta-Mosher loams, 0 to 3 percent slopes, is the only soil in this group. It is a deep, moderately well drained soil that has a claypan subsoil. Permeability is very slow, and the available water capacity is moderate or high. This soil has a relatively high sodium content in some part of the subsoil or underlying material. Susceptibility to erosion is slight, but there is a moderate risk of soil blowing.

This soil is poorly suited to windbreaks and other

TABLE 4.—*Productivity and management of ponderosa pine, by woodland suitability group*

[Site index for ponderosa pine in this survey area is the average height the trees will attain in 100 years and are based on plot data collected by the Forest Service and the Soil Conservation Service (*4*). Both the arithmetic mean and standard deviation of plot data indices are given. Numbers in parentheses indicate the number of samples]

Woodland group	Potential productivity			Management hazards or limitations				
	Site index	Average annual growth per acre [1]		Seedling mortality	Plant competition	Equipment limitations	Erosion hazard	Windthrow hazard
		Board feet	*Cubic feet*					
5f3	57±6 (9)	78	36	Moderate	Slight	Severe	Severe	Slight.
5r2	66±4 (7)	131	45	Moderate	Slight	Slight	Moderate	Slight.
5r3	59±5 (3)	78	36	Moderate	Slight	Severe	Severe	Slight.
6d0	45±7 (23)	4	15	Severe	Moderate	Moderate or severe.	Moderate or severe.	Moderate.

[1] Board foot volume is based on trees 11.6 inches DBH and larger; cubic foot volume is based on trees 6.6 inches DBH and larger; both are based on stands 100 years of age.

types of woody plantings. No trees or shrubs grow well, but plantings of adapted species can be established if optimum survival, growth, and vigor are not required or expected. Field windbreaks are not recommended.

Windbreak group 10

This group consists of soils that are too steep or too wet for machine plantings. In additon, most of the soils are too shallow, are too high in salt content, or have some other characteristic that adversely affects the growth and survival of most trees and shrubs.

The soils in this group are not suited to windbreaks, but some of them can be used for other types of woody plantings if the trees are planted by hand and given special care. Trees and shrubs should be selected that are tolerant of the conditions at a particular site.

Woodland [7]

Approximately 55,000 acres of native woodland is in the Black Hills part of the survey area. Ponderosa pine is the only species of commercial value. Other species common to the Black Hills part of the survey area include American elm, bur oak, hophornbeam, paper birch, and quaking aspen. Narrow strips of deciduous trees are along streams in other parts of the survey area. Species common to these areas are American elm, bur oak, and plains cottonwood.

The woodland soils in the survey area are placed into woodland suitability groups to assist landowners in planning the use of the soils for wood crops. Each group consists of soils that are suitable for the same trees, require similar management, and have similar production potential.

Table 4 lists the woodland groups in the survey area and gives the potential productivity and some of the management hazards or limitations for each group. Only those soils that are naturally suited to growing trees are placed in a woodland group.

Each woodland group listed in table 4 is identified by a 3-part symbol, such as 5r2 or 6d0. The first part of the symbol, a number, indicates the relative potential productivity of the soils for the growing of ponderosa pine: *1* indicates very high potential productivity; *2*, high; *3*, moderately high; *4*, moderate; *5*, low; and *6*, very low. These ratings are based on field determinations of the average site index for ponderosa pine.

The second part of the woodland group symbol is a lower-case letter that indicates the kind of soil properities or site features that limit the use of the soils for wood crops. The letter *o* indicates that the soils have few limitations that restrict their use for trees; *d* indicates that the main limitation is a restricted rooting depth; *f* indicates that coarse fragments in the soil may limit or restrict woodland use or management; and *r* indicates that the major limitation is steep slopes.

The third part of the woodland group symbol indicates the degree of hazards or limitations of the soils in the group for woodland use. The number *1* indicates that the soils have no or only slight hazards; *2* indicates one or more moderate hazards or limitations; *3* indicates one or more severe hazards or limitations; and *0* indicates that the soils have very low productivity or have too many severe hazards and limitations to justify management for timber production.

The *potential productivity* for each woodland group is expressed in table 4 as a site index and as the average annual growth per acre. These are given only for ponderosa pine because it is the only species that has economic importance for timber production.

The *site index* for ponderosa pine in this survey area is the average height the trees will attain in 100 years. The values given in table 4 are based on plot and field data collected in the Black Hills by the Rocky Mountain Forest and Range Experiment Station, the Black Hills National Forest, and the Soil Conservation Service. The range of site indices for ponderosa pine is grouped into six site quality classes (*4*): a site index of 113 and over is in Class I; 99 to 112 is in Class II; 85 to 98 is in Class III; 71 to 84 is in Class

[7] By DAVID L. HINTZ, forester, Soil Conservation Service.

IV; 57 to 70 is in Class V; and 43 to 56 is in Class VI. These site quality classes correspond to the first part of the woodland group symbol.

The *average annual growth per acre* for ponderosa pine in each woodland group, expressed in board feet and cubic feet, is based on research studies (*4*).

The hazards or limitations that affect management of soils for woodland are seedling mortality, plant competition, equipment limitation, and the hazards of erosion and windthrow.

Seedling mortality refers to the expected mortality of planted seedlings as influenced by soil properties when plant competition is not a limiting factor. Considered in the ratings are soil depth and structure. Normal rainfall and the use of good planting stock and proper planting methods are assumed. A rating of *slight* indicates an expected loss of less than 25 percent of the planted seedlings; *moderate,* a loss of 25 to 50 percent; and *severe,* a loss of more than 50 percent of the seedlings.

Ratings of *plant competition* are based on the degree to which undesirable plants invade openings in the tree canopy. Considered in the ratings are the available water capacity, fertility, and drainage. A rating of *slight* means that competition from other plants is not a problem; *moderate,* that plant competition delays development of fully stocked stands of ponderosa pine; and *severe,* that plant competition prevents establishment of a desirable stand unless intensive site preparation and weeding or other special practices are used to control undesirable plants.

Equipment limitations are rated on the basis of soil characteristics that restrict or prohibit the use of equipment commonly used in the tending or harvesting of trees. In this survey area, the major soil characteristics that limit use of equipment are slope, presence of large amounts of coarse fragments in the soil, and presence of rock outcrop. A rating of *slight* means there is no restriction on the kind of equipment or on the time of the year that it can be used; *moderate,* that the use of equipment is restricted for less than 3 months of the year; and *severe,* that special equipment is needed and that its use is restricted for more than 3 months of the year.

Erosion hazard refers to the potential hazard of soil losses on woodland soils. The hazard is *slight* if expected soil losses are small; *moderate* if some losses are expected and care is needed during logging and construction to reduce them; and *severe* if special methods of operation are necessary for preventing excessive losses.

Windthrow hazard measures the effect of soil properties on root development and the ability of the soil to hold trees firmly. The hazard is *slight* if the effective rooting depth is more than 20 inches and trees can withstand most winds; *moderate* if effective rooting depth is 10 to 20 inches and some trees are blown down during periods of excessive soil wetness and strong winds; and *severe* if the effective rooting depth is 10 inches or less and trees cannot withstand strong winds.

In the following paragraphs, the woodland groups in this survey area are described and their productivity and management for timber production are discussed. Only the soils suited to native woodland are placed in woodland groups.

Woodland group 5f3

The Vanocker part of the Vanocker-Citadel association, steep, is the only soil in this group. It is a deep, well drained, steep, loamy soil that contains many coarse fragments throughout the profile. Permeability is moderate, and the available water capacity is low or moderate. Runoff is medium to rapid.

This soil has low potential productivity for timber production. Equipment limitations and the hazard of erosion are severe. The other major hazards and limitations are slight or moderate.

Ponderosa pine is the species to favor for timber production. Timber stands can be managed to provide greater forage production for livestock grazing and improved wildlife habitat. In places where deciduous trees and shrubs are dominant, the wildlife resource can be improved by favoring and managing those species for maximum production of browse. Where reforestation is desired, ponderosa pine is the only species recommended for planting.

Woodland group 5r2

Lakoa-Maitland association, hilly, and Citadel association, hilly, are the soils in this group. This group consists of deep, well drained, strongly sloping to hilly, loamy and silty soils. Permeability is moderate or moderately slow, and the available water capacity is high. Runoff is medium to rapid.

The soils in this group have low potential for timber production. But these soils are capable of producing commercial stands of timber and are the best woodland soils in the survey area for this use.

Seedling mortality and the hazard of erosion are moderate. Equipment limitations are slight or moderate. The other major hazards and limitations are slight.

Ponderosa pine is the species to favor for timber production. Timber stands can be managed to provide greater forage production for livestock grazing and improved wildlife habitat. In places where deciduous trees and shrubs are dominant, the wildlife resource can be improved by favoring and managing those species for maximum production of browse. Where reforestation is desired, ponderosa pine is the only species recommended for planting.

Woodland group 5r3

The Citadel part of Vanocker-Citadel association, steep, is the only soil in this group. It is a deep, well drained, steep soil that has a silty or loamy surface layer. Permeability is moderately slow, and the available water capacity is high. Runoff is medium to rapid.

This soil has low potential productivity for timber production. However, it is capable of producing commercial stands of timber. The steep slopes are a severe limitation for equipment operation, and the hazard of erosion is severe after logging operations. Seedling mortality is moderate. The other major hazards are slight.

Ponderosa pine is the species to favor for timber

production. Timber stand can be managed to provide greater forage production for livestock grazing and improved wildlife habitat. In places where deciduous trees and shrubs are dominant, the wildlife resource can be improved by favoring and managing those species for maximum production of browse. In places where reforestation is desired, ponderosa pine is the only species recommended for planting.

Woodland group 6d0

The Paunsaugunt part of Paunsaugunt-Rock outcrop complex, 3 to 40 percent slopes, is the only soil in this group. It is a shallow, well drained to somewhat excessively drained, gently sloping to steep soil that is underlain by hard, fractured limestone. The available water capacity is very low. Runoff is rapid.

This soil has very low potential productivity for timber production. Generally the stands of ponderosa pine are of little commercial value as sawlogs, but some trees are cut for posts and poles. All limitations and hazards are moderate or severe.

The highest potential of this soil is its use for woodland grazing, wildlife habitat, and recreation.

Wildlife [8]

Wildlife is a product of the land and will respond to good management of soil resources. The level of wildlife production depends on the availability of the essential habitat elements of food, water, and cover. The kinds and amounts of habitat plants, both introduced and native, are closely associated with the suitability of the soil. Most species of wildlife are dependent on several kinds of soil to produce all the elements of habitat they require.

In table 5, the major soils in each of the 13 soil associations in the survey area are rated according to their ability to produce habitat appropriate to four kinds of wildlife. Each association is rated for its highest wildlife potential and for its present wildlife potential based on current land use. These two ratings differ for some associations. The kinds of wildlife listed in table 5 are described in the following paragraphs.

Farmland wildlife includes animals that frequent croplands, pastures, meadows, and planted woodlands. Although they use other areas, such as naturally wooded draws and bottom land, they are most closely associated with cultivated areas. Examples of farmland wildlife are pheasant, gray (Hungarian) partridge, mourning dove, cottontail, jackrabbit, fox, raccoon, whitetail deer, and many species of songbirds.

Woodland wildlife includes animals that use large areas of natural woodlands. These areas are bordered by and commonly include areas of farmland, range, and pasture. However, natural woodland is the major habitat element that affects this kind of wildlife. The ratings do not apply to planted woodlands, because these can be established on many more soils than those on which they occur naturally. Examples of woodland wildlife are mule deer, whitetail deer, cottontail, tree squirrels, raccoon, coyote, turkey, ruffed grouse, thrushes, vireos, scarlet tanagers, and owls.

Wetland wildlife include animals that use areas of natural or improved wetlands as all or part of their breeding habitat. Examples of wetland wildlife are ducks, geese, herons, shorebirds, coot, red-winged blackbird, yellow-headed blackbird, mink, muskrat, and beaver.

Rangeland wildlife includes animals that use extensive areas of native grassland or range. These areas generally include wooded draws and bottom land, scattered areas of farmland, and some planted woodland. However, rangeland is the major habitat element that affects this kind of wildlife. Examples of rangeland wildlife are mule deer, whitetail deer, pronghorn antelope, jackrabbit, coyote, sharptailed grouse, sage grouse, prairie chicken, magpie, horned lark, lark bunting, and mourning dove.

The suitability ratings of soils given in table 5 are as follows:

Good—habitat can easily be established, constructed, improved, or maintained. There are few or no soil limitations for habitat management, and results generally are satisfactory.

Fair—habitat usually can be established, constructed, improved, or maintained, but some soil limitations affect habitat management or construction. A moderate intensity of management and frequent attention is necessary for satisfactory results.

Poor—habitat usually can be established, constructed, improved, or maintained, but soil limitations are severe. Habitat establishment, management, or construction generally is difficult or expensive or requires intensive effort, and satisfactory results cannot be predicted.

Very poor—natural habitat can be maintained if specific management practices are used, but it generally is not possible or feasible to establish, construct, or improve habitat on soils with this rating.

Engineering [9]

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural

[8] By JOHN B. FARLEY, biologist, Soil Conservation Service.

[9] HENRY V. DAHLQUIST, agricultural engineer, Soil Conservation Service, assisted in preparing this section.

TABLE 5.—*Wildlife suitability interpretations, by soil association*

Soil association	Major soils in association and extent[1]		Suitability of major soils for—				Highest potential of soil association.	Present potential of soil association based on current land use
			Farmland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife		
		Pct						
1	Delphill	55	Poor	Very poor	Very poor	Fair.	Rangeland wildlife	Rangeland wildlife.
	Assinniboine	30	Fair	Very poor	Very poor	Good.		
2	Nunn	45	Fair	Very poor	Very poor	Good.	Rangeland wildlife	Farmland wildlife.
	Satanta	20	Fair	Very poor	Very poor	Good.		
	Zigweid	10	Poor	Very poor	Very poor	Fair.		
3	Blackpipe	30	Fair	Very poor	Very poor	Good.	Rangeland wildlife	Rangeland wildlife.
	Savo	25	Fair	Very poor	Very poor	Good.		
	Manvel	10	Poor	Very poor	Very poor	Fair.		
4	Blackpipe	50	Fair	Very poor	Very poor	Good.	Rangeland wildlife	Rangeland wildlife.
	Assinniboine	25	Fair	Very poor	Very poor	Good.		
	Savo	10	Fair	Very poor	Very poor	Good.		
5	Canyon	40	Very poor	Very poor	Very poor	Poor.	Woodland wildlife	Woodland wildlife.
	Lakoa	25	Very poor	Good	Very poor	Very poor.		
	Maitland	15	Poor	Fair	Very poor	Poor.		
6	Citadel	65	Very poor	Good	Very poor	Very poor.	Woodland wildlife	Woodland wildlife.
	Vanocker	25	Very poor	Good	Very poor	Very poor.		
7	Tilford	70	Fair	Very poor	Very poor	Good.	Rangeland wildlife	Rangeland and farmland wildlife.
	Nevee	15	Poor	Very poor	Very poor	Fair.		
8	St. Onge	35	Good	Poor	Poor	Good.	Rangeland wildlife	Farmland wildlife.
	Keith	30	Fair	Very poor	Very poor	Good.		
9	Lohmiller	45	Fair	Very poor	Poor	Fair.	Rangeland wildlife	Rangeland wildlife.
	Glenberg	30	Fair	Very poor	Very poor	Fair.		
10	Kyle	55	Fair	Very poor	Very poor	Fair.	Rangeland wildlife	Rangeland wildlife.
	Pierre	20	Poor	Very poor	Very poor	Fair.		
	Hisle	10	Very poor	Very poor	Very poor	Poor.		
11	Winler	35	Very poor	Very poor	Very poor	Poor.	Rangeland wildlife	Rangeland wildlife.
	Lismas	30	Very poor	Very poor	Very poor	Very poor.		
	Swanboy	10	Very poor	Very poor	Very poor	Very poor.		
12	Samsil	35	Very poor	Very poor	Very poor	Poor.	Rangeland wildlife	Rangeland wildlife.
	Lismas	25	Very poor	Very poor	Very poor	Very poor.		
	Pierre	20	Poor	Very poor	Very poor	Fair.		
13	Grummit	50	Very poor	Very poor	Very poor	Poor.	Rangeland wildlife	Rangeland wildlife.
	Pierre	35	Poor	Very poor	Very poor	Fair.		

[1] The major soils in an association do not total 100 percent; minor soils make up the difference.

soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 6 shows, for each kind of soil, the degree and kind of limitations for building site development; table 7, for sanitary facilities; and table 9, for water management. Table 8 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

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

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 6. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features is so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or tenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 6 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Roads and streets referred to in table 6 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill

TABLE 6.—*Building site development*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Altvan:					
AlA	Severe: cutbanks cave.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell, frost action, low strength.
AlB	Severe: cutbanks cave.	Moderate: shrink-swell, frost action.	Moderate: shrink-swell.	Moderate: shrink-swell, slope, frost action.	Moderate: shrink-swell, frost action, low strength.
Arvada:					
AnB, ArB [1]	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Assinniboine:					
AsB	Slight	Moderate: frost action:	Slight	Moderate: slope, frost action.	Moderate: frost action, low strength.
Bankard:					
Ba [1]	Severe: cutbanks cave, floods.	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Blackpipe:					
BlD	Moderate: slope, too clayey, depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell.	Severe: slope, shrink-swell, low strength.	Severe: shrink-swell, low strength.
BsD: [1]					
Blackpipe part	Moderate: slope, too clayey, depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell.	Severe: slope, shrink-swell, low strength.	Severe: shrink-swell, low strength.
Shingle part	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope	Moderate: depth to rock, slope.
Cabbart:					
CaE	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Canyon:					
CbD: [1]					
Canyon part	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Moderate: depth to rock, slope.	Severe: slope	Moderate: depth to rock, slope.
Bridget part	Moderate: slope	Moderate: low strength, slope.	Moderate: low strength, slope.	Severe: slope	Moderate: low strength, frost action, slope.
CDE: [1]					
Canyon part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Butche part	Severe: slope, depth to rock, large stones.	Severe: slope, depth to rock, large stones.	Severe: slope, depth to rock, large stones.	Severe: slope, depth to rock, large stones.	Severe: slope, depth to rock, low strength.
Citadel:					
CTE [1]	Severe: slope	Severe: slope, shrink-swell.	Severe: slope, shrink-swell.	Severe: slope	Severe: slope, low strength, shrink-swell.
Delphill:					
DaD	Moderate: slope, depth to rock.	Moderate: slope, frost action.	Moderate: slope, depth to rock.	Severe: slope	Moderate: slope, frost action, low strength.

See footnote at end of table.

TABLE 6.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Enning:					
EaD:[1]					
Enning part	Moderate: slope, depth to rock.	Moderate: slope, depth to rock.	Moderate: slope, depth to rock.	Severe: slope	Severe: low strength.
Manvel part	Moderate: slope	Moderate: low strength, slope.	Moderate: low strength, slope.	Severe: slope	Moderate: slope, low strength.
EbE:[1]					
Enning part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope, low strength.
Rock outcrop part. (Too variable to be rated.)					
Glenberg:					
Ga[1]	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Grummit:					
GbD	Moderate: depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell.	Severe: slope, shrink-swell, low strength.	Severe: shrink-swell, low strength.
GcE[1]	Severe: slope	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell.	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.
Hisle:					
HbB:[1]					
Hisle part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Slickspots part. (Too variable to be rated.)					
Hoven:					
Ho	Severe: too clayey, floods, wetness.	Severe: shrink-swell, floods, wetness.	Severe: shrink-swell, floods, wetness.	Severe: shrink-swell, floods, wetness.	Severe: shrink-swell, low strength, floods.
Keith:					
KaA	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action, low strength.
KaB	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
Kyle:					
KbA, KbB, KcB[1]	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Lakoa:					
LAD[1]	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Lismas:					
LbE	Severe: slope, too clayey.	Severe: slope, low strength, shrink-swell.	Severe: slope, low strength, shrink-swell.	Severe: slope, low strength, shrink-swell.	Severe: slope, shrink-swell, low strength.

See footnote at end of table.

TABLE 6.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
LCD:[1]	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: slope, low strength, shrink-swell.	Severe: shrink-swell, low strength.
Lohmiller: Le	Moderate: floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength.
Lh:[1] Lohmiller part	Moderate: floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength.
Glenberg part	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Macken: Ma	Severe: floods, too clayey, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, shrink-swell.
Manvel: MbB	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength, slope.	Moderate: low strength.
Marshdale: McB:[1] Marshdale part	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, low strength, frost action.
Maitland part	Moderate: slope	Moderate: slope, low strength, shrink-swell.	Moderate: slope, low strength, shrink-swell.	Severe: slope	Moderate: slope, shrink-swell, frost action.
Midway: MdD:[1] Midway part	Severe: slope, too clayey.	Severe: slope, shrink-swell.	Severe: slope, shrink-swell.	Severe: slope, shrink-swell.	Severe: slope, shrink-swell, low strength.
Blackpipe part	Moderate: slope, too clayey, depth to rock.	Severe: shrink-swell, low strength.	Severe: shrink-swell.	Severe: slope, shrink-swell, low strength.	Severe: shrink-swell, low strength.
Nevee: NaD:[1] Nevee part	Moderate: slope	Moderate: slope, low strength.	Moderate: slope, low strength.	Severe: slope	Moderate: slope, low strength.
Spearfish part	Moderate: slope, depth to rock.	Moderate: slope, depth to rock.	Moderate: slope, depth to rock.	Severe: slope	Moderate: low strength, slope.
Nihill: NbE	Severe: slope, small stones.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Nunn: NcA, NcB, NcC	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Onita: OaA	Severe: floods	Severe: floods, shrink-swell, frost action.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell, frost action.	Severe: floods, shrink-swell, low strength.

See footnote at end of table.

TABLE 6.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Paunsaugunt:					
PaE:[1]					
Paunsaugunt part	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.
Rock outcrop part (Too variable to be rated.)					
Pierre:					
PbB	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
PbC	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: low strength, shrink-swell.
Samsil:					
SaE	Severe: slope, too clayey.	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.
SBD[1]	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: shrink-swell, low strength.
SCE:[1]					
Samsil part	Severe: slope, too clayey.	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.
Rock outcrop part. (Too variable to be rated.)					
Satanta:					
SdA, SdB, SdC	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.
SeA:[1]					
Satanta part	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.
Mosher part	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Savo:					
ShA	Slight	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
SkB:[1]					
Savo part	Slight	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Blackpipe part	Moderate: depth to rock, too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Spearfish:					
SlE:[1]					
Spearfish part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.

See footnote at end of table.

TABLE 6.—*Building site development*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Rock outcrop part. (Too variable to be rated.)					
St. Onge: So	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Stetter: St	Severe: too clayey, floods.	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.	Severe: floods, shrink-swell, low strength.	Severe: shrink-swell, low strength, floods.
Swanboy: SwB	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
SyB:[1] Swanboy part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Slickspots part. (Too variable to be rated.)					
Tilford: TaA	Slight	Moderate: frost action.	Slight	Moderate: frost action.	Moderate: frost action, low strength.
TaB	Slight	Moderate: frost action.	Slight	Moderate: slope, frost action.	Moderate: frost action, low strength.
Vanocker: VAE:[1] Vanocker part	Severe: slope, small stones.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Citadel part	Severe: slope	Severe: slope, shrink-swell.	Severe: slope, shrink-swell.	Severe: slope	Severe: slope, low strength, shrink-swell.
Winetti: Wa	Moderate: floods.	Severe: floods	Severe: floods	Severe: floods	Moderate: frost action, floods.
Winler: WbC, WcB[1]	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Zigweid: ZaD:[1] Zigweid part	Moderate: slope, too clayey.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope	Severe: low strength.
Nihill part	Severe: small stones.	Moderate: frost action, slope.	Moderate: slope	Severe: slope	Moderate: slope, frost action.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

TABLE 7.—*Sanitary facilities*

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils]

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Altvan:					
AlA, AlB	Slight	Severe: seepage	Severe: seepage	Slight	Fair: thin layer.
Arvada:					
AnB, ArB[1]	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Assinniboine:					
AsB	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Good.
Bankard:					
Ba[1]	Severe: floods	Severe: floods, seepage.	Severe: floods, seepage.	Severe: floods	Fair: too sandy.
Blackpipe:					
BlD	Severe: depth to rock, percs slowly.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Fair: too clayey, area reclaim, slope.
BsD:[1]					
Blackpipe part	Severe: depth to rock, percs slowly.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Fair: too clayey, area reclaim, slope.
Shingle part	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Poor: thin layer, area reclaim.
Cabbart:					
CaE	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope	Poor: slope, thin layer, area reclaim.
Canyon:					
CbD:[1]					
Canyon part	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope	Poor: thin layer, area reclaim.
Bridget part	Moderate: slope	Severe: slope	Moderate: slope	Moderate: slope	Fair: slope.
CDE:[1]					
Canyon part	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope	Poor: thin layer, area reclaim, slope.
Butche part	Severe: slope, depth to rock, large stones.	Severe: slope, depth to rock, large stones.	Severe: slope, depth to rock, large stones.	Severe: slope	Poor: area reclaim, large stones, thin layer.
Citadel:					
CTE[1]	Severe: slope, percs slowly.	Severe: slope	Moderate: slope, too clayey.	Severe: slope	Poor: slope.
Delphill:					
DaD	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Fair: thin layer, slope.
Enning:					
EaD:[1]					
Enning part	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Poor: thin layer, area reclaim.
Manvel part	Moderate: percs slowly, slope.	Severe: slope	Slight	Moderate: slope	Fair: too clayey, slope, area reclaim.
EbE:[1]					
Enning part	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope	Poor: slope, thin layer, area reclaim.

See footnote at end of table.

TABLE 7.—*Sanitary facilities*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Rock outcrop part. (Too variable to be rated.)					
Glenberg: Ga[1]	Severe: floods	Severe: floods, seepage.	Severe: floods	Severe: floods	Good.
Grummit: GbD	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, too clayey.	Moderate: slope, seepage.	Poor: too clayey, thin layer.
GcE[1]	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock, too clayey.	Severe: slope	Poor: slope, too clayey, thin layer.
Hisle: HbB:[1] Hisle part	Severe: percs slowly, depth to rock.	Moderate: slope	Severe: too clayey, depth to rock.	Slight	Poor: too clayey, area reclaim.
Slickspots part. (Too variable to be rated.)					
Hoven: Ho	Severe: percs slowly, floods.	Slight	Severe: too clayey, floods, wetness.	Severe: floods, wetness.	Poor: too clayey, wetness, hard to pack.
Keith: KaA	Slight	Moderate: seepage.	Slight	Slight	Good.
KaB	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Kyle: KbA	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
KbB, KcB[1]	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
Lakoa: LAD:[1] Lakoa part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Maitland part	Severe: slope	Severe: slope	Moderate: slope, too clayey.	Severe: slope	Poor: slope.
Lismas: LbE	Severe: slope, percs slowly, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock, too clayey.	Severe: slope	Poor: slope, too clayey, thin layer.
LCD:[1] Lismas part	Severe: percs slowly, depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, too clayey.	Moderate: slope	Poor: too clayey, thin layer, area reclaim.
Winler part	Severe: percs slowly, depth to rock.	Severe: slope, depth to rock.	Severe: too clayey, depth to rock.	Slight	Poor: too clayey, area reclaim.
Lohmiller: Le	Severe: percs slowly.	Severe: floods	Moderate: too clayey, floods.	Moderate: floods.	Fair: too clayey.

See footnote at end of table.

TABLE 7.—*Sanitary facilities*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Lh:[1]					
Lohmiller part	Severe: percs slowly.	Severe: floods	Moderate: too clayey, floods.	Moderate: floods.	Fair: too clayey.
Glenberg part	Severe: floods	Severe: floods, seepage.	Severe: floods	Severe: floods	Good.
Macken:					
Ma	Severe: percs slowly, floods.	Slight	Severe: floods, too clayey, wetness.	Severe: floods, wetness.	Poor: hard to pack, too clayey, wetness.
Manvel:					
MbB	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: too clayey, area reclaim.
Marshdale:					
McB:[1]					
Marshdale part	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Maitland part	Moderate: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Fair: slope, too clayey.
Midway:					
MdD:[1]					
Midway part	Severe: slope, percs slowly, depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: slope	Poor: slope, too clayey, thin layer.
Blackpipe part	Severe: depth to rock, percs slowly.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Fair: too clayey, area reclaim, slope.
Nevee:					
NaD:[1]					
Nevee part	Severe: depth to rock.	Severe: slope	Moderate: depth to rock.	Moderate: slope	Fair: slope.
Spearfish part	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope	Poor: thin layer, area reclaim.
Nihill:					
NbE	Severe: slope	Severe: slope, seepage, small stones.	Severe: slope, seepage, small stones.	Severe: slope, seepage.	Poor: slope, small stones.
Nunn:					
NcA	Severe: percs slowly.	Slight	Slight	Slight	Fair: too clayey.
NcB	Severe: percs slowly.	Moderate: slope	Slight	Slight	Fair: too clayey.
NcC	Severe: percs slowly.	Severe: slope	Slight	Slight	Fair: too clayey.
Onita:					
OaA	Severe: percs slowly, floods.	Slight	Severe: floods	Severe: floods	Fair: too clayey.
Paunsaugunt:					
PaE:[1]					
Paunsaugunt part	Severe: slope, depth to rock.	Severe: slope, depth to rock, small stones.	Severe: depth to rock, small stones.	Severe: slope	Poor: slope, thin layer, small stones.
Rock outcrop part. (Too variable to be rated.)					

See footnote at end of table.

TABLE 7.—*Sanitary facilities*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Pierre:					
PbB	Severe: percs slowly, depth to rock.	Moderate: slope	Severe: too clayey, depth to rock.	Slight	Poor: too clayey, area reclaim.
PbC	Severe: percs slowly, depth to rock.	Severe: slope	Severe: too clayey, depth to rock.	Moderate: slope	Poor: too clayey, area reclaim.
Samsil:					
SaE	Severe: slope, percs slowly, depth to rock.	Severe: slope, depth to rock.	Severe: slope, too clayey, depth to rock.	Severe: slope	Poor: slope, too clayey, area reclaim.
SBD:[1]					
Samsil part	Severe: percs slowly, depth to rock.	Severe: slope, depth to rock.	Severe: too clayey, depth to rock.	Moderate: slope	Poor: too clayey, area reclaim.
Pierre part	Severe: percs slowly, depth to rock.	Severe: slope	Severe: too clayey, depth to rock.	Moderate: slope	Poor: too clayey, area reclaim.
SCE:[1]					
Samsil part	Severe: slope, percs slowly, depth to rock.	Severe: slope, depth to rock.	Severe: slope, too clayey, depth to rock.	Severe: slope	Poor: slope, too clayey, area reclaim.
Rock outcrop part. (Too variable to be rated.)					
Satanta:					
SdA	Slight	Moderate: seepage.	Slight	Slight	Good.
SdB	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
SdC	Slight	Severe: slope	Slight	Slight	Good.
SeA:[1]					
Satanta part	Slight	Moderate: seepage.	Slight	Slight	Good.
Mosher part	Severe: percs slowly, wetness.	Slight	Moderate: too clayey, hard to pack.	Moderate: wetness.	Fair: hard to pack, too clayey.
Savo:					
ShA	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
SkB:[1]					
Savo part	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Blackpipe part	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Slight	Fair: too clayey, area reclaim.
Spearfish:					
SlE:[1]					
Spearfish part	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope	Poor: slope, thin layer, area reclaim.

See footnote at end of table.

TABLE 7.—*Sanitary facilities*—Continued

Soil series and map symbols	Degree and kind of limitation for—				
	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Rock outcrop part. (Too variable to be rated.)					
St. Onge: So	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Good.
Stetter: St	Severe: percs slowly, floods.	Severe: floods	Severe: too clayey, floods.	Severe: floods	Poor: too clayey, hard to pack.
Swanboy: SwB	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
SyB:[1] Swanboy part	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
Slickspots part. (Too variable to be rated.)					
Tilford: TaA	Slight	Moderate: seepage.	Slight	Slight	Good.
TaB	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Vanocker: VAE:[1] Vanocker part	Severe: slope, small stones.	Severe: slope	Severe: slope, small stones.	Severe: slope	Poor: slope, small stones.
Citadel part	Severe: slope, percs slowly.	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Winetti: Wa	Moderate: floods.	Severe: seepage, floods.	Severe: seepage	Severe: seepage	Fair: slope, thin layer.
Winler: WbC	Severe: percs slowly, depth to rock.	Moderate: slope, depth to rock.	Severe: too clayey, depth to rock.	Slight	Poor: too clayey, area reclaim.
WcB:[1] Winler part	Severe: percs slowly, depth to rock.	Moderate: slope, depth to rock.	Severe: too clayey, depth to rock.	Slight	Poor: too clayey, area reclaim.
Swanboy part	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
Zigweid: ZaD:[1] Zigweid part	Moderate: slope, percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Fair: slope, too clayey.
Nihill part	Moderate: slope	Severe: seepage, small stones.	Severe: seepage, small stones.	Severe: seepage	Poor: small stones.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

TABLE 8.—*Construction materials*

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor"]

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
Altvan: AlA, AlB	Good	Fair: excess fines	Fair: excess fines	Fair: thin layer.
Arvada: AnB, ArB [1]	Severe: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer, excess sodium.
Assinniboine: AsB	Fair: frost action, low strength.	Poor: excess fines	Unsuited	Good.
Bankard: Ba [1]	Good	Fair: excess fines	Unsuited	Poor: too sandy.
Blackpipe: BlD	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer.
BsD: [1] Blackpipe part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer.
Shingle part	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim.
Cabbart: CaE	Poor: thin layer, slope.	Unsuited	Unsuited	Poor: slope, thin layer, area reclaim.
Canyon: CbD: [1] Canyon part	Poor: thin layer	Unsuited	Unsuited	Poor: area reclaim.
Bridget part	Fair: low strength, frost action.	Unsuited	Unsuited	Fair: slope.
CDE: [1] Canyon part	Poor: thin layer, slope.	Unsuited	Unsuited	Poor: area reclaim, slope.
Butche part	Poor: slope, thin layer, low strength.	Unsuited	Unsuited	Poor: slope, large stones, thin layer.
Citadel: CTE [1]	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: slope, area reclaim.
Delphill: DaD	Poor: thin layer, area reclaim.	Unsuited	Unsuited	Fair: slope, thin layer.
Enning: EaD: [1] Enning part	Poor: low strength	Unsuited	Unsuited	Poor: thin layer, excess lime, area reclaim.
Manvel part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: excess lime, area reclaim, slope.
EbE: [1] Enning part	Poor: slope, low strength.	Unsuited	Unsuited	Poor: slope, thin layer, excess lime.
Rock outcrop part. (Too variable to be rated.)				
Glenberg: Ga [1]	Fair: low strength	Poor: excess fines	Unsuited	Good.

See footnote at end of table.

TABLE 8.—*Construction materials*—Continued

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
Grummit:				
GbD	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey, area reclaim.
GcE[1]	Poor: slope, shrink-swell, low strength.	Unsuited	Unsuited	Poor: slope, too clayey, area reclaim.
Hisle:				
HbB:[1]				
Hisle part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey, excess salt.
Slickspots part. (Too variable to be rated.)				
Hoven:				
Ho	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer, wetness.
Keith:				
KaA, KaB	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Good.
Kyle:				
KbA, KbB, KcB[1]	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Lakoa:				
LAD:[1]				
Lakoa part	Poor: slope	Unsuited	Unsuited	Poor: slope, area reclaim.
Maitland part	Fair: slope, low strength, shrink-swell.	Unsuited	Unsuited	Poor: slope.
Lismas:				
LbE	Poor: slope, shrink-swell, low strength.	Unsuited	Unsuited	Poor: slope, too clayey.
LCD:[1]				
Lismas part	Poor: shrink-swell, thin layer, low strength.	Unsuited	Unsuited	Poor: too clayey.
Winler part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
Lohmiller:				
Le	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Lh:[1]				
Lohmiller part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Glenberg part	Fair: low strength	Poor: excess fines	Unsuited	Good.
Macken:				
Ma	Poor: low strength, shrink-swell, wetness.	Unsuited	Unsuited	Poor: too clayey, wetness.
Manvel:				
MbB	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: excess lime, area reclaim.
Marshdale:				
McB:[1]				
Marshdale part	Poor: wetness, low strength, frost action.	Unsuited	Unsuited	Poor: wetness.

See footnote at end of table.

TABLE 8.—*Construction materials*—Continued

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
Maitland part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: slope.
Midway:				
MdD:[1]				
Midway part	Poor: shrink-swell, low strength, thin layer.	Unsuited	Unsuited	Poor: slope.
Blackpipe part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer.
Nevee:				
NaD:[1]				
Nevee part	Fair: low strength	Unsuited	Unsuited	Fair: slope.
Spearfish part	Fair: low strength, area reclaim.	Unsuited	Unsuited	Poor: thin layer.
Nihill:				
NbE	Poor: slope	Unsuited	Poor: excess fines	Poor: slope, small stones.
Nunn:				
NcA, NcB, NcC	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer, too clayey.
Onita:				
OaA	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Paunsaugunt:				
PaE:[1]				
Paunsaugunt part	Poor: thin layer	Unsuited	Unsuited	Poor: slope, small stones, thin layer.
Rock outcrop part. (Too variable to be rated.)				
Pierre:				
PbB, PbC	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Samsil:				
SaE	Poor: slope, shrink-swell, low strength.	Unsuited	Unsuited	Poor: slope, too clayey, area reclaim.
SBD:[1]				
Samsil part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey, area reclaim.
Pierre part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
SCE:[1]				
Samsil part	Poor: slope, shrink-swell, low strength.	Unsuited	Unsuited	Poor: slope, too clayey, area reclaim.
Rock outcrop part. (Too variable to be rated.)				
Satanta:				
SdA, SdB, SdC	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
SeA:[1]				
Satanta part	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.

See footnote at end of table.

TABLE 8.—*Construction materials*—Continued

Soil series and map symbols	Suitability as a source of—			
	Roadfill	Sand	Gravel	Topsoil
Mosher part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer.
Savo:				
ShA	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey.
SkB:[1]				
Savo part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey.
Blackpipe part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer.
Spearfish:				
SlE:[1]				
Spearfish part	Poor: slope, low strength, area reclaim.	Unsuited	Unsuited	Poor: slope, thin layer.
Rock outcrop part. (Too variable to be rated.)				
St. Onge:				
So	Fair: shrink-swell, low strength.	Unsuited	Unsuited	Good.
Stetter:				
St	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
Swanboy:				
SwB	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
SyB:[1]				
Swanboy part	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
Slickspots part. (Too variable to be rated.)				
Tilford:				
TaA, TaB	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Vanocker:				
VAE:[1]				
Vanocker part	Poor: slope, low strength.	Unsuited	Unsuited	Poor: slope, thin layer.
Citadel part	Poor: slope, low strength, shrink-swell.	Unsuited	Unsuited	Poor: slope, area reclaim.
Winetti:				
Wa	Fair: frost action, area reclaim.	Poor: excess fines	Poor: excess fines	Poor: small stones, too sandy.
Winler:				
WbC, WcB[1]	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
Zigweid:				
ZaD:[1]				
Zigweid part	Poor: low strength	Unsuited	Unsuited	Fair: slope, too clayey.
Nihill part	Fair: frost action	Unsuited	Poor: excess fines	Poor: small stones.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

TABLE 9.—*Water management*

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary]

Soil series and map symbols	Soil properties and site features that affect—					
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Altvan:						
AlA	Seepage	Thin layer, low strength, piping.	Not needed	Favorable	Rooting depth	Rooting depth.
AlB	Seepage	Thin layer, low strength, piping.	Not needed	Slope	Rooting depth	Rooting depth, slope, erodes easily.
Arvada:						
AnB, ArB[1]	Slope	Low strength, shrink-swell, compressible.	Percs slowly, excess sodium, slope.	Slope, percs slowly, excess sodium.	Percs slowly	Percs slowly, excess sodium.
Assinniboine:						
AsB	Slope, seepage	Piping, low strength.	Slope, frost action.	Slope, fast intake, seepage.	Piping, soil blowing.	Slope, erodes easily.
Bankard:						
Ba[1]	Seepage	Piping, seepage, erodes easily.	Cutbanks cave, floods, poor outlets.	Droughty, floods, seepage.	Erodes easily, piping.	Droughty, erodes easily.
Blackpipe:						
BlD	Slope, depth to rock, seepage.	Shrink-swell, low strength, compressible.	Not needed	Slope, percs slowly, slow intake.	Depth to rock, percs slowly.	Slope, erodes easily.
BsD:[1]						
Blackpipe part	Slope, depth to rock, seepage.	Shrink-swell, low strength, compressible.	Not needed	Slope, percs slowly, slow intake.	Depth to rock, percs slowly.	Slope, erodes easily.
Shingle part	Slope, depth to rock.	Low strength, thin layer.	Not needed	Slope, rooting depth.	Slope, depth to rock.	Slope, rooting depth.
Cabbart:						
CaE	Slope, depth to rock.	Low strength, thin layer, hard to pack.	Not needed	Slope, rooting depth.	Complex slope, depth to rock, rooting depth.	Slope, rooting depth, erodes easily.
Canyon:						
CbD:[1]						
Canyon part	Depth to rock, slope.	Thin layer, low strength.	Not needed	Rooting depth, slope.	Depth to rock, slope.	Droughty, slope.
Bridget part	Slope, seepage	Erodes easily, piping, low strength.	Not needed	Slope, erodes easily.	Erodes easily, piping.	Erodes easily, slope.
CDE:[1]						
Canyon part	Depth to rock, slope.	Thin layer, low strength.	Not needed	Rooting depth, slope.	Depth to rock, slope.	Droughty, slope.
Butche part	Depth to rock, slope, seepage.	Large stones, thin layer, low strength.	Not needed	Slope	Depth to rock, large stones, slope.	Large stones, slope, erodes easily.
Citadel:						
CTE[1]	Slope	Low strength, shrink-swell, compressible.	Not needed	Slope	Slope	Slope, erodes easily.

See footnote at end of table.

TABLE 9.—*Water management*—Continued

Soil series and map symbols	Soil properties and site features that affect—					
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Delphill:						
DaD	Slope, depth to rock, seepage.	Thin layer, low strength, hard to pack.	Not needed	Complex slope, rooting depth.	Complex slope, depth to rock, rooting depth.	Slope, erodes easily.
Enning:						
EaD:[1]						
Enning part	Slope, depth to rock.	Low strength	Not needed	Slope, excess lime, rooting depth.	Slope, depth to rock.	Rooting depth, slope, erodes easily.
Manvel part	Slope, seepage	Erodes easily, low strength, piping.	Not needed	Excess lime, slope, erodes easily.	Erodes easily	Erodes easily, slope.
EbE:[1]						
Enning part	Slope	Low strength	Not needed	Slope, excess lime, rooting depth.	Slope, depth to rock.	Rooting depth, slope, erodes easily.
Rock outcrop part. (Too variable to be rated.)						
Glenberg:						
Ga[1]	Seepage	Piping, erodes easily.	Not needed	Floods	Floods, piping	Favorable.
Grummit:						
GbD, GcE[1]	Slope, depth to rock, seepage.	Shrink-swell, low strength, compressible.	Not needed	Slope	Slope, depth to rock.	Slope, rooting depth, erodes easily.
Hisle:						
HbB:[1]						
Hisle part	Slope, depth to rock.	Shrink-swell, low strength, compressible.	Not needed	Slow intake, excess salt.	Depth to rock, percs slowly.	Slope, excess salt.
Slickspots part. (Too variable to be rated.)						
Hoven:						
Ho	Favorable	Shrink-swell, low strength, hard to pack.	Percs slowly, poor outlets, excess salt.	Excess salt, floods, slow intake.	Not needed	Excess salt, wetness.
Keith:						
KaA	Seepage	Piping, erodes easily, low strength.	Not needed	Favorable	Not needed	Favorable.
KaB	Seepage	Piping, erodes easily, low strength.	Not needed	Erodes easily, slope.	Erodes easily, slope.	Erodes easily, slope.
Kyle:						
KbA	Favorable	Shrink-swell, low strength, compressible.	Not needed	Slow intake, percs slowly.	Not needed	Percs slowly.
KbB, KcB[1]	Slope	Shrink-swell, low strength, compressible.	Not needed	Slow intake, percs slowly.	Percs slowly	Slope, erodes easily.
Lakoa:						
LAD:[1]						
Lakoa part	Slope	Low strength, piping.	Not needed	Slope	Slope	Slope, erodes easily.

See footnote at end of table.

TABLE 9.—*Water management*—Continued

Soil series and map symbols	Soil properties and site features that affect—					
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Maitland part	Slope	Low strength, shrink-swell.	Not needed	Slope	Slope	Slope, erodes easily.
Lismas: LbE	Slope, depth to rock, seepage.	Low strength, thin layer, shrink-swell.	Not needed	Complex slope, rooting depth, excess salt.	Slope, depth to rock, poor outlets.	Complex slope, excess salt, percs slowly.
LCD:[1] Lismas part	Slope, depth to rock, seepage.	Low strength, thin layer, shrink-swell.	Not needed	Complex slope, rooting depth, excess salt.	Slope, depth to rock, poor outlets.	Complex slope, excess salt, percs slowly.
Winler part	Slope, depth to rock.	Shrink-swell, low strength, compressible.	Not needed	Slope, slow intake, rooting depth.	Depth to rock, percs slowly.	Slope, percs slowly.
Lohmiller: Le	Shrink-swell	Low strength, shrink-swell.	Floods, percs slowly.	Floods, percs slowly, slow intake.	Percs slowly, poor outlets.	Percs slowly.
Lh:[1] Lohmiller part	Shrink-swell	Low strength, shrink-swell.	Floods, percs slowly.	Floods, percs slowly, slow intake.	Percs slowly, poor outlets.	Percs slowly.
Glenberg part	Seepage	Piping, erodes easily.	Not needed	Floods	Floods, piping	Soil blowing.
Macken: Ma	Favorable	Compressible, low strength, shrink-swell.	Floods, percs slowly, poor outlets.	Floods, slow intake, wetness.	Not needed	Not needed.
Manvel: MbB	Slope, seepage	Erodes easily, low strength, piping.	Not needed	Excess lime, slope, erodes easily.	Erodes easily	Erodes easily, slope.
Marshdale: McB:[1] Marshdale part	Slope	Low strength, compressible, hard to pack.	Wetness, frost action, floods.	Wetness, floods.	Wetness	Wetness.
Maitland part	Slope	Low strength, shrink-swell.	Not needed	Slope	Slope	Slope, erodes easily.
Midway: MdD:[1] Midway part	Slope, depth to rock, seepage.	Thin layer, shrink-swell, low strength.	Not needed	Complex slope, rooting depth, slow intake.	Slope, depth to rock, poor outlets.	Slope, percs slowly.
Blackpipe part	Slope, depth to rock, seepage.	Shrink-swell, low strength, compressible.	Not needed	Slope, percs slowly, slow intake.	Slope	Slope, erodes easily.
Nevee: NaD:[1] Nevee part	Slope, seepage, depth to rock.	Low strength, piping, hard to pack.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Spearfish part	Slope, depth to rock, seepage.	Low strength, piping, thin layer.	Not needed	Slope, rooting depth.	Slope, depth to rock, piping.	Slope, rooting depth, erodes easily.

See footnote at end of table.

TABLE 9.—*Water management*—Continued

Soil series and map symbols	Soil properties and site features that affect—					
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Nihill:						
NbE	Seepage, slope	Hard to pack, piping.	Not needed	Complex slope, droughty.	Complex slope, piping, poor outlets.	Complex slope, droughty.
Nunn:						
NcA, NcB	Favorable	Compressible, shrink-swell, low strength.	Percs slowly, slope, slow intake.	Percs slowly, slope.	Percs slowly	Favorable.
NcC	Slope	Compressible, shrink-swell, low strength.	Percs slowly, slope, slow intake.	Percs slowly, slope.	Percs slowly	Favorable.
Onita:						
OaA	Favorable	Low strength, shrink-swell, compressible.	Poor outlets, percs slowly.	Slow intake	Not needed	Favorable.
Paunsaugunt:						
PaE:[1]						
Paunsaugunt part.	Depth to rock, slope, small stones.	Thin layer, low strength, piping.	Not needed	Slope	Slope, depth to rock.	Slope, rooting depth.
Rock outcrop part. (Too variable to be rated.)						
Pierre:						
PbB	Slope, depth to rock.	Low strength, shrink-swell, compressible.	Not needed	Slow intake	Percs slowly, depth to rock.	Slope, percs slowly, erodes easily.
PbC	Slope, depth to rock.	Low strength, shrink-swell, compressible.	Not needed	Slope, slow intake.	Slope, percs slowly, depth to rock.	Slope, percs slowly, erodes easily.
Samsil:						
SaE	Slope, depth to rock.	Shrink-swell, low strength, compressible.	Not needed	Slope, rooting depth, slow intake.	Slope, depth to rock, percs slowly.	Slope, percs slowly, erodes easily.
SBD:[1]						
Samsil part	Slope, depth to rock.	Shrink-swell, low strength, compressible.	Not needed	Slope, rooting depth, slow intake.	Slope, depth to rock, percs slowly.	Slope, percs slowly, erodes easily.
Pierre part	Slope, depth to rock.	Low strength, shrink-swell, compressible.	Not needed	Slope, slow intake.	Slope, percs slowly, depth to rock.	Slope, percs slowly, erodes easily.
SCE:[1]						
Samsil part	Slope, depth to rock.	Shrink-swell, low strength, compressible.	Not needed	Slope, rooting depth, slow intake.	Slope, depth to rock, percs slowly.	Slope, percs slowly, erodes easily.
Rock outcrop part. (Too variable to be rated.)						
Satanta:						
SdA	Seepage	Shrink-swell, low strength, piping.	Not needed	Favorable	Favorable	Favorable.
SdB, SdC	Seepage	Shrink-swell, low strength, piping.	Not needed	Slope	Favorable	Slope, erodes easily.

See footnote at end of table.

TABLE 9.—*Water management*—Continued

Soil series and map symbols	Soil properties and site features that affect—					
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
SeA:[1] Satanta part	Seepage	Shrink-swell, low strength, piping.	Not needed	Favorable	Favorable	Favorable.
Mosher part	Seepage	Shrink-swell, low strength, compressible.	Not needed	Slow intake, excess salt, percs slowly.	Not needed	Excess salt.
Savo: ShA	Favorable	Shrink-swell, low strength, compressible.	Not needed	Slow intake, percs slowly.	Not needed	Favorable.
SkB:[1] Savo part	Slope	Shrink-swell, low strength, compressible.	Not needed	Slow intake, percs slowly.	Percs slowly	Slope, erodes easily.
Blackpipe part	Slope, depth to rock, seepage.	Shrink-swell, low strength, compressible.	Not needed	Percs slowly, slow intake.	Depth to rock, percs slowly.	Slope, erodes easily.
Spearfish: SlE:[1] Spearfish part	Slope, depth to rock, seepage.	Low strength, piping, thin layer.	Not needed	Slope, rooting depth.	Slope, depth to rock, piping.	Slope, rooting depth, erodes easily.
Rock outcrop part. (Too variable to be rated.)						
St. Onge: So	Seepage	Low strength, piping, shrink-swell.	Not needed	Floods	Not needed	Favorable.
Stetter: St	Favorable	Shrink-swell, low strength, compressible.	Not needed	Slow intake, percs slowly, floods.	Not needed	Not needed.
Swanboy: SwB	Slope	Shrink-swell, low strength, compressible.	Not needed	Slow intake, excess salt.	Percs slowly	Excess salt, percs slowly.
SyB:[1] Swanboy part	Favorable	Shrink-swell, low strength, compressible.	Not needed	Slow intake, excess salt.	Percs slowly	Excess salt, percs slowly.
Slickspots part. (Too variable to be rated.)						
Tilford: TaA	Seepage	Low strength, piping.	Not needed	Favorable	Not needed	Favorable.
TaB	Slope, seepage	Low strength, piping.	Not needed	Favorable	Favorable	Slope, erodes easily.
Vanocker: VAE:[1] Vanocker part	Slope	Low strength	Not needed	Slope	Slope	Slope.

See footnote at end of table.

TABLE 9.—*Water management*—Continued

Soil series and map symbols	Soil properties and site features that affect—					
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Citadel part	Slope	Low strength, shrink-swell, compressible.	Not needed	Slope	Slope	Slope, erodes easily.
Winetti: Wa	Slope, seepage	Piping	Not needed	Fast intake, droughty.	Slope, small stones.	Slope, small stones, droughty.
Winler: WbC	Slope, depth to rock.	Shrink-swell, low strength, compressible.	Not needed	Slow intake, rooting depth.	Depth to rock, percs slowly.	Slope, percs slowly.
WcB:[1] Winler part	Slope, depth to rock.	Shrink-swell, low strength, compressible.	Not needed	Slow intake, rooting depth.	Depth to rock, percs slowly.	Slope, percs slowly.
Swanboy part	Slope	Shrink-swell, low strength, compressible.	Not needed	Slow intake, excess salt.	Percs slowly	Excess salt, percs slowly.
Zigweid: ZaD:[1] Zigweid part	Slope	Low strength, shrink-swell.	Not needed	Slope	Slope	Slope.
Nihill part	Seepage, slope	Hard to pack, piping.	Not needed	Complex slope, droughty.	Complex slope, piping, poor outlets.	Complex slope, droughty.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 7 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* or *poor,* which, respectively, mean about the same as the terms *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured

bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 7 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 8 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 10 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 8 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of min-

erals, reaction, and stratification are given in the soil series descriptions and in table 10.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slopes, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 9 the soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in the tables in this section. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 10 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 10 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Descriptions of the soils."

Texture is described in table 10 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*3*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*2*). In table 10 soils in the survey area are classified according to both systems.

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL–ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified 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. Soils in group A–1 are coarse grained and low in content of fines. At the other extreme, in group A–7, are fine-grained soils. Highly organic soils are classified in group A–8 on the basis of visual inspection.

When laboratory data are available, the A–1, A–2, and A–7 groups are further classified 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 desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 11. The estimated classification, without group index numbers, is given in table 10. Also in table 10 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Test data

The results of analyses of engineering properties on selected horizons of 12 soils at specific locations in the survey area are given in table 11. The tests were made by the South Dakota Department of Transportation, Division of Highways, in accordance with standard procedures of the AASHTO system of soil classification. Some of the terms used in table 11 that are not defined elsewhere are explained in the following paragraphs.

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

Mechanical analysis shows the percentages, by weight, of soil particles that pass sieves of specified size. Sand and other coarse particles do not pass through a number 200 sieve, but silt and clay do. Percentages of fractions smaller than those passing the number 200 sieve were determined by the hydrometer method, rather than by the pipette method that most soil scientists use in determining the clay content of soil samples.

Physical and chemical properties

Table 12 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward

movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 12. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

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

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 13 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff

TABLE 10.—*Engineering properties*

[The symbol < means less than; > means more than. Dashes

Soil series and map symbols	Depth	USDA texture	Classification		Fragments >3 inches
			Unified	AASHTO	
	In				*Pct*
Altvan:					
AlA, AlB	0–7	Loam	ML, CL	A–4	0
	7–22	Clay loam, loam	CL	A–6, A–7	0
	22–32	Loam, silt loam, fine sandy loam	ML, CL	A–4	0
	32–60	Sand and gravel	SP, SP–SM	A–1	0
Arvada:					
AnB, ArB[1]	0–3	Silt loam	ML, CL	A–4	0
	3–12	Clay	CL, CH	A–7	0
	12–60	Clay loam	CL	A–7	0
Assinniboine:					
AsB	0–5	Fine sandy loam	SM, ML	A–4	0
	5–17	Sandy clay loam	SC, CL	A–6, A–4	0
	17–41	Fine sandy loam	SM, ML	A–4	0
	41–60	Fine sandy loam stratified with fine sand, loam, and very fine sandy loam.	SM	A–2, A–4	0
Bankard:					
Ba[1]	0–5	Very fine sandy loam	SM	A–4	0
	5–60	Loamy fine sand, very fine sandy loam, and fine sand.	SP–SM, SM	A–2, A–3	0–5
Blackpipe:					
BlD	0–6	Silt loam	ML, CL	A–4, A–6, A–7	0
	6–17	Silty clay loam, silty clay	CL, CH	A–6, A–7	0
	17–34	Silty clay loam	CL	A–6, A–7	0
	34–50	Unweathered bedrock			
BsD:[1]					
Blackpipe part	0–6	Silt loam	ML, CL	A–4, A–6, A–7	0
	6–17	Silty clay loam, silty clay, clay	CL, CH	A–6, A–7	0
	17–34	Silty clay loam, silt loam, loam	CL	A–6, A–7	0
	34–50	Unweathered bedrock			
Shingle part	0–3	Loam	CL	A–6	0–5
	3–17	Clay loam, loam	CL	A–6	0
	17–60	Unweathered bedrock			
Cabbart:					
CaE	0–4	Loam	CL, CL–ML	A–4	0
	4–18	Loam, clay loam, silty clay loam	CL, CL–ML	A–4, A–6	0
	18–60	Weathered bedrock			
Canyon:					
CbD:[1]					
Canyon part	0–4	Loam	ML, CL	A–4, A–6	0–5
	4–11	Very fine sandy loam, loam, silt loam.	ML, CL	A–4, A–6	0–5
	11–60	Weathered bedrock			
Bridget part	0–7	Loam	ML, CL–ML	A–4	0
	7–11	Very fine sandy loam	ML, CL–ML	A–4	0
	11–60	Very fine sandy loam	ML, CL–ML	A–4	0
CDE:[1]					
Canyon part	0–4	Loam	ML, CL, SM	A–4, A–6	0–5
	4–11	Very fine sandy loam, loam, silt loam.	ML, CL, SM	A–4, A–6	0–5
	11–60	Weathered bedrock			
Butche part	0–4	Loam	ML, CL	A–4, A–6	0–40
	4–14	Stony loam	ML, CL	A–4, A–6	20–50
	14–20	Unweathered bedrock			
Citadel:					
CTE:[1]	0–8	Silt loam	ML, CL	A–4, A–6	0
	8–29	Clay loam, clay	CL, CH	A–6, A–7	0–10
	29–60	Loam, clay loam, silt loam	CL	A–6, A–7	0–15

See footnote at end of table.

and classifications

indicate that data were not estimated. NP means nonplastic]

Percentage passing sieve number—				Liquid limit	Plasticity index
4	10	40	200		
				Pct	
90–100	85–100	60–95	50–75	25–35	5–15
95–100	95–100	85–100	70–80	35–50	15–25
90–100	85–100	60–95	45–75	15–35	5–15
75–95	70–90	25–35	0–10	<25	NP–5
100	100	95–100	85–100	25–40	5–15
80–100	75–100	70–100	65–95	40–65	20–35
80–100	75–100	70–100	55–80	40–45	20–25
100	100	70–85	40–55	<30	NP–5
100	100	80–90	35–55	25–35	10–15
100	100	70–85	40–55	<30	NP–5
100	100	50–75	15–45	<25	NP–5
100	100	85–95	50–65	15–25	NP–5
70–100	60–100	40–70	5–25	<20	NP–5
100	100	95–100	85–100	30–45	5–25
100	100	95–100	85–100	35–65	15–40
100	95–100	90–100	75–100	30–50	10–30
100	100	95–100	85–100	30–45	5–25
100	100	95–100	85–100	35–65	15–40
100	95–100	90–100	75–100	30–50	10–30
75–100	75–100	65–95	55–80	30–40	10–20
75–100	75–100	65–100	50–80	30–40	10–20
100	100	85–95	60–80	20–30	4–10
100	100	85–95	60–85	20–40	5–20
95–100	75–100	45–95	35–75	25–35	4–15
95–100	75–100	45–95	35–80	20–35	NP–15
95–100	95–100	85–95	80–95	20–35	4–10
95–100	95–100	85–95	80–95	20–35	3–7
95–100	95–100	85–95	80–95	20–35	3–7
95–100	75–100	45–95	35–75	25–35	4–15
95–100	75–100	45–95	35–80	20–35	NP–15
80–90	80–90	80–90	60–75	25–40	5–20
80–90	80–90	80–90	60–75	25–40	5–20
100	100	85–100	60–90	25–35	5–15
95–100	90–100	85–100	70–95	35–60	15–35
95–100	90–100	85–100	65–95	30–50	10–30

TABLE 10.—*Engineering properties*

Soil series and map symbols	Depth	USDA texture	Classification		Fragments >3 inches
			Unified	AASHTO	
	In				*Pct*
Delphill:					
DaD	0–3	Loam	CL–ML, ML	A–4, A–6	0
	3–32	Loam, clay loam, silty clay loam	CL–ML, CL	A–4, A–6	0
	32–60	Weathered bedrock			
Enning:					
EaD:[1]					
Enning part	0–5	Silty clay loam	ML, MH	A–7	0
	5–14	Silt loam, silty clay loam	ML, MH	A–7	0
	14–40	Weathered bedrock	ML, MH	A–7	0
Manvel part	0–3	Silt loam	ML, MH	A–7	0
	3–60	Silt loam, silty clay loam	ML, MH	A–7	0
EbE:[1]					
Enning part	0–5	Silty clay loam	ML, MH	A–7	0
	5–14	Silt loam, silty clay loam	ML, MH	A–7	0
	14–40	Weathered bedrock	ML, MH	A–7	0
Rock outcrop part. (Too variable to be rated.)					
Glenberg:					
Ga[1]	0–6	Fine sandy loam	SM, SM–SC	A–4, A–2	0
	6–60	Stratified loamy sand to loam	SM, SM–SC	A–2, A–4	0
Grummit:					
GbD, GcE[1]	0–15	Shaly clay	CH, MH, ML	A–7	0
	15–60	Unweathered bedrock	CH, MH, ML	A–7	0
Hisle:					
HbB:[1]					
Hisle part	0–34	Clay	CH, MH	A–7	0
	34–60	Unweathered bedrock	CH, MH	A–7	0
Slickspots part. (Too variable to be rated.)					
Hoven:					
Ho	0–5	Silt loam	ML, CL	A–4, A–6	0
	5–16	Silty clay, clay, clay loam	CH, MH	A–7	0
	16–60	Silty clay, clay, clay loam	CL, CH	A–6, A–7	0
Keith:					
KaA, KaB	0–5	Silt loam	ML, CL	A–4	0
	5–60	Silt loam, silty clay loam	CL	A–6	0
Kyle:					
KbA, KbB, KcB[1]	0–60	Clay	CH, MH	A–7	0
Lakoa:					
LAD:[1]					
Lakoa part	0–10	Loam, very fine sandy loam	ML, CL	A–4, A–6	0
	10–33	Clay loam	CL	A–6, A–7	0–5
	33–60	Loam, clay loam	CL	A–6	0–15
Maitland part	0–9	Loam	ML, CL	A–4, A–6	0
	9–60	Loam, clay loam	CL	A–6, A–7	0
Lismas:					
LbE	0–5	Clay	MH, CH	A–7	0
	5–15	Clay, silty clay	MH, CH	A–7	0
	24–60	Weathered bedrock			
LCD:[1]					
Lismas part	0–5	Clay	MH, CH	A–7	0
	5–15	Clay, silty clay	MH, CH	A–7	0
	24–60	Weathered bedrock			

See footnote at end of table.

and classifications—Continued

Percentage passing sieve number—				Liquid limit	Plasticity index
4	10	40	200		
				Pct	
100	100	85–95	60–75	25–35	5–15
100	100	85–95	65–85	25–35	5–15
95–100	95–100	90–100	85–100	40–55	15–25
95–100	95–100	90–100	90–100	40–55	15–25
100	95–100	90–100	90–100	40–60	15–30
95–100	95–100	95–100	85–100	45–60	15–30
95–100	95–100	95–100	90–100	45–60	15–30
95–100	95–100	90–100	85–100	40–55	15–25
95–100	95–100	90–100	90–100	40–55	15–25
100	95–100	90–100	90–100	40–60	15–30
95–100	85–100	60–100	30–45	<25	NP–5
90–100	75–100	50–100	25–40	<25	NP–5
100	85–100	75–100	65–100	40–60	10–30
100	95–100	90–100	80–100	40–60	10–30
95–100	90–100	85–100	80–100	45–85	20–55
100	95–100	95–100	85–100	50–90	30–60
100	100	90–100	75–95	27–40	5–20
100	95–100	95–100	80–100	50–80	20–60
95–100	90–100	80–100	70–100	35–75	11–45
100	100	95–100	85–95	25–40	5–15
100	100	95–100	85–100	30–45	10–20
100	100	90–100	80–100	50–75	20–45
100	100	85–95	60–75	25–35	5–15
95–100	90–100	85–100	65–80	35–45	10–20
90–100	85–100	75–95	55–90	30–40	10–20
100	100	85–100	50–90	25–40	5–20
100	100	85–100	60–80	30–45	10–25
100	95–100	90–100	75–100	50–80	20–45
100	100	95–100	80–95	50–85	20–45
100	95–100	90–100	75–100	50–80	20–45
100	100	95–100	80–95	50–85	20–45

TABLE 10.—*Engineering properties*

Soil series and map symbols	Depth	USDA texture	Classification		Fragments >3 inches
			Unified	AASHTO	
	In				*Pct*
Winler part	0–3	Clay	CH, MH	A–7	0
	3–21	Clay, shaly clay	CH, MH	A–7	0
	21–60	Unweathered bedrock	CH	A–7	0
Lohmiller:					
Le	0–60	Silty clay loam	CL, CH	A–7	0
Lh:[1]					
Lohmiller part	0–60	Silty clay loam	CL, CH	A–7	0
Glenberg part	0–6	Fine sandy loam	SM, SM–SC	A–4, A–2	0
	6–60	Stratified loamy sand to loam	SM, SM–SC	A–2, A–4	0
Macken:					
Ma	0–60	Silty clay	CH, MH	A–7	0
Manvel:					
MbB	0–3	Silt loam	ML, MH	A–7	0
	3–60	Silt loam, silty clay loam	ML, MH	A–7	0
Marshdale:					
McB:[1]					
Marshdale part	0–16	Loam	ML	A–4, A–5, A–7	0
	16–60	Clay loam, loam	ML, MH	A–4, A–5, A–7	0–5
Maitland part	0–9	Loam	ML, CL	A–4, A–6	0
	9–60	Loam, clay loam	CL	A–6, A–7	0
Midway:					
MdD:[1]					
Midway part	0–13	Silty clay loam, silty clay	CL, CH	A–7	0
	13–60	Weathered bedrock			
Blackpipe part	0–6	Silt loam	ML, CL	A–4, A–6, A–7	0
	6–17	Silty clay loam, silty clay, clay	CL, CH	A–6, A–7	0
	17–34	Sitly clay loam, silt loam, loam	CL	A–6, A–7	0
	34–50	Unweathered bedrock			
Nevee:					
NaD:[1]					
Nevee part	0–8	Silt loam	ML, CL–ML	A–4	0
	8–60	Silt loam, loam, very fine sandy loam.	CL–ML, CL	A–4, A–6	0
Spearfish part	0–8	Loam	ML, CL	A–4, A–6	0
	8–16	Loam, very fine sandy loam, silt loam.	ML, CL	A–4, A–6	0
	16–60	Unweathered bedrock			
Nihill:					
NbE	0–6	Gravelly loam	GM–GC, GM, SM–SC, SM	A–2, A–4	0–5
	6–60	Very gravelly loam, gravelly loam.	GM	A–2, A–1	0–5
Nunn:					
NcA, NcB, NcC	0–7	Clay loam	CL, SC	A–6, A–4	0–5
	7–32	Clay loam, clay	CL, CH	A–6, A–7	0–5
	32–60	Clay loam, loam, gravelly sandy loam.	CL, CL–ML, SM–SC	A–4, A–6, A–2	0–5
Onita:					
OaA	0–11	Clay loam	ML, CL	A–4, A–6	0
	11–40	Silty clay loam, clay loam, silty clay.	CL, CH	A–6, A–7	0
	40–60	Silty clay loam, clay loam, silt loam.	CL, CH	A–6, A–7	0–5

See footnote at end of table.

and classifications—Continued

Percentage passing sieve number—				Liquid limit	Plasticity index
4	10	40	200		
				Pct	
100	100	90–100	80–100	50–90	20–65
100	100	90–100	80–100	50–90	20–65
100	100	90–100	80–100	50–90	25–65
100	100	90–100	90–95	40–60	25–40
100	100	90–100	90–95	40–60	25–40
95–100	85–100	60–100	30–45	<25	NP–5
90–100	75–100	50–100	25–40	<25	NP–5
100	100	90–100	75–100	40–80	20–45
95–100	95–100	95–100	85–100	45–60	15–30
95–100	95–100	95–100	90–100	45–60	15–30
100	95–100	85–100	60–80	30–45	5–15
95–100	90–100	85–100	60–85	35–60	5–15
100	100	85–100	50–90	25–40	5–20
100	100	85–100	60–80	30–45	10–25
100	100	90–100	80–95	45–60	20–35
100	100	95–100	85–100	30–45	5–25
100	100	95–100	85–100	35–65	15–40
100	95–100	90–100	75–100	30–50	10–30
100	100	95–100	70–100	20–30	NP–5
100	100	95–100	80–100	20–35	5–15
100	100	85–100	65–90	25–35	NP–15
95–100	80–100	70–100	50–90	25–35	NP–15
45–80	35–75	30–70	20–50	25–35	5–10
30–60	20–50	15–45	12–35	20–35	NP–5
95–100	80–95	70–95	45–75	25–40	7–20
95–100	90–100	85–95	65–75	35–60	20–35
80–100	80–100	60–90	25–75	15–40	5–20
100	95–100	90–100	70–100	30–40	5–20
100	95–100	90–100	75–100	35–60	10–35
95–100	95–100	85–100	65–100	30–55	10–30

TABLE 10.—*Engineering properties*

Soil series and map symbols	Depth	USDA texture	Classification		Fragments >3 inches
			Unified	AASHTO	
	In				*Pct*
Paunsaugunt:					
PaE:[1]					
Paunsaugunt part	0–15	Gravelly loam	GM–GC, GC, SM–SC, SC	A–2	0
Rock outcrop part. (Too variable to be rated.)	15–18	Unweathered bedrock			
Pierre:					
PbB, PbC	0–4	Clay	CH, MH	A–7	0
	4–34	Clay	CH, MH	A–7	0
	34–60	Unweathered bedrock	CH	A–7	0
Samsil:					
SaE	0–14	Clay, shaly clay	CH, MH	A–7	0
	14–60	Weathered bedrock	CH, MH	A–7	0
SBD:[1]					
Samsil part	0–14	Clay, shaly clay	CH, MH	A–7	0
	14–60	Weathered bedrock	CH, MH	A–7	0
Pierre part	0–4	Clay	CH, MH	A–7	0
	4–34	Clay	CH, MH	A–7	0
	34–60	Unweathered bedrock	CH	A–7	0
SCE:[1]					
Samsil part	0–14	Clay, shaly clay	CH, MH	A–7	0
	14–60	Weathered bedrock	CH, MH	A–7	0
Rock outcrop part. (Too variable to be rated.)					
Satanta:					
SdA, SdB, SdC	0–6		ML, CL	A–4, A–6	0
	6–21	Loam, clay loam, sandy clay loam.	SC, CL	A–7, A–6, A–4	0
	21–60	Loam, clay loam, fine sandy loam.	ML, CL, SM, SC	A–4, A–6	0
SeA:[1]					
Satanta part	0–6	Loam	ML, CL	A–4, A–6	0
	6–21	Loam, clay loam, sandy clay loam.	SC, CL	A–7, A–6, A–4	0
	21–60	Loam, clay loam, fine sandy loam.	ML, CL, SM, SC	A–4, A–6	0
Mosher part	0–11	Loam	ML, CL	A–4, A–6	0
	11–22	Clay loam, clay	CL, CH	A–7	0
	22–60	Clay loam, silty clay loam	CL, CH	A–6, A–7	0
Savo:					
ShA	0–4	Silty clay loam	CL	A–6, A–7	0
	4–22	Silty clay loam, silty clay	CL, CH	A–6, A–7	0
	22–60	Silty clay loam, silt loam, clay loam.	CL, CH	A–6, A–7	0
SkB:[1]					
Savo part	0–4	Silty clay loam	CL	A–6, A–7	0
	4–22	Silty clay loam, silty clay	CL, CH	A–6, A–7	0
	22–60	Silty clay loam, silt loam, clay loam.	CL, CH	A–6, A–7	0
Blackpipe part	0–6	Silt loam	ML, CL	A–4, A–6, A–7	0
	6–17	Silty clay loam, silty clay, clay	CL, CH	A–6, A–7	0
	17–34	Silty clay loam, silt loam, loam	CL	A–6, A–7	0
	34–50	Unweathered bedrock			

See footnote at end of table.

and classifications—Continued

Percentage passing sieve number—				Liquid limit	Plasticity index
4	10	40	200		
				Pct	
45–70	35–60	30–55	25–35	20–30	5–10
100	100	90–100	80–100	50–75	22–45
95–100	95–100	90–100	80–100	50–80	22–55
100	100	90–100	80–100	45–85	16–60
100	85–100	80–100	70–100	50–85	25–60
100	95–100	90–100	85–100	50–120	25–85
100	85–100	80–100	70–100	50–85	25–60
100	95–100	90–100	85–100	50–120	25–85
100	100	90–100	80–100	50–75	22–45
95–100	95–100	90–100	80–100	50–80	22–55
100	100	90–100	80–100	45–85	16–60
100	85–100	80–100	70–100	50–85	25–60
100	95–100	90–100	85–100	50–120	25–85
100	95–100	80–100	50–85	22–36	2–15
100	95–100	50–100	40–75	25–45	5–25
100	95–100	80–100	35–85	20–36	2–15
100	95–100	80–100	50–85	22–36	2–15
100	95–100	50–100	40–75	25–45	5–25
100	95–100	80–100	35–85	20–36	2–15
100	100	85–100	70–85	25–40	5–20
100	95–100	90–100	70–90	40–65	15–40
100	95–100	90–100	70–100	35–60	10–35
100	100	95–100	85–95	35–50	10–30
100	100	95–100	85–95	35–65	15–40
100	100	90–100	70–95	30–55	10–35
100	100	95–100	85–95	35–50	10–30
100	100	95–100	85–95	35–65	15–40
100	100	90–100	70–95	30–55	10–35
100	100	95–100	85–100	30–45	5–25
100	100	95–100	85–100	35–65	15–40
100	95–100	90–100	75–100	30–50	10–30

TABLE 10.—*Engineering properties*

Soil series and map symbols	Depth	USDA texture	Classification		Fragments >3 inches
			Unified	AASHTO	
	In				*Pct*
Spearfish:					
SlE:[1]					
Spearfish part	0–8	Loam	ML, CL	A–4, A–6	0
	8–16	Loam, very fine sandy loam, silt loam.	ML, CL	A–4, A–6	0
	16–60	Unweathered bedrock			
Rock outcrop part. (Too variable to be rated.)					
St. Onge:					
So	0–29	Loam	ML, CL	A–4, A–6, A–7	0
	29–60	Stratified fine sandy loam to clay loam.	ML, CL	A–4, A–6, A–7	0
Stetter:					
St	0–60	Clay	CH, MH	A–7	0
Swanboy:					
SwB	0–60	Clay	CH	A–7	0
SyB:[1]					
Swanboy part	0–60	Clay	CH	A–7	0
Slickspots part. (Too variable to be rated.)					
Tilford:					
TaA, TaB	0–9	Silt loam	CL–ML, CL	A–4, A–6	0
	9–26	Silt loam, loam	CL–ML, CL	A–4, A–6	0
	26–60	Loam, silt loam	CL, ML	A–4, A–6	0
Vanocker:					
VAE:[1]					
Vanocker part	0–2	Channery loam	ML, CL	A–4, A–6	10–45
	2–60	Channery loam, channery clay loam, very channery clay loam.	ML, CL	A–6, A–7	45–75
Citadel part	0–8	Silt loam	ML, CL	A–4, A–6	0
	8–29	Clay loam, clay	CL, CH	A–6, A–7	0–10
	29–60	Loam, clay loam, silt loam	CL	A–6, A–7	0–15
Winetti:					
Wa	0–3	Gravelly loam	SM–SC, SC	A–2	0
	3–12	Gravelly sandy loam, sandy loam, gravelly loamy sand.	SM, SC, SM–SC	A–2	0
	12–60	Very gravelly sandy loam	GM, SM, GW–GM	A–1	0–5
Winler:					
WbC	0–3	Clay	CH, MH	A–7	0
	3–21	Clay, shaly clay	CH, MH	A–7	0
	21–60	Unweathered bedrock	CH	A–7	0
WcB:[1]					
Winler part	0–3	Clay	CH, MH	A–7	0
	3–21	Clay, shaly clay	CH, MH	A–7	0
	21–60	Unweathered bedrock	CH	A–7	0
Swanboy part	0–60	Clay	CH	A–7	0
Zigweid:					
ZaD:[1]					
Zigweid part	0–60	Clay loam	CL	A–6	0
Nihill part	0–6	Gravelly loam	GM–GC, GM, SM–SC, SM	A–2, A–4	0–5
	6–60	Very gravelly loam, gravelly loam.	GM	A–2, A–1	0–5

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition

and classifications—Continued

Percentage passing sieve number—				Liquid limit	Plasticity index
4	10	40	200		
				Pct	
100	100	85–100	65–90	25–35	NP–15
95–100	80–100	70–100	50–90	25–35	NP–15
100	100	85–100	50–100	25–45	5–25
100	100	85–100	50–100	25–45	5–25
100	100	90–100	75–100	50–90	25–65
100	100	90–100	75–95	50–100	30–60
100	100	90–100	75–95	50–100	30–60
100	100	95–100	60–95	25–35	5–15
100	100	95–100	70–95	25–35	5–15
95–100	95–100	95–100	70–95	25–35	5–15
90–95	75–90	65–80	50–65	25–40	5–20
90–95	75–90	65–80	50–65	30–45	10–25
100	100	85–100	60–90	25–35	5–15
95–100	90–100	85–100	70–95	35–60	15–35
95–100	90–100	85–100	65–95	30–50	10–30
65–75	60–70	50–60	30–45	20–30	5–10
70–100	60–90	35–65	15–35	15–30	NP–10
35–60	25–40	10–30	5–15	15–25	NP–5
100	100	90–100	80–100	50–90	20–65
100	100	90–100	80–100	50–90	20–65
100	100	90–100	80–100	50–90	25–65
100	100	90–100	80–100	50–90	20–65
100	100	90–100	80–100	50–90	20–65
100	100	90–100	80–100	50–90	25–65
100	100	90–100	75–95	50–100	30–60
75–100	75–100	65–100	50–80	25–40	15–20
45–80	35–75	30–70	20–50	25–35	5–10
30–60	20–50	15–45	12–35	20–35	NP–5

and behavior characteristics of the mapping unit.

TABLE 11.—*Engineering*

[Tests performed by South Dakota

Soil name and location	Parent material	Depth	Horizon	Moisture density [1]	
				Maximum dry density	Optimum moisture
		Inches		*Lb/cu ft*	*Percent*
Enning silty clay loam: 1,700 feet S. and 650 feet E. of NW. corner of sec. 11, T. 4 N., R. 7 E. (Modal)	Chalky shale.	5–14 14–60	C Cr	---------- 86	---------- 30
Glenberg fine sandy loam: 2,200 feet W. and 1,500 feet N. of SE. corner of sec. 8, T. 7 N., R. 8 E. (Modal)	Alluvium from Belle Fourche River.	4–13 24–60	AC C	117 115	14 15
Grummit clay: 2,600 feet N. and 1,300 feet E. of SW. corner of sec. 35, T. 6 N., T. 5 E. (Modal)	Acid shale.	4–9 15–60	C1 Cr	95 97	24 23
Kyle clay: 1,400 feet W. and 150 feet N. of SE. corner of sec. 34, T. 5 N., R. 8 E. (Modal)	Clay over clay shale.	5–17 30–60	B2 Ccs	91 ----------	26 ----------
Lismas clay: 2,400 feet W. and 2,000 feet N. of SE. corner of sec. 5, T. 6 N., R. 10 E. (Modal)	Clay shale.	5–15 15–60	C Cr	84 84	31 31
Manvel silt loam: 1,300 feet S. and 150 feet W. of NE. corner of sec. 36, T. 7 N., R. 5 E. (Modal)	Silt loam over chalky shale.	2–43 43–60	C C	89 88	28 30
Pierre clay: 1,700 feet S. and 330 feet E. of NW. corner, sec. 4, T. 7 N., R. 8 E. (Modal)	Clay shale.	7–18 32–43	B2 Cr	94 90	24 28
Samsil clay: 2,300 feet W. and 1,000 feet W. of NW. corner of sec. 12, T. 3 N., R. 13 E. (Modal)	Clay shale.	2–10 10–60	C Cr	---------- 93	---------- 25
Satanta loam: 550 feet N. and 60 feet E. of SW. corner of sec. 22, T 5 N., R. 10 E. (Modal)	Loamy alluvium.	4–20 20–31 31–60	B2t B3ca C	113 117 115	15 14 14
Spearfish loam: 350 feet W. and 100 feet S. of NE. corner of sec. 22, T. 5 N., R. 5 E. (Modal)	Reddish siltstone.	4–10 10–60	AC Cr	107 113	18 15
Stetter clay: 1,700 feet W. and 1,500 feet S. of NE. corner of sec. 17, T. 5 N., R. 11 E. (Modal)	Clayey alluvium.	10–30	C2	93	25
Tilford silt loam: 1,400 feet S. and 400 feet W. of NE. corner of sec. 15, T. 3 N., R. 6 E. (Modal)	Silt loam over reddish siltstone.	5–16 16–60	B C	102 108	20 17

[1] Based on AASHTO Designation T 99–57 (*2*).

[2] Mechanical analyses according to the AASHTO Designation T–88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Services (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 soil survey procedure, the fine material is

from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

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

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moder-

test data

Department of Highways]

Mechanical analysis [2]					Liquid limit	Plasticity index	Classification	
Percentage passing sieve—				Percentage smaller than 0.005 mm			AASHTO [3]	Unified [4]
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)					
98	98	96	94	71	54	18	A–7–5(14)	MH
		100	97	69	48	17	A–7–5(13)	ML
	100	95	43	15	22	5	A–4(2)	SM–SC
	100	98	36	13	20	2	A–4(0)	SM
100	99	96	92	54	46	15	A–7–5(17)	ML
	100	95	89	47	44	14	A–7–5(11)	ML
	100	98	96	61	62	30	A–7–5(20)	MH–CH
	100	98	93	57	63	35	A–7–6(20)	CH
100	99	99	98	67	79	33	A–7–5(20)	MH
	100	97	95	64	85	43	A–7–5(20)	MH
100	99	95	87	56	57	26	A–7–5(18)	MH–CH
	100	99	91	62	60	30	A–7–5(20)	MH–CH
98	96	90	87	67	64	30	A–7–5(20)	MH
	100	98	97	79	77	43	A–7–5(20)	MH–CH
	100	99	87	46	51	19	A–7–5(14)	MH
	100	99	88	40	52	22	A–7–5(15)	MH–CH
100	99	95	44	19	24	8	A–4(2)	SC
98	96	92	38	19	22	8	A–4(1)	SC
	100	98	36	19	22	5	A–4(0)	SM–SC
	100	99	68	12	30	5	A–4(7)	ML
	100	98	84	17	31	10	A–4(8)	CL–ML
		100	97	57	57	28	A–7–6(18)	CH
		100	61	19	30	7	A–4(5)	CL–ML
99	98	96	74	29	30	9	A–4(8)	CL–ML

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.

[3] Based on AASHTO Designation M 145–49 (*2*).

[4] Based on the Unified Soil Classification System (*3*).

ately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These

TABLE 12.—*Physical and chemical*

[Dashes indicate data were not available. The symbol < means less than;

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Altvan:					
AlA, AlB	0–7	0.6–2.0	0.20–0.24	6.1–7.3	<2
	7–22	0.6–2.0	0.15–0.17	6.1–7.3	<2
	22–32	0.6–2.0	0.17–0.19	7.4–9.0	<2
	32–60	>20	0.02–0.04	7.4–9.0	<2
Arvada:					
AnB, ArB[1]	0–3	2.0–6.0	0.13–0.15	6.6–8.4	<4
	3–12	<0.06	0.07–0.09	7.4–9.0	<4
	12–60	0.06–0.2	0.09–0.11	7.9–9.0	<8
Assinniboine:					
AsB	0–5	2.0–6.0	0.10–0.14	6.6–7.3	<2
	5–17	0.6–2.0	0.12–0.16	6.6–8.4	<2
	17–41	2.0–6.0	0.10–0.14	7.4–8.4	<2
	41–60	2.0–6.0	0.06–0.14	7.4–8.4	<2
Bankard:					
Ba[1]	0–5	2.0–6.0	0.15–0.17	7.4–8.4	<2
	5–60	6.0–20	0.05–0.08	7.4–8.4	<2
Blackpipe:					
BlD	0–6	0.6–2.0	0.19–0.22	6.1–7.3	<2
	6–17	0.2–0.6	0.11–0.19	6.6–7.8	<2
	17–34	0.2–0.6	0.13–0.20	7.4–8.4	<2
	34–50				
BsD:[1]					
Blackpipe part	0–6	0.6–2.0	0.19–0.22	6.1–7.3	<2
	6–17	0.2–0.6	0.11–0.19	6.6–7.8	<2
	17–34	0.2–0.6	0.13–0.20	7.4–8.4	<2
	34–50				
Shingle part	0–3	0.6–2.0	0.19–0.21	7.4–9.0	<2
	3–17	0.6–2.0	0.16–0.21	7.9–9.0	<2
	17–60				
Cabbart:					
CaE	0–4	0.6–2.0	0.16–0.22	7.4–8.4	<4
	4–18	0.06–0.6	0.12–0.20	7.4–9.0	2–8
	18–60				
Canyon:					
CbD:[1]					
Canyon part	0–4	0.6–6.0	0.20–0.22	7.4–8.4	<2
	4–11	0.6–2.0	0.13–0.18	7.4–8.4	<2
	11–60				
Bridget part	0–7	0.6–2.0	0.20–0.24	6.6–7.8	<2
	7–11	0.6–2.0	0.17–0.19	6.6–7.8	<2
	11–60	0.6–2.0	0.17–0.19	7.4–8.4	<2
CDE:[1]					
Canyon part	0–4	0.6–6.0	0.20–0.22	7.4–8.4	<2
	4–11	0.6–2.0	0.13–0.18	7.4–8.4	<2
	11–60				
Butche part	0–4	0.6–6.0	0.14–0.20	6.1–7.8	<2
	4–14	0.6–2.0	0.16–0.18	6.1–7.8	<2
	14–20				
Citadel:					
CTE[1]	0–8	0.6–2.0	0.16–0.20	5.1–6.5	<2
	8–21	0.2–0.6	0.11–0.17	5.1–6.5	<2
	21–60	0.2–2.0	0.17–0.20	6.6–7.8	<2

See footnote at end of table.

properties of soils

> means more than. The erosion tolerance factor (T) is for the entire profile.]

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Low	Low	Low	0.28	3	6
Moderate	Low	Low	0.28		
Low	Low	Low	0.28		
Low	Low	Low	0.10		
Low	High	Moderate	0.43	5	8
High	High	Moderate	0.28		
High	High	Moderate	0.28		
Low	Moderate	Low	0.28	5	3
Low	High	Low	0.28		
Low	High	Low	0.28		
Low	High	Low	0.28		
Low	Moderate	Low	0.10	5	8
Low	Moderate	Low	0.10		
Moderate	High	Low	0.32	4–3	6
High	High	Low	0.32		
High	High	Low	0.32		
Moderate	High	Low	0.32	4–3	6
High	High	Low	0.32		
High	High	Low	0.32		
Moderate	High	Low	0.32	2	8
Moderate	High	Low	0.32		
Low	High	Low	0.32	2	5
Moderate	High	Low	0.32		
Low	Low	Low	0.28	1	8
Low	Low	Low	0.28		
Low	High	Low	0.32	5–4	5
Low	High	Low	0.32		
Low	High	Low	0.32		
Low	Low	Low	0.28	1	8
Low	Low	Low	0.28		
Moderate	Moderate	Low	0.28	1	8
Moderate	Moderate	Low	0.28		
Low	High	Moderate	0.32	3–2	8
High	High	Moderate	0.32		
Moderate	High	Moderate	0.32		

TABLE 12.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Delphill:					
DaD	0–3	0.6–2.0	0.16–0.20	7.4–8.4	<4
	3–32	0.6–2.0	0.14–0.20	7.4–9.0	<4
	32–60				
Enning:					
EaD:[1]					
Enning part	0–5	0.6–2.0	0.14–0.17	6.6–7.8	<2
	5–14	0.6–2.0	0.14–0.17	7.4–8.4	<2
	14–40			7.4–8.4	<2
Manvel part	0–3	0.6–2.0	0.18–0.20	7.9–8.4	<2
	3–60	0.2–2.0	0.16–0.18	7.9–8.4	2–4
EbE:[1]					
Enning part	0–5	0.6–2.0	0.14–0.17	6.6–7.8	<2
	5–14	0.6–2.0	0.14–0.17	7.4–8.4	<2
Rock outcrop part. (Too variable to be rated.)	14–40			7.4–8.4	<2
Glenberg:					
Ga[1]	0–6	2.0–6.0	0.09–0.13	6.6–8.4	<2
	6–60	2.0–6.0	0.07–0.12	7.4–8.4	<2
Grummit:					
GbD, GcE[1]	0–15	0.6–2.0	0.08–0.12	3.6–5.5	<2
	15–60				
Hisle:					
HbB:[1]					
Hisle part	0–34	<0.06	0.05–0.12	7.4–9.0	2–16
	34–60	<0.06		6.1–8.4	<2
Slickspots part. (Too variable to be rated.)					
Hoven:					
Ho	0–5	0.6–2.0	0.19–0.22	5.6–7.3	<2
	5–16	<0.06	0.10–0.19	6.1–8.4	<2
	16–60	<0.2	0.08–0.17	7.4–9.0	<2
Keith:					
KaA, KaB	0–9	0.6–2.0	0.22–0.24	6.1–7.8	<2
	9–60	0.6–2.0	0.20–0.22	6.6–8.4	<2
Kyle:					
KbA, KbB, KcB[1]	0–60	<0.06	0.08–0.12	6.6–8.4	<2
Lakoa:					
LAD:[1]					
Lakoa part	0–10	0.6–2.0	0.17–0.20	5.6–7.3	<2
	10–33	0.6–2.0	0.17–0.20	5.6–7.3	<2
	33–60	0.6–2.0	0.16–0.20	6.6–7.8	<2
Maitland part	0–9	0.6–2.0	0.16–0.19	5.1–6.5	<2
	9–39	0.6–2.0	0.16–0.20	5.1–6.5	<2
	39–60	0.6–2.0	0.12–0.18	6.1–7.8	<2
Lismas:					
LbE	0–5	<0.2	0.12–0.16	6.6–9.0	4–16
	5–15	<0.2	0.12–0.16	7.4–9.0	>8
	24–60				
LCD:[1]					
Lismas part	0–5	<0.2	0.12–0.16	6.6–9.0	4–16
	5–15	<0.2	0.12–0.16	7.4–9.0	>8
	24–60				

See footnote at end of table.

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Low	High	Low	0.32	2	5
Low	High	Low	0.32		
Low	Moderate	Low	0.37	2	8
Low	Moderate	Low	0.37		
	Moderate	Moderate			
Moderate	Moderate	Moderate	0.37	5	8
Moderate	High	Moderate	0.37		
Low	Moderate	Low	0.37	2	8
Low	Moderate	Low	0.37		
	Moderate	Moderate			
Low	Moderate	Low			3
Low	High	Low			
High	High	High	0.24	1	8
High	High	Moderate	0.28	1	8
High	High	Moderate			
Moderate	Moderate	Moderate			8
High	High	Moderate			
High	High	Moderate			
Low	Low	Low	0.32	5	6
Moderate	Low	Low	0.43		
High	High	Low	0.28	5	4
Low	High	Moderate	0.32	4–3	8
Moderate	High	Moderate	0.32		
Moderate	High	Moderate	0.32		
Low	High	Moderate	0.28	4–3	8
Moderate	High	Moderate	0.28		
Low	High	Moderate	0.28		
High	High	Moderate	0.28	1	8
High	High	Moderate	0.28		
High	High	Moderate	0.28	1	8
High	High	Moderate	0.28		

TABLE 12.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Winler part	0–3	<0.06	0.08–0.14	6.6–7.3	<2
	3–21	<0.06	0.08–0.12	5.6–8.4	<2
	21–60				
Lohmiller:					
Le	0–60	0.06–0.6	0.13–0.18	7.4–8.4	<8
Lh:[1]					
Lohmiller part	0–60	0.06–0.6	0.13–0.18	7.4–8.4	<8
Glenberg part	0–6	2.0–6.0	0.09–0.13	6.6–8.4	<2
	6–60	2.0–6.0	0.07–0.12	7.4–8.4	<2
Macken:					
Ma	0–60	0.06–0.2	0.10–0.18	5.6–8.4	<2
Manvel:					
MbB	0–3	0.6–2.0	0.18–0.20	7.9–8.4	<2
	3–60	0.2–2.0	0.16–0.18	7.9–8.4	2–4
Marshdale:					
McB:[1]					
Marshdale part	0–16	0.06–0.6	0.19–0.21	6.1–7.3	<2
	16–60	0.06–0.6	0.17–0.19	6.1–7.8	<2
Maitland part	0–9	0.6–2.0	0.16–0.19	5.1–6.5	<2
	9–39	0.6–2.0	0.16–0.20	5.1–6.5	<2
	39–60	0.6–2.0	0.12–0.18	6.1–7.8	<2
Midway:					
MdD:[1]					
Midway part	0–13	0.06–0.2	0.12–0.17	7.4–9.0	2–8
	13–60				
Blackpipe part	0–6	0.6–2.0	0.19–0.22	6.1–7.3	<2
	6–17	0.2–0.6	0.11–0.19	6.6–7.8	<2
	17–34	0.2–0.6	0.13–0.20	7.4–8.4	<2
	34–50				
Nevee:					
NaD:[1]					
Nevee part	0–8	0.6–2.0	0.17–0.20	6.6–7.8	<2
	8–60	0.6–2.0	0.12–0.20	7.4–9.0	2–4
Spearfish part	0–8	0.6–2.0	0.16–0.22	6.6–8.4	<2
	8–16	0.6–2.0	0.15–0.20	7.4–8.4	2–4
	16–60				
Nihill:					
NbE	0–6	0.6–2.0	0.12–0.16	6.6–7.8	<2
	6–60	2.0–6.0	0.07–0.09	6.6–8.4	<4
Nunn:					
NcA, NcB, NcC	0–7	0.6–2.0	0.15–0.20	6.6–7.8	<2
	7–32	0.2–0.6	0.15–0.18	6.6–8.4	<2
	32–60	0.2–2.0	0.10–0.18	7.4–8.4	<2
Onita:					
OaA	0–11	0.6–2.0	0.19–0.22	5.6–7.3	<2
	11–27	0.2–0.6	0.11–0.17	6.1–7.3	<2
	27–60	0.2–0.6	0.17–0.20	7.4–8.4	<2
Paunsaugunt:					
PaE:[1]					
Paunsaugunt part	0–15	0.6–2.0	0.08–0.13	7.4–9.0	<2
	15–18				
Rock outcrop part. (Too variable to be rated.)					

See footnote at end of table.

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
High	High	Low	0.28	3	8
High	High	High	0.28		
Moderate	High	Low			6
Moderate	High	Low			6
Low	Moderate	Low			3
Low	High	Low			
High	High	Moderate			8
Moderate	Moderate	Moderate	0.37	5	8
Moderate	High	Moderate	0.37		
Moderate	High	Low			6
Moderate	High	Low			
Low	High	Moderate	0.28	4–3	8
Moderate	High	Moderate	0.28		
Low	High	Moderate	0.28		
High	High	Low	0.28	1	8
Moderate	High	Low	0.32	4–3	6
High	High	Low	0.32		
High	High	Low	0.32		
Low	Moderate	Low	0.32	3	8
Low	High	Moderate	0.43		
Low	High	Moderate	0.32	1	8
Low	High	Moderate	0.32		
Low	High	Low	0.24	2	5
Low	High	Low	0.20		
Moderate	Moderate	Low	0.24	5	6
High	High	Low	0.28		
Moderate	High	Low	0.24		
Moderate	Moderate	Low	0.28	5	6
High	High	Low	0.28		
High	High	Low	0.28		
Low	High	Moderate	0.20	1	8

TABLE 12.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
Pierre:					
PbB, PbC	0–4	<0.06	0.08–0.12	6.1–7.3	<2
	4–34	<0.06	0.08–0.12	6.6–8.4	<2
	34–60				<2
Samsil:					
SaE	0–14	0.06–0.2	0.08–0.12	7.4–8.4	<2
	14–60			5.6–8.4	<2
SBD:[1]					
Samsil part	0–14	0.06–0.2	0.08–0.12	7.4–8.4	<2
	14–60			5.6–8.4	<2
Pierre part	0–4	<0.06	0.08–0.12	6.1–7.3	<2
	4–34	<0.06	0.08–0.12	6.6–8.4	<2
	34–60				<2
SCE:[1]					
Samsil part	0–14	0.06–0.2	0.08–0.12	7.4–8.4	<2
	14–60			5.6–8.4	<2
Rock outcrop part. (Too variable to be rated.)					
Satanta:					
SdA, SdB, SdC	0–6	0.6–2.0	0.20–0.22	6.1–7.8	<2
	6–21	0.6–2.0	0.15–0.19	6.6–8.4	<2
	21–60	0.6–2.0	0.16–0.19	7.4–8.4	<2
SeA:[1]					
Satanta part	0–6	0.6–2.0	0.20–0.22	6.1–7.8	<2
	6–21	0.6–2.0	0.15–0.19	6.6–8.4	<2
	21–60	0.6–2.0	0.16–0.19	7.4–8.4	<2
Mosher part	0–11	0.6–2.0	0.18–0.22	6.1–7.8	<2
	11–22	<0.06	0.08–0.19	7.4–8.4	2–4
	22–60	0.06–0.2	0.11–0.22	7.9–9.0	4–16
Savo:					
ShA	0–4	0.6–2.0	0.19–0.22	6.1–7.3	<2
	4–22	0.2–0.6	0.11–0.19	6.6–7.8	<2
	22–60	0.2–2.0	0.11–0.17	7.4–8.4	<2
SkB:[1]					
Savo part	0–4	0.6–2.0	0.19–0.22	6.1–7.3	<2
	4–22	0.2–0.6	0.11–0.19	6.6–7.8	<2
	22–60	0.2–2.0	0.11–0.17	7.4–8.4	<2
Blackpipe part	0–6	0.2–0.6	0.16–0.22	6.1–7.3	<2
	6–17	0.2–0.6	0.11–0.19	6.6–7.8	<2
	17–34	0.2–0.6	0.13–0.20	7.4–8.4	<2
	34–50				
Spearfish:					
SIE:[1]					
Spearfish part	0–8	0.6–2.0	0.16–0.22	6.6–8.4	<2
	8–16	0.6–2.0	0.15–0.20	7.4–8.4	<2
	16–60				
Rock outcrop part. (Too variable to be rated.)					
St. Onge:					
So	0–29	0.6–2.0	0.17–0.22	6.6–7.8	<2
	29–60	0.6–2.0	0.16–0.20	6.6–8.4	<2
Stetter:					
St	0–60	<0.2	0.08–0.16	6.6–8.4	<2
Swanboy:					
SWB	0–60	<0.06	0.08–0.12	6.6–9.0	<2

See footnote at end of table.

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
High	High	Low	0.28	4–3	8
High	High	Low	0.28		
High	High	Moderate	0.28	1	8
High	High	Moderate			
High	High	Moderate	0.28	1	8
High	High	Moderate			
High	High	Low	0.28	4–3	8
High	High	Low	0.28		
High	High	Moderate	0.28	1	8
High	High	Moderate			
Low	Low	Low	0.28	5–4	6
Low	Low	Low	0.28		
Low	Low	Low	0.28		
Low	Low	Low	0.28	5–4	6
Low	Low	Low	0.28		
Low	Low	Low	0.28		
Moderate	Moderate	Moderate	0.43	4–3	6
High	High	Moderate	0.32		
High	High	Moderate	0.32		
High	Moderate	Low	0.32	5–4	7
High	High	Low	0.32		
High	High	Moderate	0.32		
High	Moderate	Low	0.32	5–4	7
High	High	Low	0.32		
High	High	Moderate	0.32		
High	High	Low	0.32	4–3	7
High	High	Low	0.32		
High	High	Low	0.32		
Low	High	Moderate	0.32	1	8
Low	High	Moderate	0.32		
Moderate	High	Low			6
Moderate	High	Low			
High	High	Low			4
High	High	Moderate	0.28	5	8

TABLE 12.—*Physical and chemical*

Soil series and map symbols	Depth	Permeability	Available water capacity	Soil reaction	Salinity
	In	*In/hr*	*In/in*	*pH*	*Mmhos/cm*
SyB:[1]					
Swanboy part	0–60	<0.06	0.08–0.12	6.6–9.0	<2
Slickspots part. (Too variable to be rated.)					
Tiliford:					
TaA, TaB	0–9	0.6–2.0	0.19–0.22	6.6–7.8	<2
	9–26	0.6–2.0	0.17–0.20	6.6–8.4	<2
	26–60	0.6–2.0	0.16–0.18	7.4–8.4	<2
Vanocker:					
VAE:[1]					
Vanocker part	0–2	0.6–2.0	0.10–0.12	6.1–7.3	<2
	2–60	0.6–2.0	0.09–0.11	6.1–7.8	<2
Citadel part	0–8	0.6–2.0	0.16–0.20	5.1–6.5	<2
	8–29	0.2–0.6	0.11–0.17	5.1–6.5	<2
	29–60	0.2–2.0	0.17–0.20	6.6–7.8	<2
Winetti:					
Wa	0–3	2.0–6.0	0.08–0.10	7.4–7.8	<2
	3–12	2.0–6.0	0.06–0.11	7.4–8.4	<2
	12–60	2.0–6.0	0.04–0.08	7.4–8.4	<2
Winler:					
WbC	0–3	<0.06	0.08–0.14	6.6–7.3	<2
	3–21	<0.06	0.08–0.12	5.6–8.4	<2
	21–60				
WcB:[1]					
Winler part	0–3	<0.06	0.08–0.14	6.6–7.3	<2
	3–21	<0.06	0.08–0.12	5.6–8.4	<2
	21–60				
Swanboy part	0–60	<0.06	0.08–0.12	6.6–9.0	<2
Zigweid:					
ZaD:[1]					
Zigweid part	0–60	0.6–2.0	0.16–0.21	7.4–8.4	<2
Nihill part	0–6	0.6–2.0	0.12–0.16	6.6–7.8	<2
	6–60	2.0–6.0	0.07–0.09	6.6–8.4	<4

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition

consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

A *seasonal high water table* is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
High	High	Moderate	0.28	5	8
Low	Moderate	Low	0.32	5–4	6
Low	Moderate	Low	0.43		
Low	Moderate	Low	0.43		
Moderate	High	Moderate	0.24	1	8
Moderate	High	Moderate	0.24		
Low	High	Moderate	0.32	3–2	8
High	High	Moderate	0.32		
Moderate	High	Moderate	0.32		
Low	High	Moderate			8
Low	High	Moderate			
Low	High	Moderate			
High	High	Low	0.28	3	8
High	High	High	0.28		
High	High	Low	0.28	3	8
High	High	High	0.28		
High	High	Moderate	0.28	5	8
Moderate	High	Low	0.32	5	6
Low	High	Low	0.24	2	5
Low	High	Low	0.20		

and behavior characteristics of the mapping unit.

undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 13 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the

TABLE 13.—*Soil and water features*

[Dashes indicate the feature is not a concern. See text for explanation of hydrologic groups. The definitions of "flooding" and "water table" in the Glossary explain the terms "rare," "brief," and "perched." The symbol < means less than; > means more than]

Soil series and map symbols	Hydrologic group	Flooding			Seasonal high water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			*In*		
Altvan:										
AlA, AlB	B	None			>6.0			>60		Moderate.
Arvada:										
AnB, ArB[1]	D	None			>6.0			>60		Low.
Assinniboine:										
AsB[1]	B	None			>6.0			>60		Moderate.
Bankard:										
Ba[1]	A	Frequent	Brief	Mar-Jun	>6.0			>60		Low.
Blackpipe:										
BlD	C	None			>6.0			20–40	Rippable	Low.
BsD:[1]										
Blackpipe part	C	None			>6.0			20–40	Rippable	Low.
Shingle part	D	None			>6.0			10–20	Rippable	Low.
Cabbart:										
CaE	D	None			>6.0			10–20	Rippable	Low.
Canyon:										
CbD:[1]										
Canyon part	D	None			>6.0			6–20	Rippable	Low.
Bridget part	B	None to rare			>6.0			>60		Moderate.
CDE:[1]										
Canyon part	D	None			>6.0			6–20	Rippable	Low.
Butche part	B	None			>6.0			7–20	Hard	Low.
Citadel:										
CtE[1]	B	None			>6.0			>60		Moderate.
Delphill:										
DaD	C	None			>6.0			20–40	Rippable	Moderate.
Enning:										
EaD:[1]										
Enning part	C	None			>6.0			>20	Rippable	Low.
Manvel part	C	None			>6.0			>60		Low.
EbE:[1]										
Enning part	C	None			>6.0			>20	Rippable	Low.
Rock outcrop part. (Too variable to be rated.)										
Glenberg:										
Gl[1]	B	Rare to common	Very brief	Apr-Aug	>6.0			>60		Low.

See footnote at end of table.

Grummit:										
GbD, GcE[1]	D	None			>6.0			5–20	Rippable	Low.
Hisle:										
HbB:[1]										
Hisle part	D	None			>6.0			20–40	Rippable	Low.
Slickspots part. (Too variable to be rated.)										
Hoven:										
Ho	D	Common	Very long	Sep-Jul	>6.0			>60		Moderate.
Keith:										
KaA, KaB	B	None			>6.0			>60		Moderate.
Kyle:										
KbA, KbB, KcB[1]	D	None			>6.0			>60		Low.
Lakoa:										
LAD[1]	B	None			>6.0			>60		Moderate.
Lismas:										
LbE	D	None			>6.0			5–18	Rippable	Low.
LCD:[1]										
Lismas part	D	None			>6.0			5–18	Rippable	Low.
Winler part	D	None			>6.0			20–40	Rippable	Low.
Lohmiller:										
Le	C	Rare			>6.0			>60		Low.
Lh:[1]										
Lohmiller part	C	Rare			>6.0			>60		Low.
Glenberg part	B	Rare to common	Very brief	Apr-Aug	>6.0			>60		Low.
Macken:										
Ma	D	Common	Very long	Sep-Jun	>6.0			>60		Moderate.
Manvel:										
MbB	C	None			>6.0			>60		Low.
Marshdale:										
McB:[1]										
Marshdale part	C	Common	Very brief	Apr-Oct	1.5–2.0	Apparent	Apr-Oct	>60		High.
Maitland part	B	None			>6.0			>60		Moderate.
Midway:										
MdD:[1]										
Midway part	D	None			>6.0			10–20	Rippable	Low.
Blackpipe part	C	None			>6.0			20–40	Rippable	Low.
Nevee:										
NaD:[1]										
Nevee part	B	None			>6.0			40–60	Rippable	Low.
Spearfish part	B	None			>6.0			6–20	Rippable	Low.
Nihill:										
NbE	B	None			>6.0			>60		Moderate.
Nunn:										
NcA, NcB, NcC	C	None			>6.0			>60		Moderate.
Onita:										
OaA	C	None to common	Very brief	Oct-Jun	4.0–6.0	Perched	Oct-Jun	>60		Low.

See footnote at end of table.

TABLE 13.—*Soil and water features*—Continued

Soil series and map symbols	Hydrologic group	Flooding			Seasonal high water table			Bedrock		Potential frost action
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	
					Ft			*In*		
Paunsaugunt:										
PaE:[1]										
Paunsaugunt part	D	None			>6.0			10–20	Hard	Moderate.
Rock outcrop part. (Too variable to be rated.)										
Pierre:										
PbB, PbC	D	None			>6.0			20–40	Rippable	Low.
Samsil:										
SaE	D	None			>6.0			4–20	Rippable	Low.
SBD:[1]										
Samsil part	D	None			>6.0			4–20	Rippable	Low.
Pierre part	D	None			>6.0			20–40	Rippable	Low.
SCE:[1]										
Samsil part	D	None			>6.0			4–20	Rippable	Low.
Rock outcrop part. (Too variable to be rated.)										
Satanta:										
SdA, SdB, SdC	B	None			>6.0			>60		Low.
SeA:[1]										
Satanta part	B	None			>6.0			>60		Low.
Mosher part	D	Rare			3.0–6.0	Perched	Oct-Jun	>60		Moderate.
Savo:										
ShA	C	None			>6.0			>60		Low.
SkB:[1]										
Savo part	C	None			>6.0			>60		Low.
Blackpipe part	C	None			>6.0			20–40	Rippable	Low.
Spearfish:										
SlE:[1]										
Spearfish part	B	None			>6.0			6–20	Rippable	Low.
Rock outcrop part. (Too variable to be rated.)										
St. Onge:										
So	B	Common	Very brief	Sep-Jun	>6.0			>60		Moderate.
Stetter:										
St	D	Common	Brief	Mar-Oct	>6.0			>60		Low.
Swanboy:										
SwB	D	None			>6.0			>60		Low.

See footnote at end of table.

SyB:[1]										
Swanboy part	D	None			>6.0			>60		Low.
Slickspots part. (Too variable to be rated.)										
Tilford:										
TaA, TaB	B	None			>6.0			>60		Moderate.
Vanocker:										
VAE:[1]										
Vanocker part	C	None			>6.0			>60		Moderate.
Citadel part	B	None			>6.0			>60		Moderate.
Winetti:										
Wa	B	Rare			>6.0			>60		Moderate.
Winler:										
WbC	D	None			>6.0			20–40	Rippable	Low.
WcB:[1]										
Winler part	D	None			>6.0			20–40	Rippable	Low.
Swanboy part	D	None			>6.0			>60		Low.
Zigweid:										
ZaD:[1]										
Zigweid part	B	None			>6.0			>60		Low.
Nihill part	B	None			>6.0			>60		Moderate.

[1] This mapping unit is made up of two or more dominant soils. See the description of the mapping unit for the composition and behavior characteristics of the mapping unit.

freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Formation and classification of the soils

In this section, the factors of soil formation are discussed and related to the development of the soils in the survey area. In addition, the system of soil classification currently used is explained, and each soil series in the survey area is placed in classes of the system.

Factors of soil formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agents. The characteristics of the soil at any given time are determined by 5 factors: the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to 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 that has a distinct profile. It may be much or little, but some time is always required for differentiation of horizons. The development of distinct horizons generally takes a long time.

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

Parent material

Parent material is the disintegrated and partly weathered rock from which soil has formed. It determines the limits of the chemical and physical characteristics of soil such as color, texture, reaction, and consistency.

Many geologic formations in the survey area are at or near the surface because of the Black Hills uplift and subsequent erosion cycles. These range from the Deadwood Formation of Cambrian age to undifferentiated beds of the White River Group of Tertiary age (*1*). The oldest formations in the survey area are in the Black Hills and dip sharply so that each formation in turn dips below a younger formation. Because of this a number of sedimentary formations in the western part of the survey area are exposed in narrow bands and contribute to a wide variety of soil parent material (fig. 19).

The Deadwood Formation consists of red to light brown, fine to very coarse grained sandstone and of red to brownish gray, sandy or silty shale. It is overlain in succession by the Whitewood, Englewood, and Pahasapa Formations. The Whitewood and Englewood Formations consist of pink to lavender dolomite or limestone. The Pahasapa Formation is cavernous limestone that weathers to buff or brown. It is overlain in succession by the Minnelusa, Opeche, and Minnekahta Formations. The Minnelusa Formation consists of sandstone, limestone, and shale. It is dominantly light brown to gray but commonly weathers to red. The Opeche Formation is red, silty, or sandy shale, and the Minnekahta Formation is light brown to purple limestone. The Citadel, Paunsaugunt, and Vanocker soils formed in material that weathered from all of these formations. In places, material that weathered from igneous rocks such as porphyries, quartz monzonite, and rhyolite also have contributed to the parent material of these soils.

The Spearfish Formation is the dominant formation underlying the area known as the "redbed valley." It is red shale or siltstone that commonly contains seams and beds of gypsum. Nevee, Spearfish, and Tilford soils formed in material derived from the Spearfish Formation.

The redbed valley is rimmed by a prominent ridge commonly referred to as the outer hogback of the Black Hills. A succession of sandstone and shale belonging to the Sundance, Unkpapa, and Morrison Formations is exposed on the inner face of the hogback. The sandstone is gray to white or brown to buff colored. Bridget and Canyon soils formed in material that weathered from this sandstone. Sandstone and shale of the Fall River and Lakota Formations are on the upper part of the hogback ridge. The Butche and Lakoa soils formed in material that weathered from these formations.

On the plains side of the outer hogback of the Black Hills, narrow bands of several shale formations are exposed. The Graneros Formation consists of dark gray acid shale, which is the parent material of the Grummit soils. The Greenhorn Formation consists of dark gray to light brown shale and light gray to tan limestone interbedded with light gray to buff siltstone. The Carlile Formation is dark gray shale interbedded with brown sandstone, and the Niobrara Formation consists of light gray to light brown chalky shale, marl, and siltstone. The Enning, Manvel, and Midway soils formed in materials that weathered from the Greenhorn, Carlile, and Niobrara Formations.

The most extensive underlying geologic formation in the survey area is the Pierre Formation. It is gray to dark gray and weathers to brown or olive brown. Hisle, Kyle, Lismas, Pierre, Samsil, and Winler soils formed in material derived from the Pierre Formation.

The Fox Hills Formation is above the Pierre Formation and is mainly in the northeastern part of the survey area. It consists of brown or pale brown interbedded sandy shale, sandstone, and siltstone. Assiniboine, Cabbart, and Delphill soils formed in material derived from the Fox Hills Formation.

High terraces along the Belle Fourche and Cheyenne Rivers and drainage divides between the major

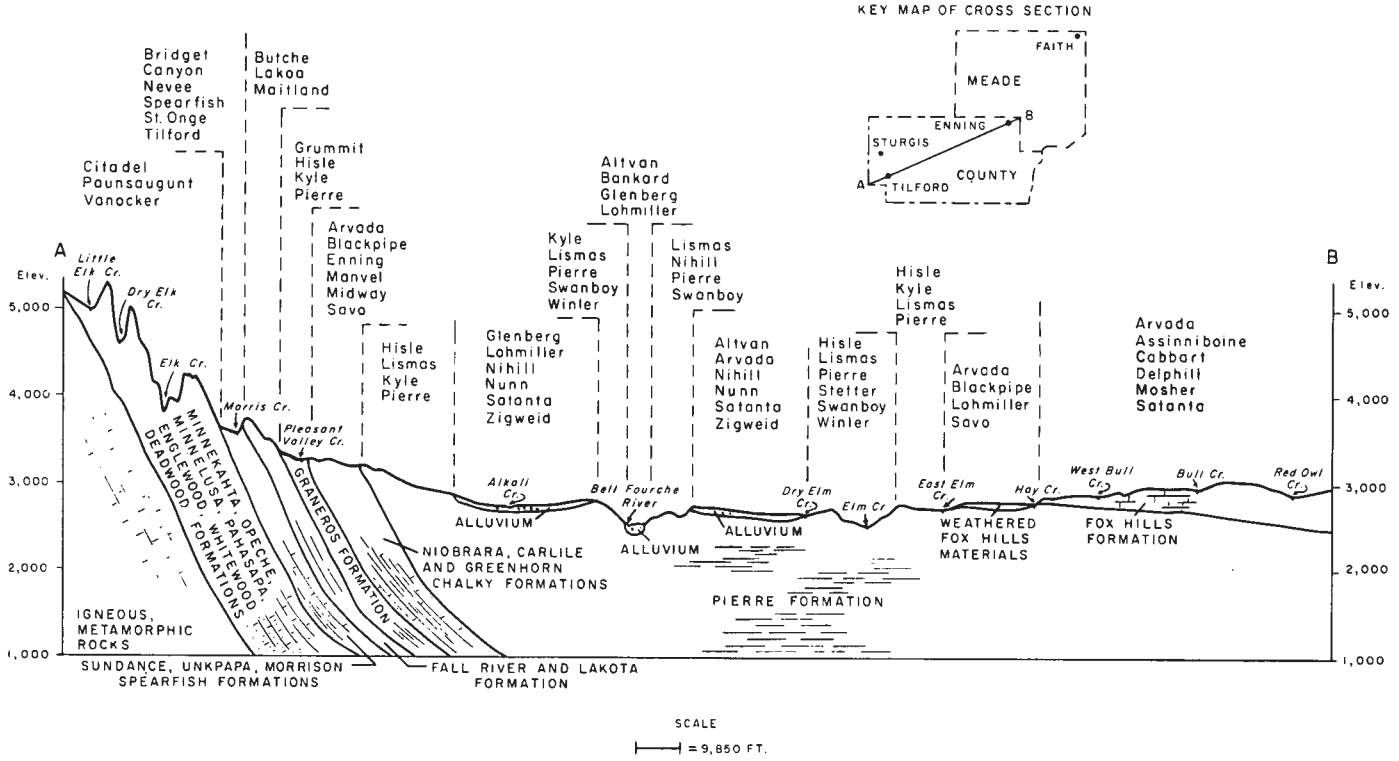


Figure 19.—**Generalized geologic cross section of Meade County, Southern Part, along line A-B, showing relationship of soil series to geologic materials.**

creeks east of the Black Hills are mantled by old alluvium. Nunn and Satanta soils formed in these materials. Some terraces are mantled by silty loess, which is the parent material of Keith soils.

Glenberg, Lohmiller, and St. Onge soils formed in alluvium of the Holocene Epoch.

Climate

Meade County has a continental type of climate characterized by cold winters and hot summers. This kind of climate promotes a relatively slow rate of soil formation.

The climate is relatively uniform in the part of the survey area east of the Black Hills. Mean annual precipitation ranges from less than 14 inches at Union Center in the northeastern part of the survey area to about 16 inches in the southern part. Precipitation in the Black Hills ranges from 17 inches at Sturgis to 21 inches in the southwestern corner of the survey area. The mean annual temperature is about 47° F in much of the survey area east of the Black Hills, but it is about 45° in the northeast corner and about 44° in the higher part of the Black Hills.

Further information about the climate is given in the section "Environmental Factors Affecting Soil Use."

Plant and animal life

Plants, animals, insects, earthworms, bacteria, and fungi are important in the formation of soils. Plants, although influenced by climate and relief, cause changes in the amounts of organic matter and soil nutrients. Most nearly level to sloping soils have similar kinds and amounts of vegetation, varying with the kind of soil. Therefore, they have similar amounts of organic matter. Steeper soils, such as Canyon and Samsil soils, have a different composition of grasses, lose much of the rainfall through runoff, and are more susceptible to erosion. As a result, these soils have a thinner A horizon and lower organic-matter content. Animals, especially burrowing ones such as prairie dogs, have mixed the horizons in some soils. Earthworm activity has improved the porosity of soils on favorable moisture sites such as Onita and St. Onge soils.

Relief

Relief affects soil formation because of differences in slope. The steep Cabbart and Samsil soils lose much of the rainfall through runoff. Less sloping soils, for example, Assinniboine and Pierre soils, absorb more moisture. This additional moisture influences the kinds and amounts of vegetation and, in turn, the development of soil horizons.

Time

The length of time that soil material has been exposed to other soil-forming factors determines the kind of soils that form. Soils on older landscapes have well defined soil horizons, for example, Nunn and Satanta soils. The more youthful Lohmiller and Glenburg soils formed in recent alluvium.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to *Soil Taxonomy* (*8*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 14, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

Order. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Entisol.

Suborder. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Orthent (*Orth*, meaning common ones, plus *ent*, from Entisol).

Great Group. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic ho-

TABLE 14.—*Classification of the soils*

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics that are outside the range of the series]

Soil series	Family or higher taxonomic class
Altvan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aridic Argiustolls.
Arvada	Fine, montmorillonitic, mesic Ustollic Natrargids.
Assinniboine	Fine-loamy, mixed Aridic Argiborolls.
Bankard	Sandy, mixed, mesic Ustic Torrifluvents.
Blackpipe	Fine, montmorillonitic, mesic Aridic Argiustolls.
Bridget	Coarse-silty, mixed, mesic Torriorthentic Haplustolls.
Butche	Loamy, mixed, nonacid, mesic Lithic Ustic Torriorthents.
Cabbart	Loamy, mixed (calcareous), frigid, shallow Ustic Torriorthents.
Canyon	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents.
Citadel	Fine, montmorillonitic Typic Eutroboralfs.
Delphill	Fine-loamy (calcareous), frigid Ustic Torriorthents.
Enning	Loamy, mixed (calcareous), mesic, shallow, Ustic Torriorthents.
Glenberg	Coarse-loamy, mixed (calcareous), mesic Ustic Torrifluvents.
Grummit	Clayey, montmorillonitic, acid, mesic, shallow Ustic Torriorthents.
Hisle	Fine, montmorillonitic, mesic Ustollic Natrargids.
Hoven	Fine, montmorillonitic, mesic Typic Natraquolls.
Keith	Fine-silty, mixed, mesic Aridic Argiustolls.
Kyle	Very-fine, montmorillonitic, mesic Ustertic Camborthids.
Lakoa	Fine-loamy, mixed Typic Eutroboralfs.
Lismas	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents.
Lohmiller	Fine, montmorillonitic (calcareous), mesic Ustic Torrifluvents.
Macken	Fine, montmorillonitic, mesic Vertic Haplaquolls.
*Maitland	Fine-loamy, mixed Mollic Eutroboralfs.
Manvel	Fine-silty, mixed (calcareous), mesic Ustic Torriorthents.
Marshdale	Fine-loamy, mixed, frigid Cumulic Haplaquolls.
Midway	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents.
*Mosher	Fine, montmorillonitic, mesic Typic Natrustolls.
Nevee	Coarse-silty, mixed (calcareous), mesic Ustic Torriorthents.
Nihill	Loamy-skeletal, mixed (calcareous), mesic Ustic Torriorthents.
Nunn	Fine, montmorillonitic, mesic Aridic Argiustolls.
Onita	Fine, montmorillonitic, mesic Pachic Argiustolls.
Paunsaugunt	Loamy-skeletal, mixed Lithic Haploborolls.
Pierre	Very-fine, montmorillonitic, mesic Ustertic Camborthids.
Samsil	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents.
Satanta	Fine-loamy, mixed, mesic Aridic Argiustolls.
Savo	Fine, montmorillonitic, mesic Aridic Argiustolls.
Shingle	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents.
Spearfish	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents.
St. Onge	Fine-loamy, mixed, mesic Cumulic Haplustolls.
Stetter	Fine, montmorillonitic, nonacid, mesic Ustertic Torrifluvents.
Swanboy	Very-fine, montmorillonitic, mesic Ustertic Camborthids.
Tilford	Fine-silty, mixed, mesic Torriorthentic Haplustolls.
Vanocker	Loamy-skeletal, mixed, frigid Typic Eutrochrepts.
Winetti	Loamy-skeletal, mixed (calcareous), frigid Typic Ustifluvents.
Winler	Very-fine, montmorillonitic, mesic Ustertic Camborthids.
Zigweid	Fine-loamy, mixed, mesic Ustollic Camborthids.

rizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Torriorthents (*Torri,* meaning a torric moisture regime, plus *orthent,* the suborder of Entisols that are the common ones).

Subgroup. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceeding the name of the great group. The adjective *Ustic* identifies the subgroup that is intergrading to an ustic moisture regime. An example is Ustic Torriorthents.

Family. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is clayey, montmorillonitic (calcareous), mesic, Ustic Torriorthents.

Series. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Environmental factors affecting soil use

In this section, the natural and cultural factors that affect soil use are discussed. Natural features include relief, water, and climate. Cultural features include settlement and population, transport facilities, manufacturing and business services, schools and recreation, and trends in soil use.

Relief

Elevation ranges from 2,200 feet above sea level along the Cheyenne River in the eastern part of the survey area to 5,400 feet on some of the ridges and peaks in the extreme southwestern part. Relief ranges from nearly level to very steep. Extensive hilly to steep areas are on the breaks of the Belle Fourche and Cheyenne Rivers and in the Black Hills. In about 43 percent of the survey area, slopes are too steep for cultivation.

Water

The Belle Fourche and Cheyenne Rivers are surface streams that have a continuous flow. Tributary streams that lead out of the Black Hills generally cease flowing in midsummer. Shallow ground water is scarce on the uplands in much of the survey area, especially in soil associations 9, 10, 11, 12, and 13. Shallow wells generally are obtainable on bottom lands and terraces along the Belle Fourche and Cheyenne Rivers and along major creeks, but the quantity is limited and the quality is variable. Deep artesian wells are obtainable near the outer hogback of the Black Hills and along the major streams. Deep wells in the plains part of the survey area generally require pumping.

Small ponds of surface water created by dams and dugouts provide much of the water for livestock use, but an increasing amount of livestock water is provided by deep wells and distributed by neighborhood pipelines.

About 3,825 acres in the survey area are irrigated. Of this, about 2,500 acres are in the Belle Fourche irrigation project along the Butte County line north of Sturgis. The other irrigated areas consist mainly of small pumping projects along the Belle Fourche and Cheyenne Rivers. Further use of irrigation on those soils that have a potential for it is limited by the availability of water.

Mineral resources

One small calcite mine is in operation near Piedmont in the southwestern part of the survey area. Several gravel pits are near the Black Hills. Oil exploration is continuing, but no producing wells have been established.

Climate[10]

Most of the survey area is located east of the northern part of the Black Hills. This location may be the reason for the reduced rainfall in the plains part of the survey area and for the westerly or southwesterly flow of air into the region. The climate is semiarid, and the survey area typically has very hot summers and cold winters. About 82 percent of the annual precipitation falls during the growing season.

The climatic summary is based on data recorded at Union Center from 1952 to 1974. The elevation at Union Center is 2,970 feet above mean sea level. The data are the best records available for most of the survey area, but they may differ from surrounding counties where 1941–1970 records are available. Also, the average annual temperature at Union Center probably is 1 to 2 degrees cooler than in the plains part of the survey area that is south of the Belle Fourche River. The precipitation data from Union Center are fairly representative of the plains area east and northeast of the Black Hills, but precipitation is significantly greater in the Black Hills.

The temperature ranges greatly from summer to winter, and at times the daily range is also great. Summer temperatures above 90° F occur on an average of 53 days a year. Temperatures above 100° occur on 5 days a year. The warmest summer month on record is July 1966, when the maximum temperature

[10] By WILLIAM F. LYTLE, South Dakota State University.

averaged 92.6° and the minimum temperature averaged 62.5°. In winter, the temperature drops to —20° at least once a year. The coldest month on record is January 1957, when the maximum temperature for the month averaged 19.1° and the minimum temperature averaged —3.9°.

Table 15 gives the probability of specified temperatures occuring after certain dates in spring and before certain dates in fall. The probability is 50 percent that a temperature of 32° or lower will occur before September 20. The probability that a temperature of 32° or lower will occur after May 18 is 50 percent. Therefore, the average length of the growing season is 125 days.

Other data on monthly temperature and precipitation are given in table 16. The lowest annual precipitation in the period of record was 7.35 inches in 1952. The highest annual precipitation was 19.24 inches in 1971. Precipitation in the growing season ranged from 5.92 inches in 1952 to 14.18 inches in 1971. Most rainfall during the growing season occurs as thunderstorms of widely differing intensities. About once in every two years, a rainfall of 1 inch an hour occurs; once in 25 years, a rainfall of 2 inches per hour occurs. Rainfall of 2 inches in 24 hours occurs once in two years, and rainfall of 3 inches in 24 hours occurs once in 10 years.

The average annual snowfall at Union Center is 22.6 inches. A cover of snow protects fields and pastures, but a heavy snow cover delays fieldwork in spring. The smallest seasonal snowfall was 13.0 inches and occurred during 1960–61. The highest snowfall, 52.8 inches, occured in 1969–70. The average number of days with a snow cover of 1 inch or more is 64, and this number has ranged from 22 days in 1955 to 125 days in 1971. The greatest snowfall in one day was 12 inches on April 18, 1970. As a result of strong winds that occur in winter, the depth of the snow cover is greater in sheltered places and less in open fields that have little or no vegetative cover or crop residue.

In an average year sunshine can be expected about 62 percent of the time. The highest percentage of sunshine occurs in July and August, when it averages 72 percent.

In summer, the windspeed averages 10 miles per hour and the prevailing direction is north-northwest. In winter, the windspeed averages 11 miles per hour and the prevailing direction is north-northwest. A windspeed of more than 50 miles per hour can occur during a storm in any month of the year but it is more likely to occur in summer during a thunderstorm. Thunderstorms occur on about 40 to 45 days a year. Hail often accompanies thunderstorms and can be expected three times a year on the average. Hail is most likely to occur in May or June.

The relative humidity ranges widely from early morning to afternoon and from day to day. The annual average humidity is 70 percent in the morning and 50 percent in the afternoon.

The potential water loss from soil and crops is indicated by the loss of water from an evaporation pan. The average annual evaporation from a Class A pan is about 55 inches in the southern part of Meade County. An average of about 43 inches evaporates during the growing season. The average annual evaporation loss from small lakes is about 39 inches, and the annual water loss from the soil and from crops is generally lower, depending upon the available soil moisture.

Settlement and population

Meade County was created in 1889 by an act of the Dakota Territory legislature. Its present boundaries were fixed in 1897 by the state legislature. Before that time, however, the present southern part of Meade County was in Lawrence and Pennington counties at different times. Sturgis is the county seat and the largest town in the county.

Settlement began in 1875 when a cavalry post was established at Fort Meade, although trappers and fur traders had frequented the area earlier. When gold was discovered at Deadwood in 1876, settlement of the western part of the survey area proceeded rapidly.

TABLE 15.—*Probability of specified damaging temperatures in spring and fall*

[Data from records at Union Center, South Dakota, 1952–74]

Probability	Dates for given probability and temperature					
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower	36° F or lower
After specified dates in spring:						
90 percent	March 16	March 25	April 3	April 16	April 30	May 5
70 percent	March 26	April 2	April 11	April 24	May 8	May 14
50 percent	April 8	April 15	April 24	May 5	May 18	May 28
30 percent	April 22	April 28	May 7	May 17	May 28	June 10
10 percent	May 1	May 6	May 15	May 24	June 4	June 19
Before specified dates in fall:						
10 percent	October 10	October 5	September 21	September 10	September 4	August 9
30 percent	October 18	October 11	September 28	September 17	September 10	August 20
50 percent	October 30	October 21	October 8	September 28	September 20	September 8
70 percent	November 11	October 31	October 19	October 9	September 30	September 27
90 percent	November 19	November 6	October 25	October 16	October 6	October 3

TABLE 16.—*Temperature and precipitation*

[From data recorded at Union Center, S. Dak. 1952–74]

Month	Temperature				Precipitation							
			Two years in 10 will have—					One year in 10 will have—			Average number of days with—	
	Average daily maximum	Average daily minimum	Monthly average of the daily maximum equal to or higher than—	Monthly average of the daily minimum equal to or lower than—	Average total	Maximum total	Minimum total	Less than—	More than—	Average total snowfall	Snowfall of 1 inch or more	Snow depth of 1 inch or more
	°F	°F	°F	°F	In.	In.	In.	In.	In.	In.		
January	29.3	6.0	37.6	−1.8	0.24	0.84	0	0.05	0.48	2.0	2	19
February	34.6	11.6	42.9	5.7	.29	.61	.04	.07	.57	3.9	2	14
March	42.2	19.1	50.7	12.6	.54	2.32	.04	.07	1.22	4.7	3	11
April	57.2	30.6	63.1	27.2	1.52	4.81	.02	.34	3.07	4.1	2	2
May	68.2	41.7	73.2	38.7	2.64	8.88	.50	.73	5.09	1.2	0	0
June	77.6	51.7	83.8	48.8	3.07	7.09	.63	1.14	5.41	0	0	0
July	86.7	56.9	91.5	53.0	1.42	3.71	.30	.50	2.56	0	0	0
August	87.3	56.4	91.8	53.3	1.18	2.52	.07	.31	2.30	0	0	0
September	74.9	44.6	80.9	40.6	1.29	4.20	.12	.16	2.68	.3	0	0
October	63.3	33.6	69.7	29.4	.70	2.73	0	.04	1.56	.4	1	1
November	45.3	21.0	51.9	16.1	.27	1.09	.02	.06	.55	2.2	1	4
December	34.2	11.6	41.8	5.1	.24	.58	0	.05	.46	2.9	2	13
Year	57.0	32.0	65.0	30.7	13.40	[1] 19.24	[2] 7.35	9.57	17.65	22.6	13	64

[1] 1971.

[2] 1952.

Population growth was gradual until 1930, when rural population began to decline. This decline was offset by military activites at Fort Meade and at Ellsworth Air Force Base during World War II, by the conversion of Fort Meade into a Veterans Administration Hospital after World War II, and by the continuation of Ellsworth Air Force Base as a permanent military installation.

The population in Meade County grew from 12,044 in 1960 to 16,618 in 1970, according to the U.S. Bureau of the Census. This increase was due mainly to urban sprawl along Interstate Highway 90 between Sturgis and Rapid City. Sturgis had a population of 4,536 in 1970. According to the 1970 census, most of the county's inhabitants live in the survey area. About 1,500 live in the northern part of the county.

Transportation

Interstate Highway 90, U. S Highways 14 and 14A, and State Highways 34 and 79 traverse the survey area and provide travel routes into Sturgis. In addition, a network of graveled secondary roads provides access to most of the farms and ranches. A rail freight service is available at Sturgis. Commercial airline service is available at Rapid City in neighboring Pennington County.

Manufacturing and markets

Much of the livestock produced in the area is sold at public sales barns in Sturgis and in nearby Belle Fourche, Faith, Rapid City, St. Onge, and Wall. However, some ranchers sell calves on consignment directly to cornbelt feeders. A packing plant in Rapid City provides a market for slaughter cattle. Small slaughter facilities and locker plants are at Sturgis and Union Center.

Grain elevators at Sturgis and in nearby Faith, New Underwood, Rapid City, and Wall provide markets for grain not used or stored on farms and ranches. Dairy operators market whole milk at processing plants in Rapid City and at a cheese factory in Sturgis.

Saw logs are marketed at sawmills in Sturgis and Whitewood. Small trees are marketed at post and pole plants in Whitewood or sold as pulpwood and shipped by rail to paper mills in Wisconsin.

Retailers of farm equipment, hardware, lumber, feed and seed, and other farm and ranch supplies are at Sturgis and Rapid City.

Schools

Much of the survey area has been combined into one public school district. A few elementary schools are located in outlying areas, but most of the students are bussed to Sturgis, where a 12-year program of elementary and secondary education is provided. Some students from areas along the Pennington County line attend schools at the Douglas school adjacent to Ellsworth Air Force Base and at schools in New Underwood and Rapid City. Post-high school vocational training is offered at the Northwest Area Vocational-Technical School at Sturgis. Black Hills State College at Spearfish in Lawrence County and the South Dakota School of Mines and Technology at Rapid City in Pennington County are nearby higher-education facilities. In addition, private schools of business and nursing are at Rapid City.

Trends in soil use

About 501 farms and ranches are in the survey area. They range from less than 160 acres to more than 10,000 acres in size, and they average about 2,300 acres. Historical data for the survey area is not available, but census data for Meade County indicate that the number of operating farms has declined steadily since World War II and that the average size has increased. About 75 percent of the farm income in the survey area is derived from the sale of livestock and livestock products. Raising livestock is the main enterprise, but wheat farming is important in some places.

Beef cattle production has always been important, but cattle numbers have increased markedly since World War II. The average number of cattle of all classes on farms in Meade County for the years 1924–1943 was 60,300, according to agricultural statistics compiled by the South Dakota Crop and Livestock Reporting Service. Cattle of all classes on farms on January 1, 1974 numbered 141,000, of which 2,800 were kept for milk production. Other types of livestock on farms in 1974 were 44,700 sheep, 3,100 hogs, and 33,400 chickens.

Winter wheat grown on summer fallow land, oats, and alfalfa are the main crops. Before World War II, the main crops were spring wheat, corn, oats, and alfalfa. During the years 1926 to 1943, the area planted to spring wheat in Meade County averaged 57,400 acres; during the years 1924–1943, the area planted to corn averaged 43,700 acres. During and after the drought years of the 1930's, some cropland was converted to tame and native grasses. After World War II, the acreage in annual crops decreased, except for that in winter wheat, and the acreage in alfalfa increased. According to the South Dakota Crop and Livestock Reporting Service (*5*), 48,000 acres was in winter wheat in Meade County in 1974, 30,000 acres in oats, 6,700 acres in corn, 6,200 acres in spring wheat, 5,700 acres in barley, 4,700 acres in sorghum, and about 103,000 acres in alfalfa. Summer fallow acreage has increased with the increase in acreage planted to winter wheat.

Further information on the history of cropping and of livestock population can be obtained from the annual reports of the South Dakota Crop and Livestock Reporting Service.

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Glossary

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

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

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

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

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

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

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

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

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, 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 classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Emergency tillage. Cultivation by listing, ridging, chiseling, or other means to roughen the soil surface for temporary control of wind erosion.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

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

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for

the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. None means that flooding is not probable; rare that it is unlikely but possible under unusual weather conditions; occasional that it occurs on an average of once or less in 2 years; and frequent that it occurs on an average of more than once in 2 years. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, and long if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

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 a combination of these: (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

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

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

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

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

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

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

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are just past the stage of rapid decomposition. Classes of organic matter in soil are based on the percent of organic matter in the upper ten inches of soil: *very low*, less than 0.5 percent; *low*, 0.5 to 1.0 percent; *moderately low*, 1.0 to 2.0 percent; *moderate*, 2.0 to 4.0 percent; *high*, 4.0 to 8.0 percent; and *very high*, 8.0 to 16.0 percent.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Proper grazing use. Grazing rangeland and pastureland at such intensity that the quality of the vegetation will not deteriorate and the amount of plant residue will be sufficient to conserve soil and water.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

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

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium. Ratings for the salinity of soils, based on the electrical conductivity of the saturation extract, are expressed in millimhos per centimeter at 25°C.: *none*, less than 2.0; *low*, 2.0 to 4.0; *moderate*, 4.0 to 8.0; *high*, 8.0 to 16.0; and *very high*, more than 16.0.

Salts. Products other than water that result when an acid reacts with a base. Salts commonly found in soils break up into cations (sodium, calcium, and others) and anions (chloride, sulphate, and others) when dissolved in water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

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

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

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

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

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

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

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

Absence of a range site, capability unit, pasture group, or windbreak group designation indicates that the mapping unit is not placed in a specified grouping or that the individual soils that make up a mapping unit are designated separately. 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. Only the mapping units CTE, LAD, PaE, and VAE have been placed in woodland groups, which are discussed on pages 73 to 75. Pasture groups are described on pages 67 and 68. Windbreak groups are described beginning on page 68.

Map symbol	Mapping unit	Page	Range site		Capability unit		Pasture group	Windbreak group
			Name	Page	Symbol	Page	Letter	Number
AlA	Altvan loam, 0 to 2 percent slopes	14	Silty	58	IVs-1	64	D	6
AlB	Altvan loam, 2 to 6 percent slopes	14	Silty	58	IVe-2	63	D	6
AnB	Arvada silt loam, 0 to 6 percent slopes	15	Thin Claypan	60	VIs-3	66	-	10
ArB	Arvada-Slickspots complex, 0 to 6 percent slopes	15		--		--	-	--
	Arvada part	--	Thin Claypan	60	VIs-3	66	-	10
	Slickspots part	--		--	VIIIs-3	67	-	--
AsB	Assinniboine fine sandy loam, 2 to 9 percent slopes	16	Sandy	58	IVe-7	63	H	5
Ba	Bankard soils	16	Sands	58	VIe-8	65	-	7
BlD	Blackpipe silt loam, 6 to 15 percent slopes	17	Silty	58	IVe-1	63	F	3
BsD	Blackpipe-Shingle complex, 6 to 15 percent slopes	18		--		--	-	--
	Blackpipe part	--	Silty	58	IVe-1	63	F	3
	Shingle part	--	Shallow	59	VIe-11	65	-	10
CaE	Cabbart loam, 15 to 40 percent slopes	20	Shallow	59	VIIe-4	66	-	10
CbD	Canyon-Bridget loams, 6 to 20 percent slopes	20		--		--	-	--
	Canyon part	--	Shallow	59	VIe-11	65	-	10
	Bridget part	--	Silty	58	IVe-1	63	F	3
CDE	Canyon-Butche association, steep	21	Shallow	59	VIIe-4	66	-	10
CTE	Citadel association, hilly	22		--	VIe-13	65	-	--
DaD	Delphill loam, 6 to 15 percent slopes	23	Thin Upland	59	VIe-3	65	-	10
EaD	Enning-Manvel complex, 6 to 20 percent slopes	24		--	VIe-11	65	-	10
	Enning part	--	Shallow	59		--	-	--
	Manvel part	--	Thin Upland	59		--	-	--
EbE	Enning-Rock outcrop complex, 20 to 40 percent slopes	24		--		--	-	--
	Enning part	--	Shallow	59	VIIe-4	66	-	10
	Rock outcrop part	--		--	VIIIs-1	67	-	--
Ga	Glenberg soils	25	Overflow	57	IVe-6	63	H	1
GbD	Grummit clay, 6 to 15 percent slopes	25	Shallow	59	VIe-12	65	-	10
GcE	Grummit-Rock outcrop complex, 15 to 40 percent slopes	26		--		--	-	--
	Grummit part	--	Shallow	59	VIIe-5	66	-	10
	Rock outcrop part	--		--	VIIIs-1	67	-	--
HbB	Hisle-Slickspots complex, 0 to 6 percent slopes	27		--		--	-	--
	Hisle part	--	Thin Claypan	60	VIs-3	66	-	10
	Slickspots part	--		--	VIIIs-3	67	-	--
Ho	Hoven silt loam	28	Closed Depression	58	VIs-3	66	B	10
KaA	Keith silt loam, 0 to 2 percent slopes	29	Silty	58	IIIc-1	62	F	3
KaB	Keith silt loam, 2 to 6 percent slopes	29	Silty	58	IIIe-1	61	F	3
KbA	Kyle clay, 0 to 2 percent slopes	29	Clayey	59	IVs-3	64	I	4
KbB	Kyle clay, 2 to 6 percent slopes	30	Clayey	59	IVe-3	63	I	4
KcB	Kyle soils, 2 to 6 percent slopes, mounded	30	Clayey	59	IVe-3	63	I	4
LAD	Lakoa-Maitland association, hilly	31		--	VIe-13	65	-	--
LbE	Lismas clay, 15 to 40 percent slopes	32	Shallow Dense Clay	60	VIIe-5	66	-	10

Map symbol	Mapping unit	Page	Range site Name	Page	Capability unit Symbol	Page	Pasture group Letter	Windbreak group Number
LCD	Lismas-Winler association, sloping------	32	----------	--	VIe-12	65	-	10
	Lismas part----------	--	Shallow Dense Clay	60	--------	--	-	--
	Winler part----------	--	Dense Clay	59	--------	--	-	--
Le	Lohmiller silty clay loam----------	33	Overflow	57	IIIc-2	62	F	1
Lh	Lohmiller and Glenberg soils, channeled-	33	Overflow	57	VIw-1	66	-	10
Ma	Macken silty clay----------	34	Closed Depression	58	Vw-1	65	B	10
MbB	Manvel silt loam, 4 to 9 percent slopes-	35	Thin Upland	59	IVe-8	64	G	8
McB	Marshdale-Maitland loams, 2 to 9 percent slopes----------	37	----------	--	--------	--	-	--
	Marshdale part----------	--	Subirrigated	57	IVw-1	64	B	2
	Maitland part----------	--	----------	--	IIIe-1	61	F	--
MdD	Midway-Blackpipe complex, 9 to 40 percent slopes----------	38	----------	--	--------	--	-	10
	Midway part----------	--	Shallow	59	VIIe-5	66	-	--
	Blackpipe part----------	--	Silty	58	VIe-1	65	F	--
NaD	Nevee-Spearfish complex, 6 to 15 percent slopes----------	39	----------	--	VIe-3	65	-	10
	Nevee part----------	--	Thin Upland	59	--------	--	G	--
	Spearfish part----------	--	Shallow	59	--------	--	-	--
NbE	Nihill gravelly loam, 9 to 40 percent slopes----------	40	Thin Upland	59	VIIe-1	66	-	10
NcA	Nunn clay loam, 0 to 2 percent slopes---	41	Clayey	59	IIIc-1	62	F	3
NcB	Nunn clay loam, 2 to 6 percent slopes---	41	Clayey	59	IIIe-1	61	F	3
NcC	Nunn clay loam, 6 to 9 percent slopes---	41	Clayey	59	IVe-1	63	F	3
OaA	Onita clay loam, 0 to 4 percent slopes--	42	Silty	58	IIIe-2	61	K	1
PaE	Paunsaugunt-Rock outcrop complex, 3 to 40 percent slopes----------	43	----------	--	--------	--	-	--
	Paunsaugunt part----------	--	----------	--	VIIs-1	67	-	--
	Rock outcrop part----------	--	----------	--	VIIIs-1	67	-	--
PbB	Pierre clay, 2 to 6 percent slopes------	44	Clayey	59	IVe-3	63	I	4
PbC	Pierre clay, 6 to 15 percent slopes-----	44	Clayey	59	VIe-4	65	I	10
SaE	Samsil clay, 15 to 40 percent slopes----	45	Shallow	59	VIIe-5	66	-	10
SBD	Samsil-Pierre association, sloping------	45	----------	--	VIe-12	65	-	10
	Samsil part----------	--	Shallow	59	--------	--	-	--
	Pierre part----------	--	Clayey	59	--------	--	I	--
SCE	Samsil-Rock outcrop association, steep--	45	----------	--	--------	--	-	--
	Samsil part----------	--	Shallow	59	VIIe-5	66	-	10
	Rock outcrop part----------	--	----------	--	VIIIs-1	67	-	--
SdA	Satanta loam, 0 to 2 percent slopes-----	46	Silty	58	IIIc-1	62	F	3
SdB	Satanta loam, 2 to 6 percent slopes-----	46	Silty	58	IIIe-1	61	F	3
SdC	Satanta loam, 6 to 9 percent slopes-----	46	Silty	58	IVe-1	63	F	3
SeA	Satanta-Mosher loams, 0 to 3 percent slopes----------	46	----------	--	--------	--	-	--
	Satanta part----------	--	Silty	58	IIIc-1	62	F	3
	Mosher part----------	--	Claypan	59	IVs-2	64	C	9
ShA	Savo silty clay loam, 0 to 2 percent slopes----------	47	Silty	58	IIIc-1	62	F	3
SkB	Savo and Blackpipe soils, 2 to 6 percent slopes----------	47	Silty	58	IIIe-1	61	F	3
SlE	Spearfish-Rock outcrop complex, 15 to 40 percent slopes----------	49	----------	--	--------	--	-	--
	Spearfish part----------	--	Shallow	59	VIIe-4	66	-	10
	Rock outcrop part----------	--	----------	--	VIIIs-1	67	-	--
So	St. Onge loam----------	49	Overflow	57	IIIc-3	62	K	1
St	Stetter clay----------	50	Overflow	57	IVs-3	64	I	4
SwB	Swanboy clay, 2 to 6 percent slopes-----	51	Dense Clay	59	VIs-6	66	-	10
SyB	Swanboy-Slickspots complex, 0 to 6 percent slopes----------	51	----------	--	--------	--	-	--
	Swanboy part----------	--	Dense Clay	59	VIs-6	66	-	10
	Slickspots part----------	--	----------	--	VIIIs-3	67	-	--

Map symbol	Mapping unit	Page	Range site		Capability unit		Pasture group	Windbreak group
			Name	Page	Symbol	Page	Letter	Number
TaA	Tilford silt loam, 0 to 2 percent slopes	52	Silty	58	IIIc-1	62	F	3
TaB	Tilford silt loam, 2 to 6 percent slopes	52	Silty	58	IIIe-1	61	F	3
VAE	Vanocker-Citadel association, steep	53	----------	--	VIIe-9	66	-	--
Wa	Winetti gravelly loam	54	Overflow	57	VIw-1	66	-	10
WbC	Winler clay, 2 to 9 percent slopes	55	Dense Clay	59	VIs-6	66	-	10
WcB	Winler-Swamboy clays, 0 to 6 percent slopes	55	Dense Clay	59	VIs-6	66	-	10
ZaD	Zigweid-Nihill complex, 6 to 15 percent slopes	56	Thin Upland	59	VIe-3	65	-	10

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