

# SOIL SURVEY

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# Carbon County Area Montana

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UNITED STATES DEPARTMENT OF AGRICULTURE  
Soil Conservation Service  
and  
Forest Service  
In cooperation with  
MONTANA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1968. Soil names and descriptions were approved in 1971. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1969. This survey was made by the Soil Conservation Service and the Forest Service in cooperation with the Montana Agricultural Experiment Station. It is part of the technical assistance furnished to the Carbon Soil and Water Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

## HOW TO USE THIS SOIL SURVEY

**T**HIS 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 the Carbon County Area 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 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 page for the windbreak group and range site to which the soil has been assigned.

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 the 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 descriptions of the capability units, the range sites, and the windbreak groups.

*Foresters and others* can refer to the section "Use of the Soils for Windbreaks," where the soils of the Area are grouped according to their suitability for trees.

*Game managers, sportsmen, and others* can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

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

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

*Engineers and builders* can find, under "Engineering Uses of the Soils," tables that contain 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 Carbon County 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 section "General Nature of the Area."

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# SOIL SURVEY OF CARBON COUNTY AREA, MONTANA

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UNITED STATES DEPARTMENT OF AGRICULTURE IN COOPERATION WITH THE MONTANA AGRICULTURAL EXPERIMENT STATION

**T**HE CARBON COUNTY AREA consists of all of Carbon County but some parts within the Custer National Forest and the Gallatin National Forest in the southwest corner of the county (fig. 1). The area surveyed is about 1,072,247 acres, or 1,675 square miles. It extends 43 miles north and south and 73 miles east and west, at its widest part. Red Lodge, the county seat and the largest town, has a population of 2,278. Bridger, the second largest town, has a population of 824. Several small towns that have populations of 300 or less are in the Rock Creek and Clarks Fork Valleys.

Physiographically, the area consists of the Rock Creek and Clarks Fork Valleys and steep and rolling uplands that merge with the high Beartooth Plateau to the southwest. The climate can be described as continental. Winters are cold, summers are warm, and variation in seasonal precipitation is marked. About 8 percent of the survey area is irrigated, 9 percent is dryfarmed, 72 percent is range, and 11 percent is forest. Livestock is the principal source of income. Small grain, hay, row crops, large grain, and ensilage are supplemental crops grown chiefly for livestock feed.

About 80,000 acres of the Carbon County Area is Federal land in the Custer National Forest, which is administered by the Forest Service. Other federally owned land, totaling about 505,280 acres, is administered by the Bureau of Land Management. About 42,050 acres is State land that is administered by the State Land Board of Commissioners. The rest, 443,920 acres, is privately owned.

## How This Survey Was Made

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

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with

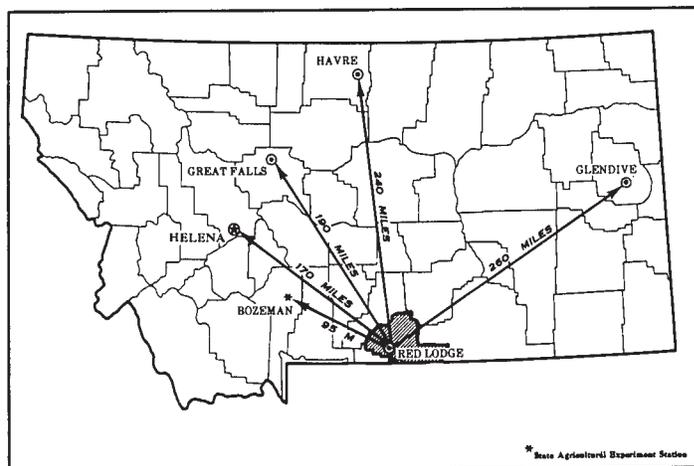


Figure 1.—Location of Carbon County Area in Montana.

those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Harvey and Heldt, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Harvey loam, 2 to 4 percent slopes, is one of several phases within the Harvey series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries

accurately. The soil map at the back of this publication was prepared from aerial photographs.

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

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

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

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

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

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

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

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agrono-

mists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

## General Soil Map

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

A map showing soil associations is useful to people who want a general idea of the soils in an area, who want to compare different parts of an area, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community development. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey have been grouped into five general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in each group are described in the paragraphs that follow. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1, the words "silty clay loams" and "fine sandy loams" refer to the texture of the surface layer.

### Nearly Level to Gently Sloping, Deep, Well-Drained Soils of the Flood Plains

The soils of these associations are on flood plains. They formed in recent alluvium. The average annual precipitation ranges from 10 to 14 inches, and the frost-free period is 125 to 130 days. The soils are used mainly for irrigated crops and pasture. Some areas in brushy rangeland have sparse to dense stands of cottonwoods and willows.

#### 1. Haverson-Glenberg association

*Nearly level to gently sloping, deep, well-drained silty clay loams and fine sandy loams*

This association is on flood plains of the Yellowstone River and the Clarks Fork of the Yellowstone River. It is nearly level to gently sloping.

The association makes up about 2 percent of the Carbon County Area. It is about 70 percent Haverson soils, 25 percent Glenberg soils, and 5 percent Heldt soils and small areas of Riverwash.

Haverson soils have a surface layer of silty clay loam, and the underlying material is stratified sandy loam to silty clay loam. Glenberg soils have a surface layer of

fine sandy loam, and the underlying material has an average texture of fine sandy loam.

This association is used mainly for corn, wheat, barley, oats, sugar beets, alfalfa, and pasture. These crops are irrigated in much of the association. Many areas are subject to flooding in spring. Cottonwood trees and willows grow along the streambanks.

### **Nearly Level to Steep, Shallow to Deep, Well-Drained Soils of the Shale and Sandstone Uplands**

These soils of the uplands formed in material weathered from shale and sandstone. The average precipitation ranges from 10 to 19 inches, and the frost-free period is 90 to 130 days. The soils are used mainly for range. Some areas are used for dryfarmed crops. The native vegetation is mainly mid and short grasses.

#### **2. Wayden-Cabba-Rentsac association**

*Strongly sloping to steep, shallow, well-drained clay loams, silty clay loams, and channery loams*

This association is on uplands in the central part of the Carbon County Area. It is strongly sloping to steep.

The association makes up about 4 percent of the Carbon County Area. It is about 30 percent Wayden soils; 30 percent Cabba soils; 30 percent Rentsac soils; and 10 percent Abac, Absarokee, and Macar soils and areas of Shale outcrop and Rock outcrop.

Wayden soils are moderately steep to steep. They have surface and subsurface layers of clay loam and are underlain by clay shale at a depth of about 14 inches. Cabba soils are strongly sloping to steep. They have a surface layer of silty clay loam and a subsurface layer of clay loam or silty clay loam. They are underlain by soft silty shale at a depth of about 18 inches. Rentsac soils are strongly sloping and have surface and subsurface layers of channery loam. They are underlain by sandstone at a depth of about 20 inches.

This association is used mainly for range. The native vegetation is mainly short and mid grasses. A few ponderosa pines grow on the Rentsac soils.

#### **3. Absarokee-Sinnigam association**

*Gently sloping to moderately steep, moderately deep and shallow, well-drained clay loams and channery clay loams*

This association is on uplands in the northern part of the Carbon County Area. It is gently sloping to moderately steep.

The association makes up about 14 percent of the Carbon County Area. It is about 60 percent Absarokee soils, 30 percent Sinnigam soils, and 10 percent Macar, Shane, and Rentsac soils.

Absarokee soils are gently sloping to strongly sloping. They have a surface layer of clay loam and a subsurface layer of clay. Shale is at a depth of about 35 inches. Sinnigam soils are gently sloping to moderately steep. They have a surface layer of channery clay loam and a subsurface layer of very channery silty clay and are about 20 inches deep over interbedded shale and sandstone.

About 60 percent of this association is used for dryfarmed crops and 40 percent for range. Winter wheat and barley are the main crops. The native vegetation

is mainly short and mid grasses. A few ponderosa pines grow on the shallow soils.

#### **4. Kyle association**

*Nearly level to strongly sloping, deep, well-drained clays*

This association is on uplands in the northeastern part of the Carbon County Area. It is nearly level to strongly sloping.

The association makes up about 1 percent of the Carbon County Area. It is about 85 percent Kyle soils and 15 percent Heldt, Lismas, and Toluca soils.

Kyle soils are nearly level to strongly sloping. They have a surface layer and subsoil of clay and underlying material of clay weathered from clay shale.

This association is used mainly for range. A small acreage is used for crops. The main dryfarmed crops are wheat, barley, oats, and alfalfa. Corn, wheat, barley, oats, sugar beets, and alfalfa are the main irrigated crops. The native vegetation is mainly short grasses.

#### **5. Midway-Travessilla association**

*Strongly sloping to steep, shallow, well-drained silt loams and silty clay loams*

This association is on uplands in the central and southeastern parts of the Carbon County Area. It is strongly sloping to steep.

The association makes up about 28 percent of the Carbon County Area. It is about 60 percent Midway soils, 35 percent Travessilla soils, and 5 percent Bowbac, Lismas, Stutzman, and Nelson soils.

Midway soils are moderately steep to steep. They have a surface layer of silty clay loam and underlying material of silty clay. Interbedded shale is at a depth of about 14 inches. Travessilla soils are strongly sloping to steep. They have a surface layer and underlying material of silt loam. Sandstone is at a depth of 18 inches.

These soils are used for range. The native vegetation is mainly short and mid grasses.

### **Nearly Level to Steep, Deep and Moderately Deep, Well-Drained Soils of the Intermediate Terraces and Fans**

The soils of these associations are on intermediate terraces and fans. They formed in old alluvium. The average annual precipitation ranges from 5 to 14 inches, and the frost-free period is 90 to 130 days. The soils in two associations are used mainly for range, and the native vegetation is mainly short and mid grasses and sagebrush. In one association the soils are used mainly for irrigated crops and pasture. The soils in the other association are used for irrigated crops in some areas and for dryfarmed crops in others.

#### **6. Romberg-Harvey association**

*Gently sloping to moderately steep, deep, well-drained very stony loams and loams*

This association is on intermediate stream terraces and alluvial fans in the south-central and southeastern parts of the Carbon County Area. It is gently sloping to moderately steep.

The association makes up 6 percent of the Carbon County Area. It is about 75 percent Romberg soils, 20

percent Harvey soils, and 5 percent Lismas, McRae, and Vona soils.

Romberg soils are gently sloping to moderately steep. They have a surface layer of very stony loam and a subsoil and underlying material of gravelly clay loam. Harvey soils are gently sloping to strongly sloping. They have a surface layer of loam and a subsoil and underlying material of silty clay loam.

This association is used mainly for range. About 5 percent of it is used for hay and irrigated pasture. The native vegetation is mainly short and mid grasses and sagebrush.

#### **7. Harvey-Stormitt association**

*Nearly level to steep, deep, well-drained loams*

This association is on intermediate stream terraces and alluvial fans in the southeastern part of the Carbon County Area. It is nearly level to steep.

The association makes up about 7 percent of the Carbon County Area. It is about 50 percent Harvey soils, 40 percent Stormitt soils, and 10 percent Neville, La Fonda, Nihill, Spearfish, and Torchlight soils.

Harvey soils are gently sloping to strongly sloping. They have a surface layer of loam and a subsoil and underlying material of silty clay loam. Stormitt soils are nearly level to steep. They have a surface layer of loam, a subsoil of silty clay loam, and underlying material of very gravelly silty clay loam. Some areas of Stormitt soils have a surface layer of gravelly loam or stony loam.

The association is used mainly for range. About 5 percent of the acreage is used for field crops and hay. The main crops are wheat and barley. The native vegetation is short and mid grasses and sagebrush.

#### **8. Nunn-Wormser association**

*Nearly level and gently sloping, deep and moderately deep, well-drained silty clay loams and loams*

This association is on intermediate stream terraces, alluvial fans, and shale uplands that finger onto the terraces and fans in the northeastern part of the Carbon County Area. It is nearly level and gently sloping.

The association makes up about 2 percent of the Carbon County Area. It is about 60 percent Nunn soils, 30 percent Wormser soils, and 10 percent Thurlow, Fort Collins, McRae, and Vona soils.

Nunn soils are nearly level and gently sloping. They have a surface layer of silty clay loam, a subsoil of silty clay loam and silty clay, and underlying material of silty clay loam. Wormser soils are gently sloping. They have a surface layer of loam, a subsoil of clay loam, and underlying material of fine sandy loam over interbedded sandstone and shale, which is at a depth of about 38 inches.

The soils in this association are used mainly for irrigated and dryfarmed crops. The main crops are corn, sugar beets, alfalfa, wheat, barley, and oats. About 5 percent of the acreage is used as range. The native vegetation is mainly short and mid grasses.

#### **9. Heldt-Fort Collins association**

*Nearly level to strongly sloping, deep, well-drained silty clay loams and loams*

This association is on intermediate stream terraces and alluvial fans in the valley of the Clarks Fork of the

Yellowstone River. It is nearly level to gently sloping.

The association makes up about 8 percent of the Carbon County Area. It is about 85 percent Heldt soils, 10 percent Fort Collins soils, and 5 percent Tonra and Vona soils.

Heldt soils are nearly level to strongly sloping. Their surface layer, subsoil, and underlying material are silty clay loam. Fort Collins soils are nearly level and gently sloping. They have a surface layer of loam, a subsoil of clay loam, and underlying material of fine sandy loam.

This association is used mainly for irrigated crops and pasture. The main crops are sugar beets, corn, potatoes, alfalfa, wheat, barley, and oats. About 5 percent of the association is used as range. The native vegetation is cottonwoods and willows along the streambanks and an understory of grasses and shrubs.

### **Nearly Level to Steep, Deep and Moderately Deep, Well-Drained Soils of the High Terraces and Valley Sides**

The soils of the high terraces and valley sides formed in old alluvium and in material weathered from granite. The average annual precipitation ranges from 15 to 25 inches, and the frost-free period is 50 to 110 days. One of the soils in one association is used mainly for irrigated crops, hay, and pasture; the other is mainly in grazable woodland. The soils in the other association are used chiefly for short and mid range grasses.

#### **10. Maurice-Woodrock association**

*Nearly level to steep, deep and moderately deep, well-drained stony loams and clay loams*

This association is on high terraces and valley sides along Red Lodge and Rosebud Creeks in the western part of the Carbon County Area. It is nearly level to steep.

The association makes up about 6 percent of the Carbon County Area. It is about 50 percent Maurice soils, 40 percent Woodrock soils, and 10 percent Charlos, Bearmouth, and Redlodge soils.

Maurice soils are nearly level to steep. They have a surface layer of stony loam and a subsoil and underlying material of very gravelly fine sandy loam. Woodrock soils are moderately steep to steep. They have a surface layer of clay loam, a subsoil of sandy clay loam and sandy loam, and underlying material of strongly weathered granite bedrock.

About 60 percent of this association is used for irrigated crops, hay, and pasture. The main crops are wheat, alfalfa, oats, and native hay. About 40 percent of the area is grazable woodland of ponderosa pine and aspen. The understory is short and mid grasses.

#### **11. Heath-Charlos association**

*Nearly level to steep, deep, well-drained clay loams and loams*

This association is on high terraces and valley sides in the western part of the Carbon County Area. It is nearly level to steep.

The association makes up about 9 percent of the Carbon County Area. It is about 65 percent Heath soils, 25

percent Charlos soils, and 10 percent Adel, Bynum, Woodrock, and Hanson soils.

Heath soils are gently sloping to steep. They have a surface layer of clay loam, a subsoil of silty clay loam, and underlying material of clay loam. Charlos soils are nearly level and gently sloping. They have a surface layer of loam, a subsoil of clay loam, and underlying material of gravelly clay loam. Very gravelly and cobbly sandy material is at a depth of 30 inches.

This association is used mainly for range. About 5 percent of it is used to grow wheat, barley, alfalfa, and pasture plants. The native vegetation is mainly short and mid grasses.

### Limestone Outcrops and Strongly Sloping to Steep, Shallow to Deep, Well-Drained Soils of the Mountains

The soils of the mountains formed in material weathered from limestone. The average annual precipitation ranges from 15 to 19 inches, and the frost-free period is 70 to 115 days. The soils are used mainly for summer grazing. A small amount of timber is produced on minor soils in the association.

#### 12. Limestone outcrop-Lap-Windham association

*Very steep limestone outcrops and strongly sloping to steep, shallow and deep, well-drained channery loams and cobbly clay loams on the tops and upper sides of ridges*

This association is in the mountains in the southeastern part of the Carbon County Area. It is strongly sloping to very steep.

The association makes up about 13 percent of the Carbon County Area. It is about 35 percent Limestone outcrop, 30 percent Lap soils, 15 percent Windham soils, and 20 percent Trapper, Mayflower, Duncom, Hanson, Tiban, and Tarrete soils.

Limestone outcrop occurs as very steep canyon walls and narrow ridges and as vertical cliffs in the Pryor Mountains. Lap soils are moderately steep and steep. They have a surface layer of channery loam and underlying material of very channery loam. Limestone is at a depth of about 18 inches. Windham soils are strongly sloping to steep. They have a surface layer of cobbly clay loam and gravelly loam and underlying material of gravelly or very gravelly loam or clay loam.

This association is used for summer grazing and limited timber production. It has numerous caves and scenic

canyons and is part of an important recreational area in south-central Montana.

### Descriptions of the Soils

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

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

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

Following the name of each mapping unit is a symbol in parentheses. This symbol 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 group to which the mapping unit has been assigned. The page for the description of each capability unit and range site can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (5).<sup>1</sup>

<sup>1</sup> Italic numbers in parentheses refer to Literature Cited, p. 136.

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

Soil	Acre	Extent	Acre	Acre	Extent
Abac-Twin Creek complex, steep <sup>1</sup> .....	3, 690	0. 3	Absarokee-Shane clay loams, 6 to 15 percent slopes.....	3, 140	0. 3
Abac-Windham association, steep <sup>1</sup> .....	1, 800	. 2	Absarokee-Sinnigam clay loams, 4 to 8 percent slopes.....	7, 680	. 7
Absarokee clay loam, 2 to 4 percent slopes.....	1, 010	. 1	Absarokee-Sinnigam clay loams, 8 to 15 percent slopes.....	4, 100	. 4
Absarokee clay loam, 4 to 8 percent slopes.....	17, 850	1. 7	Adel silty clay loam, 0 to 4 percent slopes.....	6, 200	. 6
Absarokee clay loam, 8 to 15 percent slopes.....	12, 280	1. 1	Adel silty clay loam, 4 to 8 percent slopes.....	1, 630	. 1
Absarokee-Cabba clay loam, 4 to 8 percent slopes.....	2, 500	. 2	Alice fine sandy loam, 0 to 8 percent slopes.....	3, 400	. 3
Absarokee-Cabba clay loams, 8 to 15 percent slopes.....	3, 380	. 3			

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

Soil	Acres	Extent	Soil	Acres	Extent
Alice fine sandy loam, 8 to 15 percent slopes	1,680	0.2	Martinsdale clay loam, 4 to 8 percent slopes	1,770	0.2
Allentine clay loam, 2 to 4 percent slopes	10,270	1.0	Maurice stony loam, moderately steep <sup>1</sup>	2,280	.2
Alluvial land	7,220	.1	Maurice stony loam, steep <sup>1</sup>	2,010	.2
Bowbac loam, 2 to 4 percent slopes	1,910	.2	Maurice-Bearmouth complex, 0 to 4 percent slopes	4,110	.4
Bowbac loam, 4 to 8 percent slopes	4,270	.4	Mayflower silt loam, rolling <sup>1</sup>	1,000	.1
Bowbac loam, 8 to 15 percent slopes	2,190	.2	McRae loam, 2 to 4 percent slopes	1,560	.1
Bowbac-Harvey loams, 2 to 4 percent slopes	1,900	.2	Midway-Travessilla association, hilly <sup>1</sup>	28,650	2.7
Bowbac-Travessilla complex, 4 to 8 percent slopes	4,570	.4	Midway-Travessilla association, steep <sup>1</sup>	42,350	4.0
Bowbac-Torchlight association, undulating <sup>1</sup>	4,160	.4	Nelson fine sandy loam, 4 to 8 percent slopes	1,660	.2
Cabba-Rentsac complex, rolling <sup>1</sup>	1,590	.1	Neville silty clay loam, 2 to 4 percent slopes	1,390	.1
Charlos loam, 0 to 2 percent slopes	25,340	2.4	Neville silty clay loam, 4 to 8 percent slopes	5,330	.5
Charlos loam, 2 to 8 percent slopes	10,440	1.0	Nihill very gravelly loam, moderately steep <sup>1</sup>	7,410	.7
Charlos loam, wet, 0 to 2 percent slopes	1,850	.2	Nunn silty clay loam, 0 to 2 percent slopes	4,060	.4
Charlos stony loam, 0 to 4 percent slopes	1,790	.2	Nunn silty clay loam, 2 to 4 percent slopes	1,270	.1
Colby silt loam, 2 to 4 percent slopes	1,630	.1	Nunn silty clay loam, 4 to 8 percent slopes	1,350	.1
Colby silt loam, 4 to 8 percent slopes	8,170	.8	Olney fine sandy loam, 2 to 4 percent slopes	1,460	.1
Colby silt loam, 8 to 15 percent slopes	2,260	.2	Olney fine sandy loam, 4 to 8 percent slopes	1,160	.1
Duncom gravelly silt loam, hilly <sup>1</sup>	3,980	.4	Peritsa silt loam, 4 to 8 percent slopes	1,560	.1
Duncom-Hanson association, rolling <sup>1</sup>	1,650	.2	Razor clay loam, 2 to 8 percent slopes	1,350	.1
Fort Collins loam, 0 to 2 percent slopes	3,590	.3	Razor-Thedalund clay loams, 4 to 15 percent slopes	1,350	.1
Fort Collins loam, 2 to 4 percent slopes	1,460	.1	Redlodge-Adel silty clay loams	3,920	.4
Fort Collins loam, wet, 0 to 2 percent slopes	1,220	.1	Redlodge-Adel silty clay loams, wet	1,220	.1
Glenberg loam, gravel substratum	3,300	.3	Reeder-Castner association, rolling <sup>1</sup>	3,060	.3
Glenberg-Haverson complex	1,680	.2	Rentsac channery loam, sloping <sup>1</sup>	10,950	1.0
Hanson clay loam, 4 to 8 percent slopes	1,610	.1	Rentsac-Rock outcrop complex, steep	33,680	3.1
Hanson very stony loam, rolling <sup>1</sup>	6,140	.6	Riverwash	1,090	.1
Hanson extremely stony loam, sloping <sup>1</sup>	3,060	.3	Rock outcrop-Lambeth complex, 5 to 15 percent slopes <sup>1</sup>	1,000	.1
Hanson association, very steep <sup>1</sup>	25,240	2.4	Rock outcrop-Travessilla complex, steep <sup>1</sup>	81,367	7.6
Hanson-Duncom association, rolling <sup>1</sup>	1,910	.2	Romberg very stony loam, rolling <sup>1</sup>	7,840	.7
Harvey loam, 2 to 4 percent slopes	6,920	.6	Romberg extremely stony loam, sloping <sup>1</sup>	4,390	.4
Harvey loam, 4 to 8 percent slopes	3,750	.3	Romberg-Shale outcrop complex, moderately steep <sup>1</sup>	1,680	.2
Harvey loam, 8 to 15 percent slopes	1,490	.1	Romberg-Stutzman association, undulating <sup>1</sup>	1,450	.1
Harvey stony loam, 2 to 8 percent slopes	11,580	1.1	Rottulee silt loam, 4 to 8 percent slopes	1,020	.1
Haverson silty clay loam, 0 to 2 percent slopes	3,870	.4	Ryorp sandy loam, steep <sup>1</sup>	3,520	.3
Haverson-Heldt silty clay loams, 0 to 4 percent slopes	8,360	.8	Sandstone outcrop <sup>1</sup>	27,390	2.6
Heath clay loam, 4 to 8 percent slopes	7,780	.7	Sebud very bouldery loam, steep <sup>1</sup>	5,840	.5
Heath clay loam, 8 to 15 percent slopes	23,340	2.2	Shale outcrop <sup>1</sup>	18,000	1.7
Heath-Bynum association, steep <sup>1</sup>	21,890	2.0	Shale outcrop-Abac complex, very steep <sup>1</sup>	9,990	1.0
Heldt silty clay loam, 0 to 2 percent slopes	13,190	1.2	Shane clay loam, 4 to 8 percent slopes	4,690	.4
Heldt silty clay loam, 2 to 4 percent slopes	7,490	.7	Shane clay loam, 8 to 15 percent slopes	4,640	.4
Heldt silty clay loam, 4 to 8 percent slopes	4,700	.4	Shane-Cabba clay loams, 4 to 8 percent slopes	2,340	.2
Heldt silty clay loam, 8 to 15 percent slopes	1,440	.1	Shane-Cabba clay loams, 8 to 15 percent slopes	3,010	.3
Heldt silty clay loam, saline, 0 to 6 percent slopes	8,040	.7	Sicklesteets loam, moderately steep	4,600	.4
Hydro silt loam, 4 to 8 percent slopes	2,450	.2	Sinnigam channery clay loam, sloping <sup>1</sup>	7,800	.7
Kyle clay, 0 to 2 percent slopes	3,110	.3	Sinnigam channery clay loam, moderately steep <sup>1</sup>	16,700	1.7
Kyle clay, 2 to 4 percent slopes	2,240	.2	Spearfish-Shale outcrop complex, hilly <sup>1</sup>	5,320	.5
Kyle clay, 4 to 8 percent slopes	2,920	.3	Stormitt loam, 2 to 4 percent slopes	7,140	.6
Kyle clay, 8 to 15 percent slopes	1,590	.1	Stormitt gravelly loam, 4 to 8 percent slopes	4,320	.4
La Fonda loam, 0 to 2 percent slopes	1,060	.1	Stormitt gravelly loam, saline, 0 to 4 percent slopes	1,400	.1
La Fonda loam, 2 to 4 percent slopes	1,700	.2	Stormitt stony loam, 0 to 8 percent slopes	5,190	.5
Lambeth silt loam, 4 to 8 percent slopes	1,610	.1	Stormitt stony loam, steep <sup>1</sup>	1,670	.2
Lap-Armington association, hilly <sup>1</sup>	3,590	.3	Stormitt complex, undulating	720	.1
Lap-Rock outcrop association, moderately steep <sup>1</sup>	12,600	1.2	Stutzman silty clay	1,380	.1
Lap-Windham association, steep <sup>1</sup>	2,370	.2	Tarrate loam, moderately steep <sup>1</sup>	1,780	.2
Larim gravelly sandy loam, 8 to 15 percent slopes	1,340	.1	Tarrate clay, moderately steep <sup>1</sup>	2,430	.2
Limestone outcrop <sup>1</sup>	43,980	4.1	Tarrate-Hanson association, steep <sup>1</sup>	1,000	.1
Lisam-Marias complex, 8 to 15 percent slopes	2,340	.2	Teton stony loam, moderately steep <sup>1</sup>	4,460	.4
Lisam-Marias complex, steep <sup>1</sup>	3,250	.3	Thedalund clay loam, 4 to 8 percent slopes	2,130	.2
Lismas clay, hilly <sup>1</sup>	13,600	1.3	Thedalund clay loam, 8 to 15 percent slopes	1,790	.2
Lohler silty clay loam, 0 to 2 percent slopes	3,930	.4	Thiel cobbly clay loam, 4 to 8 percent slopes	3,430	.3
Lohler silty clay loam, 2 to 4 percent slopes	1,760	.2	Thiel-Bynum association, steep <sup>1</sup>	2,880	.3
Lohler silty clay loam, saline, 0 to 4 percent slopes	1,630	.2	Thurlow silty clay loam, 4 to 8 percent slopes	1,390	.1
Macar-Cabba clay loams, 4 to 8 percent slopes	4,940	.5	Thurlow-Toluca silty clay loams, 4 to 8 percent slopes	1,460	.1
Macar-Cabba clay loams, 8 to 15 percent slopes	44,640	4.2	Tiban extremely stony loam, moderately steep <sup>1</sup>	5,070	.5
Marias clay, 2 to 8 percent slopes	8,360	.8	Tiban-Tarrete association, steep <sup>1</sup>	1,680	.2
Marias clay, 8 to 15 percent slopes	2,760	.3	Toluca clay loam, 0 to 2 percent slopes	1,030	.1
Marsh <sup>1</sup>	1,600	.1	Toluca clay loam, 2 to 4 percent slopes	3,320	.3
Martinsdale clay loam, 2 to 4 percent slopes	1,390	.1			

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

Soil	Acres	Extent	Soil	Acres	Extent
Toluca clay loam, 4 to 8 percent slopes.....	6,380	0.6	Vona fine sandy loam, wet, 0 to 2 percent slopes..	1,290	0.1
Toluca clay loam, 8 to 15 percent slopes.....	2,230	.2	Wayden-Cabba association, hilly <sup>1</sup> .....	7,340	.7
Toluca-Midway complex, moderately steep <sup>1</sup> ....	1,840	.2	Wayden-Cabba association, steep <sup>1</sup> .....	16,530	1.5
Toluca-Rock outcrop complex, sloping.....	1,760	.2	Wayden-Castner association, steep <sup>1</sup> .....	24,700	2.3
Tonra gravelly silty clay loam, 2 to 4 percent slopes.....	2,680	.2	Windham cobbly clay loam, sloping.....	4,920	.5
Torchlight clay, sloping <sup>1</sup> .....	9,590	.9	Windham cobbly clay loam, steep <sup>1</sup> .....	9,400	.9
Trapper soils, sloping <sup>1</sup> .....	3,500	.3	Woodrock-Bynum association, hilly.....	1,100	.1
Travessilla silt loam, sloping <sup>1</sup> .....	11,800	1.1	Woodrock-Rock outcrop association, steep.....	6,990	.7
Twin Creek silty clay loam, 4 to 8 percent slopes.....	1,540	.1	Work clay loam, 4 to 8 percent slopes.....	1,200	.1
Vona fine sandy loam, 0 to 2 percent slopes....	1,880	.2	Wormser loam, 4 to 8 percent slopes.....	1,700	.2
Vona fine sandy loam, 2 to 4 percent slopes....	1,690	.1	Yegan fine sandy loam, 2 to 4 percent slopes....	1,860	.2
Vona fine sandy loam, 4 to 8 percent slopes....	1,130	.1	Yegan fine sandy loam, 4 to 8 percent slopes....	1,790	.2
Vona fine sandy loam, 8 to 15 percent slopes....	1,320	.1	Yegan fine sandy loam, 8 to 15 percent slopes..	1,540	.1
			Total.....	1,072,247	100.0

<sup>1</sup> Mapped at low intensity.

## Abac Series

The Abac series consists of shallow, steep soils that are well drained. These soils formed in loamy residuum weathered from red shale. The annual precipitation is 14 to 20 inches, and the mean annual soil temperature is 44° to 46° F. The frost-free period is 65 to 95 days. The natural vegetation is mixed grasses, forbs, and pine trees.

In a representative profile the surface layer is reddish-brown loam about 4 inches thick. The underlying layers are red loam about 16 inches thick. At a depth of about 20 inches is red, calcareous, interbedded, fine-grained sandstone and siltstone.

The available water capacity is very low, and permeability is moderate. These soils are suitable for grazing.

Representative profile of an Abac loam, 2,680 feet east and 50 feet south of NW. corner of sec. 10, T. 6 S., R. 24 E.

A1—0 to 4 inches, reddish-brown (2.5YR 4/4) loam, dark reddish brown (2.5YR 3/4) moist; very weak, fine, angular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine roots and pores; mildly alkaline; clear, wavy boundary.

C1—4 to 16 inches, red (2.5YR 5/6) loam, dark red (2.5YR 3/6) moist; massive, slightly hard, very friable, nonsticky and nonplastic; 15 percent flat sandstone fragments; very thin crust of lime on undersides of fragments; moderately alkaline; clear, wavy boundary.

C2—16 to 20 inches, red (2.5YR 5/6) channery loam, dark red (2.5YR 3/6) moist; massive; soft, friable, nonsticky and nonplastic; 30 percent channery sandstone; strongly effervescent; strongly alkaline; abrupt boundary.

C3—20 inches, red (2.5YR 5/6 and 4/6) moist, interbedded fine-grained sandstone and siltstone; slightly effervescent; moderately alkaline.

The A1 horizon is reddish-brown to dark-red loam. The thickness of the combined A and C horizons ranges from 14 to 20 inches. Coarse fragments at depths below 8 inches are mostly sandstone, but a few are limestone. They make up 15 to 30 percent of the volume. Hues range from 2.5YR to 5YR or redder. In places the lower part of the C horizon contains a few threads and soft masses of segregated lime.

**Abac-Twin Creek complex, steep (AA).**—This complex consists of Abac loam and Twin Creek silty clay loam. The soils have the profiles described as representative of their respective series. Slopes are 15 to 45 percent.

A typical area is about 65 percent Abac loam, 25 percent Twin Creek silty clay loam, and 10 percent other soils. Abac loam is on the ridges and divides where the slope is 15 to 20 percent, and Twin Creek silty clay loam is on the smooth middle foot slopes and in swales where the slope is 8 to 15 percent. Included with these soils in mapping are deep soils on stream bottoms and terraces in narrow valleys and small areas of shallow soils overlying hard rock on broad divides between valley drainageways. The drainage pattern is dendritic. Stream channels are narrow, and in most places have cut into the bedrock below the deep alluvium. The erosion hazard is slight, and runoff is medium.

Soils of this complex are used for grazing. Scattered pine trees and juniper grow on the Abac soil. Capability unit VIe-1, dryland. Abac soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3. Twin Creek soil in Silty range site, 15 to 19 inches precipitation, and windbreak group 1.

**Abac-Windham association, steep (AB).**—This association consists of Abac loam and Windham cobbly clay loam. Slopes are 15 to 45 percent.

A typical area is about 60 percent Abac loam, 35 percent Windham cobbly clay loam, and 5 percent other soils. The Abac soil is on escarpments and steep divides, and the Windham soil is on smooth alluvial fans and terrace remnants. The included soils are similar to Abac and Windham soils. They occupy small, irregularly shaped areas 5 acres or less in size.

This association occurs along narrow drainageways. The drainage pattern is dendritic. In some places stream channels have cut into the bedrock. The hazard of erosion is moderate, and runoff is medium.

The soils of this association are used for grazing and wildlife habitat. Capability unit VIe-1, dryland. Abac soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3. Windham soil in Silty range site, 15 to 19 inches precipitation, and windbreak group 1.

## Absarokee Series

The Absarokee series consists of moderately deep, gently sloping and strongly sloping, well-drained soils. These soils formed in clayey residuum weathered from

shale. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 43° to 47° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is dark grayish-brown clay loam about 3 inches thick. The subsoil is 19 inches thick. It is brown clay in the upper 15 inches and light olive-gray clay in the lower 4 inches. The substratum is pale-olive clay about 13 inches thick. Hard stratified shale is at a depth of 35 inches.

The available water capacity is low or moderate, and permeability is moderate. These soils are used for dry-farmed crops and range.

Representative profile of Absarokee clay loam, 800 feet north and 60 feet east of SW. corner of sec. 3, T. 5 S., R. 21 E.

- A1—0 to 3 inches, dark grayish-brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; few fine and many very fine roots; common very fine pores; neutral; abrupt boundary.
- B21t—3 to 9 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) moist and coatings of very dark grayish brown (10YR 3/2) moist; weak prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; few fine and many very fine roots; many very fine pores; thick prominent clay films; few hard chert fragments; neutral; gradual boundary.
- B22t—9 to 18 inches, brown (10YR 5/3) clay, brown (10YR 4/3) moist and coatings of dark grayish brown (10 YR 4/2) moist; strong prismatic structure parting to strong, medium and fine, angular blocky; hard, friable, sticky and plastic; common very fine roots; many very fine pores; thick prominent clay films; few hard chert fragments; neutral; abrupt boundary.
- B3ca—18 to 22 inches, light olive-gray (5Y 6/2) clay, olive (5Y 5/3) moist; strong prismatic structure parting to strong, medium and fine, angular blocky; hard, friable, sticky and plastic; common compressed micro roots; common very fine pores; few lime pockets, splotches, and seams; prominent clay films; strongly effervescent; moderately alkaline; gradual boundary.
- C1ca—22 to 28 inches, pale-olive (5Y 6/3) clay, light olive gray (5Y 6/2) moist; massive; hard, friable, sticky and plastic; very fine roots and pores; lime specks, pockets, seams, and splotches; strongly effervescent; moderately alkaline; gradual boundary.
- C2cs—28 to 35 inches, pale-olive (5Y 6/3) clay, olive (5Y 5/3) moist; massive; hard, friable, sticky and plastic; very few very fine roots and pores; fine shale fragments; many gypsum crystals; strongly effervescent; moderately alkaline; abrupt boundary.
- R—35 inches, pale-olive (5Y 6/3) hard, stratified bedded shale.

The B2t horizon is 40 to 45 percent clay. Depth to the C horizon ranges from 15 to 30 inches. Gypsum crystals are below a depth of 35 inches.

**Absarokee clay loam, 2 to 4 percent slopes (Ac).**—This gently sloping and undulating soil is on uplands. It has the profile described as representative of the series.

A typical area is about 90 percent Absarokee clay loam and 10 percent included Macar, Cabba, and Sinnigam clay loams. The Macar soil is in narrow swales, and Cabba and Sinnigam soils are on convex ridges and narrow divides. Areas are irregular in shape and are 5 acres or less in size. The drainage pattern is dendritic. Streamways are smooth and U-shaped, and in places stream channels have cut into the bedrock. Runoff is medium, and the hazard of erosion is slight.

This soil is used for small grain and grass. About 95 percent of the acreage is cultivated, and the rest is range. Capability unit IIe-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 2.

**Absarokee clay loam, 4 to 8 percent slopes (Ad).**—This soil is on uplands. Runoff is medium, and the hazard of erosion is moderate. About 90 percent of the acreage is used for small grain, and the rest is range. Capability unit IIIe-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 2.

**Absarokee clay loam, 8 to 15 percent slopes (Ae).**—This rolling soil is on uplands. Runoff is medium, and the hazard of erosion is moderate. About 85 percent of the acreage is used for small grain, and the rest is range. Capability unit IVe-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 2.

**Absarokee-Cabba clay loams, 4 to 8 percent slopes (Af).**—These soils are on uplands. The Cabba soil has a profile similar to the one described as representative of its series, but the surface layer is clay loam.

A typical area is about 70 percent Absarokee clay loam, 25 percent Cabba clay loam, and 5 percent Rentsac and Sinnigam soils. The Absarokee clay loam is on the broad smooth divides, in swales, and on foot slopes below and surrounding the Cabba soils. The Cabba clay loam is on the narrow convex ridges and knolls. Rentsac and Sinnigam soils are on narrow convex ridges that traverse the unit. Areas are irregular in shape and are 5 acres or less in size. Drainageways are smooth and U-shaped. Some streams are cutting new channels. The drainage pattern is dendritic. Runoff is medium, and the hazard of erosion is slight.

About 80 percent of the acreage is cultivated, and the rest is used for range. Capability unit IIIe-2, dryland. Absarokee clay loam in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Cabba clay loam in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

**Absarokee-Cabba clay loams, 8 to 15 percent slopes (Ag).**—These strongly sloping and rolling soils are on uplands. The Cabba soil has a profile similar to the one described as representative of its series, but the surface layer is clay loam.

Runoff is medium, and the hazard of erosion is moderate. About 70 percent of the acreage is cultivated, and the rest is range. Capability unit IVe-2, dryland. Absarokee clay loam in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Cabba clay loam in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

**Absarokee-Shane clay loams, 6 to 15 percent slopes (Ah).**—These soils are along narrow stream valleys on uplands. A typical area is about 50 percent Absarokee clay loam, 40 percent Shane clay loam, and 10 percent Cabba and Rentsac soils.

Absarokee clay loam is on the upper slopes, and Shane clay loam is on the lower. The Cabba and Rentsac soils are on knolls and narrow ridges in scattered, irregularly shaped areas. The meandering stream channel has cut deeply into the bedrock; consequently fields are irregular in shape. The drainage pattern is dendritic. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for dryfarmed wheat, barley, and alfalfa, and for pasture and range. Capability unit

IVe-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 2.

**Absarokee-Sinnigam clay loams, 4 to 8 percent slopes (Ak).**—These sloping and gently rolling soils are on uplands. The Sinnigam soil has a profile similar to the one described as representative of its series, but the surface layer is clay loam.

A typical area is about 70 percent Absarokee clay loam, 25 percent Sinnigam clay loam, and 5 percent Cabba and Rentsac soils that are in areas of less than 5 acres in size. The Absarokee clay loam is on broad divides and narrow foot slopes. The Sinnigam clay loam is on narrow convex divides and knolls. Sandstone crops out in a few small places in areas of Rentsac and Sinnigam soils. The drainage pattern is dendritic. Stream channels cut deeply into the bedrock. Runoff is medium, and the hazard of erosion is moderate.

These soils are used for small grain and grass. About 75 percent of the acreage is cultivated, and the rest is range. Capability unit IIIe-2, dryland. Absarokee clay loam in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Sinnigam clay loam in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

**Absarokee-Sinnigam clay loams, 8 to 15 percent slopes (Am).**—These strongly sloping and rolling soils are on uplands. The Sinnigam soil has a profile similar to the one described as representative of its series, but the surface layer is clay loam.

Runoff is medium, and the hazard of erosion is moderate. About 65 percent of the acreage is cultivated; the rest is range. Capability unit IVe-2, dryland. Absarokee clay loam in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Sinnigam clay loam in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

## Adel Series

The Adel series consists of deep, nearly level to gently sloping, well-drained soils. These soils formed in deep alluvium. Annual precipitation is 15 to 19 inches. Mean annual soil temperature is 40° to 45° F., and the frost-free period is 60 to 90 days. The natural vegetation is cool-season mixed grasses and forbs and trees.

In a representative profile the surface layer is black silty clay loam in the upper 18 inches and very dark gray between 18 and 23 inches. The underlying material is grayish brown and extends to a depth of more than 60 inches. The upper part is clay loam, and the lower part is gravelly clay loam.

The available water capacity is high, and permeability is moderate. These soils are used for small grain, alfalfa, and pasture grasses. They can be cultivated intensively. Crops respond to the application of lime. About 95 percent of the acreage is hay meadow; the rest is stands of aspen trees and willow groves.

Representative profile of Adel silty clay loam, 800 feet east and 1,000 feet north of W $\frac{1}{4}$  corner of sec. 33, T. 6 S., R. 20 E.

A11—0 to 3 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) moist and coatings of black (10YR 2/1) moist; moderate, medium and fine, angular blocky structure; soft, friable, sticky and plastic;

many fine and very fine roots; slightly acid; clear wavy boundary.

A12—3 to 18 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) moist and coatings of black (10YR 2/1) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, very sticky and very plastic; common very fine roots and pores; mildly alkaline; clear, wavy boundary.

A13—18 to 23 inches, very dark gray (5Y 5/1) clay loam, very dark gray (10YR 3/1) moist and mottles of dark brown (7.5YR 4/4) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots and pores; mildly alkaline; clear, wavy boundary.

C1—23 to 31 inches, grayish-brown (10YR 5/2) clay loam, grayish brown (10YR 5/2) moist mottled with dark brown (7.5YR 4/4) moist; massive; hard, friable, sticky and plastic; very few, very fine roots and pores; mildly alkaline; gradual, wavy boundary.

C2—31 to 60 inches, grayish-brown (10YR 5/2) gravelly clay loam, grayish brown (10YR 5/2) moist mottled with dark brown (7.5Y 4/4) moist; massive; hard, friable, sticky and plastic; 15 to 25 percent gravel and cobbles; mildly alkaline.

The A horizon is black to very dark gray and is 20 to 36 inches thick. In places this soil contains a few pebbles and stones.

**Adel silty clay loam, 0 to 4 percent slopes (An).**—This gently sloping and undulating soil is on stream terraces and fans and on foot slopes along the stream valleys. It has the profile described as representative of the series.

A typical area is about 95 percent Adel silty clay loam, and 5 percent other soils that are similar to this soil. These included soils are in irregularly shaped areas about 5 acres in size. Stream valleys and branching drainageways form a dendritic pattern. In some places stream channels have cut deeply into the soil. Runoff is slow, and the hazard of erosion is slight.

This soil is used for small grain, alfalfa, meadow hay, and pasture grasses. About 95 percent of the acreage is used for meadow hay and pasture. Aspen trees and willows line the streambanks. Capability unit IVe-3, irrigated, and IVe-5, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 6.

**Adel silty clay loam, 4 to 8 percent slopes (Ao).**—This gently sloping and gently rolling soil is on fans and foot slopes along the sides of stream valleys.

Runoff is medium, and the hazard of erosion is moderate. About 80 percent of the acreage is used for meadow hay; the rest is used for irrigated pasture and small grain. Aspen trees and willows grow along the streambanks. Capability unit IVe-3, irrigated, and IVe-5, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 6.

## Alice Series

The Alice series consists of deep, nearly level to strongly sloping, well-drained soils. These soils formed in material weathered from limy, very soft sandstone bedrock. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 38° to 45° F., and the frost-free period is from 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown fine sandy loam. The subsoil is brown fine sandy loam about 13 inches thick. The substratum is 25 inches of pale-brown fine sandy loam. Soft sandstone is at a depth of 45 inches.

The available water capacity is low or moderate, and permeability is moderately rapid. These soils are used only for range.

Representative profile of Alice fine sandy loam, 200 feet north and 1,560 feet east of the SW. corner of sec. 36, T. 9 S., R. 24 E.

- A1—0 to 7 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, fine, crumb structure; soft, friable, nonsticky and nonplastic; many fine roots; many fine pores; neutral; gradual boundary.
- B21—7 to 14 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; weak prismatic structure parting to weak, medium and fine, angular blocky; soft, friable, nonsticky and nonplastic; many fine roots and pores; neutral; gradual boundary.
- B22—14 to 20 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; weak prismatic structure parting to weak, medium and fine, angular blocky; slightly hard, friable, nonsticky and nonplastic; many fine roots and pores; neutral; gradual boundary.
- C1—20 to 45 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; many very fine roots and pores; weakly effervescent; slightly alkaline; clear, wavy boundary.
- C2—45 inches, yellowish to gray soft sandstone.

Depth to soft sandstone ranges from 40 inches to more than 60 inches. Typically the B horizon is fine sandy loam, and less commonly loamy very fine sand that is less than 18 percent clay. The C horizon ranges from very fine sandy loam to loamy very fine sand.

**Alice fine sandy loam, 0 to 8 percent slopes (Ar).**—This soil is on fans and terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Alice fine sandy loam and 5 percent Rentsac and Cabba soils. The Rentsac and Cabba soils are on narrow ridgetops and knolls throughout the unit. Areas are irregular in shape and less than 5 acres in size.

Runoff is slow, and the hazard of erosion is slight. The drainage pattern is dendritic. Stream channels have cut deeply into the bedrock in many places. This soil is used for range. Capability unit IVE-2, dryland; Sandy range site, 15 to 19 inches precipitation; windbreak group 5.

**Alice fine sandy loam, 8 to 15 percent slopes (As).**—This soil is on uplands. Runoff is slow, and the hazard of erosion is moderate.

This soil is used as range. Capability unit IVE-2, dryland; Sandy range site, 15 to 19 inches precipitation; windbreak group 5.

## Allentine Series

The Allentine series consists of deep, well-drained alkali soils on valley floors. These soils formed in deep alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 48° or 49° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, greasewood, and sagebrush.

In a representative profile the surface layer is light brownish-gray and grayish-brown clay loam about 5 inches thick. The subsoil is about 6 inches thick. The upper 4 inches is grayish-brown clay, and the lower part is light brownish-gray clay. The substratum is gray and olive gray and extends to a depth of more than 60 inches. The upper 12 inches is clay, and the lower part is strati-

fied silt, fine sandy loam, and clay that is high in content of gypsum crystals.

The available water capacity is moderate, and permeability is very slow. These soils are used for grazing. The high content of salts limits the variety of plants that can be grown.

Representative profile of Allentine clay loam, 200 feet west and 1,840 feet north of S $\frac{1}{4}$  corner of sec. 9, T. 7 S., R. 22 E.

- A1—0 to 2 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) crushed and moist; weak platy structure parting to fine granular; soft, friable, slightly sticky and plastic; few fine and very fine roots and pores; strongly effervescent; moderately alkaline; abrupt, smooth boundary.
- AB—2 to 5 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) crushed and moist; weak, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; common very fine roots and pores; strongly effervescent; moderately alkaline; gradual, wavy boundary.
- B2t—5 to 9 inches, grayish-brown (2.5Y 5/2) clay, grayish brown (2.5Y 5/2) crushed and moist; moderate prismatic structure parting to medium and fine subangular blocky; extremely hard, friable, sticky and plastic; few very fine roots and pores; very strongly effervescent; moderately alkaline; gradual, wavy boundary.
- B3ca—9 to 11 inches, light brownish-gray (2.5Y 6/2) clay, olive gray (5Y 5/2) crushed and moist; weak prismatic structure parting to weak, fine and medium, subangular blocky; extremely hard, friable, sticky and plastic; few very fine roots and pores; very strongly effervescent; few distinct threads and seams of segregated lime; moderately alkaline; gradual, wavy boundary.
- C1ca—11 to 23 inches, gray (5Y 5/1) clay, olive gray (5Y 5/2) crushed and moist; weak prismatic structure parting to weak, medium, subangular blocky; extremely hard, friable, sticky and plastic; few very fine roots and pores; very strongly effervescent; abundant salt and gypsum crystals; strongly alkaline; gradual, wavy boundary.
- C2cs—23 to 60 inches, olive-gray (5Y 5/2) stratified silt, fine sandy loam, and clay that has a high content of salt and gypsum crystals; strata range from  $\frac{1}{4}$  to 1 inch in thickness; strongly effervescent; strongly alkaline.

The B2t horizon is 50 to 60 percent clay. It has blocky, prismatic blocky, or columnar blocky structure of a moderate or strong grade. The C horizon is 30 to 50 percent clay and more than 15 percent exchangeable sodium in places above a depth of 60 inches.

**Allentine clay loam, 2 to 4 percent slopes (At).**—This soil is on valley floors. It has the profile described as representative of the series.

A typical area is about 90 percent Allentine clay loam and 10 percent included soils that are similar to this soil. Areas are in irregular patterns and are about 5 acres or less in size. Stream channels, which cross the unit, are cut deeply into the soil. The hazard of erosion is slight, and runoff is medium.

The soil is used for limited grazing. The high content of salts limits the variety and growth of plants. Only salt-tolerant plants grow. Capability unit VIs-1, dryland; Dense Clay range site, 10 to 14 inches precipitation; windbreak group 11.

## Alluvial Land

Alluvial land (AU) is in old abandoned river channels and on recent flood plains and has slopes of less than 4

percent. It is either too wet or too gravelly to be cultivated. It commonly supports dense thickets of willows, groves of cottonwood trees, herbaceous plants, and small meadows. Capability unit VI<sub>s</sub>-1, dryland; Shallow to Gravel range site, 15 to 19 inches precipitation; wind-break group 9.

### Armington Series

The Armington series consists of deep, moderately steep and hilly, well-drained soils. These soils formed in clay residuum weathered from red clay shale. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 41° to 46° F., and the frost-free period is 90 to 115 days. The natural vegetation is mixed grasses, forbs, shrubs, and scattered pines.

In a representative profile the surface layer is reddish-brown silty clay about 4 inches thick. The subsoil is 29 inches thick. It is a reddish-brown clay in the upper 7 inches and weak-red clay in the lower 22 inches. The substratum is red clay to a depth of 60 inches or more.

The available water capacity is moderate, and permeability is very slow. These soils are used for range and recreation.

The Armington soils in the Carbon County Area are mapped only with Lap soils.

Representative profile of Armington silty clay, 2,300 feet east and 500 feet south of NE. corner of sec. 22, T. 7 S., R. 29 E.

A1—0 to 4 inches, reddish-brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) moist; weak, thick, platy structure parting to strong, very fine, subangular blocky; hard, firm, very sticky and plastic; common fine and very fine roots; few medium roots; 10 percent limestone, chert, and shale fragments; mildly alkaline; gradual boundary.

B1—4 to 11 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate, fine, prismatic structure parting to strong, fine and medium, blocky; hard, firm, sticky and plastic; few very fine, fine, and medium pores; common fine and medium tubular pores, and root channels; strongly effervescent; moderately alkaline; clear boundary.

B21—11 to 16 inches, weak-red (10R 4/4) clay, red (10R 4/6) moist; moderate, fine, prismatic structure parting to strong, fine and medium, blocky; very hard, firm, very sticky and very plastic; few very fine, fine, and medium roots; common fine and medium tubular root channels; 10 percent limestone and chert fragments; strongly effervescent; moderately alkaline; gradual boundary.

B22—16 to 33 inches, weak-red (10R 4/4) clay, red (10R 4/6) moist; strong, medium and coarse, prismatic structure parting to strong, coarse, blocky; few slickensides; extremely hard, very firm, sticky and plastic; few roots, mainly between pedes; few fine and medium tubular pores; strongly effervescent, few lime splotches that have diffuse boundaries; moderately alkaline; gradual boundary.

C—33 to 60 inches, red (10R 5/6) clay, red (10R 4/6) moist; massive; extremely hard, very firm, very sticky and very plastic; very few roots; few fine pores; strongly effervescent; moderately alkaline.

Depth to shale, mudstone, or claystone ranges from 48 to 60 inches. The surface layer ranges from 8 to 12 inches in thickness. The C horizon contains a few lime segregations in places.

### Bearmouth Series

The Bearmouth series consists of deep, nearly level to gently sloping, well-drained soils. These soils formed in

gravelly alluvium. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 45° to 47° F., and the frost-free period is 90 to 110 days. The natural vegetation is meadow grasses, willows, and cottonwoods.

In a representative profile the surface layer is dark grayish-brown very cobbly loam about 7 inches thick. The underlying material is 53 inches of dark grayish-brown very gravelly and cobbly loamy sand.

The available water capacity is very low, and permeability is rapid. These soils are used for meadow, hay, and pasture.

The Bearmouth soils in the Carbon County Area are mapped only with Maurice soils.

Representative profile of Bearmouth very cobbly loam in an area of Maurice-Bearmouth complex, 1,600 feet west and 1,250 feet north of SE. corner of sec. 20, T. 5 S., R. 21 E.

A1—0 to 7 inches, dark grayish-brown (10YR 4/2) very cobbly loam, black (10YR 2/1) moist; weak granular structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; neutral; 60 percent stones, cobblestones, and gravel; clear, wavy boundary.

IIC—7 to 60 inches, dark grayish-brown (10YR 4/2) very gravelly and cobbly loamy sand, black (10YR 2/1) moist; single grained; 70 to 80 percent stones, cobblestones, gravel, and coarse sand; neutral.

Content of coarse fragments ranges from 35 to 80 percent throughout the profile. During the irrigation season the water table is within a depth of less than 20 inches.

### Bowbac Series

The Bowbac series consists of gently sloping to strongly sloping, well-drained soils that are moderately deep over fractured sandstone. These soils formed in loamy residuum weathered from calcareous sandstone. Annual precipitation is 5 to 9 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free period is 110 to 130 days. The natural vegetation is mixed grasses, forbs, and sagebrush.

In a representative profile the surface layer is light-gray loam about 5 inches thick. The subsoil is about 18 inches thick. The upper 13 inches is yellowish-brown clay loam, and the lower 5 inches is brownish-yellow clay loam. The upper 13 inches of the substratum is light yellowish-brown, fractured sandstone, and the lower part is light-gray fractured sandstone. Hard consolidated sandstone is at a depth of 58 inches.

The available water capacity is low, and permeability is moderate. All the acreage is used for range.

Representative profile of a Bowbac loam, 1,800 feet north and 1,000 feet east of SW corner of sec. 33, T. 9 S., R. 24 E.

A1—0 to 5 inches, light-gray (10YR 7/2) loam, grayish brown (10YR 5/2) moist; weak platy structure parting to moderate granular; soft, friable, nonsticky and nonplastic; many very fine roots and pores; many clear and stained sand and silt grains; neutral; clear boundary.

B2t—5 to 18 inches, yellowish-brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate prismatic structure parting to moderate, medium and fine, angular blocky; hard, friable, sticky and plastic; common very fine roots; many very fine pores; distinct clay films; root holes have smooth surfaces; mildly alkaline; gradual boundary.

B3ca—18 to 23 inches, brownish-yellow (10YR 6/6) clay loam, yellowish brown (10YR 5/4) moist; moderate,

medium and fine, angular blocky structure; hard, friable, sticky and plastic; common very fine roots; many very fine pores; few, fine, distinct lime mottles; a crust of lime on underside of sandstone fragments; slightly effervescent; moderately alkaline; abrupt boundary.

C1ca—23 to 36 inches, light yellowish-brown (10YR 6/4) fractured sandstone, brownish yellow (10YR 6/6) moist; massive; extremely hard, firm, slightly sticky and plastic; few very fine roots along bedding planes; common very fine pores; many, medium, distinct, white threads and seams of lime; strongly effervescent; moderately alkaline; gradual boundary.

C2—36 to 58 inches, light-gray (10YR 7/2) fractured sandstone, pale brown (10YR 6/3) moist; massive; extremely hard, friable, slightly sticky and plastic; very few fine roots along bedding planes; white specks of lime; moderately effervescent; moderately alkaline; gradual boundary.

R—58 to 60 inches, light yellowish-brown (10YR 6/4) consolidated sandstone, brownish yellow (10YR 6/6) moist; massive; soft in places, extremely hard on exposure; few lime specks; slightly effervescent.

Roots penetrate the sandstone only through the fractures. Depth to weakly consolidated sandstone ranges from 20 to 40 inches. The B2t horizon is light clay loam, sandy clay loam, or loam that is more than 20 percent fine and medium sand and less than 10 percent coarse and very coarse sand.

**Bowbac loam, 2 to 4 percent slopes (Bb).**—This soil is on foot slopes and in swales in the uplands. It has the profile described as representative of the series.

A typical area is about 90 percent Bowbac loam and 10 percent included Torchlight clay and Travessilla silt loam. Areas of Torchlight clay and Travessilla silt loam are irregular in shape and are less than 5 acres in size. The drainage pattern is dendritic. In some places stream channels have cut deeply into the bedrock. The hazard of erosion is slight, and runoff is slow.

This soil is used for summer grazing. Capability unit VIe-1, dryland; Silty range site, 5 to 9 inches precipitation; windbreak group 2.

**Bowbac loam, 4 to 8 percent slopes (Bc).**—This soil is on upland foot slopes and divides. The hazard of erosion is moderate, and runoff is medium.

All the acreage is used for range. Thick stands of sagebrush are typical. Capability unit VIe-1, dryland; Silty range site, 5 to 9 inches precipitation; windbreak group 2.

**Bowbac loam, 8 to 15 percent slopes (Bd).**—This soil is on upland foot slopes and divides. The hazard of erosion is moderate, and runoff is medium.

All the acreage is used for range. Thick stands of sagebrush are typical. Capability unit VIe-1, dryland; Silty range site, 5 to 9 inches precipitation; windbreak group 2.

**Bowbac-Harvey loams, 2 to 4 percent slopes (Bh).**—This complex is on fans and foot slopes. A typical area is about 60 percent Bowbac loam, 35 percent Harvey loam, and 5 percent other soils that are similar to these soils. The Bowbac loam is on the smooth upland foot slopes. The Harvey loam is on the smooth divides and small terrace remnants. Areas of the included soils are 5 acres or less in size.

These soils are moderately deep along the narrow drainageways. In some places the stream channels have cut deeply into the bedrock. Runoff is slow, and the hazard of erosion is slight.

These soils are used for grazing and wildlife. Capability unit VIe-1, dryland. Bowbac soil in Silty range

site, 5 to 9 inches precipitation, and windbreak group 2. Harvey soil in Limy range site, 5 to 9 inches precipitation, and windbreak group 7.

**Bowbac-Travessilla complex, 4 to 8 percent slopes (8m).**—This complex is on uplands. A typical area is about 55 percent Bowbac loam, 35 percent Travessilla soils, and 10 percent soils that are similar to these soils. The Bowbac loam is on the smooth middle foot slopes and divides. The Travessilla soil is on narrow divides, knobs, and ridge points. Areas of the included soils are irregular in shape and are less than 10 acres in size.

Stream channels have cut deeply into the bedrock of most drainageways. Runoff is medium, and the hazard of erosion is slight.

Soils of this complex are used for grazing and wildlife. Capability unit VIe-1, dryland. Bowbac soil in Silty range site, 5 to 9 inches precipitation, and windbreak group 2. Travessilla soil in Shallow range site, 10 to 14 inches precipitation, and windbreak group 3.

**Bowbac-Torchlight association, undulating (BT).**—This association consists of soils on fan terraces and foot slopes. Slopes are 2 to 8 percent.

A typical area of this association is about 60 percent Bowbac loam, about 30 percent Torchlight soils, and about 9 percent soils that are similar to these soils. The Bowbac loam is on the smooth foot slopes and divides. The Torchlight soil is on the valley floors of the drainageways. Areas of the included soils are irregular in shape and are 5 acres or less in size. Sandstone crops out on the ridge points and narrow divides. In places these outcrops make up about 1 percent of this association.

Stream channels have cut into the bedrock. The drainage pattern is dendritic. Runoff is medium, and the hazard of erosion is moderate.

The soils of this association are used for summer grazing and wildlife. Capability unit VIe-1, dryland. Bowbac soil in Silty range site, 5 to 9 inches precipitation, and windbreak group 2. Torchlight soil in Dense Clay range site, 5 to 9 inches precipitation, and windbreak group 11.

## Bynum Series

The Bynum series consists of moderately steep or steep, well-drained soils that are moderately deep over weathered shale. These soils formed in clay loam residuum weathered from calcareous, weakly consolidated clay shale, siltstone, and sandstone bedrock. Annual precipitation is 15 to 22 inches. The mean annual soil temperature is 39° or 40° F., and the frost-free period is 70 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown sandy clay loam about 7 inches thick. The subsoil is 23 inches thick. It is brown sandy clay loam in the upper 10 inches and brown clay loam in the lower 13 inches. The substratum is light olive-gray stratified sandstone, claystone, and siltstone.

The available water capacity is low, and permeability is moderate. These soils are used mainly for range.

The Bynum soils in the Carbon County Area are mapped with Heath, Thiel, and Woodrock soils.

Representative profile of Bynum sandy clay loam in an area of Woodrock-Bynum association, hilly, 1,320 feet

south and 200 feet west of NE. corner of sec. 29, T. 7 S., R. 20 E.

- Ap—0 to 7 inches, grayish-brown (10YR 5/2) sandy clay loam that is high in content of granite sand, very dark grayish brown (10YR 3/2) crushed and moist; weak, fine, granular structure; soft, friable, slightly sticky and nonplastic; many fine and very fine roots and pores; mildly alkaline; clear, wavy boundary.
- B21—7 to 17 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) crushed and moist; weak prismatic structure parting to weak, medium and fine, angular blocky; hard, friable, sticky and plastic; few very fine roots and pores; mildly alkaline; gradual, wavy boundary.
- B22—17 to 30 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak prismatic structure parting to weak, fine, angular blocky; hard, friable, slightly sticky and plastic; few very fine roots and pores; moderately alkaline; clear, wavy boundary.
- C1—30 to 48 inches, light olive-gray (5Y 6/2), weathered, stratified sandy and clayey shale mottled with white (5Y 8/2); strata range from 4 to 6 inches in thickness; strongly effervescent, strongly alkaline; clear, wavy boundary.
- C2—48 to 60 inches, light-gray to gray shale (5Y 6/1) mottled with reddish brown (2.5YR 5/4) and yellowish brown (10YR 5/6); massive; hard, very firm, sticky and plastic; strongly effervescent, strongly alkaline.

Structure of the A horizon is granular, and texture is sandy clay loam or clay loam. Depth to weathered bedrock ranges from 20 to 40 inches. Fragments of the bedrock material occur throughout the C horizon.

## Cabba Series

The Cabba series consists of shallow, strongly sloping and rolling, well-drained soils. These soils formed in loamy residuum weathered from gray and yellowish-brown, weakly consolidated claystone, siltstone, and sandstone beds. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 43° to 46° F., and the frost-free period is 90 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown silty clay loam about 5 inches thick. The underlying material is light brownish-gray clay loam in the upper 10 inches and olive-brown silty clay loam in the lower 3 inches. Unweathered shale is at a depth of about 18 inches.

The available water capacity is very low or low, and permeability is moderately slow. These soils are used mainly for range. A small acreage is in small grain.

Representative profile of Cabba silty clay loam in an area of Shane-Cabba clay loams, 8 to 15 percent slopes, 700 feet south and 500 feet east of W $\frac{1}{4}$  corner of sec. 13, T. 4 S., R. 21 E.

- A—0 to 5 inches, grayish-brown (2.5Y 5/2) silty clay loam, olive brown (2.5Y 4/4) moist; weak, fine, granular or crumb structure; soft, friable, slightly sticky and plastic; common very fine roots and very fine tubular pores; very strongly effervescent, strongly alkaline; clear, wavy boundary.
- C1ca—5 to 15 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/6) moist; weak, medium and fine, blocky structure parting to fine blocky; hard, friable, sticky and plastic; many very fine and fine roots and very fine pores; very strongly effervescent; few threads and soft lime in pockets, strongly alkaline; clear, wavy boundary.

C2—15 to 18 inches, olive-brown (2.5Y 4/4) silty clay loam, olive brown (2.5Y 4/4) moist; massive; stratified layers of shale  $\frac{1}{4}$ - to  $\frac{1}{8}$ -inch thick; hard, friable, sticky and plastic; very strongly effervescent, moderately alkaline; gradual, wavy boundary.

C3—18 to 30 inches, reworked silty and clayey shale; extremely hard, friable, sticky and plastic; very strongly effervescent, moderately alkaline.

The A horizon has a hue of 2.5Y to 10YR and a value of 5 or 6 dry. It is clay loam or silty clay loam. Content of organic carbon is less than 2 percent.

**Cabba-Rentsac complex, rolling (CA).**—This complex consists of Cabba silty clay loam and Rentsac soils. A typical area is about 52 percent Cabba soils, 30 percent Rentsac soils, 15 percent other soils, and 3 percent sandstone outcrop. The Cabba silty clay loam is on broad ridges and narrow divides, and the Rentsac channery loam is on convex ridge points and narrow divides. Small areas of Shane clay loam, Absarokee clay loam, and Macar clay loam on narrow foot slopes and valley floors and in swales were included in mapping.

In most places stream channels have cut deeply into the bedrock plain. Runoff is medium, and the hazard of erosion is moderate.

These soils are used mostly for range. Capability unit VI $\bar{s}$ -1, dryland; Shallow range site, 15 to 19 inches precipitation; windbreak group 3.

## Castner Series

The Castner series consists of shallow, moderately steep and steep, well-drained soils. These soils formed in material weathered from hard sandstone bedrock. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 42° to 45° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is dark grayish-brown or brown channery loam about 8 inches thick. The underlying layer is light-gray silt loam about 10 inches thick. Gray hard sandstone is at a depth of 18 inches.

The available water capacity is very low, and permeability is moderately rapid. These soils are used only for range.

The Castner soils in the Carbon County Area are mapped only with Reeder and Wayden soils.

Representative profile of Castner channery loam in an area of Reeder-Castner association, rolling, 1,200 feet west and 1,300 feet south of NE. corner of sec. 7, T. 6 S., R. 25 E.

- A11—0 to 7 inches, dark grayish-brown (10YR 4/2) channery loam, dark brown (10YR 3/3) moist; fine granular structure; soft, friable, nonsticky and nonplastic; many fine and very fine root pores; 20 percent channers; neutral; gradual boundary.
- A12—7 to 8 inches, brown (10YR 4/3) channery loam, dark brown (10YR 3/3) moist; weak blocky structure parting to fine granular; soft, friable, nonsticky and nonplastic; many clear and stained sand grains; many fine and very fine roots and pores; 20 percent channers; mildly alkaline; clear, wavy boundary.
- Cca—8 to 18 inches, light-gray (10YR 7/2) silt loam, light brownish gray (10YR 6/2) moist; massive; slightly hard, friable, slightly sticky and nonplastic; many fine and very fine roots and pores; 40 percent sandstone fragments; very strongly effervescent, few

pockets of soft lime and lime coatings on underside of fragments; moderately alkaline; abrupt boundary. R—18 inches, gray hard sandstone.

Depth to sandstone bedrock ranges from 16 to 20 inches.

## Charlos Series

The Charlos series consists of deep, nearly level to gently sloping, well-drained soils. These soils formed in loamy alluvium overlying sands and gravels on high outwash terraces. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 43° to 46° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed meadow grasses, forbs, and shrubs. Willows line the drainageways and irrigation ditches.

In a representative profile the surface layer is dark-gray or dark grayish-brown loam about 6 inches thick. The subsoil is about 11 inches of brown clay loam. The substratum is brown gravelly clay loam 13 inches thick. It is underlain by deep, very gravelly and stony material.

The available water capacity is moderate, and permeability is moderate. These soils are used mostly for dry-farmed and irrigated small grain, meadow grass, pasture, and alfalfa. A small acreage is in range.

Representative profile of Charlos loam, 300 feet north and 800 feet west of SE. corner of sec. 16, T. 7 S., R. 20 E.

A11—0 to 3 inches, dark-gray (10YR 4/1) loam, very dark brown (10YR 2/2) moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; common fine and very fine roots and pores; medium acid; clear, smooth boundary.

A12—3 to 6 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine, granular structure; soft, friable, nonsticky and nonplastic; common fine and very fine roots and pores; medium acid; gradual boundary.

B21t—6 to 11 inches (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable, sticky and plastic; thin distinct clay films; common very fine roots and pores; medium acid; gradual boundary.

B22t—11 to 17 inches, brown (7.5Y 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable, sticky and plastic; thin distinct clay films on ped faces; common very fine roots and pores; few pebbles and coarse sand particles; medium acid; gradual boundary.

C1—17 to 30 inches, brown (7.5YR 5/4) gravelly clay loam, brown (7.5YR 4/4) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots and common pores; 50 percent gravel; slightly acid; gradual boundary.

IIC2—30 to 60 inches, gravelly sand, cobblestones, and boulders.

The A horizon is loam or stony loam. The B2t horizon is as much as 35 percent clay in some places. Some lime-coated gravel is deep in the profile; elsewhere, the soil is medium acid to neutral. Depth to sand and gravel ranges from 30 to 40 inches.

**Charlos loam, 0 to 2 percent slopes (Cb).**—This soil is on high outwash terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Charlos loam and 5 percent Thiel cobbly loam and Heath clay loam. The Charlos loam is on broad terraces and the upper part of terrace edges. Thiel cobbly loam and Heath clay loam are along the edges of terraces or in areas where terraces

are only a few feet wide. Areas of the included soils are irregular in shape and are 5 acres or less in size.

Drainageways are smooth and show very little cutting into the gravelly alluvium in most places. Where the stream leaves the terrace, it has cut deeply into the gravel beds. The hazard of erosion is very slight, and runoff is slow.

Most of the acreage is used for dryfarmed and irrigated small grain, hay, and pasture. A small acreage is used for range. Capability unit IIIs-3, irrigated and IIIs-2, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 1.

**Charlos loam, 2 to 8 percent slopes (Cc).**—This gently sloping and undulating soil is on high outwash terraces.

Runoff is medium, and the hazard of erosion is slight. This soil is used mainly for dryfarmed and irrigated grain, hay, and pasture. Some areas are used for range. Capability unit IIIe-3, irrigated and IIIe-2, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 1.

**Charlos loam, wet, 0 to 2 percent slopes (Cd).**—This soil is in low swales and drainageways in high outwash terraces. Run-in and seepage of excess irrigation water from soils in higher areas keep this soil wet.

Runoff is slow, and the hazard of erosion is slight. This soil is used mainly for pasture. Trees and shrubs grow in groves along drainageways. Capability unit IIIw-1, irrigated; windbreak group 9. Not in a range site.

**Charlos stony loam, 0 to 4 percent slopes (Ce).**—This nearly level or undulating soil is on high outwash terraces. Its profile is similar to the one described as representative of the series, but the surface layer has some large stones.

Runoff is slow, and the hazard of erosion is slight. This soil is used for grazing. Capability unit IIIs-2, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 1.

## Colby Series

The Colby series consists of deep, gently sloping and strongly sloping, well-drained soils. These soils formed in silty alluvium and wind-laid silty mantles deposited over alluvium. Annual precipitation is 5 to 9 inches. The mean annual soil temperature ranges from 49° to 54° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is 8 inches of olive silt loam. The upper 12 inches of the underlying material is light olive-gray silt loam, and the lower 42 inches is pale-olive silty clay loam and silt loam.

The available water capacity is high, and permeability is moderate. These soils are used for small grain, hay, and pasture.

Representative profile of Colby silt loam, 1,200 feet west and 700 feet south of E $\frac{1}{4}$  corner of sec. 29, T. 6 S., R. 23 E.

A1—0 to 8 inches, olive (5Y 5/3) silt loam, olive (5Y 4/3) moist and coatings of olive (5Y 5/3) moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; many fine roots and common very fine roots and pores; strongly effervescent; moderately alkaline; gradual, smooth boundary.

C1—8 to 20 inches, light olive-gray (5Y 6/2) silt loam, olive (5Y 4/3) moist and coatings of olive gray (5Y 4/2) moist; strong, coarse, prismatic structure parting to moderate, medium and fine, angular blocky; soft, friable, nonsticky and nonplastic; many very fine roots; common fine tubular pores; strongly effervescent; moderately alkaline; gradual, wavy boundary.

C2ca—20 to 36 inches, pale-olive (5Y 6/3) silty clay loam, olive (5Y 5/4) moist and coatings of olive (5Y 4/3) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots and pores; distinct lime mottles and segregations; violently effervescent; moderately alkaline; clear boundary.

C3—36 to 62 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/4) moist; massive; stratified material  $\frac{1}{2}$  to  $\frac{3}{4}$  inch thick; soft, friable, nonsticky and nonplastic; very strongly effervescent; moderately alkaline.

Depth of the solum over any contrasting material ranges from 50 to more than 72 inches. Depth to the Cca horizon ranges from 19 to 23 inches.

**Colby silt loam, 2 to 4 percent slopes (Cf).**—This gently sloping, undulating soil is in swales and low areas on fans and foot slopes. It has the profile described as representative of the series.

A typical area is about 95 percent Colby silt loam and 5 percent included areas of Haverson silty clay loam and Heldt silty clay loam. Areas of the included soils are irregular in shape and about 2 to 3 acres in size.

Runoff is slow, and the hazard of erosion is slight. About half the acreage is used for hay pasture and small grain under sprinkler irrigation; the other half is used for grazing. Capability unit IIe-1, irrigated and IVe-6, dryland; Silty range site, 5 to 9 inches precipitation; windbreak group 1.

**Colby silt loam, 4 to 8 percent slopes (Cg).**—This soil is on fans and foot slopes. Runoff is medium, and the hazard of erosion is slight. About 40 percent of the acreage is used for irrigated crops. The rest is used for range. Capability unit IIIe-1, irrigated and IVe-6, dryland; Silty range site, 5 to 9 inches precipitation; windbreak group 1.

**Colby silt loam, 8 to 15 percent slopes (Ch).**—This soil is on fans and foot slopes. Runoff is medium, and the hazard of erosion is moderate. About 90 percent of the acreage is used for range, and the rest for pasture and alfalfa hay. Capability unit IVe-1, irrigated and IVe-6, dryland; Silty range site, 5 to 9 inches precipitation; windbreak group 1.

## Duncom Series

The Duncom series consists of shallow, rolling and hilly, well-drained soils. These soils formed in gravelly or channery residuum weathered from limestone. Annual precipitation is 15 to 20 inches. The mean annual soil temperature ranges from 37° to 42° F., and the frost-free period is 40 to 50 days. The natural vegetation is mixed short grasses, forbs, and shrubs.

In a representative profile the surface layer is dark-brown or brown gravelly silt loam about 10 inches thick. The underlying material is light-brown very channery loam about 6 inches thick. Hard rock is at a depth of 16 inches.

The available water capacity is very low, and permeability is moderate. These soils are used only for summer grazing, wildlife, and recreation.

Representative profile of Duncom gravelly silt loam, 1,370 feet west and 200 feet north of SE. corner of sec. 35, T. 7 S., R. 25 E.

A11—0 to 7 inches, dark-brown (7.5YR 3/2) gravelly silt loam, very dark brown (7.5YR 2/2) moist; weak, fine, crumb structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots and pores; 15 percent flat limestone fragments; weakly effervescent; mildly alkaline; clear, wavy boundary.

A12—7 to 10 inches, brown (7.5YR 4/2) gravelly silt loam, dark brown (7.5 YR 3/2) moist; medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; 12 percent clay by field estimate; common very fine roots and pores; 15 percent flat limestone fragments; slightly effervescent; mildly alkaline; clear, wavy boundary.

C2—10 to 16 inches, light-brown (7.5YR 6/4) very channery loam, brown (7.5YR 4/4) moist; massive; hard, friable, nonsticky and nonplastic; few very fine roots and pores; 60 percent coarse fragments; violently effervescent; moderately alkaline; abrupt boundary.

R—16 inches, hard gray limestone.

Depth to hard limestone bedrock ranges from 12 to 20 inches.

These Duncom soils contain slightly more coarse fragments than is defined as the range for the series, but this difference does not alter their usefulness or behavior.

**Duncom gravelly silt loam, hilly (DG).**—This soil is on limestone uplands. A typical area is about 90 percent Duncom gravelly silt loam and 10 percent included areas of Windham cobbly clay loam and Trapper and Spearfish silt loams. The Duncom soil is on ridges and the included soils are on fan terraces and the sides of deep valleys. The drainage pattern is dendritic. Stream channels have cut to the hard limestone bedrock.

Runoff is medium, and the hazard of erosion is moderate. This soil is used for summer grazing, recreation, and wildlife. Capability unit VI-1, dryland; Shallow range site, 15 to 19 inches precipitation; windbreak group 3.

**Duncom-Hanson association, rolling (DH).**—This association is on strongly sloping mountainsides. A typical area is about 70 percent Duncom soils, 25 percent Hanson soils, and 5 percent included areas of Tiban and Peritsa soils. The included soils are in deep swales and on the sides of fans where slopes are steep. The drainage pattern is dendritic. Drainageways are steep limestone canyons. In places the stream channels have cut down to the limestone bedrock.

Runoff is rapid, and the hazard of erosion is slight. Some areas are used for grazing late in summer and early in fall. Some are recreation areas. Wildlife is abundant. Capability unit VI-1, dryland. Duncom soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3. Hanson soil in Silty range site, 15 to 19 inches precipitation, and windbreak group 8.

## Fort Collins Series

The Fort Collins series consists of deep, nearly level and gently sloping, well-drained soils. These soils formed in alluvium on fans and terraces. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free period is 110 to 130 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown loam about 4 inches thick. The subsoil is about 11 inches thick. The upper 8 inches is brown clay loam, and the lower 3 inches is pale-brown clay loam. The substratum, extending to a depth of 60 inches, is light-gray clay loam and fine sandy loam in the upper 23 inches and light brownish-gray fine sandy loam in the lower part.

The available water capacity is moderate or high, and permeability is moderate. These soils are used for row crops, small grain, pasture, and alfalfa. About 95 percent of the acreage is used for irrigated crops; the rest is used for range.

Representative profile of Fort Collins loam, 700 feet east and 50 feet south of NW. corner of sec. 20, T. 4 S., R. 23 E.

- A1—0 to 4 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak, medium and fine, platy structure; hard, friable, sticky and plastic; many fine and very fine roots and pores; mildly alkaline; clear, smooth boundary.
- B2t—4 to 12 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 4/3) moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; distinct clay films and bridgings; many fine and very fine roots; many fine and very fine tubular pores; mildly alkaline; gradual boundary.
- B22t—12 to 15 inches, pale-brown (10YR 6/3) clay loam, dark grayish brown (10YR 4/2) moist; weak prismatic structure parting to moderate, medium, subangular blocky; hard, friable, sticky and plastic; many very fine roots; many very fine tubular pores; mildly alkaline; clear, wavy boundary.
- C1ca—15 to 24 inches, light-gray (10YR 7/1) clay loam, grayish brown (10YR 5/2) moist; massive; hard, friable, sticky and plastic; common very fine roots and pores; few, common, distinct threads and seams of segregated lime; strongly effervescent; strongly alkaline; gradual boundary.
- IIC2—24 to 38 inches, light-gray (10YR 7/2) fine sandy loam, grayish brown (10YR 5/2) moist; massive; soft, friable, nonsticky and nonplastic; very few very fine roots and pores; strongly effervescent; strongly alkaline; gradual boundary.
- IIC3—38 to 60 inches, light brownish-gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; massive; soft, friable, nonsticky and nonplastic; strongly effervescent; strongly alkaline.

The solum ranges from 15 to 24 inches in thickness. The B2t horizon is loam, silty clay loam, or clay loam that is 18 to 35 percent clay. The C horizon is clay loam, fine sandy loam, or gravelly loam to a depth of 40 inches or more.

**Fort Collins loam, 0 to 2 percent slopes (Fc).**—This soil is on fans and stream terraces. It has the profile described as representative of the series.

A typical area is about 90 percent Fort Collins loam and about 10 percent included Vona fine sandy loam, Heldt silty clay loam, and Toluca clay loam. The included soils are in irregularly shaped areas 5 acres or less in size. The stream channels have cut into the valley floors where excess water accumulates during irrigation. Runoff is slow, and the hazard of erosion is slight.

All the acreage is used for irrigated crops, row crops, small grain, alfalfa, and irrigated pasture. Capability unit I-1, irrigated; windbreak group 1.

**Fort Collins loam, 2 to 4 percent slopes (Fd).**—This soil is on gently sloping and undulating fans and stream terraces. Runoff is medium, and the hazard of erosion is moderate. All areas of this soil are used for irrigated

crops, alfalfa hay, and pasture. Capability unit IIe-1, irrigated; windbreak group 1.

**Fort Collins loam, wet, 0 to 2 percent slopes (Fe).**—This soil is in swales and smooth drainageways on fans and stream terraces. It is wet from overirrigation and seepage from surrounding areas. Runoff is slow, and the hazard of erosion is slight. This soil can be drained easily.

All the acreage is used for pasture. Capability unit IIw-1, irrigated; Subirrigated range site, 20 to 24 inches precipitation; windbreak group 9.

## Glenberg Series

The Glenberg series consists of deep, nearly level and gently sloping, well-drained soils. These soils formed in deep, stratified alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 49° to 54° F., and the frost-free period is 125 to 130 days. The natural vegetation is mixed grasses, cottonwood trees, and willows.

In a representative profile the surface layer is light brownish-gray fine sandy loam about 6 inches thick. The underlying material is light brownish-gray fine sandy loam thinly stratified with loamy, clayey, and sandy materials to a depth of 60 inches.

The available water capacity is moderate, and permeability is rapid. These soils are used chiefly for pasture. About 2 percent of the acreage is used for irrigated crops.

Representative profile of Glenberg fine sandy loam, NW $\frac{1}{4}$  sec. 24, T. 4 S., R. 23 E.

- A1—0 to 6 inches, light brownish-gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; moderate, thin, platy structure; slightly hard, friable, nonsticky and nonplastic; few fine and very fine roots; slightly effervescent; mildly alkaline; clear, wavy boundary.
- C1—6 to 12 inches, light brownish-gray (10YR 6/2) fine sandy loam that has thin layers of fine sand, silt, clay, and coarse sand, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots and pores; slightly effervescent; mildly alkaline; clear, wavy boundary.
- C2—12 to 60 inches, light brownish-gray (10YR 6/2) fine sandy loam that has thin layers of fine sand, clay, silt, or coarse sandy loam  $\frac{1}{4}$  to  $\frac{3}{4}$  inch thick, grayish brown (10YR 5/2) moist; massive; soft, friable, nonsticky and nonplastic; very few very fine roots and pores; strongly effervescent; few lime segregations; strongly alkaline.

The A horizon is fine sandy loam or loam. The C horizon is dominantly fine sandy loam, but ordinarily contains strata,  $\frac{1}{4}$ -inch to 2 inches thick, that range from fine sandy to clay.

**Glenberg-Haverson complex (Gh).**—This complex consists of nearly level and gently sloping Glenberg fine sandy loam and Haverson silty clay loam on stream terraces. Each soil has the profile described as representative of its respective series.

A typical area is about 50 percent Glenberg fine sandy loam, 40 percent Haverson silty clay loam, and 10 percent included areas of other soils. Areas of the included soils are irregular in shape and about 2 to 5 acres in size.

Stream channels have cut deeply into the alluvial material. Runoff is slow, and the hazard of erosion is moderate. Flooding early in spring is common.

These soils are used mainly for early and late grazing. Capability unit IIIe-4, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 1.

**Glenberg loam, gravel substratum (Gb).**—This soil is on bottom lands and stream terraces. Slopes are 0 to 2 percent. The profile of this soil differs from the one described as representative of the series in having a loam surface layer and a sand and gravel substratum at a depth of 24 inches.

Included with this soil in mapping are Heldt and Haverson soils in irregularly shaped areas less than 5 acres in size.

Runoff is rapid, and the hazard of erosion is moderate. Streambanks have been cut severely.

These soils are used for irrigated crops, alfalfa hay, and pasture. Capability unit IIs-1, irrigated; windbreak group 1.

## Hanson Series

The Hanson series consists of deep, gently sloping to very steep, well-drained soils. These soil formed in deep, gravelly and cobbly alluvium on fans and high outwash terraces. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 37° to 46° F., and the frost-free period is 40 to 110 days. The natural vegetation is mixed grasses, forbs, shrubs, and occasional pine trees.

In a representative profile the surface layer is 12 inches thick. The upper 7 inches is dark grayish-brown clay loam and the lower 5 inches is brown very gravelly clay loam. The underlying material is 48 inches thick. The upper 6 inches is brown very gravelly clay loam, the next 14 inches is pale-brown very gravelly clay loam, the next 5 inches is pinkish-gray very cobbly clay loam, and the lower 23 inches is white very cobbly clay loam.

The available water capacity is low or very low, and permeability is moderately slow. These soils are used mostly for hay and range.

Representative profile of Hanson clay loam, 1,000 feet east and 500 feet north of SW. corner of sec. 25, T. 8 S., R. 20 E.

- A1—0 to 7 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, medium and fine, granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots and pores; 10 percent gravel; neutral; clear, wavy boundary.
- A12—7 to 12 inches, brown (7.5YR 5/2) very gravelly clay loam, brown (7.5YR 4/2) moist; moderate prismatic structure parting to moderate, medium and fine, sub-angular blocky; slightly hard, friable, slightly sticky and plastic; many very fine roots and pores; 40 to 70 percent lime-coated gravel fragments; slightly effervescent; mildly alkaline; clear, wavy boundary.
- C1ca—12 to 18 inches, brown (10YR 5/3) very gravelly clay loam, brown (7.5YR 4/2) moist; moderate, medium and fine, angular blocky structure parting to medium and fine angular blocky; slightly hard, friable, slightly sticky and plastic; 60 percent gravel and cobblestones; few fine and very fine roots; many very fine pores; threads and seams of segregated lime; strongly effervescent; moderately alkaline; clear, wavy boundary.
- C2ca—18 to 32 inches, pale-brown (10YR 6/3) very gravelly clay loam, light yellowish brown (10YR 6/4) moist; massive; hard, friable, slightly sticky and plastic; few very fine roots and pores; 70 percent limestone

fragments; violently effervescent; moderately alkaline; gradual boundary.

C3ca—32 to 37 inches, pinkish-gray (7.5YR 6/2) and pinkish-white (7.5YR 8/2) very cobbly clay loam, light brown (7.5YR 6/4) and pink (7.5YR 8/4) moist; massive; hard, friable, slightly sticky and plastic; many fine tubular pores, 70 percent gravel and cobblestones; lime coatings on rocks and in seams; violently effervescent; moderately alkaline; gradual boundary.

C4—37 to 60 inches, white (10YR 8/2) very cobbly clay loam, very pale brown (10YR 7/3) moist; massive; hard, friable, slightly sticky and plastic; 65 percent limestone cobblestones that have lime encrustations; violently effervescent; moderately alkaline.

The surface layer ranges from clay loam to extremely stony loam. Coarse fragments in the soil range from less than 3 inches to 10 inches in diameter.

**Hanson clay loam, 4 to 8 percent slopes (Hc).**—This soil is on fans and terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Hanson clay loam and 5 percent Thiel cobbly clay loam, Charlos loam, and Woodrock clay loam. Thiel cobbly clay loam and Charlos loam are in areas adjacent to the Hanson clay loam, and they finger into the Hanson soils. The steeper slopes where aspens grow are Woodrock clay loam. These areas are less than 5 acres in size. The drainage pattern is dendritic. In places stream channels have cut deeply into the bedrock. The hazard of erosion is moderate, and runoff is medium.

This soil is used mainly for range. Capability unit IIIc-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 1.

**Hanson very stony loam, rolling (HB).**—This soil is on foot slopes and fans where slopes are 8 to 15 percent. It has a profile similar to the one described as representative of the series, but the surface layer is very stony, and as much as 3 percent of the surface is covered with stones.

Runoff is medium, and the hazard of erosion is moderate. This soil is used for summer grazing, wildlife, and recreation. The short growing season makes farming hazardous. Capability unit VIIs-1, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 8.

**Hanson extremely stony loam, sloping (HC).**—This soil (fig. 2) is on foot slopes and fans where slopes are 8 to 15 percent. It has a profile similar to the one described as representative of the series, but the surface layer is extremely stony loam, and 90 percent of the surface is covered with stones.

A typical area is about 95 percent Hanson extremely stony loam and 5 percent included areas of Trapper soils where fans and foot slopes are steeper.

Runoff is slow, and the hazard of erosion is slight. The drainage pattern is dendritic. Drainageways have smooth rounded sides and are deep. Stream channels have cut deeply into the alluvial material. The unit is used only as range. Capability unit VIIIs-1, dryland; Stony range site, 15 to 19 inches precipitation; windbreak group 8.

**Hanson association, very steep (HD).**—This association (fig. 3) is in the slide rock and talus areas along the mountain fronts where slopes are 45 to 70 percent. This soil has the profile described as representative of the series.

A typical area is about 60 percent Hanson soils, 35 percent Trapper soils, and 5 percent included areas of Duncom, Tarrete, and Sicklestets soils and outcroppings



Figure 2.—An area of Hanson extremely stony loam, sloping.

of rock. The included soils are in the swales of open parks. The very steep Hanson soils are below limestone cliffs. The Trapper soils are on ridges under a cover of pines. Areas of the included soils are irregular in shape and 20 acres or less in size.

The drainage pattern is dendritic, and drainageways are deep canyons that show little channel cutting. Runoff is slow, and the hazard of erosion is slight. These soils are used for limited summer grazing, woodland, and recreation. Capability unit VIIe-1, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 8.

**Hanson-Duncom association, rolling (HE).**—This unit has slopes of 8 to 15 percent. A typical area is about 70 percent Hanson soils, 25 percent Duncom soils, and 5 percent included areas of Tiban, Tarrete, and Trapper soils. Areas are irregular in shape and 15 acres or less in size.

Runoff is medium, and the hazard of erosion is moderate. This association is used for summer grazing, wildlife, and recreation. Capability unit VIIs-1, dryland; Hanson soil in Stony range site, 15 to 19 inches precipitation, and windbreak group 8. Duncom soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

## Harvey Series

The Harvey series consists of deep, gently sloping to strongly sloping, well-drained soils. These soils formed in strongly calcareous alluvium. Annual precipitation is 5

to 14 inches. The mean annual soil temperature ranges from 45° to 50° F., and the frost-free period is 110 to 130 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown loam about 2 inches thick. The subsoil is 6 inches thick. The upper 3 inches is brown loam, and the lower 3 inches is pale-brown silty clay loam. The substratum extends to a depth of 60 inches or more. The upper 9 inches is white silty clay loam, the next 7 inches is very pale brown silty clay loam, and the lower 36 inches or more is light-gray silty clay loam.

The available water capacity is high, and permeability is moderate. These soils are used for range, alfalfa hay, pasture, and small grain.

Representative profile of Harvey loam, 600 feet south and 80 feet east of NW. corner of sec. 36, T. 7 S., R. 24 E.

- A11—0 to 2 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, crumb structure; slightly hard, friable, non-sticky and nonplastic; many very fine roots; moderately effervescent; moderately alkaline; clear, wavy boundary.
- B2—2 to 5 inches, brown (10YR 5/3) loam, dark yellowish brown (10YR 3/4) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; many very fine roots; moderately effervescent; moderately alkaline; clear, wavy boundary.
- B3ca—5 to 8 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable,

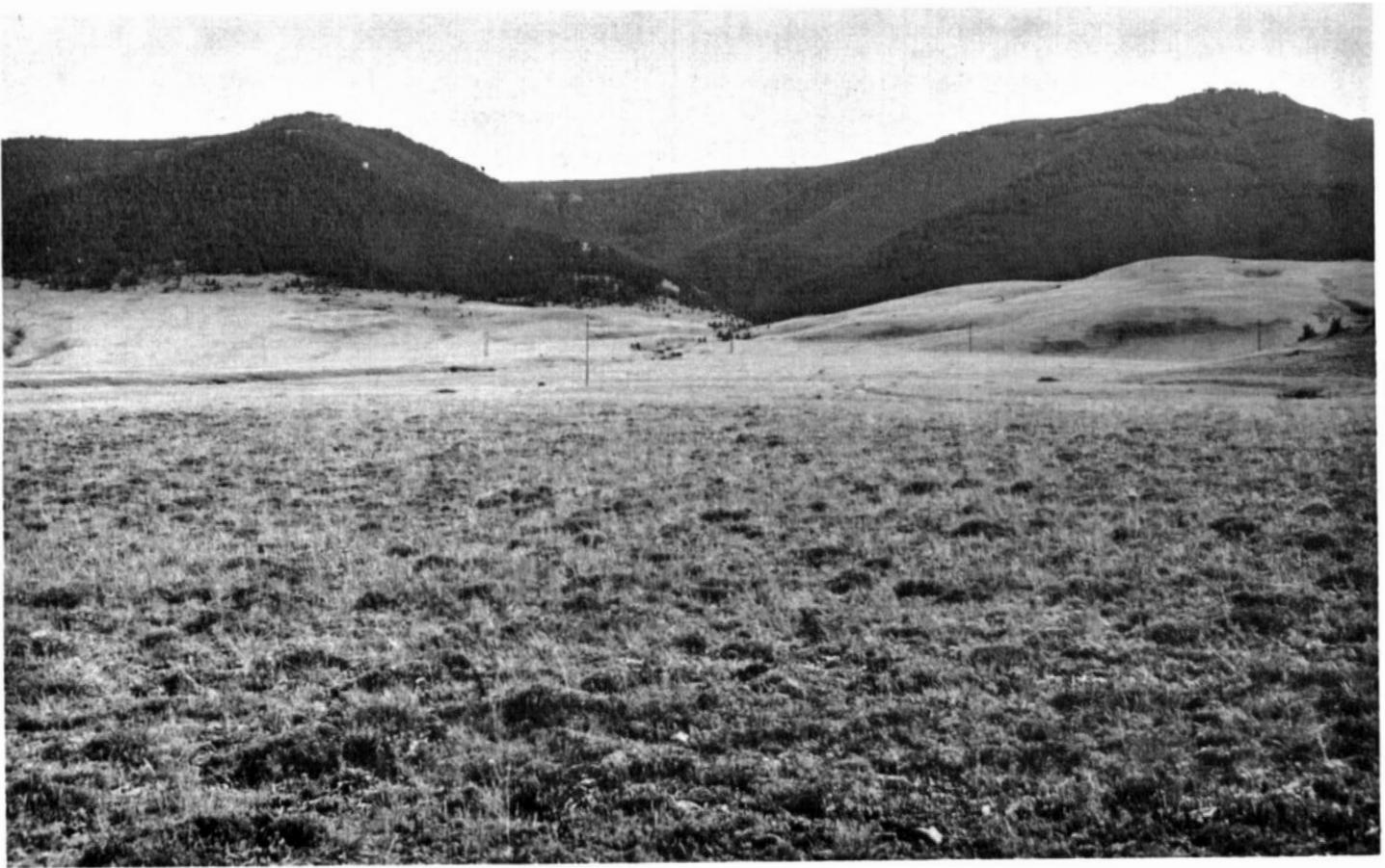


Figure 3.—An area of Hanson clay loam in the foreground. The pine-covered slopes in the background are areas of Hanson association, very steep.

sticky and plastic; many very fine roots and pores; strongly effervescent; few, common, distinct threads and splotches of lime; moderately alkaline; clear boundary.

- C1ca—8 to 17 inches, white (10YR 8/2) silty clay loam, brown (10YR 5/3) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots and pores; lime-coated pebbles, seams, casts, and threads; violently effervescent; moderately alkaline; gradual boundary.
- C2—17 to 24 inches, very pale brown (10YR 7/3) silty clay loam, pale brown (10YR 6/3) mottled with white (10YR 8/1) moist; massive; soft, friable, sticky and plastic; violently effervescent; moderately alkaline; gradual boundary.
- C3—24 to 60 inches, light-gray (10YR 7/2) silty clay loam, yellowish brown (10YR 5/4) moist; massive; soft, friable, sticky and plastic; 5 to 8 percent coarse sand, pebbles of limestone, and cherty sandstone; violently effervescent; moderately alkaline.

The A horizon is loam or stony loam. The B2 horizon is silty clay loam, loam, and clay loam. Coarse sand and fine gravel range from 5 to 10 percent by volume. Depth to the Cca horizon of lime accumulation ranges from 8 to 15 inches.

**Harvey loam, 2 to 4 percent slopes (Hf).**—This gently sloping and undulating soil is on fans and old stream terraces. It has the profile described as representative of the series.

A typical area is about 90 percent Harvey loam and 10 percent Stormitt and La Fonda soils. The Stormitt

and La Fonda soils are in convex areas and in swales that are 5 acres or less in size. The drainage pattern is dendritic. In places stream channels have cut into the bedrock.

Runoff is medium, and the hazard of erosion is slight. This soil is used mainly for grazing. A small acreage is dryfarmed to wheat, barley, alfalfa hay, and pasture. Capability unit IIIe-4, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

**Harvey loam, 4 to 8 percent slopes (Hg).**—This soil is on fans and terraces. Runoff is medium, and the hazard of erosion is moderate.

About 95 percent of the acreage is used for grazing; the rest is used for alfalfa pasture and small grain. Capability unit IIIe-4, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

**Harvey loam, 8 to 15 percent slopes (Hh).**—This soil is on strongly sloping and rolling fan terraces. Runoff is medium, and the hazard of erosion is moderate.

All the acreage is used for grazing. Capability unit IVe-4, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

**Harvey stony loam, 2 to 8 percent slopes (Hk).**—This soil is on fans and terraces. It has a profile similar to the one described as representative of the series, but its surface layer is stony.

Runoff is medium, and the hazard of erosion is slight. All the acreage is used for range. Capability unit IIIe-4, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

### Haverson Series

The Haverson series consists of deep, nearly level, well-drained soils. These soils formed in deep stratified alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 49° to 54° F. The frost-free period is 125 to 130 days. The natural vegetation is mixed grasses, forbs, and cottonwood trees along the streams.

In a representative profile the surface layer is grayish-brown silty clay loam about 10 inches thick. The underlying material extends to a depth of 60 inches. It is light brownish-gray fine sandy loam in the upper 8 inches and light brownish-gray stratified loam in the lower 42 inches.

The available water capacity is high, and permeability is moderate. These soils are used mainly for irrigated crops. A small acreage is used for pasture and range.

Representative profile of Haverson silty clay loam, 900 feet east and 1,400 feet north of SE. corner of sec. 28, T. 6 S., R. 23 E.

A1-0 to 10 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, fine, platy structure parting to fine granular; soft, friable, nonsticky and nonplastic; many very fine roots and pores; strongly effervescent; moderately alkaline; clear, smooth boundary.

IIC1-10 to 18 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; weak, fine, granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common, distinct, clear and stained sand grains; strongly effervescent; moderately alkaline; gradual boundary.

IIC2-18 to 60 inches, light brownish-gray (2.5Y 6/2) loam that is stratified with thin lenses of clay loam, fine sandy loam, and coarse sandy loam, dark grayish brown (2.5Y 4/2) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; strongly effervescent; moderately alkaline.

Lenses of clay loam in the substratum range from ¼ to 1 inch in thickness. A few gypsum crystals are between depths of 50 and 60 inches.

#### Haverson silty clay loam, 0 to 2 percent slopes (Hm).—

This soil is on stream terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Haverson soil and 5 percent Heldt silty clay loam and Glenberg loam. The Heldt and Glenberg soils are in irregularly shaped areas about 5 acres in size.

Drainageways are smooth, and in places they have cut into the deep alluvium. Runoff is slow, and the hazard of erosion is slight.

All but a small acreage is used for irrigated row crops, hay, small grain, and pasture. Capability unit I-1, irrigated; windbreak group 1.

#### Haverson-Heldt silty clay loams, 0 to 4 percent slopes (Hn).—

These soils are on flood plains or coalescing fans of narrow drainageways.

A typical area is about 70 percent Haverson soil, 25 percent Heldt soil, and 5 percent included Glenberg soils. Haverson silty clay loam and Heldt silty clay loam are in complex patterns. Both occur on fans or flood plains. The Glenberg soils are in irregularly shaped areas about

5 acres in size on flood plains. In places stream channels have cut deeply into the bedrock.

Runoff is medium, and the hazard of erosion is moderate.

These soils are used almost entirely for grazing. Some small areas are dryfarmed to grain, hay, and pasture. Capability unit IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

### Heath Series

The Heath series consists of deep, gently sloping to steep, well-drained soils. These soils formed in clay loam residuum weathered from shale or siltstone. Annual precipitation is 20 to 24 inches. The mean annual soil temperature ranges from 42° to 47° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs, and aspens grow in small groves in swales.

In a representative profile the surface layer is dark-gray clay loam about 3 inches thick. The subsoil is 25 inches thick. The upper 4 inches is dark-gray silty clay loam, the next 9 inches is brown silty clay loam, and the lower 12 inches is light olive-brown clay loam. The substratum is light olive-brown and light brownish-gray clay loam about 34 inches thick or more.

The available water capacity is high or moderate, and permeability is moderate. These soils are used for small grain, alfalfa, range, and pasture. Crops are raised mostly on the lower slopes.

Representative profile of Heath clay loam, 440 feet east and 620 feet north of SW. corner of sec. 5, T. 7 S., R. 20 E.

A1-0 to 3 inches, dark-gray (10YR 4/1) clay loam, very dark gray (10YR 3/1) moist; weak, medium and fine, granular structure; soft, friable, sticky and plastic; many fine and very fine roots; common fine tubular pores; neutral; clear boundary.

B21t-3 to 7 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist and coatings of dark brown (10YR 3/3) moist; moderate prismatic structure parting to moderate, medium and fine, angular blocky; hard, friable, sticky and plastic; common fine and very fine roots and pores; distinct clay films on faces of peds; neutral; clear, wavy boundary.

B22t-7 to 16 inches, brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist and coatings of dark grayish brown (10YR 4/2) moist; weak prismatic structure parting to moderate, medium, angular blocky; hard, friable, sticky and plastic; common very fine roots and pores; distinct clay films on faces of peds; neutral; clear, wavy boundary.

B3ca-16 to 28 inches, light olive-brown (2.5Y 5/4) clay loam, light olive brown (2.5Y 5/4) moist; moderate, medium and fine, angular blocky structure; hard, friable, sticky and plastic; few very fine roots and tubular pores, strongly effervescent; few, fine, distinct threads and seams of segregated lime; mildly alkaline; gradual boundary.

C1ca-28 to 36 inches, light olive brown (2.5Y 5/4) clay loam, grayish brown (2.5Y 5/2) moist mottled with white (2.5Y 8/2) and light brownish gray (2.5Y 6/2) moist; massive; hard, friable, sticky and plastic; few very fine roots; strongly effervescent; few common specks and seams of segregated lime; mildly alkaline; gradual boundary.

C2-36 to 62 inches, light brownish-gray (2.5Y 6/2) clay loam and weathered shale, light olive brown (2.5Y 5/4) moist; massive; hard, friable, sticky and plastic; slightly effervescent; mildly alkaline.

The subsoil ranges from silty clay loam to clay.

**Heath clay loam, 4 to 8 percent slopes (Ho).**—This soil is on bedrock plains in the uplands. It has the profile described as representative of the series.

A typical area is about 90 percent Heath clay loam and 10 percent Bynum sandy clay loam, Woodrock clay loam, and Charlos loam. The Bynum soils are on narrow divides and the convex sides. Woodrock soils are generally in swales under aspen trees. Charlos soils are in small areas of isolated remnants of outwash terraces. Areas of the included soils are 5 acres or less in size.

The drainage pattern is dendritic. Drainageways are smooth and U-shaped, and in a few places the stream channels have cut into the bedrock. Runoff is medium, and the hazard of erosion is slight.

This soil is used mainly for hay, pasture, and small grain. Some small areas are used for grazing. Capability unit IIIe-3, irrigated and IIIe-2, dryland; Clayey range site, 20 to 24 inches precipitation; windbreak group 1.

**Heath clay loam, 8 to 15 percent slopes (Hp).**—This strongly sloping and rolling soil is on bedrock plains in the uplands. Runoff is medium, and the hazard of erosion is slight. Nearly all the acreage is used for range. A very small acreage is in grain, hay, and pasture. Capability unit IVe-2, dryland; Clayey range site, 20 to 24 inches precipitation; windbreak group 1.

**Heath-Bynum association, steep (HR).**—This association is on upland bedrock plains. Slopes are 25 to 45 percent.

A typical area of this association is about 75 percent Heath clay loam, 20 percent Bynum sandy clay loam, and 5 percent Adel, Charlos, and Hanson soils. Heath soils are on ridges, divides, and knolls. Bynum soils are on convex ridges and knolls. The Hanson and Charlos soils are on scattered terrace remnants throughout the association. Adel soils are along drainageways. Areas of the included soils are less than 10 acres in size.

The drainage pattern is dendritic. Stream channels have cut deeply into the valley floors in places, and head erosion is in numerous spots. Runoff is medium, and the hazard of erosion is moderate.

These soils are used entirely for range. Capability unit VIe-1, dryland. Heath soils in Clayey range site, 20 to 24 inches precipitation, and windbreak group 1. Bynum soils in Silty range site, 15 to 19 inches precipitation, and windbreak group 2.

## Heldt Series

The Heldt series consists of deep, nearly level to strongly sloping, well-drained soils. These soils formed in deep alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 48° to 51° F., and the frost-free period is 120 to 130 days. The natural vegetation is mixed mid and short grasses, forbs, shrubs, and cottonwood trees along the streams.

In a representative profile the surface layer is grayish-brown silty clay loam about 7 inches thick. The subsoil is grayish-brown silty clay loam 11 inches thick. The upper 12 inches of the substratum is light brownish-gray silty clay loam and the lower 30 inches is light brownish-gray silty clay loam.

The available water capacity is high, and permeability is slow. These soils are used mostly for dryfarmed and

irrigated crops and pasture. A small acreage is used as range.

Representative profile of Heldt silty clay loam, 700 feet north and 200 feet east of SW. corner of sec. 28, T. 6 S., R. 23 E.

Ap—0 to 7 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; weak, thin, platy structure parting to granular; hard, friable, sticky and plastic; few very fine and fine roots and very fine pores; mildly alkaline; gradual, smooth boundary.

B21—7 to 13 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate prismatic structure parting to weak, medium, angular blocky; hard, friable, sticky and plastic; common very fine roots and pores; mildly alkaline; gradual boundary.

B22—13 to 18 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; moderate prismatic structure; hard, friable, sticky and plastic; few very fine and fine roots and very fine pores; mildly alkaline; gradual boundary.

C1—18 to 30 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; hard, friable, sticky and plastic; few very fine roots and pores; strongly effervescent; strongly alkaline; clear, wavy boundary.

C2—30 to 60 inches, light brownish-gray (5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, sticky and plastic; very few, very fine roots and pores; stratified layers of fine sandy loam, clay loam, and sandy loam; strongly effervescent; strongly alkaline.

The lower part of the B horizon contains strata of fine sandy loam and clay that range from ½ to 1 inch in thickness.

**Heldt silty clay loam, 0 to 2 percent slopes (Hs).**—This soil is on stream terraces and fans. It has the profile described as representative of the series.

A typical area is about 95 percent Heldt silty clay loam and 5 percent included Haverson and Glenberg soils. The included soils are in irregularly shaped areas 5 acres or less in size.

In many places stream channels have cut deeply into the alluvial material. Runoff is slow, and the hazard of erosion is slight.

This soil is used mainly for irrigated row crops, small grain, and alfalfa. Some areas are dryfarmed. A few small acreages are irrigated pasture. Capability units IIIs-1, irrigated and IIIs-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Heldt silty clay loam, 2 to 4 percent slopes (Ht).**—This soil is on stream terraces and fans. Runoff is slow, and the hazard of erosion is slight.

About 95 percent of the acreage is used for irrigated row crops, small grain, and alfalfa. Some small areas are dryfarmed. The rest is used for irrigated pastures. Capability unit IIe-1, irrigated and IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Heldt silty clay loam, 4 to 8 percent slopes (Hu).**—This soil is on stream terraces and fans. Runoff is medium, and the hazard of erosion is slight. About 75 percent of the acreage is used for irrigated small grain and hay. Some small areas are dryfarmed. The rest is range. Capability unit IIIe-1, irrigated and IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Heldt silty clay loam, 8 to 15 percent slopes (Hv).**—This strongly sloping and rolling soil is on fan terraces. Runoff is medium, and the hazard of erosion is moderate. About 70 percent of the acreage is in small grain, hay, and pasture; the rest is range. Capability unit IVe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Heldt silty clay loam, saline, 0 to 6 percent slopes (Hw).**—This soil is nearly level in swales and gently sloping on stream terraces. It is subject to seepage from areas of higher lying soils and irrigation canals. A high concentration of salts in the soil makes it unsuited to most crops. Drainage and soil amendments are needed. Runoff is medium, and the hazard of erosion is slight.

All the acreage is irrigated pasture. Capability unit IIw-1, irrigated; windbreak group 9.

## Hydro Series

The Hydro series consists of deep, gently sloping, well-drained soils on uplands. These soils formed in deep alluvium on fans and foot slopes. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 45° to 48° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed short grass, forbs, and shrubs.

In a representative profile the surface layer is light brownish-gray silt loam about 5 inches thick. The subsoil is 19 inches thick. The upper 8 inches is brown silty clay loam, the middle 3 inches is very dark grayish-brown silty clay, and the lower 8 inches is pale-brown silty clay. The substratum is light yellowish-brown clay loam to a depth of 60 inches or more.

The available water capacity is high, and permeability is slow. These soils are used as range.

Representative profile of Hydro silt loam, 2,000 feet south and 200 feet west of NE. corner of sec. 10, T. 6 S., R. 22 E.

A1—0 to 2 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate, thin, platy structure parting to moderate, very fine, granular; soft, friable, nonsticky and nonplastic; many fine and very fine roots and pores; slightly acid; clear, wavy boundary.

A&B—2 to 5 inches, light brownish-gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak, medium and thin, platy structure; soft, friable, nonsticky and nonplastic; many uncoated mineral grains on top of the plates; many fine and very fine roots and very fine pores; thin clay films; slightly acid; clear, wavy boundary.

B21t—5 to 13 inches, brown (10YR 5/3) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine, subangular blocky structure; hard, firm, sticky and plastic; distinct clay films; many fine and very fine compressed roots and few very fine pores; moderately alkaline; clear, wavy boundary.

B22t—13 to 16 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark gray (10YR 3/1) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, angular blocky; hard, firm, sticky, and plastic; distinct clay films; many compressed roots; many fine and very fine roots and pores; moderately alkaline; gradual, smooth boundary.

B3ca—16 to 24 inches, pale-brown (10YR 6/3) silty clay, dark grayish brown (10YR 4/2) moist; moderate, medium and fine, angular blocky structure; hard, friable, sticky and plastic; many very fine roots and pores; strongly effervescent; common threads and seams of

segregated lime; moderately alkaline; gradual, smooth boundary.

C1—24 to 40 inches, light yellowish-brown (10YR 6/4) clay loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; strongly effervescent; strongly alkaline; gradual boundary.

C2—40 to 60 inches, clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, sticky and plastic; strongly effervescent; many salt and gypsum crystals in lower part of the horizon in threads and pockets; strongly alkaline.

The combined thickness of the A and the A&B horizons ranges from 5 to 11 inches and the noncalcareous part of the solum from 14 to 18 inches. The depth to salt or gypsum crystals ranges from 48 to 50 inches.

**Hydro silt loam, 4 to 8 percent slopes (Hy).**—This soil is on upland foot slopes. It has the profile described as representative of the series.

A typical area is about 95 percent Hydro silt loam and 5 percent included areas of Razor clay loam and Heldt silty clay loam. The included soils are in irregularly shaped areas less than 2 acres in size.

The drainage pattern is dendritic. In places stream channels have cut deeply into the bedrock. The hazard of erosion is slight, and runoff is medium.

This soil is used for range. Capability unit IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 11.

## Kyle Series

The Kyle series consists of deep, nearly level to strongly sloping, well-drained soils. These soils formed in clay material derived from sediment of weathered calcareous clay shales. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 45° to 53° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed mid and short grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown clay about 2 inches thick. The subsoil is 34 inches thick. It is light brownish gray in the upper 22 inches and light gray clay in the lower 12 inches. The substratum is light brownish-gray, calcareous clay.

The available water capacity is high, and permeability is very slow. These soils are used for small grain, alfalfa hay, pasture, and range.

Representative profile of Kyle clay, 600 feet west and 840 feet north of SW. corner of sec. 24, T. 6 S., R. 23 E.

A1—0 to 2 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; soft, friable, sticky and plastic; many fine and very fine roots and pores; mildly alkaline; clear, wavy boundary.

B2—2 to 24 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; moderate, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; distinct pressure faces; common very fine and fine roots and very fine pores; mildly alkaline; gradual boundary.

B3ca—24 to 36 inches, light-gray (10YR 7/2) clay, grayish brown (10YR 5/2) moist; moderate, medium, subangular blocky structure; hard, friable, sticky and plastic; many very fine roots and tubular pores; common fine and distinct lime segregations; strongly effervescent; moderately alkaline, gradual boundary.

C1ca—36 to 44 inches, light brownish-gray (2.5Y 6/2) clay, grayish brown (10YR 5/2) moist, mottled with white (2.5Y 8/2) moist; massive; hard, friable, sticky and

plastic; few very fine roots and pores; common distinct threads and seams of segregated lime, strongly alkaline; gradual boundary.

C2—44 to 60 inches, light brownish-gray (2.5Y 6/2) clay that has many particles of shale, light brownish gray (10YR 6/2) moist; massive; soft, friable, sticky and plastic; strongly effervescent; strongly alkaline; few fine gypsum crystals.

Cracks  $\frac{1}{4}$  to 1 inch wide appear at the surface when these soils dry. These soils are more than 60 percent clay to a depth of 40 inches. Depth to unweathered shale ranges from 48 to 65 inches. Gypsum crystals are below a depth of 48 inches.

**Kyle clay, 0 to 2 percent slopes (Kc).**—This soil is on uplands. It has the profile described as representative of the series.

A typical area is about 95 percent Kyle clay and 5 percent included areas of Marias clay and Lismas clay. The Marias and Lismas soils are on ridges and the sides of drainage ways in irregularly shaped areas about 2 to 3 acres in size. The drainage pattern is dendritic. In many places stream channels have cut deeply into the clay material. The hazard of erosion is slight, and runoff is slow.

Nearly all the acreage is used for row crops, small grain, alfalfa hay, and pasture. About 75 percent of the acreage is cultivated, and the rest is range. Capability unit IIIs-1, irrigated and IIIs-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 4.

**Kyle clay, 2 to 4 percent slopes (Kd).**—This soil is on uplands. Runoff is medium, and the hazard of erosion is slight. About 75 percent of the acreage is used for row crops, small grain, hay, and pasture; the rest is used as range. Capability unit IIIe-1, irrigated and IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 4.

**Kyle clay, 4 to 8 percent slopes (Ke).**—This gently sloping and rolling soil is on uplands. Runoff is medium, and the hazard of erosion is slight. About half the acreage is used for small grain, hay, and pasture and half is used for range. Capability unit IVe-1, irrigated and IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 4.

**Kyle clay, 8 to 15 percent slopes (Kf).**—This strongly sloping and rolling soil is on uplands. Runoff is medium, and the hazard of erosion is severe. The entire acreage is used for grazing. Capability unit IVe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 4.

## La Fonda Series

The La Fonda series consists of deep, nearly level and gently sloping, well-drained soils. These soils formed in deep loamy alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 48° to 55° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed short and mid grasses, forbs, and shrubs.

In a representative profile the surface layer is reddish-brown loam about 5 inches thick. The subsoil is 16 inches thick. It is reddish-brown silty clay loam in the upper 11 inches and light reddish-brown silty clay loam in the lower 5 inches. The substratum is 51 inches thick. The upper 32 inches is reddish-brown clay loam, and the lower 19 inches is reddish-brown very gravelly loam.

The available water capacity is high or moderate, and permeability is moderate. These soils are used for range.

Representative profile of La Fonda loam, 100 feet east and 80 feet south of NW. corner of sec. 30, T. 7 S., R. 25 E.

A1—0 to 5 inches, reddish-brown (5YR 5/3) loam, reddish brown (5YR 4/3) moist and coatings of dark reddish gray (5YR 4/2) moist; weak platy structure parting to weak, medium and fine, granular; soft, friable, nonsticky and nonplastic; common fine and very fine roots and pores; slightly effervescent; mildly alkaline; clear, wavy boundary.

B2—5 to 16 inches, reddish-brown (5YR 5/3) light silty clay loam, dark reddish brown (5YR 3/3) moist, and coatings of dark reddish gray (5YR 4/2) moist; prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; distinct clay films; common fine and very fine roots and pores; slightly effervescent; mildly alkaline; clear, wavy boundary.

B3ca—16 to 21 inches, light reddish-brown (5YR 6/3) light silty clay loam, dark reddish brown (5YR 3/3) moist, and coatings of reddish gray (5YR 4/2) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; strongly effervescent; few, fine, distinct threads and seams of segregated lime; moderately alkaline; gradual boundary.

C1—21 to 53 inches, reddish-brown (5YR 5/3) clay loam, reddish brown (5YR 4/3) moist, mottled with reddish brown (5YR 5/3) moist; massive; slightly hard, friable, sticky and plastic; very strongly effervescent; moderately alkaline; 10 percent gravel; gradual boundary.

C2—53 to 72 inches, reddish-brown (5YR 5/3) very gravelly loam, reddish brown (5YR 4/3) moist; massive; 75 percent pebbles less than 3 inches in diameter, 15 percent larger than 3 inches; very strongly effervescent; strongly alkaline.

The most common rock fragments are quartz, argillite, and limestone. Depth to the very gravelly loam substratum ranges from 50 to 60 inches.

**La Fonda loam, 0 to 2 percent slopes (la).**—This soil is on high stream terraces and fans. It has the profile described as representative of the series.

A typical area is about 95 percent La Fonda loam and 5 percent included Stormitt and Harvey soils. The areas of Harvey and Stormitt soils are irregular in shape and 5 acres or less in size. They are in slightly higher lying areas. The drainage pattern is dendritic. Stream channels are smooth and U-shaped and show only a little cutting. Runoff is slow, and the hazard of erosion is slight.

This soil is used for range. Capability unit IIIc-1, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 1.

**La Fonda loam, 2 to 4 percent slopes (lb).**—This soil is on terraces and fans. Runoff is slow, and the hazard of erosion is moderate.

This soil is used for range. Capability unit IIIe-4, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 1.

## Lambeth Series

The Lambeth series consists of deep, gently sloping, well-drained soils. The soils formed in silt loam residuum. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 44° to 47° F., and the frost-free

period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is 7 inches thick. The upper 3 inches is grayish-brown silt loam, and the lower 4 inches is pale-brown silt loam. The underlying material is 35 inches thick. The upper 8 inches is pale-brown silt loam, the middle 21 inches is light yellowish-brown silt loam, and the lower 6 inches is very pale brown very fine sandy loam. Hard sandstone is at a depth of 42 inches.

The available water capacity is moderate, and permeability is slow. All the acreage is used for range.

Representative profile of Lambeth silt loam, 700 feet east and 1,000 feet south of NW. corner of sec. 1, T. 6 S., R. 24 E.

A11—0 to 3 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate to fine granular structure; soft, friable, nonsticky and nonplastic; many fine and very fine roots and pores; slightly effervescent; mildly alkaline; clear, wavy boundary.

A12—3 to 7 inches, pale-brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) coated with brown (10YR 5/3) moist; moderate, fine, granular structure; soft, friable, nonsticky and nonplastic; many fine and very fine roots and pores; slightly effervescent; mildly alkaline; clear, wavy boundary.

C1—7 to 15 inches, pale-brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) moist and coatings of light yellowish brown (10YR 6/4) moist; weak blocky structure parting to moderate granular; soft, friable, nonsticky and nonplastic; few fine and very fine roots and tubular pores; strongly effervescent; moderately alkaline; gradual boundary.

C2—15 to 36 inches, light yellowish-brown (10YR 6/4) silt loam, yellowish brown (10YR 5/4) moist; massive; soft, friable, nonsticky and nonplastic; few very fine roots; strongly effervescent; moderately alkaline; gradual boundary.

IIC3—36 to 42 inches, very pale brown (10YR 7/3) very fine sandy loam, yellowish brown (1YR 5/4) moist; massive; soft, friable, nonsticky and nonplastic; few fine roots; strongly effervescent; strongly alkaline; abrupt boundary.

IIR—42 inches, sandstone that has a lime coating on underside of shale plates.

Depth to siltstone or sandstone is 40 to 60 inches.

**Lambeth silt loam, 4 to 8 percent slopes (lc).**—This soil is on uplands. It has the profile described as representative of the series.

A typical area is about 95 percent Lambeth silt loam and 5 percent included Cabba and Rentsac soils. The Cabba and Rentsac soils are on convex ridges and divides in areas of 5 acres or less. The drainage pattern is dendritic. In places stream channels have cut into the bedrock. Runoff is medium, and the hazard of erosion is slight.

All the acreage is used as range. Capability unit IIIe-4, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 2.

## Lap Series

The Lap series consists of shallow, moderately steep and steep, well-drained soils. These soils formed in residuum weathered from limestone. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 41° to 46° F., and the frost-free period is 70 to

115 days. The natural vegetation is mixed short grasses, black sage, and juniper.

In a representative profile the surface layer is dark grayish-brown channery loam about 5 inches thick. The underlying material is 13 inches thick. The upper 2 inches is light brownish-gray very channery loam, and the lower 11 inches is pale-yellow very channery loam. Limestone bedrock is at a depth of 18 inches.

The available water capacity is very low, and permeability is moderate. All the acreage is used as summer range.

The Lap soils in the Carbon County Area are mapped only with Armington and Windham soils and with Rock outcrop.

Representative profile of Lap channery loam in an area of Lap-Rock outcrop association, moderately steep, 800 feet south and 700 feet west of the NE. corner of sec. 23, T. 7 S., R. 25 E.

A—0 to 5 inches, dark grayish-brown (2.5Y 4/2) channery loam, very dark grayish brown (2.5Y 3/2) moist; weak, coarse, platy structure; soft, friable, slightly sticky and slightly plastic; common fine and very fine roots; few very fine pores; slightly effervescent; mildly alkaline; 45 percent flat fragments of limestone; clear, wavy boundary.

C1—5 to 7 inches, light brownish-gray (2.5Y 6/2) very channery loam, dark grayish brown (2.5Y 4/2) moist; medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots but mats of roots under gravel; very strongly effervescent; moderately alkaline; 55 percent flat fragments of limestone that have pendants of lime on underside; clear, wavy boundary.

C2—7 to 18 inches, pale-yellow (2.5Y 7/4) very channery loam, light olive brown (2.5Y 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; violently effervescent; few matted fine roots; moderately alkaline; 70 percent flat fragments of limestone that have pendants of lime on underside; abrupt boundary.

R—18 inches, hard, shattered limestone.

The C horizon is 14 to 22 percent clay, 40 to 50 percent silt, and 40 to 70 percent coarse fragments. Depth to limestone is 6 to 20 inches.

**Lap-Armington association, hilly (ld).**—This association of soils is on limestone and shale uplands. Slopes are 15 to 25 percent. A typical area is about 50 percent Lap channery loam, 40 percent Armington silty clay, and 10 percent Rottulee silt loam and Hanson soils. The Lap soil is on the narrow divides and ridges. The Armington soil is on the side slopes.

Runoff is rapid, and the hazard of erosion is moderate. The drainage pattern is dendritic and includes deep limestone canyons. In places stream channels have cut deeply into shale beds.

This association is used only for grazing. Capability unit VIe-1, dryland. Lap soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3. Armington soil in Clayey range site, 15 to 19 inches precipitation, and windbreak group 4.

**Lap-Rock outcrop association, moderately steep (le).**—The soil part of this association has the profile described as representative of its series. A typical area is about 75 percent Lap soils, 20 percent Rock outcrop of limestone, and 5 percent Windham soils. The Lap soils are on narrow ridges between the deep canyons. The Windham and Peritsa soils are on the upper parts of the broader slopes.

Runoff is rapid, and the hazard of erosion is slight. Drainageways are deep limestone canyons. Stream channels have cut down to the limestone.

This association is used for summer range. Shallow range site, 15 to 19 inches precipitation; windbreak group 3. Lap soil in capability unit VIe-1, dryland. Rock outcrop in capability unit VIIIs-1, dryland.

**Lap-Windham association, steep (LF).**—A typical area of this association is about 75 percent Lap soil and limestone outcrop and 25 percent Windham soil. The outcrops of limestone are ledges along the steep canyon walls and convex ridges throughout the association. The Lap soil is on the narrow ridges between the steep canyons. The Windham soil is on fans below the smooth ridges.

Runoff is rapid, and the hazard of erosion is moderate. The drainage pattern is dendritic. The drainageways are steep limestone canyons. The association is used only for summer grazing and some forms of recreation. Wildlife is abundant. Capability unit VIe-1, dryland. Lap soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3. Windham soil in Silty range site, 15 to 19 inches precipitation, and windbreak group 1.

### Larim Series

The Larim series consists of deep, strongly sloping, well-drained soils on the edges of terraces. These soils formed in deep gravelly alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 48° to 52° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is light brownish-gray gravelly sandy loam about 4 inches thick. The subsoil is brown very gravelly clay loam about 6 inches thick. The substratum is very gravelly sand to a depth of 60 inches and more.

The available water capacity is very low, and permeability is moderately rapid. All the acreage is used for grazing.

Representative profile of Larim gravelly sandy loam, 500 feet north and 400 feet west of SW. corner of sec. 31, T. 2 S., R. 24 E.

A1—0 to 4 inches, light brownish-gray (10YR 6/2) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; single grained to granular structure; slightly hard, friable, nonsticky and nonplastic; many fine and very fine roots; neutral; gradual boundary.

B2t—4 to 10 inches, brown (10YR 4/3) very gravelly clay loam, very dark grayish brown (10YR 3/2) moist; weak angular blocky structure; hard, friable, nonsticky and nonplastic; few very fine roots; neutral; gradual boundary.

IIC—10 to 60 inches, very gravelly sand.

Depth to sand and gravel ranges from 10 to 15 inches. The B2t horizon is 35 to 60 percent gravel and cobblestones.

**Larim gravelly sandy loam, 8 to 15 percent slopes (lg).**—This soil is on the edges of terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Larim gravelly sandy loam and 5 percent included Olney and Midway soils. The Olney soils finger into the Larim soils in irregularly shaped areas less than 3 acres in size. The Midway soils are on the lower part of terrace edges.

The drainage pattern is dendritic. Stream channels are smooth and U-shaped. Runoff is slow, and the hazard of erosion is slight. This soil is used only for grazing. Capability unit VIe-1, dryland; Sandy range site, 10 to 14 inches precipitation; windbreak group 10.

### Limestone Outcrop

Limestone outcrop (LH) consists of cliffs and canyon walls. Slopes are more than 90 percent. A typical area is about 95 percent outcrop and 5 percent included shallow to deep soils. The shallow soils are on the narrow, convex divides between deep limestone canyons and the deeper talus soil material below the limestone cliffs.

Runoff is rapid, and the hazard of erosion is slight. Streams flow on the limestone bedrock.

This unit is used for watershed, wildlife, and recreation. Capability unit VIIIs-1.

### Lisam Series

The Lisam series consists of shallow, strongly sloping to steep, well-drained soils. These soils formed in clayey shales. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 42° to 47° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is light gray clay about 4 inches thick. The underlying material is gray clay and sandstone. Gray platy shale and sandstone are at a depth of about 18 inches.

The available water capacity is very low, and permeability is very slow. These soils are used entirely for grazing.

The Lisam soils in the Carbon County Area are mapped only with Marias soils.

Representative profile of Lisam clay, 1,000 feet east and 2,000 feet north of the SW. corner of sec. 36, T. 4 S., R. 22 E.

A1—0 to 4 inches, light-gray (2.5Y 6/1) clay, grayish brown (2.5Y 5/2) moist; weak platy and granular structure; slightly hard, friable, sticky and plastic; few very fine roots; slightly effervescent; moderately alkaline; gradual boundary.

C1—4 to 14 inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) moist; platy structure; hard, sticky and plastic; fibrous roots penetrate the fractures and mat between layers of weathered shale; slightly effervescent; moderately alkaline; gradual, smooth boundary.

C2—14 to 18 inches, gray (5Y 5/1) clay, dark gray (5Y 4/1) moist; platy; hard, sticky and plastic; common partly weathered shale fragments; slightly effervescent; strongly alkaline; few gypsum and salt crystals; abrupt boundary.

C3—18 inches, shale that has hard layers of sandstone.

Segregations of gypsum or lime are in the lower part of the C horizon or the upper part of the R horizon. Depth to unweathered shale is 10 to 20 inches.

**Lisam-Marias complex, 8 to 15 percent slopes (lm).**—This complex is on uplands. A typical area is about 70 percent Lisam clay, 20 percent Marias clay, and 10 percent included areas of Absarokee clay loam, Sinnigam soils, and outcrops of sandstone and shale. The Lisam clay is on broad ridgetops, tabular divides, and convex areas throughout the complex.

The drainage pattern is dendritic. In places stream channels have cut deeply into the bedrock. The hazard of erosion is moderate, and runoff is rapid.

These soils are used for grazing. Capability unit VIe-1, dryland. Lisam soil in Shallow to Clay range site, 10 to 14 inches precipitation, and windbreak group 3. Marias soil in Clayey range site, 10 to 14 inches precipitation, and windbreak group 4.

**Lisam-Marias complex, steep (LN).**—This complex is on shale uplands. Slopes are 15 to 45 percent. The Lisam soil makes up 65 percent of the acreage and the Marias soil 35 percent. Runoff is rapid, and the hazard of erosion is moderate.

This complex is used for grazing. Capability unit VIe-1, dryland. Lisam soil in Shallow to Clay range site, 10 to 14 inches precipitation, and windbreak group 3. Marias soil in Clayey range site, 10 to 14 inches precipitation, and windbreak group 4.

### Lismas Series

The Lismas series consists of shallow, hilly, well-drained soils. These soils formed in clay residuum weathered from clayey shale. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 48° to 52° F., and the frost-free period is 110 to 120 days. The natural vegetation is Gardner saltbush, mixed grasses, greasewood, and shrubs.

In a representative profile the surface layer is olive-gray clay about 4 inches thick. The underlying material is dark-gray clay about 8 inches thick. Shale is at a depth of 12 inches.

The available water capacity is very low, and permeability is very slow. All the acreage is used for range.

Representative profile of Lismas clay, hilly, 1,400 feet north of S $\frac{1}{4}$  corner of sec. 10, T. 7 S., R. 23 E.

A—0 to 4 inches, olive-gray (5Y 5/2) clay, olive (5Y 5/4) moist; surface crust is one-eighth inch thick; strong angular structure; hard, firm, sticky and plastic; few fine and very fine roots and interstitial pores; very strongly effervescent; very strongly alkaline; clear, wavy boundary.

C1—4 to 12 inches, dark-gray (5Y 4/1) weathered clay shale, mottled with gray (5Y 5/1) and black (5Y 2/1) moist; massive; very hard, firm; common gypsum and salt crystals; common partly weathered shale fragments; very strongly effervescent; strongly alkaline; abrupt boundary.

C2—12 inches, dark-gray (5Y 4/1) platy shale, roots penetrate shale layers only through fractures, shale easily chipped or broken; many gypsum and salt crystals between shale layers.

A thin, soft, vesicular crust  $\frac{1}{8}$  to  $\frac{1}{4}$  inch thick is on the surface in places. Depth to shale bedrock ranges from 8 to 15 inches.

**Lismas clay, hilly (LO).**—This soil is on shale uplands. Slopes are 8 to 15 percent. This soil has the profile described as representative of the series.

A typical area is about 90 percent Lismas clay and 10 percent included areas of Kyle clay, Midway clay loam, and Travessilla soils. Kyle clay is on benches and in swales. Midway and Travessilla soils are on the convex ridges and narrow divides. The drainage pattern is dendritic. Stream channels in places are U-shaped and smooth. Some have cut into the bedrock where slopes are steeper. The hazard of erosion is moderate, and runoff is rapid.

This soil is used entirely for grazing. Capability unit VIe-1, dryland; Shallow to Clay range site, 10 to 14 inches precipitation; windbreak group 3.

### Lohler Series

The Lohler series consists of deep, nearly level to gently sloping, well-drained soils. These soils formed in clayey alluvium on fans and stream terraces. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 43° to 45° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, shrubs, willows, and trees.

In a representative profile the surface layer is grayish-brown silty clay loam about 2 inches thick. The underlying material is 60 inches thick. The upper 12 inches is grayish-brown silty clay. The next 28 inches is gray and light olive-gray clay loam that has segregations of lime. The lower 20 inches is light olive-gray clay loam.

The available water capacity is high, and permeability is moderately slow. These soils are used for small grain, alfalfa, meadow hay, and pasture.

Representative profile of Lohler silty clay loam, 1,200 feet north and 300 feet east of SW. corner of sec. 36, T. 4 S., R. 21 E.

A1—0 to 2 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, fine, blocky structure parting to weak granular; slightly hard, friable, sticky and plastic; few very fine roots and pores; neutral; clear, wavy boundary.

C1—2 to 14 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium and fine, blocky structure; slightly hard, friable, sticky and plastic; about 40 percent clay; many fine and very fine roots and pores; slightly effervescent; mildly alkaline; clear, wavy boundary.

C2—14 to 20 inches, gray (5Y 6/1) clay loam, olive gray (5Y 5/2) moist; moderate, medium and fine, blocky structure; slightly hard, friable, sticky and plastic; strongly effervescent; moderately alkaline; clear, wavy boundary.

C3ca—20 to 42 inches, light olive-gray (5Y 6/2) clay loam, olive gray (5Y 5/2) moist, mottled with white (5Y 8/2) moist; massive; slightly hard, friable, sticky and plastic; common distinct mottles of lime, threads and seams of segregated lime, and lime-coated gravel; strongly effervescent; moderately alkaline; gradual boundary.

C4—42 to 62 inches, light olive-gray (5Y 6/2) clay loam, olive (5Y 5/3) moist; massive; soft, friable, sticky and plastic; strongly effervescent; moderately alkaline.

Moist soils do not contain segregations of lime. In the lower part of the B horizon and throughout the C horizon the gravel is coated with lime.

**Lohler silty clay loam, 0 to 2 percent slopes (Lp).**—This soil is on bottom land and stream terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Lohler silty clay loam and 5 percent included Adel, Bearmouth, and Maurice soils. The included soils finger through this unit in irregularly shaped areas 5 acres or less in size. The Bearmouth soils are next to stream channels and in low swales.

Stream channels are smooth, and only in places have they actively cut into the deep alluvium. Runoff is slow, and the hazard of erosion is slight.

This soil is used for irrigated crops, chiefly small grain, alfalfa, meadow hay, and pasture grass. Capability unit IIs-1, irrigated and IIs-2, dryland; Clayey

range site, 15 to 19 inches precipitation; windbreak group 1.

**Lohler silty clay loam, 2 to 4 percent slopes (Lr).**—This soil is on fans and stream terraces. Runoff is medium, and the hazard of erosion is slight. The soil is used for small grain, alfalfa, grass, hay, and pasture. Capability unit IIe-1, irrigated and IIe-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 1.

**Lohler silty clay loam, saline, 0 to 4 percent (Ls).**—This soil is on bottom lands, stream terraces, and fans. It is subject to seepage from higher lying areas and irrigation canals. A high concentration of salts, which has accumulated throughout this soil, makes the soil unsuited to most crops. Through proper drainage and the addition of corrective amendments, the range of suitability can be increased.

All the acreage is in irrigated pasture, commonly of salt-tolerant grasses. Runoff is slow, and the hazard of erosion is slight. Capability unit IIw-1, irrigated; windbreak group 9.

## Macar Series

The Macar series consists of deep, gently weathered from clayey, silty, and sandy shale. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 42° to 45° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown clay loam about 7 inches thick. The subsoil also is clay loam, which is grayish brown in the upper 11 inches and light olive gray in the lower 11 inches. The substratum is light olive-gray and light-gray sandy clay loam and silt loam.

The available water capacity is high, and permeability is moderate. These soils are used for small grain, alfalfa hay, and pasture. About 95 percent of the acreage is cropped, and the rest is range.

Representative profile of Macar clay loam, 1,400 feet west and 1,400 feet south of NE. corner of sec. 1, T. 5 S., R. 21 E.

Ap—0 to 7 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist and coatings of very dark grayish brown (2.5Y 3/2) moist; weak, medium and fine, angular blocky structure parting to moderate, medium and fine, granular; slightly hard, friable, sticky and plastic; few very fine roots and tubular pores; mildly alkaline; gradual boundary.

B2—7 to 18 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist, and coatings of dark grayish brown (2.5Y 4/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, very sticky and plastic; distinct clay films; many very fine roots and pores; mildly alkaline; gradual boundary.

B3ca—18 to 29 inches, light olive-gray (5Y 6/2) clay loam, olive gray (5Y 4/2) moist, mottled with olive gray (5Y 5/2) moist and light gray (5Y 7/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, angular blocky; hard, friable, sticky and plastic; few very fine roots and pores; common distinct splotches and threads of segregated lime; strongly effervescent; moderately alkaline; abrupt, wavy boundary.

C1—29 to 38 inches, light olive-gray (5Y 6/2) sandy clay loam, olive gray (5Y 5/2) moist; massive; slightly

hard, friable, sticky and nonplastic; violently effervescent; strongly alkaline; gradual boundary.

C2—38 to 62 inches, light-gray (5Y 6/1) silt loam, gray (5Y 5/1) moist; massive; soft, friable, nonsticky and nonplastic; violently effervescent; strongly alkaline; abrupt, wavy boundary.

Depth to the B3ca horizon ranges from 18 to 22 inches.

**Macar-Cabba clay loams, 4 to 8 percent slopes (Mc).**—The soils of this mapping unit are on uplands. The profile of the Cabba soil is similar to the one described as representative of its series, but the surface layer is clay loam.

A typical area is about 70 percent Macar clay loam and 25 percent Cabba clay loam. The remaining 5 percent is Absarokee and Rentsac soils. The Macar soil is in swales and on short foot slopes below knobs of Cabba soil. The Absarokee and Rentsac soils are in convex areas above the Cabba soils. The drainage pattern is dendritic. Drainageways are smooth and U-shaped. In places stream channels have cut into the underlying bedrock.

Runoff is slow, and the hazard of erosion is moderate.

These soils are mostly dryfarmed to small grain, alfalfa hay, and pasture. A small acreage is used for range. Capability unit IIIe-2, dryland. Macar soil in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Cabba soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

**Macar-Cabba clay loams, 8 to 15 percent slopes (Mb).**—These strongly sloping and rolling soils are on uplands. The Cabba has a soil profile similar to the one described as representative of its series, but the surface layer is clay loam. Runoff is medium, and the hazard of erosion is moderate.

About 85 percent of the acreage is used for crops, alfalfa hay, and pasture; the rest is used as range. Capability unit IVe-2, dryland. Macar soil in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Cabba soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

## Marias Series

The Marias series consists of deep, gently sloping to strongly sloping, well-drained soils. These soils formed in thick clayey materials. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 45° to 47° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown clay about 5 inches thick. The underlying material is 55 inches thick. The upper 12 inches is grayish-brown clay, the middle 25 inches is light olive-gray clay, and the lower 18 inches or more is pale-olive clay.

The available water capacity is moderate, and permeability is very slow. These soils are used mainly for crops, alfalfa hay, and pasture. A small acreage is range.

Representative profile of Marias clay, 2,000 feet south and 100 feet east of NW. corner of sec. 5, T. 7 S., R. 24 E.

A1—0 to 5 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; many fine and very fine roots and pores; a crust one-fourth inch thick has formed on the surface; strongly effervescent; moderately alkaline; clear, wavy boundary.

C1ca—5 to 17 inches, grayish-brown (2.5Y 5/2) clay, olive gray (5Y 5/2) moist; weak, medium and moderately fine, blocky structure; hard, firm, sticky and plastic; few very fine roots and pores; many threads; splotches and small pockets of soft lime; strongly effervescent; strongly alkaline; gradual boundary.

C2ca—17 to 42 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 5/2) moist; strong, coarse and moderate, prismatic structure parting to weak, coarse, blocky; extremely hard, firm, sticky and plastic; few very fine roots and pores; common, fine, distinct segregations of lime; strongly effervescent; strongly alkaline; gradual boundary.

C3ca—42 to 60 inches, pale-olive (5Y 6/3) clay mottled with gray (5Y 6/1), olive (5Y 4/3) moist; massive; hard, firm, sticky and plastic; common distinct and fine lime segregations; strongly effervescent; strongly alkaline.

The content of clay ranges from 40 to 60 percent in all horizons. Gypsum crystals are below a depth of 40 inches.

**Marias clay, 2 to 8 percent slopes (Mc).**—This soil is on plains and valley terraces of uplands. It has the profile described as representative of the series.

A typical area is about 90 percent Marias clay and 10 percent included Absarokee, Rentsac, and Wayden soils. These included soils are on convex ridges, narrow divides, and edges of terraces.

The drainage pattern is dendritic. Streamways are smooth and U-shaped. In a few places the stream channels have cut deeply into the underlying bedrock. The hazard of erosion is slight, and runoff is slow.

This soil is used for small grain, pasture, and alfalfa, and a small acreage is range. Capability unit IIIe-4, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 4.

**Marias clay, 8 to 15 percent slopes (Md).**—This strongly sloping and rolling soil is on plains and fan terraces of uplands. Runoff is medium, and the hazard of erosion is moderate.

About 80 percent of the acreage is used for small grain and pasture. The rest is used for grazing. Capability unit IVe-4, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 4.

## Marsh

Marsh (Me) is not used for farming. It is used mostly as habitat for water-adapted animals and fowl. Herbaceous plants are the only vegetation. Capability unit VIIIw-1.

## Martinsdale Series

The Martinsdale series consists of deep, gently sloping, well-drained soils. These soils formed in old alluvium. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 43° to 47° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, shrubs, and brush.

In a representative profile the surface layer is dark grayish-brown clay loam about 4 inches thick. The subsoil is 22 inches thick. It is dark grayish-brown clay loam in the upper 5 inches and brown clay loam in the lower 17 inches. The substratum is white limy clay loam and gravelly clay loam.

The available water capacity is moderate, and permeability is moderate. These soils are used for small grain, alfalfa hay, pasture, and range.

Representative profile of Martinsdale clay loam, 1,800 feet south and 100 feet east of S $\frac{1}{4}$  corner of sec. 36, T. 4 S., R. 21 E.

A1—0 to 4 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2); moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; many very fine roots; abundant, clear, unstained silt and sand grains; neutral; clear boundary.

B2t—4 to 9 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine, prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; common very fine roots; many very fine pores; prominent clay films; mildly alkaline; gradual boundary.

B22t—9 to 20 inches, brown (10YR 5/3) clay loam, dark yellowish brown (10YR 4/4) moist and coatings of dark grayish brown (10YR 4/2) moist; moderate prismatic and fine angular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; common very fine pores; prominent clay films; mildly alkaline; abrupt boundary.

B3ca—20 to 26 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) moist and coatings of dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, sticky and plastic; common very fine roots; many very fine pores; distinct thin clay films; few lime-coated pebbles; strongly effervescent; moderately alkaline; abrupt boundary.

C1ca—26 to 40 inches, white (5Y 8/1) clay loam mottled with light gray (5Y 7/2); massive; hard, friable, nonsticky and nonplastic; common very fine roots; common very fine pores; about 20 percent coarse fragments; strongly effervescent; strongly alkaline; gradual boundary.

C2—40 to 62 inches, white (5Y 8/1) gravelly clay loam, light gray (5Y 7/1) moist; few very fine roots; common very fine pores; violently effervescent; strongly alkaline.

The B horizon ranges from 14 to 24 inches in thickness. The Cca horizon is 20 to 40 percent calcium carbonates and 30 to 40 percent gravel by volume. Depth to the gravelly substratum is 36 to 48 inches.

**Martinsdale clay loam, 2 to 4 percent slopes (Mf).**—This soil is on old, high terrace remnants. It has the profile described as representative of the series.

A typical area is 90 percent Martinsdale clay loam and 10 percent included acres of Charles and Work soils. The included soils are in irregularly shaped areas 5 acres or less in size. They are in swales and on the edges of smooth terraces.

The drainage pattern is dendritic. In places stream channels have cut deeply into old alluvium. Runoff is medium, and the hazard of erosion is slight. This soil is used for grain, hay, and pasture. Capability unit IIe-1, irrigated and IIe-2, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 1.

**Martinsdale clay loam, 4 to 8 percent slopes (Mg).**—This soil is on old, high terrace remnants. Runoff is medium, and the hazard of erosion is moderate. About 90 percent of the acreage is used for range and the rest for small grain, alfalfa hay, and pasture. Capability unit IIIe-1, irrigated and IIIe-2, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 1.

## Maurice Series

The Maurice series consists of deep, nearly level to steep, well-drained soils. These soils formed in deep gravelly and cobbly alluvium on flood plains, stream

terraces, and fans. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 43° to 47° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, shrubs, cottonwood trees, and a few pines.

In a representative profile the surface layer is dark grayish-brown stony loam and loam about 13 inches thick. The subsoil is dark-brown very gravelly fine sandy loam about 11 inches thick. The substratum is light brownish-gray very gravelly fine sandy loam 36 inches thick or more.

The available water capacity is low or moderate, and permeability is rapid. In places the water table is within 24 inches of the surface during the irrigation season. These soils are used mostly for grass hay. A small acreage is used as range.

Representative profile of Maurice stony loam, 1,800 feet west and 1,250 feet north of SE. corner of sec. 20, T. 5 S., R. 21 E.

- A11—0 to 3 inches, dark grayish-brown (10YR 4/2) stony loam, very dark grayish brown (10YR 3/2) moist and coatings of very dark gray (10YR 3/1) moist; fine granular structure; soft, friable, nonsticky and nonplastic; many fine and very fine roots; neutral; clear, wavy boundary.
- A12—3 to 13 inches, dark grayish-brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist and coatings of black (10YR 2/1) moist; weak prismatic structure parting to medium and fine angular blocky; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; faint clay films; neutral; clear boundary.
- B2—13 to 24 inches, dark-brown (10YR 4/3) very gravelly fine sandy loam, dark brown (10YR 4/3) moist; massive; soft, friable, nonsticky and nonplastic; common very fine roots; moderately alkaline; gradual boundary.
- C1—24 to 60 inches, light brownish-gray (10YR 6/2) very gravelly fine sandy loam, grayish brown (10YR 5/2) moist; very few very fine roots; common, distinct, clear fine sand grains; mildly alkaline.

The B and C horizons are 5 to 15 percent clay and 40 to 60 percent gravel and cobblestones.

**Maurice stony loam, moderately steep (MH).**—This soil is on fans in the uplands.

A typical area is about 90 percent Maurice soils and 10 percent included areas of Hanson and Woodrock soils. These included soils are on terrace remnants, wooded side slopes, and narrow divides. Areas are irregular in shape and less than 15 acres in size.

The drainage pattern is dendritic. Stream channels are smooth and U-shaped and in places have cut into the bedrock. Runoff is slow, and the hazard of erosion is slight.

This soil is used for range. Capability unit VIe-1, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 10.

**Maurice stony loam, steep (MK).**—This soil is on fans in the uplands. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for range. A few groves of aspen and pine trees are in the drainageways. Capability unit VIIe-1, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 10.

**Maurice-Bearmouth complex, 0 to 4 percent slopes (Mm).**—This complex is on flood plains and stream terraces. Each soil has a profile similar to the one described as representative of its respective series, but a water table

is within 24 inches of the surface during the irrigation season.

A typical area is about 65 percent Maurice soil and 30 percent Bearmouth soil. The rest consists of included areas of Thiel, Redlodge, and Adel soils. The Maurice soil is convex, and the Bearmouth soil is concave. The included soils finger through and between the Maurice and Bearmouth soils in irregularly shaped areas 2 acres or less in size. The drainage pattern is dendritic. Runoff is very slow, and the hazard of erosion is slight except in some places where the stream channels are eroding.

These soils are used for grass hay, pasture, and range. Capability unit VI-1, dryland. Maurice soil in Silty range site, 15 to 19 inches precipitation, and windbreak group 10. Bearmouth soil in Shallow to Gravel range site, 15 to 19 inches precipitation, and windbreak group 10.

## Mayflower Series

The Mayflower series consists of moderately deep, rolling, well-drained soils. These soils formed in red shale beds. Annual precipitation is 15 to 20 inches. The mean annual soil temperature ranges from 40° to 46° F., and the frost-free period is 60 to 90 days. The natural vegetation is mixed grasses, forbs, and sagebrush.

In a representative profile the surface layer is dark grayish-brown silt loam about 10 inches thick. The subsoil is brown clay loam about 28 inches thick. The substratum is red clay shale.

The available water capacity is moderate, and permeability is slow. These soils are used for summer range and recreation. All the acreage is in range grasses.

Representative profile of Mayflower silt loam, 1 mile east and 1¼ miles north of Ice Cave elevation marker 8786, T. 7 S., R. 27 E.

- A11—0 to 4 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist and coatings of very dark grayish brown (10YR 3/2) moist; moderate, medium, crumb structure; soft, friable, nonsticky and nonplastic; many fine and very fine roots and few very fine pores; mildly alkaline; clear, wavy boundary.
- A12—4 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist and coatings of very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure parting to moderate, coarse, crumb; soft, friable, nonsticky and nonplastic; common very fine roots and pores; mildly alkaline; clear, wavy boundary.
- B21t—10 to 19 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate, coarse, prismatic structure parting to moderate, coarse, angular blocky; hard, friable, sticky and plastic; thin clay bridgings between clear and stained sand grains; common very fine roots and tubular pores; mildly alkaline; clear, wavy boundary.
- B22t—19 to 23 inches, brown (10YR 5/3) clay loam, dark yellowish brown (10YR 4/4) moist; moderate, medium and coarse, angular blocky structure; very hard, friable, sticky and plastic; thin patchy clay films; mildly alkaline; gradual, wavy boundary.
- B23t—23 to 26 inches, brown (10YR 5/3) clay loam, yellowish brown (10YR 5/4) moist and coatings of brown (10YR 5/3) moist; moderate, coarse and medium, prismatic structure parting to moderate, medium and fine, angular blocky; very hard, firm, very sticky and very plastic; few very fine roots and pores; medium patchy clay films; moderately alkaline; gradual, wavy boundary.

- B24t**—26 to 38 inches, brown (10YR 5/3) clay loam, yellowish brown (10YR 5/4) moist and coatings of dark brown (10YR 4/3) moist; moderate, medium and fine, angular blocky structure; hard, firm, very sticky and plastic; few very fine roots; few specks of red clay shale in lower part of the horizon; slightly effervescent; moderately alkaline; abrupt boundary.
- C**—38 to 60 inches, red clay shale.

The noncalcareous part of the solum ranges from 25 to 36 inches in thickness. Coarse fragments are common, but make up less than 15 percent of the volume. The mollic epipedon ranges from 18 to 26 inches in thickness. Depth to red shale bedrock ranges from 30 to 40 inches.

**Mayflower silt loam, rolling (MN).**—This soil is on mountain foot slopes. It has a profile described as representative of the series. Slopes are 8 to 15 percent.

A typical area is 85 percent Mayflower soils that have smooth, rolling, short slopes and about 15 percent included Tarrete and Windham soils. These included soils occupy swales, divides, and valleys. Areas are irregular in shape and 10 acres or less in size.

Runoff is medium, and the hazard of erosion is slight. The soil is deep along the drainageways. Stream channels have cut deeply into the bedrock. The drainage pattern is dendritic.

This soil is used for summer grazing and recreational purposes. Wildlife is plentiful. Capability unit IVE-5, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 2.

## McRae Series

The McRae series consists of deep, gently sloping and undulating, well-drained soils. These soils formed in residuum from softly consolidated shale beds. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 48° to 50° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed mid and short grasses and forbs.

In a representative profile the surface layer is grayish-brown loam about 7 inches thick. The subsoil is 19 inches thick. The upper 7 inches is light olive-brown clay loam, the next 9 inches is grayish-brown clay loam, and the lower 3 inches is light brownish-gray clay loam. The substratum is 10 inches of light brownish-gray clay loam over 24 inches of gray clay loam.

The available water capacity is high, and permeability is moderate. These soils are used chiefly for crops, alfalfa hay, and pasture. A small acreage is range.

Representative profile of McRae loam, 2,000 feet west and 300 feet north of the E $\frac{1}{4}$  corner of sec. 20, T. 6 S., R. 23 E.

- A1**—0 to 7 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (2.5Y 4/2) with coatings of very dark grayish brown (2.5Y 3/2) moist; weak, medium, granular structure; soft, friable, nonsticky and nonplastic; many fine, and very fine roots and pores; mildly alkaline; gradual, wavy boundary.
- B21**—7 to 14 inches, light olive-brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; weak prismatic structure parting to moderate, medium and fine, angular blocky; soft, friable, sticky and plastic; common fine and very fine roots and tubular pores; slightly effervescent; moderately alkaline; gradual boundary.
- B22**—14 to 23 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) with coats of very dark grayish brown (2.5Y 3/2) moist; moderate, medium and fine, blocky structure; soft, friable, sticky and plastic; few very fine roots and pores; patchy clay

films as bridgings; slightly effervescent; mildly alkaline; gradual boundary.

- B3ca**—23 to 26 inches, light brownish-gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/4) moist and coatings of grayish brown (2.5Y 5/2) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots and tubular pores; strongly effervescent; moderately alkaline; clear, wavy boundary.
- C1ca**—26 to 36 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots and pores; common distinct threads, seams, and splotches of segregated lime; strongly effervescent; moderately alkaline; gradual boundary.
- C2**—36 to 60 inches, gray (5Y 6/1) clay loam, very dark gray (5Y 3/1) moist; massive; soft, friable, sticky and plastic; violently effervescent; strongly alkaline; abrupt boundary.

The texture between depths of 14 and 36 inches is light loam or clay loam that is 18 to 30 percent clay and more than 15 percent fine and coarse sands.

**McRae loam, 2 to 4 percent slopes (Mo).**—This soil is on uplands. It has the profile described as representative of the series.

A typical area is about 95 percent McRae loam, 2 to 4 percent slopes. The rest consists of included Toluca and Wormser soils. The areas of included soils are irregularly shaped and 5 acres or less in size.

Drainageways are deep, and in places have cut into the bedrock. The drainage pattern is dendritic. Runoff is medium, and the hazard of erosion is slight.

About half the acreage is used for small grain, alfalfa hay, and pasture, and half is used for grazing. Capability unit IIe-1, irrigated and IIIe-4, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 1.

## Midway Series

The Midway series consists of shallow, hilly and steep, well-drained soils. These soils formed in gray and yellow shale beds. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 48° to 50° F., and the frost-free period is 110 to 120 days. The natural vegetation is short and mid mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is light yellowish-brown silty clay loam about 4 inches thick. The underlying material is 10 inches thick. It is light yellowish-brown silty clay in the upper 4 inches and light brownish-gray weathered shale in the lower 6 inches. Interbedded shale is at a depth of about 14 inches.

The available water capacity is very low, and permeability is slow. This soil is used only for range.

Representative profile of Midway silt clay loam in an area of Midway-Travessilla association NW $\frac{1}{4}$ NW $\frac{1}{4}$  of sec. 1, T. 7 S., R. 21 E.

- A1**—0 to 4 inches, light yellowish-brown (10YR 6/4) silty clay loam, light olive brown (2.5Y 5/4) moist; weak, thin, platy structure parting to fine granular; soft, friable, sticky and plastic; few fine and very fine roots and pores; strongly effervescent; moderately alkaline; gradual boundary.
- C1**—4 to 8 inches, light yellowish-brown (2.5Y 6/4) light silty clay, light olive brown (2.5Y 5/4) moist; thin platy weathered shale; soft, friable, sticky and plastic; few fine matted roots; strongly effervescent; moderately alkaline; abrupt boundary.
- C2**—8 to 14 inches, light brownish-gray (2.5Y 6/2) thin interbedded silts, clays, and sandy shale mottled with yellow, gray, and rust color; roots are matted and

compressed between shale layers; gypsum crystals in clusters are between shale layers; abrupt boundary. C3—14 inches, interbedded silty, clayey, and sandy shale with salt and seams of gypsum.

Depth to shale ranges from 6 to 20 inches. The surface layer is silty clay loam or clay loam.

**Midway-Travessilla association, hilly (MR).**—This association is on upland plains. A typical area is about 65 percent Midway soils, 25 percent Travessilla soils, and 10 percent included soils that have slopes of 15 to 45 percent.

The Midway soil is on the sides and tops of broad divides. The Travessilla soil is on ridges and narrow divides. The included soils, Kyle, Nelson, and Razor soils, are on broad foot slopes and divides. The drainage pattern is dendritic. Stream channels are eroding back toward the high divides. Runoff is rapid, and the hazard of erosion is moderate.

This association is used only as range and wildlife habitat. Capability unit VIe-1, dryland; Shallow range site, 10 to 14 inches precipitation; windbreak group 3.

**Midway-Travessilla association, steep (MT).**—These soils are on uplands. They are used only for grazing. Runoff is rapid, and the hazard of erosion is moderate. Capability unit VIIe-1, dryland; Shallow range site, 10 to 14 inches precipitation; windbreak group 3.

## Nelson Series

The Nelson series consists of moderately deep, gently sloping, well-drained soils. These soils formed in sandy loam residuum weathered from sandy shale and sandstone bedrock. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 48° to 54° F., and the frost-free period is 110 to 120 days. The natural vegetation is short mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown fine sandy loam about 6 inches thick. The underlying material is light brownish-gray fine sandy loam in the upper 24 inches and soft sandstone in the lower 30 inches.

The available water capacity is low, and permeability is moderately rapid. These soils are used for range.

Representative profile of Nelson fine sandy loam, 1,800 feet west and 400 feet north of E1 $\frac{1}{4}$  corner of sec. 20, T. 6 S., R. 23 E.

A—0 to 6 inches, grayish-brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; single grain; soft, friable, nonsticky and nonplastic; many fine and very fine roots; slightly effervescent; mildly alkaline; gradual, wavy boundary.

C1—6 to 30 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, grayish brown (2.5Y 5/2) moist coated with light brownish gray (2.5Y 6/2) moist; very weak prismatic structure parting easily to fine granular; soft, friable, nonsticky and nonplastic; many very fine roots; common very fine pores; slightly effervescent; mildly alkaline; abrupt boundary.

C2—30 to 60 inches, soft sandstone.

Depth to soft sandstone ranges from 29 to 36 inches. In some places the soil is noncalcareous.

**Nelson fine sandy loam, 4 to 8 percent slopes (Ne).**—This soil is on bedrock plains of the uplands. It has the profile described as representative of the series.

A typical area is about 95 percent Nelson fine sandy loam and 5 percent included Travessilla soils. The included soils are on ridges and narrow divides. The drainage pattern is dendritic. The stream channels have cut down to bedrock in places. Runoff is slow, and the hazard of erosion is moderate.

This soil is used for grazing. Capability unit IIIe-4, dryland; Sandy range site, 10 to 14 inches precipitation; windbreak group 5.

## Neville Series

The Neville series consists of deep, gently sloping, well-drained soils on uplands. These soils formed in deep reddish alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 49° to 53° F., and the frost-free period ranges from 110 to 130 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is reddish-brown silty clay loam about 4 inches thick. The underlying material extends to a depth of 62 inches. It is light reddish-brown silty clay loam in the upper 20 inches and reddish-brown silty clay loam in the lower part.

The available water capacity is high, and permeability is moderate. These soils are used mainly for range. A small acreage is used for grain, alfalfa hay, and pasture.

Representative profile of Neville silty clay loam, 600 feet south and 100 feet east of NW. corner of sec. 36, T. 7 S., R. 24 E.

A1—0 to 4 inches, reddish-brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist and coatings of dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; soft, friable, slightly sticky and slightly plastic; many very fine roots and pores; slightly effervescent; moderately alkaline; clear boundary.

C1—4 to 11 inches, light reddish-brown (5YR 6/4) and pink (5YR 7/3) silty clay loam, red (2.5YR 4/6) moist and coatings of dark red (2.5YR 3/6) moist; weak prismatic structure parting to weak angular blocky; soft, friable, sticky and plastic; many very fine roots and pores; strongly effervescent; moderately alkaline; gradual boundary.

C2ca—11 to 24 inches, light reddish-brown (5YR 6/4) and pink (5YR 7/3) silty clay loam, red (2.5YR 4/6) moist and coatings of dark red (2.5YR 3/6) moist; moderate, medium and fine, angular blocky structure; soft, friable, sticky and plastic; common very fine roots; many very fine pores; many lime specks and threads; violently effervescent; moderately alkaline; gradual boundary.

C3—24 to 43 inches, reddish-brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist and coatings of yellowish red (5YR 4/6) moist; weak, medium, sub-angular blocky structure; soft, friable, sticky and plastic; common very fine roots and pores; violently effervescent; strongly alkaline; gradual boundary.

C4cs—43 to 62 inches, reddish-brown (5YR 5/4) and pinkish-gray (5YR 7/2) silty clay loam, reddish brown (5YR 4/4) moist; massive; soft, friable, sticky and plastic; few very fine roots and pores; common, distinct, clear gypsum crystals in clusters and seams; violently effervescent; strongly alkaline.

The soil to a depth of 40 inches or more ranges from silt loam to clay loam that is 20 to 35 percent clay.

**Neville silty clay loam, 2 to 4 percent slopes (Nf).**—This soil is on fans and stream terraces. It has the profile described as representative of the series.

A typical area is 90 percent Neville silty clay loam and 10 percent inclusions of Harvey, La Fonda, and Stormitt soils. Areas of included soils are irregular in shape and 5 acres or less in size.

The drainage pattern is dendritic. Drainageways have cut into the bedrock plain. Runoff is slow, and the hazard of erosion is slight.

About 95 percent of the acreage is used as range. A small acreage is dryfarmed to wheat, barley, alfalfa hay, and pasture. Capability unit IIIe-4; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Neville silty clay loam, 4 to 8 percent slopes (Ng).**—This soil is on fans and stream terraces. Runoff is medium, and the hazard of erosion is slight.

Almost all the acreage is range. Only a very small acreage is used for hay, pasture, and small grain. Capability unit IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

### Nihill Series

The Nihill series consists of deep, moderately steep, well-drained soils. These soils formed in gravelly alluvium on terraces. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 47° to 54° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and sagebrush.

In a representative profile the surface layer is grayish-brown very gravelly loam about 8 inches thick. The underlying material is very gravelly loam. The upper 27 inches is brown, and the lower 25 inches or more is pale brown.

The available water capacity is very low or low, and permeability is moderately rapid. The entire acreage is used as range.

Representative profile of Nihill very gravelly loam, 100 feet west and 200 feet north of SE. corner of sec. 29, T. 8 S., R. 25 E.

A—0 to 8 inches, grayish-brown (10YR 5/2) very gravelly loam, dark grayish brown (10YR 4/2) moist; medium granular structure; soft, friable, nonsticky and nonplastic; common very fine roots; slightly effervescent; mildly alkaline; clear, wavy boundary.

C1ca—8 to 35 inches, brown (10YR 4/3) very gravelly loam, brown (10YR 4/3) moist; massive; soft, friable, nonsticky and nonplastic; few very fine roots; very violently effervescent; lime segregations and crusts on pebbles; strongly alkaline; abrupt boundary.

C2—35 to 60 inches, pale-brown (10YR 6/3) very gravelly loam, brown (10YR 5/3) moist; massive; increases in fine and coarse sand, small pebbles, and cobblestone; violently effervescent; lime coatings on pebbles; strongly alkaline.

The C horizon is very gravelly loam to very gravelly sandy loam. The variable segregated lime coatings on pebbles range from distinct to thin. Content of gravel in the solum and substratum ranges from 40 to 70 percent.

**Nihill very gravelly loam, moderately steep (NH).**—This soil is on the edges of terraces. It has the profile described as representative of the series.

A typical area is 95 percent Nihill soil and 5 percent inclusions of La Fonda and Stormitt soils. The included soils finger through the Nihill soil in irregularly shaped areas less than 3 acres in size.

The drainage pattern is dendritic. Stream channels have cut deep into the underlying gravelly alluvium. Runoff is medium, and the hazard of erosion is slight.

This soil is used for grazing. Capability unit VIe-1, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 10.

### Nunn Series

The Nunn series consists of deep, nearly level and sloping, well-drained soils. These soils formed in mixed alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free period is 110 to 130 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown silty clay loam about 6 inches thick. The subsoil is 16 inches thick. The upper 6 inches is dark grayish-brown silty clay loam, the next 6 inches is grayish-brown clay, and the lower 4 inches is pale-brown clay. The substratum is 38 inches of limy silty clay loam that is pale brown in the upper 26 inches and pale yellow in the lower 12 inches.

The available water capacity is high, and permeability is moderately slow. These soils are used for irrigated and dryfarmed crops, hay, and pasture.

Representative profile of Nunn silty clay loam, 300 feet west and 600 feet north of SE. corner of sec. 34, T. 7 S., R. 23 E.

Ap—0 to 6 inches, grayish-brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, fine and medium, granular structure; hard, friable, sticky and plastic; many fine and very fine roots and pores; neutral; abrupt boundary.

B21t—6 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium, coarse and fine, subangular blocky; hard, friable, sticky and plastic; distinct clay films; many very fine roots and pores; neutral; clear, wavy boundary.

B22t—12 to 18 inches, grayish-brown (10YR 5/2) light clay, dark grayish brown (10YR 4/2) moist; strong prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable, sticky and plastic; distinct clay films; many very fine roots; many fine pores; slightly effervescent; moderately alkaline; clear, wavy boundary.

B3ca—18 to 22 inches, pale-brown (10YR 6/3) light clay, brown (10YR 4/3) moist; strong, medium and coarse, angular blocky structure parting to moderate, medium and fine, blocky; slightly hard, friable, sticky and plastic; many fine roots and very fine pores; slightly effervescent; many threads and seams of lime segregations; moderately alkaline; gradual boundary.

C1ca—22 to 48 inches, pale-brown (10YR 6/3) light silty clay loam, brown (10YR 4/3) moist; massive; slightly hard, firm, very sticky and plastic; few fine roots and very fine pores; many, common, distinct threads and seams of lime segregations; strongly effervescent; strongly alkaline; clear, wavy boundary.

C2ca—48 to 60 inches, pale-yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; massive; soft, friable, very sticky and plastic; strongly effervescent; many lime segregations; strongly alkaline.

The lower part of the B horizon ranges from clay loam to light clay. The C horizon is silty clay loam or clay loam. Depth to the Cca horizon ranges from 21 to 28 inches.

**Nunn silty clay loam, 0 to 2 percent slopes (Nk).**—This soil is on stream and fan terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Nunn silty clay loam and 5 percent included Haverson, Heldt, and McRae soils.

The areas of included soils are irregularly shaped and 5 acres or less in size.

The drainage pattern is dendritic. Deep and narrow stream channels cross areas of this soil. The channels are cut deeply into the alluvium. Runoff is very slow, and the hazard of erosion is slight.

All the acreage is used for irrigated crops and alfalfa hay. Capability unit IIs-1, irrigated; windbreak group 1.

**Nunn silty clay loam, 2 to 4 percent slopes (Nm).**—This soil is on stream and fan terraces. Runoff is slow, and the hazard of erosion is moderate.

All the acreage is used for irrigated crops and alfalfa hay. Capability unit IIe-1, irrigated; windbreak group 1.

**Nunn silty clay loam, 4 to 8 percent slopes (Nn).**—This soil is on fans. Runoff is medium, and the hazard of erosion is slight.

About 60 percent of the acreage is irrigated crops, alfalfa hay, and pasture, and the rest is dryfarmed. Capability unit IIIe-1, irrigated and IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

## Olney Series

The Olney series consists of deep, gently sloping, well-drained soils. These soils formed in sandy loam alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 48° to 54° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown fine sandy loam about 5 inches thick. The subsoil is 15 inches thick. It is brown clay loam in the upper 10 inches and light brownish-gray fine sandy loam in the lower 5 inches. The substratum is more than 39 inches thick. It is light-gray very gravelly sandy loam in the upper 39 inches and gravelly sand below.

The available water capacity is low, and permeability is moderate. These soils are used for irrigated and dryfarmed crops, hay, and pasture.

Representative profile of Olney fine sandy loam, 800 feet east and 100 feet south of NW. corner of sec. 12, T. 3 S., R. 23 E.

Ap—0 to 5 inches, grayish-brown (2.5Y 5/2) fine sandy loam, dark grayish brown (2.5Y 4/2) moist; moderate crumb structure parting to single grained; soft, friable, nonsticky and nonplastic; many fine and very fine roots; common very fine pores; neutral; clear, wavy boundary.

B2t—5 to 15 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; many fine and very fine roots and pores; distinct clay films; slightly effervescent; mildly alkaline; gradual boundary.

B3—15 to 20 inches, light brownish-gray (2.5YR 6/2) fine sandy loam, gray (10YR 6/1) moist; weak subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine roots; slightly effervescent; mildly alkaline; clear boundary.

IIIC1ca—20 to 59 inches, light-gray (10YR 7/1) very gravelly sandy loam mottled with white (10YR 8/2); massive; soft, friable, nonsticky and nonplastic; few very fine roots; few, fine, distinct lime specks, threads, and lime undercoatings on rocks; one percent pebbles greater than three inches in diameter; 50 to 70 percent gravel; strongly alkaline; strongly effervescent; gradual boundary.

IIIC2—59 inches, gravelly sand.

The content of coarse sand and pebbles increases with increasing depth. The Cca horizon ranges from moderately alkaline to very strongly alkaline. Depth to the Cca horizon ranges from 19 to 26 inches. Depth to sand and gravel ranges from 50 to 70 inches.

**Olney fine sandy loam, 2 to 4 percent slopes (Oe).**—This soil is on high outwash terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Olney fine sandy loam and 5 percent included Fort Collins, Harvey, and Toluca soils. These included soils are in irregularly shaped areas 5 acres or less in size. They occur as convex areas and shallow swales. Runoff is slow, and the hazard of erosion is slight. The drainage pattern is dendritic, and some streams are cutting new channels. Most of the acreage is used for irrigated and dryfarmed row crops, small grain, alfalfa hay, and pasture. A very small acreage is range. Capability unit IIe-1, irrigated and IIIe-4, dryland; Sandy range site, 10 to 14 inches precipitation; windbreak group 5.

**Olney fine sandy loam, 4 to 8 percent slopes (Of).**—This soil is on high outwash terraces. Runoff is medium, and the hazard of erosion is slight. About 95 percent of the acreage is used for irrigated and dryfarmed small grain, alfalfa hay, and pasture. The rest is used for range. Capability unit IIIe-1, irrigated and IIIe-4, dryland; Sandy range site, 10 to 14 inches precipitation; windbreak group 5.

## Peritsa Series

The Peritsa series consists of moderately deep, gently sloping, well-drained soils. These soils formed in red shale beds. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 40° to 46° F., and the frost-free period is 90 days or less. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is reddish brown silt loam about 3 inches thick. The subsoil is about 11 inches thick. It is reddish-brown silty clay loam in the upper 6 inches and red silty clay loam in the lower 5 inches. The upper 26 inches of the substratum is light-red silty clay loam. Light-red shale is at a depth of 40 inches.

The available water capacity is moderate, and permeability is moderate. These soils are used as range.

Representative profile of Peritsa silt loam, 3,000 feet east of Senwand Ranch Headquarters, T. 7 S., R. 27 E.

A1—0 to 3 inches, reddish-brown (5YR 4/3) silt loam, dark reddish brown (5YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots and pores; neutral; clear, wavy boundary.

B21t—3 to 7 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; moderate, medium, granular structure; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots and pores; neutral; clear, wavy boundary.

B21t—3 to 7 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; moderate, medium, prismatic structure parting to moderate, medium, blocky; hard, friable, slightly sticky and plastic; many very fine roots and pores; neutral; clear, smooth boundary.

B22t—7 to 9 inches, reddish-brown (2.5Y 5/4) silty clay loam, dark reddish brown (2.5Y 3/4) moist; moderate, medium, prismatic structure parting to weak, coarse,

angular blocky; hard, friable, sticky and plastic; few fine and very fine roots and pores; neutral; clear, smooth boundary.

B3—9 to 14 inches, red (2.5YR 5/6) silty clay loam, reddish brown (2.5YR 4/4) moist; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; hard, friable, sticky and plastic; few very fine roots; strongly effervescent; moderately alkaline; clear, wavy boundary.

C1ca—14 to 24 inches, light-red (2.5YR 6/6) silty clay loam, reddish brown (2.5YR 4/4) moist; massive; very hard, firm, sticky and plastic; few and very fine roots and pores; strongly effervescent; many fine and medium lime threads; few fine shale chips; strongly alkaline; gradual boundary.

C2—24 to 40 inches, light-red (10YR 6/6) silty clay loam, red (2.5YR 4/6) moist; massive; very hard, firm, sticky and plastic; strongly effervescent; few fine lime threads; moderately alkaline; gradual boundary.

C3—40 inches, light-red (2.5YR 6/6) partly weathered shale; strongly effervescent; moderately alkaline.

The C horizon ranges from light red to red and has distinct lime segregations. Depth to the Cca horizon ranges from 9 to 17 inches. Red shale is at a depth of 20 to 40 inches.

**Peritsa silt loam, 4 to 8 percent slopes (Pe).**—This soil is on uplands. It has the profile described as representative of the series.

A typical area is about 95 percent Peritsa silt loam and 5 percent inclusions of Rottulee and Tarrete soils. The included soils are in swales and on smooth medium-long foot slopes. The drainageways are smooth and U-shaped and show channel cutting. Runoff is medium, and the hazard of erosion is slight.

The soil is used as range. Capability unit IIIe-2, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 2.

## Razor Series

The Razor series consists of moderately deep, gently sloping to strongly sloping, well-drained soils. These soils formed in shale bedrock. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free season is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown clay loam about 4 inches thick. The subsoil is grayish-brown clay loam about 12 inches thick. The upper 12 inches of the substratum is light brownish-gray clay loam. Shale is at a depth of about 28 inches.

The available water capacity is low, and permeability is slow. These soils are used for crops, pasture, and range.

Representative profile of Razor clay loam, NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 9, T. 7 S., R. 22 E.

A1—0 to 4 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; moderate, medium and fine, granular structure; soft, friable, sticky and plastic; many fine and very fine roots and tubular pores; neutral; gradual boundary.

B2—4 to 8 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; pressure faces on peds; many fine and very fine roots and pores; neutral; clear, wavy boundary.

B3ca—8 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 medium and fine angular blocky; hard, friable, sticky and plastic; few

very fine roots; few segregations of lime threads; strongly effervescent; moderately alkaline; gradual boundary.

C1ca—16 to 28 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, sticky and plastic; common white seams and threads of segregated lime; strongly effervescent; moderately alkaline; abrupt boundary.

C2—28 inches, platy gray shale.

The horizon is 35 to 40 percent clay and has common, distinct segregations of lime in the lower part. The content of lime in the Cca horizon increases with increasing depth. Depth to the Cca horizon ranges from 12 to 18 inches. Bedded shale is at a depth of 28 to 37 inches.

**Razor clay loam, 2 to 8 percent slopes (Ra).**—This soil is on uplands. It has the profile described as representative of the series.

A typical area is about 95 percent Razor clay loam and 5 percent inclusions of Midway and Thedalund soils. The included soils occur as narrow, convex divides and as the steeper parts of slopes.

The drainage pattern is dendritic. Drainageways are steep sided and show some channel cutting. Runoff is medium, and the hazard of erosion is slight. This soil is used for dryfarmed wheat, barley, pasture, and range. Capability unit IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 2.

**Razor-Thedalund clay loams, 4 to 15 percent slopes (Rb).**—These soils are on uplands. A typical area is about 65 percent Razor soils, 20 percent Thedalund soils, 10 percent inclusions of Midway and Travessilla, and 5 percent sandstone rock outcrop. Razor and Thedalund soils are on the smooth medium-length slopes, in swales, and on valley bottoms. The included soils are on narrow divides and convex ridges.

The drainage pattern is dendritic. Drainageways are steep sided and cut into the bedrock in places. Runoff is medium, and the hazard of erosion is slight.

These soils are used mainly for range. A small acreage is dryfarmed to wheat, barley, and pasture. Capability unit IVe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 2.

## Redlodge Series

The Redlodge series consists of deep, nearly level, poorly drained soils. These soils formed in deep alluvium. Annual precipitation is 20 to 24 inches. The mean annual soil temperature ranges from 41° to 45° F., and the frost-free period is 90 days or less. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is very dark grayish-brown and very dark gray silty clay loam and clay about 16 inches thick. Below this is 9 inches of olive-gray and gray clay. The underlying material is 11 inches of gray clay mottled with olive yellow. Beneath the substratum is 24 inches of a buried soil that is dark-gray clay mottled with olive yellow in the upper 6 inches and gray and olive-yellow clay in the lower 18 inches.

The available water capacity is high, and permeability, is slow. These soils are used for meadow hay, alfalfa, pasture, and range.

Representative profile of Redlodge silty clay loam, 1,000 feet south and 300 feet west of NE. corner of sec. 14, T. 6 S., R. 19 E.

A11—0 to 2 inches, very dark grayish-brown (10YR 3/2) silty clay loam, black (10YR 2/1) moist; moderate, medium and fine, blocky structure parting to moderate, medium, granular; slightly hard, friable, sticky and plastic; few fine and many very fine roots; few fine pores; mildly alkaline; gradual boundary.

A12—2 to 10 inches, very dark gray (N 3/0) silty clay loam, black (10YR 2/1) moist; strong prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; many very fine roots, common very fine pores; mildly alkaline; gradual boundary.

A13—10 to 16 inches, very dark gray (N 3/0) clay, very dark gray (10YR 3/1) moist and coatings of black (10YR 2/1) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots and pores; prominent organically stained film on peds; mildly alkaline; clear boundary.

ACg—16 to 25 inches, olive-gray (5Y 5/2) and gray (N 6/0) clay, dark olive gray (5Y 3/2) moist and gray (N 5/0) moist; strong, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; common very fine pores; moderately alkaline; clear, wavy boundary.

C1cag—25 to 36 inches, gray (N 6/0) clay, gray (5Y 5/1) moist, mottled with olive yellow (5Y 6/6) moist, gray (5Y 6/1) moist, olive (5Y 4/4) moist, and very dark gray (5Y 4/1) moist; massive; slightly hard, friable, very sticky and plastic; strongly effervescent; many white masses of segregated lime; moderately alkaline; clear, wavy boundary.

A1bg1—36 to 42 inches, dark-gray (N 4/0) clay mottled with olive yellow (5Y 6/6), dark gray (N 4/0) moist, mottled with olive (5Y 4/4) moist, dark gray (N 3/0) moist, and gray (N 5/0) moist; massive; slightly hard, friable, very sticky and very plastic; strongly effervescent; common, small, white masses of segregated lime; moderately alkaline; gradual boundary.

A1bg2—42 to 60 inches, gray (N 6/0) and olive-yellow (2.5Y 6/6) clay, gray (5Y 5/1) moist mottled with olive (5Y 4/4) moist, gray (5Y 6/1) moist, dark gray (5Y 4/1) moist, and very dark gray (5Y 3/1) moist; massive; slightly hard, friable, sticky and plastic; strongly effervescent; common, small, white segregations of lime; moderately alkaline.

Textures are clay, clay loam, sandy clay loam, or silty clay loam that range from 35 to 60 percent clay. Depth to water table ranges from 20 to 35 inches.

**Redlodge-Adel silty clay loams (Rc).**—These soils are on wide to narrow valley floors. Slopes are 0 to 2 percent. Each of these soils has the profile described as representative of its respective series.

A typical area is about 65 percent Redlodge soils, 30 percent Adel soils, and 5 percent included Lohler, Bearmouth, and Maurice soils. The Redlodge soils are in swales or concave areas. The Adel soils are convex. The included soils are near stream channels in irregularly shaped areas 5 acres or less in size.

Stream channels have cut deeply into the valley floor in places. The drainage pattern is dendritic. Runoff is slow, and the hazard of erosion is slight.

These soils are used mainly for meadow hay, alfalfa, and pasture. Some areas are in range. Capability unit VIw-1, dryland; Subirrigated range site, 20 to 24 inches precipitation; windbreak group 9.

**Redlodge-Adel silty clay loams, wet (Rd).**—These soils are on wide to narrow valley floors. Slopes are 0 to 2 percent. Redlodge soils make up about 60 percent of the acreage and Adel soils 40 percent.

The soils are wet more than 95 percent of the time. Runoff is slow, and the hazard of erosion is slight.

These soils are used for pasture and range. Capability unit VIw-1, dryland; Wetland range site, 20 to 24 inches precipitation; windbreak group 9.

## Reeder Series

The Reeder series consists of moderately deep, rolling, well-drained soils. These soils formed in loamy material over sandy shale and sandstone bedrock. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 38° to 47° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed short and mid grasses, forbs, shrubs, and a few pine and juniper trees.

In a representative profile the surface layer is dark grayish-brown loam about 8 inches thick. The subsoil is brown clay loam about 13 inches thick. The substratum is 9 inches thick. The upper 4 inches is pale-brown clay loam, and the lower 5 inches is very pale brown loam. Sandy shale and hard sandstone are at a depth of 30 inches.

The available water capacity is low, and permeability is moderate. These soils are used for range.

Representative profile of Reeder loam, 1,600 feet east and 100 feet south of NW. corner of sec. 19, T. 6 S., R. 24 E.

A11—0 to 4 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, thick, platy structure parting to weak, medium, crumb; soft, friable, nonsticky and nonplastic; many fine and very fine roots and pores; neutral; slightly acid; clear, wavy boundary.

A12—4 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, medium, prismatic structure parting to weak, medium, angular blocky; slightly hard, friable, slightly sticky and nonplastic; many very fine roots; common very fine pores; neutral; slightly acid; clear, wavy boundary.

B21t—8 to 21 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; hard; friable, sticky and plastic; distinct clay films; many very fine roots; common very fine pores; neutral; slightly acid; gradual boundary.

C1—21 to 25 inches, pale-brown (10YR 6/3) clay loam, dark brown (10YR 4/3) moist; weak, medium, angular blocky structure; hard, friable, sticky and plastic; few very fine roots and pores; neutral; mildly alkaline; clear boundary.

C2ca—25 to 30 inches, very pale brown (10YR 7/3) loam, light yellowish brown (10YR 6/4) moist; massive; hard, friable, sticky and plastic; strongly effervescent; few, coarse, soft masses of segregated lime; moderately alkaline; abrupt boundary.

C3—30 to 60 inches, sandy shale and sandstone.

The B2t horizon is loam or clay loam and is 25 to 35 percent clay. Depth to the C horizon ranges from 20 to 26 inches. Lime segregations are in the lower part of the horizon. Depth to bedrock ranges from 30 to 40 inches.

**Reeder-Castner association, rolling (RE).**—This association is on upland plains. A typical area is about 65 percent Reeder soils, 30 percent Castner soils, and 5 percent inclusions of Lap and Hanson soils. The Reeder soils are on divides and the smooth, broad sides. The Castner soils are in localized spots and ridges. The included soils are in irregularly shaped areas 10 acres or less in size throughout the association.

Most of the drainageways are smooth and U-shaped, and they form a dendritic pattern on the landscape. In

places stream channels have cut deeply into the bedrock. Runoff is medium, and the hazard of erosion is slight.

This association is used for grazing. Capability unit IIIe-2, dryland. Reeder soil in Silty range site, 15 to 19 inches precipitation, and windbreak group 2. Castner soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

## Rentsac Series

The Rentsac series consists of shallow, strongly sloping to steep, well-drained soils. These soils formed in calcareous loamy material weathered from calcareous sandstone. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 42° to 47° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, shrubs, and scattered pines.

In a representative profile the surface layer is olive-gray channery loam about 3 inches thick. The underlying material is 17 inches thick. The upper 5 inches is gray channery loam, and the lower 12 inches is olive very channery and flaggy loam. Indurated limy sandstone is at a depth of 20 inches or less.

The available water capacity is very low, and permeability is moderately rapid. These soils are used as range.

Representative profile of Rentsac channery loam, 800 feet east and 60 feet south of NW. corner of sec. 3, T. 4 S., R. 21 E.

A1—0 to 3 inches, olive gray (5Y 5/2) channery loam, olive (5Y 5/3) moist and coatings of olive (10YR 4/3) moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; few fine and very fine roots; strongly effervescent; moderately alkaline; clear, wavy boundary.

C1—3 to 8 inches, gray (5Y 6/1) channery loam, olive gray (5Y 5/2) moist and coatings of gray (5Y 5/1) moist; massive; hard, friable, nonsticky and nonplastic; few fine matted roots between shale plates; 25 to 35 percent sandstone fragments; strongly effervescent; moderately alkaline; gradual boundary.

C2—8 to 20 inches, olive (5Y 5/6) very channery and flaggy loam, olive gray (5Y 4/2) moist; soft, friable, slightly sticky and plastic; strongly effervescent; crust of lime on fragments; about 70 percent angular gravelly and flaggy sandstone fragments; moderately alkaline; abrupt boundary.

R—20 inches, indurated calcareous sandstone that has lime crust on the surface.

Depth to sandstone bedrock ranges from 10 to 20 inches.

**Rentsac channery loam, sloping (RF).**—This strongly sloping soil is on uplands. It has the profile described as representative of the series.

A typical area is about 90 percent Rentsac channery soil and 10 percent included Sinnigam, Absarokee, and Cabba soils. Rentsac soils are on the broader and smoother parts of the landscape. The included soils are on the sharp ridgetops, narrow divides, and convex sides of ridges.

Drainageways have cut deeply into the bedrock and have exposed numerous sandstone outcrops along their courses. The drainage pattern is dendritic. Runoff is rapid, and the hazard of erosion is moderate.

This soil is used entirely for grazing. Capability unit VIs-1, dryland; Shallow range site, 10 to 14 inches precipitation; windbreak group 3.

**Rentsac-Rock outcrop complex, steep (RG).**—This complex is on uplands. It consists of moderately steep to very steep sandstone escarpments and shale beds that are a few feet to tens of feet thick. Areas face northeast and southeast, and the anticline of the steep sandstone and shale cliffs plunges in a west-southwest direction. The steep to very steep cliff formations have three distinct levels of sandstone outcroppings between short talus slopes. The Rentsac soil is on the smooth anticlines with included Wayden and Marias soils. The included soils are on the smooth side slopes between drainageways. Areas form irregular patterns 10 acres or less in size.

About 55 percent of this complex is Rentsac soil, 40 percent is sandstone Rock outcrop, and 5 percent is included soils. The drainage pattern is dendritic. Stream channels have cut deeply into bedrock. Runoff is very rapid, and the hazard of erosion is severe. This complex is used entirely for range. Capability unit VIIIe-1, dryland; Thin Breaks range site, 10 to 14 inches precipitation; windbreak group 3.

## Riverwash

Riverwash (Rh) consists of recently deposited alluvium in eddies and bars along the course of streams. Most of the alluvium is sand and gravel of mixed sizes. The newly deposited areas are generally void of vegetation. Willows and cottonwood trees invade the soils after the stream channel becomes more stable. Runoff is rapid, and the hazard of erosion is severe. Capability unit VIIIs-1.

## Rock Outcrop

Rock outcrop consists of exposures of bare rock. Most areas are too small to be delineated on the soil map. Some are identified by spot symbols. Others are mapped as soil complexes.

**Rock outcrop-Lambeth complex, 5 to 15 percent slopes (Rk).**—This complex is on uplands. Sandstone Rock outcrop makes up about 70 percent of a typical area and the Lambeth soil 30 percent. The sandstone areas are barren. The Lambeth soil occurs as islands between the spots of sandstone.

The drainage pattern is dendritic. Stream channels have cut into the bedrock in many places. Runoff is medium, and the hazard of erosion is slight.

The Lambeth soil is used entirely for range. It is in capability unit VIs-1, dryland; Silty range site, 10 to 14 inches precipitation.

**Rock outcrop-Travessilla complex, steep (RM).**—This complex is steep and very steep, and it includes rough and broken areas of the uplands.

Slopes are dominantly 25 to 70 percent, but included in this complex are areas where they are 70 to 80 percent.

A typical area is about 55 percent Rock outcrop, 30 percent Travessilla soils, and 15 percent included soils. The Rock outcrop consists of steep or very steep sandstone cliffs and areas that are more than 90 percent Rock outcrop. The Travessilla soils are on benches and divides. The included soils are between the sandstone ledges and the broad divides.

The drainage pattern is dendritic. Stream channels have cut deeply into the bedrock plain. Deep alluvial

soils are along the narrow drainageways. Runoff is rapid, and the hazard of erosion is severe.

This complex is used entirely for grazing. Travessilla soil in capability unit VIIe-1 dryland; Thin Breaks range site, 10 to 14 inches precipitation; windbreak group 3.

## Romberg Series

The Romberg series consists of deep, gently sloping to moderately steep, well-drained soils. These soils formed in deep glacial outwash. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is light brownish-gray very stony loam about 3 inches thick. The subsoil is 26 inches thick. The upper 5 inches is brown gravelly clay loam, and the lower part is yellowish-brown gravelly clay loam. The substratum is a very pale brown gravelly clay loam to a depth of 60 inches.

The available water capacity is low or very low, and permeability is moderate. These soils are used for range.

Representative profile of Romberg very stony loam, rolling, in SW $\frac{1}{4}$  of sec. 20, T. 9 S., R. 21 E.

A1—0 to 3 inches, light brownish-gray (10YR 6/2) very stony loam, brown (10YR 4/3) moist; weak, medium and fine, granular structure; soft, friable, nonsticky and nonplastic; many very fine roots; 20 percent rounded stones and 10 percent pebbles; neutral; clear, wavy boundary.

B2t—3 to 8 inches, brown (10YR 5/3) gravelly clay loam, dark brown (10YR 4/3) moist; weak, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots and tubular pores; faint patchy clay films; 20 percent pebbles; clear, wavy boundary.

B22t—8 to 29 inches, yellowish-brown (10YR 5/4) gravelly clay loam, dark yellowish brown (10YR 4/4) moist; weak, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots; 20 percent pebbles; 15 percent cobbles and stones; mildly alkaline; clear, wavy boundary.

C1ca—29 to 60 inches, very pale brown (10YR 7/3) gravelly clay loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots; common fine tubular pores; 30 percent pebbles and 10 percent stones; lime-coated pebbles and spots of soft lime; strongly effervescent; strongly alkaline.

The A horizon ranges from stony loam to extremely stony loam. The B horizon is 30 to 35 percent clay. The Cca horizon has distinct lime segregations of threads, crusts, and flour lime. These soils are 35 to 70 percent coarse fragments.

**Romberg very stony loam, rolling (RN).**—This soil is on glacial outwash terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Romberg soil and 5 percent inclusions of Vona soil. The included soil is in pockets of irregular shape and about 5 acres in size. The drainage pattern is dendritic. Stream channels have cut deeply into the alluvium, and they have rounded sides and gullied bottoms. Runoff is medium, and the hazard of erosion is slight. This soil is used for range. It is too stony for cultivation. Capability unit VIIs-1, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 8.

**Romberg extremely stony loam, sloping (RO).**—This strongly sloping soil is on glacial outwash terraces. It has a profile similar to the one described as representative of the series, but the surface layer is covered with many large erratic stones and boulders of granite.

Runoff is medium, and the hazard of erosion is slight. This soil is used for range. Capability unit VIIIs-1, dryland; Stony range site, 10 to 14 inches precipitation; windbreak group 8.

**Romberg-Shale outcrop complex, moderately steep (RP).**—This complex is on the edges of terraces. It is about 50 percent Romberg very stony loam and 50 percent Shale outcrop. The drainage pattern is dendritic, and channels of the natural drainageways have cut deeply into the shale bedrock. Runoff is rapid, and the hazard of erosion is moderate. This complex is used entirely for range. Capability unit VIIIs-1, dryland. Romberg soil in Stony range site, 10 to 14 inches precipitation; windbreak group 8.

**Romberg-Stutzman association, undulating (RS).**—This association is on glaciated valley fill. A typical area is about 65 percent Romberg very stony loam and 35 percent Stutzman silty clay. Each of these soils has the profile described as representative of its respective series, but the surface layer of the Romberg soil is stony loam. The Romberg soil occurs as convex islands surrounded by areas of the concave Stutzman soils.

Runoff is rapid on Stutzman soils and moderate on Romberg soils. Erosion is a severe hazard. The drainage pattern is dendritic. Stream channels have cut deeply into the alluvial material.

The soils of this association are used only for grazing. Romberg soils in capability unit VIIIs-1, dryland, Stony range site, 10 to 14 inches precipitation, and windbreak group 8. Stutzman soils in capability unit VIIs-1, dryland, Clayey range site, 10 to 14 inches precipitation, and windbreak group 1.

## Rottulee Series

The Rottulee series consists of moderately deep, gently sloping, well-drained soils. These soils formed in material weathered from reddish sandstone and limestone. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 44° to 47° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is dark-brown silt loam about 2 inches thick. The subsoil is 13 inches thick. The upper 4 inches is reddish-brown silt loam, and the lower 9 inches is light reddish-brown loam. The substratum is light reddish brown clay loam about 7 inches thick. Shattered limestone rock is at a depth of 22 inches.

The available water capacity is low, and permeability is moderate. These soils are used for range.

Representative profile of Rottulee silt loam, 2,600 feet east and 100 feet south of NW. corner of sec. 23, T. 8 S., R. 28 E.

A1—0 to 2 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak, thick, platy structure; slightly hard, very friable, slightly sticky and plastic; many very fine roots and tubular pores; slightly effervescent; moderately alkaline; clear, smooth boundary.

B1—2 to 6 inches, reddish-brown (5YR 5/3) silt loam, dark reddish brown (5YR 3/3) moist; weak, medium, prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine roots and tubular pores; slightly effervescent; moderately alkaline; clear, wavy boundary.

B2—6 to 10 inches, light reddish-brown (5YR 6/3) heavy silt loam, reddish brown (5YR 4/4) moist; moderate, medium, prismatic structure; hard, friable, sticky and plastic; common very fine roots; common fine and very fine tubular pores; slightly effervescent; moderately alkaline; clear, wavy boundary.

B3—10 to 15 inches, light reddish-brown (5YR 6/3) heavy silt loam, reddish brown (5YR 4/4) moist; moderate, medium and fine, angular blocky structure; hard, friable, sticky and plastic; common very fine roots and tubular pores; strongly effervescent; a few threads of soft lime; moderately alkaline; clear, wavy boundary.

Cca—15 to 22 inches, light reddish-brown (5YR 6/4) light clay loam, yellowish red (5YR 5/6) moist; weak, fine, blocky structure; hard, friable, sticky and slightly plastic; common very fine roots and tubular pores; 20 percent shale fragments; strongly effervescent; common fine threads of soft lime; strongly alkaline; gradual boundary.

R—22 inches, shattered limestone bedrock.

Texture ranges from silt loam to light silty clay loam and light clay loam that is 20 to 35 percent clay and 15 to 25 percent fine or medium sand and gravel-size shale fragments. Depth to the Cca horizon ranges from 15 to 26 inches. Limestone bedrock is at a depth of 22 to 35 inches.

**Rottulee silt loam, 4 to 8 percent slopes (Rt).**—This soil is on uplands. It has the profile described as representative of the series.

A typical area is about 90 percent Rottulee silt loam and 10 percent included Peritsa, Tarrete, and Windham soils. The included soils are on foot slopes and terrace remnants in irregularly shaped tracts less than 5 acres in size.

The drainage pattern is dendritic. Stream channels have cut deeply into the bedrock. The sides of the drainageways are smooth and rounded. Runoff is medium, and the hazard of erosion is moderate. This soil is used for range. Capability unit IIIe-2, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 2.

## Ryorp Series

The Ryorp series consists of moderately deep, steep, well-drained soils. These soils formed in weathered fine-grained sandstone. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 39° to 45° F., and the frost-free period is 50 to 90 days. The natural vegetation is lodgepole pine, grass, and forbs.

In a representative profile a thin layer of litter covers a surface layer of light brownish-gray sandy loam about 2 inches thick. The subsoil is pale-brown sandy loam about 19 inches thick. The substratum is pale-brown sandy loam about 13 inches thick over noncalcareous sandstone bedrock.

The available water capacity is low, and permeability is rapid. These soils are used for limited grazing, woodland, and recreation.

Representative profile of Ryorp sandy loam, 3,000 feet north and 4,000 feet west of Bainbridge elevation mark 8268, T. 8 S., R. 26 E.

O—2 inches to 0, loose mat of partly decomposed pine needles and twigs.

A2—0 to 2 inches, light brownish-gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak, thin, platy structure; soft, very friable, nonsticky and nonplastic; many coarse and medium, and common fine and very fine roots; slightly acid; clear, smooth boundary.

B2—2 to 21 inches, pale-brown (10YR 6/3) sandy loam and loam, dark brown (10YR 4/3) moist; moderate and weak, coarse, prismatic structure; slightly hard, very friable, nonsticky and nonplastic; common coarse, medium, fine, and very fine roots and pores in upper part and common fine and very fine roots and pores in the lower part; few, faint, coarse, brown (10YR 5/4) iron mottles; slightly acid; gradual, wavy boundary.

C—21 to 34 inches, pale-brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; massive; hard, very friable, nonsticky and nonplastic; very few fine roots and tubular pores; medium acid; abrupt boundary.

R—34 inches, noncalcareous sandstone bedrock.

The A horizon is fine sandy loam or sandy loam. Reaction ranges from slightly acid to medium acid. The content of sandstone fragments ranges from 1 to 20 percent, by volume. Depth to sandstone bedrock is 32 to 38 inches.

**Ryorp sandy loam, steep (RY).**—This soil is on mountains where slopes are 25 to 45 percent. It has the profile described as representative of the series.

A typical area is about 90 percent Ryorp sandy loam and 10 percent included Hanson and Sicklesteets soils. The included soils are in irregularly shaped areas 15 acres or less in size. The Hanson soils are steep and are below limestone ledges. The Sicklesteets soils are near areas of red-bed shale. The drainage pattern is dendritic. Streamways are heavily wooded, and this has reduced channel cutting. Runoff is slow, and the hazard of erosion is severe.

This soil is used for woodland, recreation, and limited grazing. Capability unit VIe-1, dryland.

## Sandstone Outcrop

Sandstone outcrop (SA) consists of steep or very steep, barren or partially barren, hard sandstone cliffs, ledges, and slopes. There are small areas in small basins and pockets or benches that are mantled with a thin layer of very fine sandy loam. These areas of sandy soil support a sparse growth of juniper and bunchgrass. The brushlike plants grow from deep cracks in the massive blocks of sandstone. In some areas sandstone slabs cover 90 to 100 percent of the ground surface. This results from the receding sandstone cliffs. The hard sandstone cliffs, however, show evidence of resisting geologic erosion. These cliffs are tens of feet thick. Small remnant areas of Travessilla, Midway, and Lismas soils are included with this land type, but do not exceed 2 acres in size. The included soils have hard shale or sandstone within 20 inches of the surface. Runoff is rapid, and the hazard of erosion is severe.

This unit is used for recreation, wildlife habitat, and watersheds. Capability unit VIIIs-1, dryland.

## Sebud Series

The Sebud series consists of deep, very bouldery, steep, well-drained soils. These soils formed in glacial till. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 45° to 47° F., and the frost-free period is

70 to 110 days. The natural vegetation is mixed grasses, forbs, shrubs, and pine trees.

In a representative profile the upper 4 inches of the surface layer is very dark grayish-brown very bouldery loam, and the lower 6 inches is dark grayish-brown very bouldery clay loam. The subsoil, about 12 inches thick, is yellowish-brown very bouldery clay loam. The upper 6 inches of the substratum is light yellowish-brown very bouldery coarse sandy clay loam, the next 21 inches is very pale brown very bouldery coarse sandy clay loam, and the lower 13 inches is very pale brown very bouldery clay loam.

The available water capacity is low or very low, and permeability is moderate. The entire acreage is used as range.

Representative profile of Sebud very bouldery loam, steep, 2,900 feet west and 1,000 feet south of the NE. corner of sec. 16, T. 6 S., R. 18 E.

- A11—0 to 4 inches, very dark grayish brown (10YR 3/2) very bouldery loam, very dark brown (10YR 2/2) moist; weak granular structure parting to fine crumb; soft, friable, nonsticky and nonplastic; many fine and very fine roots; 10 percent gravel and 40 percent stones and boulders; neutral; clear boundary.
- A12—4 to 10 inches, dark grayish-brown (10YR 4/2) very bouldery light clay loam, very dark grayish brown (10YR 3/2) moist and coatings of very dark brown (10YR 2/2) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots and pores; 10 percent gravel and 40 percent stones and boulders; mildly alkaline; clear, wavy boundary.
- B2—10 to 22 inches, yellowish-brown (10YR 5/4) very bouldery clay loam, dark brown (10YR 3/3) moist and coatings of dark yellowish brown (10YR 3/4) moist; moderate, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots and pores; 10 percent gravel and cobblestones and 40 percent stones and boulders; mildly alkaline; clear boundary.
- C1—22 to 28 inches, light yellowish-brown (10YR 6/4) very bouldery coarse sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and plastic; few very fine roots and pores; 5 percent small pebbles and 40 percent stones and boulders; mildly alkaline; gradual boundary.
- C2—28 to 49 inches, very pale brown (10YR 7/3) very bouldery coarse sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and plastic; few very fine roots; many sand grains of clear quartz; 5 percent highly weathered granitic rock and 40 percent hard stones and boulders; mildly alkaline; gradual boundary.
- C3—49 to 62 inches, very pale brown (10YR 7/3) very bouldery clay loam, yellowish brown (10YR 5/4) moist; massive; hard, firm, sticky and plastic; few very fine tubular pores; 5 percent pebbles and 40 percent stones and boulders; mildly alkaline.

The solum ranges from 20 to 30 inches in thickness. Soil texture includes loam or sandy clay loam that is 20 to 35 percent clay and 40 to 60 percent coarse fragments, mainly boulders and stones. Reaction is slightly acid to mildly alkaline, without free lime. The large, erratic boulders cover 40 to 60 percent of the surface.

**Sebud very bouldery loam, steep (SB).**—This strongly sloping to steep soil is on glacial till moraines at the canyon entrances to the Beartooth Plateau. It has the profile described as representative of the series.

A typical area is about 95 percent Ryorp sandy loam and 5 percent inclusions of Charlos, Woodrock, and Thiel soils. The included soils are on terrace remnants and the

edges of terraces. Areas are irregular in shape and 5 acres or less in size.

Drainageways are smooth and U-shaped. The very bouldery condition of this soil reduces channel cutting of the drainageways to only an occasional headcut. Runoff is slow, and the hazard of erosion is very slight.

This soil is used only for grazing. Capability unit VIIIs-1, dryland; Stony range site, 15 to 19 inches precipitation; windbreak group 8.

## Shale Outcrop

Shale outcrop (SC) consists of steep to very steep and nearly vertical cliffs of gray shale and sandstone.

Stream channels have cut deeply into the shale. Runoff is rapid, and the erosion hazard is severe. This unit is used for watershed, wildlife, and some recreation. Capability unit VIIIIs-1, dryland.

**Shale outcrop-Abac complex, very steep (SD).**—This complex consists of nearly vertical red cliffs that merge into smooth, rounded anticlines. Slopes range from 50 to 90 percent. This complex is characterized by its brilliant, reddish-brown cliffs of barren shale mottled with deep red, gray, purple, green, and yellow. Abac soils are along the deeply entrenched drainageways. Small areas of Neville and Tarrete soils are included with these soils.

Stream channels have cut deeply into the shale bedrock. Runoff is rapid, and the hazard of erosion is severe.

This complex is used for watershed, wildlife, and recreation. A small acreage is used for grazing. Capability unit VIIe-1, dryland. Abac soil in Shallow range site, 10 to 14 inches precipitation; windbreak group 3.

## Shane Series

The Shane series consists of moderately deep, gently sloping to strongly sloping, well-drained soils. These soils formed in materials weathered from calcareous shale. Annual precipitation is 15 to 19 inches. Mean annual soil temperature is 43° to 47° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and scattered pines.

In a representative profile the surface layer is grayish-brown clay loam about 7 inches thick. The subsoil is 12 inches thick. The upper 8 inches is yellowish-brown clay, and the lower part is grayish-brown clay. The substratum is light olive-gray clay that overlies shale at a depth of about 34 inches.

The available water capacity is low, and permeability is very slow. These soils are used for small grain, hay, pasture, and range.

Representative profile of Shane clay loam, 800 feet southeast of NW. corner of sec. 16, T. 4 S., R. 21 E.

- A11—0 to 3 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, granular structure; soft, friable, sticky and plastic; many very fine roots and pores; many clear, unstained silt and sand grains coating granules; neutral; clear, smooth boundary.
- A12—3 to 7 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate prismatic structure parting to strong, medium and fine, angular blocky; slightly hard, firm, sticky and plastic; common very fine roots; many very fine pores; many clear, unstained silt and sand grains on peds and in root channels; mildly alkaline; abrupt boundary.

**B21t**—7 to 15 inches, yellowish-brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; strong prismatic structure parting to strong, medium, subangular blocky; common coarse slickensides; hard, firm, very sticky and plastic; common very fine roots and few tubular pores; distinct clay films; mildly alkaline; gradual boundary.

**B22t**—15 to 19 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate, medium, subangular blocky structure; common coarse slickensides; hard, firm, very sticky and very plastic; common very fine roots and few tubular pores; distinct films on pedis; moderately alkaline; gradual boundary.

**C1**—19 to 34 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 4/2) moist; massive; hard, firm, very sticky and very plastic; few very fine roots and pores; slightly effervescent; moderately alkaline; abrupt boundary.

**C2**—34 inches +, white (5Y 8/2) shale mottled with olive gray (5Y 5/2).

Depth to shale ranges from 30 to 40 inches. The B2t horizon is 60 to 70 percent clay.

**Shane clay loam, 4 to 8 percent slopes (Se).**—This soil is on uplands. It has the profile described as representative of the series.

A typical area is 85 to 95 percent Shane soils and 15 percent or less included Absarokee, Cabba, and Rentsac soils. The Shane soil is on smooth foot slopes and in swales. The included soils are in irregularly shaped areas 5 acres or less in size on convex divides and ridges.

The drainage pattern is dendritic, and drainageways have cut into the bedrock in places. The hazard of erosion is slight. Runoff is slight.

About 90 percent of the acreage is used for dryland small grain, hay, and pasture. A small acreage is used for grazing. Capability unit IIIe-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 2.

**Shane clay loam, 8 to 15 percent slopes (Sf).**—This soil is on uplands. Runoff is medium, and the hazard of erosion is moderate. About 90 percent of the acreage is used for small grain, hay, and pasture. A small acreage is used for grazing. Capability unit IVe-2, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 2.

**Shane-Cabba clay loams, 4 to 8 percent slopes (Sg).**—This complex is on uplands.

A typical area is about 70 percent Shane soil, 25 percent Cabba soil, and 5 percent included Absarokee, Sinnigam, and Macar soils. The Shane soil is in broad swales and on divides. The Cabba soil is on convex ridges and narrow, tabular divides. The included soils are in swales or on divides in irregularly shaped areas 15 acres or less in size.

The drainage pattern is dendritic. Stream channels have cut into the bedrock in some places. The soils of the narrow valley floors are of deep alluvial material. The hazard of erosion is moderate, and runoff is slight.

About 85 percent of this complex is used for small grain, hay, and pasture. The rest is used for grazing. Capability unit IIIe-2, dryland. Shane soil in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Cabba soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

**Shane-Cabba clay loams, 8 to 15 percent slopes (Sh).**—This complex is on uplands. Runoff is medium, and the hazard of erosion is slight. About 85 percent of this complex is used for small grain, hay, and pasture. The rest is used for range. Capability unit IVe-2, dryland. Shane

soil in Clayey range site, 15 to 19 inches precipitation, and windbreak group 2. Cabba soil in Shallow range site, 15 to 19 inches precipitation, and windbreak group 3.

## Sicklesteets Series

The Sicklesteets series consists of deep, moderately steep, well-drained soils. These soils formed in deep, clayey, limy beds derived from limestone and shale. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 40° to 42° F., and the frost-free period is 50 to 90 days. The natural vegetation is lodgepole pines with an understory of forbs and shrubs.

In a representative profile the surface layer, which is beneath a thin layer of humus, is pinkish-gray loam about 5 inches thick. The subsoil is dusky red clay or clay loam about 17 inches thick. The substratum, 38 inches thick or more, is weak-red silty clay.

The available water capacity is moderate to high, and permeability is moderately slow. These soils are used for limited range, wildlife, and recreation.

Representative profile of Sicklesteets loam, 2,000 feet east and 5,280 feet north of Ice Cave elevation marker 8786, T. 8 S., R. 27 E.

**O**—1 inch to 0, a loose mat of partially decomposed pine needles, leaves, and twigs.

**A2**—0 to 5 inches, pinkish-gray (7.5Y 7/2) loam, brown (7.5YR 5/2) moist; moderate, thick, platy structure; soft, friable, sticky and slightly plastic; common coarse, medium, and fine roots; many very fine pores; slightly acid; abrupt boundary.

**B21t**—5 to 11 inches, dusty red (2.5YR 3/2) clay, dry or moist; moderate coarse, medium and fine, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots and pores; about 2 percent gravel; distinct clay films; slightly acid; clear, wavy boundary.

**B22t**—11 to 22 inches, dusky red (2.5Y 3/2) and light reddish-brown (2.5YR 6/4) clay loam, dry or moist; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; about 5 percent gravel; distinct clay films; slightly acid; gradual, wavy boundary.

**C1**—22 to 30 inches, weak-red (10R 4/2) and pale-red (10R 6/2) silty clay mottled with light red (10R 6/6), dry or moist; massive; hard, firm, very sticky and plastic; few very fine roots; about 5 percent pebbles; lime coating on underside of pebbles; slightly effervescent; mildly alkaline; gradual, wavy boundary.

**C2**—30 to 60 inches, weak-red (10R 4/4) gravelly silty clay mottled with pale red (10R 6/4) and reddish gray (10R 6/1), dry or moist; massive; hard, firm, very sticky and very plastic; few very fine roots; about 15 percent cobbles and pebbles; slightly effervescent; mildly alkaline.

The B2t horizon ranges from 15 to 19 inches in thickness and from 40 to 60 percent in content of clay.

**Sicklesteets loam, moderately steep (SK).**—This soil is on mountainsides. It has the profile described as representative of the series.

A typical area is about 95 percent Sicklesteets loam, and the rest is Tarrete and Tiban soils. The Tarrete soils are in open parklike areas over sandstone. The Tiban soils are on open parklike ridges above areas of the Sicklesteet soils.

The drainage pattern is dendritic. Drainageways are deep, and channels show some degree of cutting on extremely steep slopes. Runoff is medium, and the hazard of erosion is slight.

The acreage is 98 percent timber. The rest is range. Capability unit VIe-1, dryland.

### Sinnigam Series

The Sinnigam series consists of shallow, strongly sloping and moderately steep, well-drained soils. These soils formed in residuum weathered from sandstone and shale. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 40° to 43° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is dark grayish-brown channery clay loam about 5 inches thick. The subsoil is 5 inches thick. The upper 3 inches is grayish-brown very channery silty clay, and the lower 2 inches is dark grayish-brown very channery silty clay. The substratum is 10 inches of light olive brown very channery clay. Bedrock is at a depth of 20 inches.

The available water capacity is very low, and permeability is moderately slow. Sinnigam soils are used for range.

Representative profile of Sinnigam channery clay loam, sloping, 1,320 feet east and 2,100 feet north of the SW corner of sec. 8, T. 4 S., 21 E.

- A11—0 to 2 inches, dark grayish-brown (10YR 4/2) channery clay loam, very dark grayish brown (10YR 3/2) moist; weak granular structure; soft, friable, sticky and plastic; many fine and very fine and few medium and coarse roots; many fine pores; 25 to 30 percent sandstone fragments, flagstone, and some large flat stones; neutral; clear, wavy boundary.
- A12—2 to 5 inches, dark grayish-brown (10YR 4/2) very channery clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; many fine and very fine roots; common medium pores; 50 to 60 percent sandstone fragments, flagstones, and a few large stones; neutral; clear, wavy boundary.
- B21t—5 to 8 inches, grayish-brown (10YR 5/2) very channery silty clay, dark grayish brown (10YR 4/2) moist; weak prismatic structure parting to moderate, medium and fine, subangular blocky; hard, friable, very sticky and very plastic; many very fine roots and pores; 50 percent sandstone fragments; neutral; clear, wavy boundary.
- B22t—8 to 10 inches, very dark grayish-brown (10YR 3/2) very channery silty clay, brown (7.5YR 4/2) moist; weak, medium and fine, angular blocky structure; hard, friable, sticky and plastic; distinct clay films on peds and sandstone fragments; 60 to 80 percent sandstone fragments; slightly acid; abrupt, wavy boundary.
- C1—10 to 20 inches, light olive-brown (2.5Y 5/6) very channery clay, olive gray (5Y 4/2) moist, mottled with grayish brown (2.5Y 5/2) moist and black (2.5Y 2/0) moist; massive; neutral; mildly alkaline; abrupt boundary.
- R—20 inches, pale-yellow (2.5Y 7/4) shattered sandy shale and hard cherty sandstone.

The A horizon is channery clay loam or clay loam. The B2t horizon ranges from 36 to 50 percent clay and 50 to 80 percent sandstone fragments. Depth to hard sandstone ranges from 8 to 20 inches.

**Sinnigam channery clay loam, sloping (SM).**—This strongly sloping soil is on uplands. It has the profile described as representative of the series.

A typical area is about 85 percent Sinnigam channery clay loam. The rest is included Absarokee and Cabba soils. The areas of included soils are irregular in shape and

about five acres in size. The Absarokee soils are in swales, and the Cabba soils are on convex ridgetops.

Drainageways are generally U-shaped and show some deep cutting of the stream channel in places. The drainage pattern is dendritic. Runoff is slow, and the hazard of erosion is slight.

This soil is used as range. Capability unit VIe-1, dryland; Shallow range site, 15 to 19 inches precipitation; windbreak group 3.

**Sinnigam channery clay loam, moderately steep (SN).**—This soil is on uplands. Slopes are 15 to 25 percent. Runoff is medium, and the hazard of erosion is slight. All the acreage is used as range. Capability unit VIe-1, dryland; Shallow range site, 15 to 19 inches precipitation; windbreak group 3.

### Spearfish Series

The Spearfish series consists of shallow, hilly, well-drained soils. These soils formed in material weathered from red shale and red sandstone. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 48° to 50° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, brush, and shrubs.

In a representative profile the surface layer is reddish-brown loam about 4 inches thick. The underlying material natural vegetation is mixed grasses, forbs, brush, and sandstone are at a depth of 16 inches.

The available water capacity is very low or low, and permeability is moderate. These soils are used only as range.

Representative profile of Spearfish loam in an area of Spearfish-Shale outcrop complex, hilly, 3.8 miles south of Gup Spring Creek in SE $\frac{1}{4}$  of sec. 30, T. 9 S., R. 27 E.

- A11—0 to 4 inches, reddish-brown (5YR 5/3) loam, reddish brown (5YR 4/3) moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; few fine roots; slightly effervescent; moderately alkaline; clear, smooth boundary.
- C1—4 to 9 inches, pale-red (10R 6/3) heavy loam, red (10R 5/6) moist; weak, medium, blocky structure; hard, friable, sticky and nonplastic; few very fine matted roots; strongly effervescent; strongly alkaline; clear, irregular boundary.
- C2ca—9 to 16 inches, pale-red (10R 6/3) loam, red (10R 5/6) moist; massive; hard, friable, slightly sticky and slightly plastic; strongly effervescent; strongly alkaline; abrupt boundary.
- C3—16 inches, red shale and sandstone.

Depth to shale and sandstone ranges from 10 to 20 inches.

**Spearfish-Shale outcrop complex, hilly (SO).**—This complex is on upland plains. Slopes are 15 to 25 percent. A typical area is about 65 percent Spearfish soils, 30 percent Shale outcrop, and the rest included La Fonda, Neville, and Stormitt soils. These included soils are on old terrace remnants and in stream valleys. The Spearfish soils are on smooth rounded hills and in upland swales. The outcrops of shale consist of areas of red cliffs and barren shale.

The drainage pattern is dendritic. Stream channels of all drainageways have cut deeply into the bedrock. Runoff is rapid, and the hazard of erosion is severe.

This complex is used only as range. Capability unit VIe-1, dryland. Spearfish soil in Shallow range site, 10 to 14 inches precipitation; windbreak group 3.

## Stormitt Series

The Stormitt series consists of deep, nearly level to steep, well-drained soils. These soils formed in deep gravelly alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 47° to 59° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is brown loam about 6 inches thick. The subsoil is 13 inches of light-brown silty clay loam and gravelly silty clay loam. The substratum is pinkish-white very gravelly silty clay loam that is very high in content of lime.

The available water capacity is low or very low, and permeability is moderate. These soils are used only for range and alfalfa hay.

Representative profile of Stormitt loam, 1,500 feet east and 320 feet north of SW. corner of sec. 32, T. 7 S., R. 25 E.

- A1—0 to 6 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak, medium and fine, granular structure; soft, friable, nonsticky and nonplastic; common very fine roots; 10 percent rounded limestone pebbles that have a crust of lime on their underside; slightly effervescent; moderately alkaline; clear, wavy boundary.
- B2—6 to 14 inches, light-brown (7.5YR 6/4) silty clay loam, strong brown (7.5YR 5/6) moist and coatings of brown (7.5YR 5/4) moist; weak, medium and fine, angular blocky structure; soft, friable, sticky and plastic; common very fine roots; common very fine pores; 10 percent rounded limestone pebbles that are coated with lime and have a hard crust of lime on underside; strongly effervescent; moderately alkaline; gradual boundary.
- B3—14 to 19 inches, light-brown (7.5YR 6/4) gravelly silty clay loam, dark brown (7.5YR 4/4) moist; massive; slightly hard, friable, very sticky, plastic; common very fine roots and pores; many distinct segregations of flour lime and threads and seams of lime; 30 percent rounded limestone pebbles coated with lime and have lime crusts on underside; strongly effervescent; moderately alkaline; gradual boundary.
- C1ca—19 to 28 inches, pinkish-white (7.5YR 8/2) and pink (7.5YR 8/4) gravelly silty clay loam, brown (7.5YR 5/4) moist; massive; soft, friable, sticky and plastic; common very fine roots and pores; 40 percent rounded limestone pebbles encrusted with lime; strongly effervescent, differential accumulations of flour lime; moderately alkaline; gradual boundary.
- C2ca—28 to 72 inches, pinkish-white (7.5YR 8/2) very gravelly silty clay loam, pink (7.5YR 7/4) moist; massive; soft, friable, very sticky and plastic; few very fine roots; 50 to 60 percent rounded limestone and cherty sandstone cobblestones and pebbles encrusted with lime; very high content of lime; strongly effervescent; strongly alkaline.

The A horizon is loam that is gravelly or stony. The content of gravel, cobblestones, and stones increases with depth and ranges from 35 to 60 percent, by volume, between depths of 10 to 40 inches. The content of clay in the B horizon ranges from 20 to 35 percent. The estimated content of lime in the B horizon ranges from 30 to 50 percent and in the Cca horizon from 50 to 70 percent.

**Stormitt loam, 2 to 4 percent slopes (Sp).**—This soil is on stream or fan terraces. It has the profile described as representative of the series.

A typical area is about 90 percent Stormitt loam and 10 percent included La Fonda and Harvey soils. The included soils are mainly in the lower swale positions and near the center of the terraces.

The drainage pattern is dendritic. Streamways are smooth and U-shaped. Streams are cutting channels in the higher lying areas, but the cutting diminishes with distance from higher ground. Runoff is slow, and the hazard of erosion is slight.

About 95 percent of the acreage is range. The rest is used for alfalfa hay. Capability unit IVe-7, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

**Stormitt gravelly loam, 4 to 8 percent slopes (Sr).**—This soil is on stream or fan terraces. It has a profile similar to the one described as representative of the series, but the surface layer is gravelly.

Runoff is medium, and the hazard of erosion is moderate. About 95 percent of the acreage is range. The rest is used for alfalfa hay. Capability unit IVe-7, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

**Stormitt gravelly loam, saline, 0 to 4 percent slopes (Ss).**—This soil is on fan terraces. Except for a gravelly surface layer and an accumulation of salts, this soil has a profile similar to the one described as representative of the series. Runoff is slow, and the hazard of erosion is slight.

The entire acreage is range. Capability unit VIw-1, dryland; Saline Lowland range site, 10 to 14 inches precipitation; windbreak group 9.

**Stormitt stony loam, 0 to 8 percent slopes (St).**—This soil is on fans. It has a profile similar to the one described as representative of the series, but the profile is stony throughout. Runoff is slow, and the hazard of erosion is slight.

The entire acreage is range. Removal of surface stones would not make cultivation feasible, because each cultivation would bring up new stones. Capability unit VIa-1, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

**Stormitt stony loam, steep (SU).**—This steep to very steep soil is on fans and narrow terrace edges below the high mountains. It has a profile similar to the one described as representative of the series, but it is stony.

Drainageways are deep, and stream channels have cut deeply into the bedrock in places. The drainage pattern is dendritic. Runoff is rapid, and the hazard of erosion is moderate.

The entire acreage is range. The surface layer is too stony and cobbly to cultivate. Capability unit VIe-1, dryland; Limy range site, 10 to 14 inches precipitation; windbreak group 7.

**Stormitt complex, undulating (SV).**—This complex consists of soils along drainageways. These soils have a profile similar to the one described as representative of their respective series but the surface layer is gravelly.

A typical area is about 80 percent Stormitt gravelly loam and 20 percent included La Fonda gravelly loam and Harvey and Neville soils. The areas of included soils are irregular in shape and about 6 acres in size.

Drainageways are dissected by numerous channels that have cut deeply into the alluvium and bedrock. The drainage pattern is dendritic. Runoff is slow, and the hazard of erosion is moderate.

This complex is used only for summer grazing. Capability unit VIIa-1, dryland; Stony range site, 10 to 14 inches precipitation; windbreak group 7.

## Stormitt Series

The Stutzman series consists of deep, nearly level to gently sloping, well-drained soils. These soils formed in deep clay alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 47° to 59° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is light brownish gray silty clay about 4 inches thick. The underlying material is 56 inches of light yellowish-brown clay loam.

The available water capacity is high, and permeability is slow. These soils are used for irrigated row crops, grain, hay, and pasture.

Representative profile of Stutzman silty clay in SE $\frac{1}{4}$  SE $\frac{1}{4}$  of sec. 30, T. 9 S., R. 25 E.

- A1—0 to 4 inches, light brownish-gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) moist; weak platy structure in the upper half inch and moderate, fine, granular below; soft, very friable, sticky and plastic; few very fine roots and pores; slightly effervescent; moderately alkaline; clear, smooth boundary.
- C1—4 to 12 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) crushed and moist; weak, coarse, subangular blocky structure; very hard, friable, sticky and plastic; few very fine roots and pores; slightly effervescent; moderately alkaline; diffuse, wavy boundary.
- C2—12 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) crushed and moist; massive; very hard, friable, sticky and plastic; few fine and very fine roots and pores; few visible concretions of secondary calcium carbonate; slightly effervescent; moderately alkaline.

The C horizon ranges from heavy silty clay loam to clay loam. Fine concretions of calcium carbonate are in the C horizon in some places.

**Stutzman silty clay (SW).**—This soil is on stream terraces. Slopes range from 0 to 4 percent. This soil has the profile described as representative of the series.

A typical area is about 95 percent Stutzman silty clay and 5 percent Torchlight and Lismas soils. The Torchlight soil is in scattered irregularly shaped areas 5 acres or less in size.

Stream channels have cut deeply into the alluvial material all along their courses. Runoff is medium, and the hazard of erosion is slight.

This soil is used for irrigated crops, alfalfa hay, and pasture. Capability unit IIs-2, irrigated; windbreak group 1.

## Tarrete Series

The Tarrete series consists of deep, moderately steep to steep, well-drained soils. These soils formed in red clay shale. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 40° to 45° F., and the frost-free period is 50 to 90 days. The natural vegetation is mixed grasses, forbs, shrubs, and scattered pine trees.

In a representative profile the surface layer is dark reddish-gray clay about 2 inches thick. The subsoil is 26 inches thick. The upper 16 inches is reddish-brown clay, and the lower 10 inches is dark-red clay. The substratum is 32 inches thick. The upper 17 inches is dark-red clay, and the lower 15 inches is dusky red clay.

The available water capacity is moderate, and permeability is slow. These soils are used for range and recreation.

Representative profile of Tarrete clay, 10,000 feet east and 5,280 feet north of Ice Cave elevation marker 8786, T. 8 S., R. 27 E.

- A1—0 to 2 inches, dark reddish-gray (5YR 4/2) clay, dark reddish brown (5YR 3/2) moist; weak platy structure parting to moderate, coarse, granular; slightly hard, friable, sticky and plastic; many very fine roots; neutral; clear boundary.
- B21—2 to 9 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate coarse, medium, and fine, subangular blocky structure; extremely hard, firm, sticky and plastic; many very fine roots and tubular pores; neutral; clear, wavy boundary.
- B22—9 to 18 inches, reddish-brown (2.5YR 4/4) clay, yellowish red (2.5YR 4/6) moist; strong coarse, medium, and fine, subangular blocky structure; extremely hard, firm, sticky and plastic; many very fine roots and tubular pores; 10 percent subangular and rounded limestone pebbles; neutral; gradual boundary.
- B3ca—18 to 28 inches, dark-red (10R 3/6) clay, dark red (10R 3/6) moist; strong, medium and fine, subangular blocky structure; extremely hard, firm, sticky and plastic; few very fine roots; common fine tubular pores; strongly effervescent; distinct pockets and splotches of lime; moderately alkaline; gradual boundary.
- C1ca—28 to 45 inches, dark-red (10R 3/6) clay mottled with light red (10R 6/6); massive; extremely hard, firm, sticky and plastic; 2 percent argillite and quartzite pebbles; strongly effervescent; common distinct films, thread, seams, and splotches of segregated lime; moderately alkaline; gradual boundary.
- C2ca—45 to 54 inches, dusky-red (10R 3/4) clay mottled with pale red (10R 6/3); massive; extremely hard, firm, sticky and plastic; 2 percent argillite and quartzite pebbles; strongly effervescent; few segregations of lime; moderately alkaline; gradual boundary.
- C3—54 to 60 inches, dusky-red (10R 3/3) clay mottled with pale red (10R 6/2); massive; extremely hard, firm, sticky and plastic; 2 percent argillite and quartzite pebbles; strongly effervescent; moderately alkaline.

The A horizon ranges from clay to loam. Thickness of solum ranges from 16 to 32 inches. Depth to lime ranges from 16 to 32 inches.

**Tarrete loam, moderately steep (TA).**—This moderately steep and hilly soil (fig. 4) is on mountainsides and divides. It has a profile similar to the one described as representative of the series, but the surface layer is loam about 6 inches thick.

A typical area is about 95 percent Tarrete loam and 5 percent included Tiban and Windham soils. Tiban soils are on the ridges and convex areas, and Tarrete soils are on the lower foot slopes. Areas of the included soils are irregular in shape and 15 acres or less in size.

Drainageways are steep, and in some places the stream channels have cut deeply into the bedrock. The drainage pattern is dendritic. Runoff is medium, and the hazard of erosion is slight. This soil is used for summer grazing and recreation. Capability unit VIe-1, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 6.

**Tarrete clay, moderately steep (TB).**—This soil is strongly sloping or moderately steep and hilly. Slopes range from 8 to 25 percent. This soil has the profile described as representative of the series.

A typical area is about 95 percent Tarrete clay and 5 percent included Tiban and Hanson soils. The included

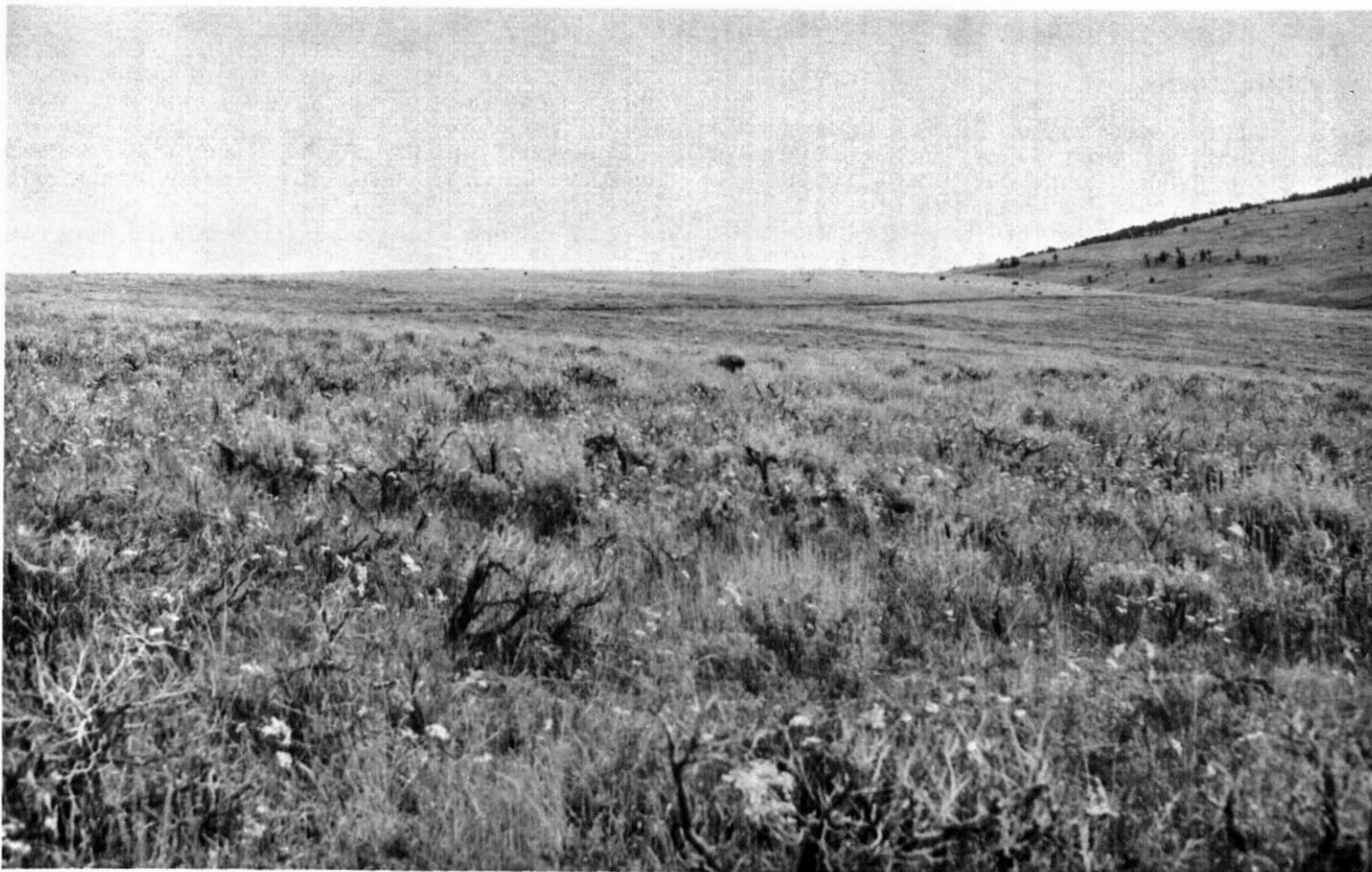


Figure 4.—An area of Tarrete loam, moderately steep.

soils are in irregularly shaped areas 10 acres or less in size. Hanson soils are on broad divides and smooth fans above Tarrete soils. Tiban soils occur as narrow, convex areas that traverse the unit.

The drainage pattern is dendritic. In places stream channels have cut into the red shale beds. Runoff is medium, and the hazard of erosion is slight.

This soil is used for summer grazing and recreation. Capability unit VIe-1, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 4.

**Tarrete-Hanson association, steep** (TC).—This association is on broken slopes at the base of mountains.

A typical area is about 50 percent Tarrete clay, 45 percent Hanson clay loam, and 5 percent Tiban soils. The Tarrete soil is in small, smooth swales, and the Hanson soil is near smooth wooded areas. Areas of Tiban soil are irregular in shape and less than 10 acres in size. They are on small, isolated ridgetops and in convex areas throughout the association.

The drainage pattern is dendritic. Stream channels are smooth and U-shaped. Runoff is medium, and the hazard of erosion is slight. The soils in this association are used for summer grazing and recreation. Capability unit VIe-1, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 4.

## Teton Series

The Teton series consists of moderately deep, moderately steep, well-drained soils. These soils formed in deep colluvial material. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 45° to 47° F., and the frost-free period ranges from 90 to 110 days. The native vegetation is mixed grass and a few pine trees.

In a representative profile the surface layer is 10 inches of grayish-brown or dark grayish-brown stony loam or loam. The subsoil is 12 inches thick. The upper 8 inches is brown clay loam and the lower 4 inches is pale-brown clay loam. The substratum is brown clay loam 13 inches thick. Hard sandstone is at a depth of 35 inches.

The available water capacity is moderate, and permeability is moderate. The entire acreage is range.

Representative profile of Teton stony loam, 5,280 feet east and 9,000 feet north of Ice Cave (in T. 8 S., R. 27 E.) elevation marker 8786. Soil site in T. 7 S., R. 27 E.

- A11—0 to 4 inches, dark grayish-brown (10YR 4/2) stony loam, very dark brown (10YR 2/2) moist; moderate, medium and coarse, crumb structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; neutral; clear, wavy boundary.
- A12—4 to 7 inches, dark grayish brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic structure; slightly hard, fri-

able, slightly sticky and plastic; few very fine roots; neutral; clear, wavy boundary.

A13—7 to 10 inches, grayish-brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) moist; moderate, coarse, prismatic structure; slightly hard, friable, slightly sticky and plastic; common very fine roots; neutral; clear boundary.

B21—10 to 18 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 4/3) moist; moderate, medium, prismatic structure; hard, firm, sticky and plastic; many very fine roots and pores; thin distinct clay films; neutral; clear, wavy boundary.

B22—18 to 22 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; moderate, medium, prismatic structure parting to weak angular blocky; hard, firm, sticky and plastic; many fine roots and tubular pores; 15 percent sandstone fragments; neutral; gradual boundary.

C1—22 to 35 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 4/3) moist; massive; hard, friable, sticky and plastic; few roots; 25 percent sandstone rock fragments; abrupt boundary.

R—35 inches, hard sandstone.

Thickness of the A horizon ranges from 10 to 14 inches. The C horizon may have distinct segregations of lime in the lower part. Depth to bedrock ranges from 32 to 40 inches.

**Teton stony loam, moderately steep (TD).**—This soil is on mountainsides. It has the profile described as representative of the series.

A typical area is about 95 percent Teton soils and 5 percent included Hanson, Tarrete, and Windham soils. Hanson soils are on convex ridges where sandstone bedrock is near the surface, Windham soils are in open park areas where slopes are long and smooth, and Tarrete soils are in areas where red bedrock is exposed. Areas of these soils are irregular in shape and 15 acres or less in size.

The drainage pattern is dendritic. Drainageways are smooth and U-shaped. Runoff is slow, and the hazard of erosion is slight.

This soil is used only for summer grazing. Capability unit VIe-1, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 2.

## Thedalund Series

The Thedalund series consists of moderately deep, gently sloping to strongly sloping, well-drained soils. These soils formed in calcareous, soft-bedded shale and sandstone. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free period is 110 to 120 days. The native vegetation is mixed grasses, forbs, and pine trees.

In a representative profile the surface layer is grayish-brown clay loam about 8 inches thick. The underlying material is about 54 inches thick. The upper 5 inches is light brownish-gray clay loam, the next 12 inches is light olive-gray silt loam, and the lower 5 inches is olive-gray soft shale and sandstone.

The available water capacity is low, and permeability is moderate. These soils are used for small grain, pasture, and range.

Representative profile of Thedalund clay loam, 2,000 feet east and 1,000 feet south of NW. corner of sec. 32, T. 9 S., R. 25 E.

Ap—0 to 8 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) crushed and moist; moderate, fine, granular structure; hard, friable, sticky and plastic; common fine and very fine roots and pores; strongly effervescent; moderately alkaline; clear, smooth boundary.

C1—8 to 13 inches, light brownish-gray (2.5Y 6/2) light clay loam, dark grayish brown (2.5Y 4/2) crushed and moist; moderate, coarse and medium, angular blocky structure; hard, friable, sticky and plastic; few very fine roots and pores; violently effervescent; few distinct threads of lime; moderately alkaline; clear, wavy boundary.

C2—13 to 25 inches, light olive-gray (5Y 6/2) silt loam, light olive gray (5Y 6/2) moist and (5Y 5/2) crushed and moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots and pores; violently effervescent; strongly alkaline; gradual, wavy boundary.

C3—25 to 30 inches, olive-gray (5Y 5/2) weathered silty and clayey shale mottled with white (5Y 8/2); massive; hard, friable, nonsticky and nonplastic; matted roots between shale layers; strongly effervescent; moderately alkaline; abrupt, smooth boundary.

C4—30 inches, soft, fine-grained, calcareous sandstone and loamy calcareous shale.

The A horizon is grayish brown to dark grayish brown. The depth to soft shale and sandstone ranges from 20 to 40 inches. Texture below a depth of 10 inches ranges from silt loam to clay loam.

**Thedalund clay loam, 4 to 8 percent slopes (Te).**—This soil is on upland plains. It has the profile described as representative of the series.

A typical area is 85 to 90 percent Thedalund soil. The rest is small areas of included Colby, Midway, and Travessilla soils. The included soils are in irregularly shaped areas 5 acres or less in size. They have properties similar to those of the Thedalund soils.

The drainage pattern is dendritic. The hazard of erosion is slight, and runoff is medium.

About 95 percent of the acreage is range. A small part is used for wheat, barley, and pasture. Capability unit IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 2.

**Thedalund clay loam, 8 to 15 percent slopes (Tf).**—This soil is on upland plains. The hazard of erosion is moderate, and runoff is medium.

About 95 percent of the acreage is range. The rest is used for small grain and pasture. Capability unit IVe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 2.

## Thiel Series

The Thiel series consists of deep, gently sloping and steep, well-drained soils. These soils formed in deep glacial outwash. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 43° to 47° F., and the frost-free period is 90 to 110 days. The native vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is brown cobbly clay loam about 3 inches thick. The subsoil is dark-brown very cobbly clay loam about 7 inches thick. The substratum is 50 inches thick. The upper 10 inches is light brownish-gray very cobbly clay loam, and the lower 40 inches is coarse sand, pebbles, and cobblestones.

The available water capacity is low or very low, and permeability is moderate. These soils are used for range.

Representative profile of Thiel cobbly clay loam, 1,700 feet south and 200 feet east of NW. corner of sec. 33, T. 6 S., R. 21 E.

A1—0 to 3 inches, brown (10YR 5/3) cobbly clay loam, dark brown (10YR 3/3) moist; granular structure; soft,

- friable, nonsticky and nonplastic; many fine and very fine roots; neutral; clear, smooth boundary.
- B2t—3 to 10 inches, dark-brown (10YR 4/3) very cobbly clay loam, dark brown (10YR 3/3) moist; weak, medium and fine, angular blocky structure; hard, friable, sticky and plastic; many very fine roots; many fine and very fine interstitial and tubular pores; about 40 percent cobblestones and pebbles, cobblestones are 3 to 6 inches in diameter; faint clay films on ped faces; many fine clay bridgings of sand grains and pebbles; mildly alkaline; abrupt boundary.
- C1ca—10 to 20 inches, light brownish-gray (10YR 6/2) very cobbly clay loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; common, matted, compressed very fine roots; few very fine pores; prominent accumulations of lime in which hard lime casts weakly cement the pebbles; strongly effervescent; strongly alkaline.
- IIC2—20 to 60 inches, coarse sand, cobblestones, and pebbles that have hard coats of lime in the upper part of the horizon.

Texture of the surface layer is cobbly clay loam or very cobbly clay loam. Depth to sand and gravel ranges from 20 to 36 inches.

#### Thiel cobbly clay loam, 4 to 8 percent slopes (Tg).—

This soil is on glaciated outwash terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Thiel cobbly clay loam and 5 percent included Bynum and Charlos loams. The areas of included soils are irregular in shape and are less than 5 acres in size.

Runoff is slow, and the hazard of erosion is slight. The drainage pattern is dendritic. Drainageways are smooth and rounded. The stream channels have cut into the bedrock in places.

The entire acreage is range. Capability unit VI<sub>s</sub>—1, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 8.

**Thiel-Bynum association, steep (TH).—**This association is on sloping edges of the glaciated terraces. A typical area is about 70 percent Thiel very cobbly clay loam and 30 percent Bynum clay loam.

The drainage pattern is dendritic. In places the stream channels have cut deeply into the shale bedrock. Runoff is medium, and the hazard of erosion is slight.

The entire acreage is range. Capability unit VII<sub>e</sub>—1, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 3.

### Thurlow Series

The Thurlow series consists of deep, gently sloping, well-drained soils. These soils formed in deep, calcareous clayey material on upland foot slopes and valleys. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free period is 110 to 125 days. The natural vegetation is mixed grasses, forbs, and sagebrush.

In a representative profile the surface layer is light brownish-gray silty clay loam about 3 inches thick. The subsoil is about 25 inches thick. The upper 6 inches is grayish-brown silty clay loam, the middle 14 inches is brown silty clay loam, and the lower part is light brownish-gray loam. The substratum is light-gray clay loam to a depth of 62 inches.

The available water capacity is high, and permeability is moderately slow. About 95 percent of the acreage is

used for small grain, alfalfa, and pasture. The rest is range. These soils could be used intensively for cultivated crops. Crops respond to the proper use of fertilizer.

Representative profile of Thurlow silty clay loam, 1,000 feet east and 750 feet south of NW. corner of sec. 27, T. 3 S., R. 23 E.

- A—0 to 3 inches, light brownish-gray (10YR 6/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium and thin, platy structure parting to weak, fine, granular; soft, friable, sticky and plastic; many fine and very fine roots and pores; neutral; clear, wavy boundary.
- B21t—3 to 9 inches, grayish-brown (10YR 5/2) silty clay loam, brown (10YR 4/3) moist; moderate, medium and fine, prismatic and angular blocky structure; hard, friable, sticky and plastic; common thin clay films; common fine and very fine roots and pores; mildly alkaline; gradual, wavy boundary.
- B22t—9 to 23 inches, brown (10YR 5/3) silty clay loam, brown (10YR 5/3) rubbed) moist; strong prismatic structure breaking to moderate, medium and coarse, angular blocky; hard, firm, sticky and plastic; many moderately thick clay films and pressure faces; common very fine roots and pores; moderately alkaline; gradual, wavy boundary.
- B3ca—23 to 28 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate, medium and fine, angular blocky structure; hard, friable, sticky and plastic; few thin clay films on faces of peds and walls of root channels; few very fine roots and pores; strongly effervescent; common, distinct segregations of lime; strongly alkaline; gradual, wavy boundary.
- C1ca—28 to 30 inches, light-gray (10YR 7/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable, sticky and plastic; few very fine roots and pores; strongly effervescent; few distinct threads of lime; moderately alkaline; gradual, smooth boundary.
- C2ca—30 to 62 inches, light-gray (10YR 7/2) clay loam, grayish brown (2.5Y 5/2) rubbed and moist; massive; hard, firm, sticky and plastic; strongly effervescent; common, distinct seams of lime.

#### Thurlow silty clay loam, 4 to 8 percent slopes (Tk).—

This soil is on valley floors along the large streams. It has the profile described as representative of the series:

A typical area is about 95 percent Thurlow silty clay loam and 5 percent small areas of included Heldt and Toluca soils. Areas of the included soils are irregular in shape and less than 5 acres in size.

The drainage pattern is dendritic, and in some places stream channels have cut deeply into the bedrock. The hazard of erosion is slight, and runoff is medium.

More than 95 percent of the acreage is used for small grain. Alfalfa and pasture grasses are also grown, and a small acreage is range. Capability unit III<sub>e</sub>—4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Thurlow-Toluca silty clay loams, 4 to 8 percent slopes (Tl).—**These soils are on uplands and terrace remnants.

A typical area is 65 to 80 percent Thurlow silty clay loam, 15 to 30 percent Toluca silty clay loam, and small areas of included Thedalund and Travessilla soils. The Thurlow soil is on broad foot slopes and terraces of medium length. The Toluca soil is along the sides of drainageways and the edges of terraces. Thedalund and Travessilla soils are on small divides and ridges that traverse the mapping unit. The included soils do not exceed 5 acres in size. The drainage pattern is dendritic. The soils are deep, and in

some places gullies are cut deeply into the underlying material. The hazard of erosion is moderate, and runoff is medium.

About 90 percent of the acreage is used for dryfarmed small grain, alfalfa, and pasture. A small acreage is used for grazing. Capability unit IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

## Tiban Series

The Tiban series consists of deep, moderately steep to steep, well-drained soils. These soils formed in residuum on mountain slopes. Annual precipitation is 15 to 19 inches. The mean annual soil temperature ranges from 40° to 45° F., and the frost-free period is 50 to 90 days. The natural vegetation is mixed grasses, forbs, shrubs, and scattered pines.

In a representative profile the surface layer is dark-brown extremely stony loam about 4 inches thick. The subsoil is grayish-brown gravelly clay loam about 9 inches thick. The substratum is 47 inches thick. It is brown gravelly clay loam in the upper 10 inches and light reddish-brown gravelly clay loam in the lower 37 inches.

The available water capacity is low or very low, and permeability is moderate. The entire acreage is range.

Representative profile of Tiban extremely stony loam, 5,000 feet east and 4,000 feet north of Ice Cave elevation marker 8786, T. 8 S., R. 27 E.

- A1—0 to 4 inches, dark-brown (7.5YR 4/2) extremely stony loam, dark brown (10YR 3/3) moist and coatings of very dark grayish brown (10YR 3/2) moist; weak, medium, subangular blocky structure parting to fine granular structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots and pores; about 35 percent stones and gravel; neutral; clear boundary.
- B2—4 to 13 inches, grayish-brown (10YR 5/2) gravelly clay loam, very dark grayish brown (10YR 3/2) moist; moderate, medium, subangular blocky structure; slightly hard, friable, sticky and plastic; many very fine roots and pores; about 35 percent cobbles and pebbles; many clear silt grains and fine sand grains; mildly alkaline; clear, wavy boundary.
- C1ca—13 to 23 inches, brown (10YR 4/3) very gravelly clay loam, brown (10YR 5/3) moist and coating of dark brown (10YR 4/3) moist; weak, medium, subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots and pores; roots matted between rocks; 50 percent pebbles; rocks lime coated with encrustations on underside, and specks of lime in the soil mass; strongly effervescent; strongly alkaline; clear, wavy boundary.
- C2—23 to 60 inches, light reddish-brown (2.5YR 6/4) gravelly clay loam, red (2.5YR 4/6) moist; massive; slightly hard, friable, sticky and plastic; few very fine roots and pores; all rocks are subangular and lime coated; strongly effervescent; strongly alkaline.

Depth to bedrock is more than 60 inches. The volume of cobbles, pebbles, and stones throughout the profile ranges from 35 to 60 percent.

**Tiban extremely stony loam, moderately steep (TM).**—This soil is on mountainsides. It has the profile described as representative of the series. Slopes are 15 to 25 percent.

A typical area is about 95 percent Tiban extremely stony loam and 5 percent small areas of included Tarrete, Duncom, and Lap soils. These included soils are on small divides and in smooth swales in areas that are irregular in shape and 15 acres or less in size.

The drainage pattern is dendritic. Stream channels have cut into the gravelly material and in some places, down to the limestone bedrock. Runoff is medium, and the hazard of erosion is moderate.

This soil is used for summer grazing, wildlife habitat, and recreation. Capability unit VIIs-1, dryland; Stony range site, 15 to 19 inches precipitation; windbreak group 8.

**Tiban-Tarrete association, steep (TN).**—This association consists of soils on mountainsides, divides, and ridges. Slopes are 25 to 75 percent.

A typical area is about 60 percent Tiban extremely stony loam, 30 percent Tarrete clay, and 10 percent Rock outcrop.

The drainage pattern is dendritic. Stream channels have cut down to the limestone bedrock in places. The hazard of erosion is moderate, and runoff is medium. These soils are used for summer grazing, wildlife habitat, and recreation. Scattered pines and junipers grow on the Tiban soils. Capability unit VIIe-1, dryland. Tiban soils in Stony range site, 15 to 19 inches precipitation, and windbreak group 8. Tarrete soils in Clayey range site, 15 to 19 inches precipitation, and windbreak group 4.

## Toluca Series

The Toluca series consists of deep, nearly level to moderately steep, well-drained soils. These soils formed in deep, calcareous loamy material. Annual precipitation is 1 to 14 inches. The mean annual soil temperature ranges from 47° to 54° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown clay loam about 3 inches thick. The subsoil is 6 inches thick. The upper 3 inches is grayish-brown clay loam, and the lower 3 inches is light brownish-gray clay loam. The substratum is 51 inches of light brownish-gray, limy clay loam.

The available water capacity is high, and permeability is moderate. These soils are used mainly for row crops, small grain, hay, and pasture. A small acreage is range.

Representative profile of Toluca clay loam, 600 feet west and 320 feet south of E $\frac{1}{4}$  corner of sec. 13, T. 5 S., R. 23 E.

- A1—0 to 3 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, thin, platy structure parting to weak, thin, platy; soft, friable, slightly sticky and plastic; many very fine roots; common clear sand grains; neutral; clear, smooth boundary.
- B2t—3 to 6 inches, grayish-brown (10YR 5/2) clay loam, brown (10YR 4/3) moist; weak prismatic structure parting to moderate, medium and fine, angular blocky; hard, friable, sticky and plastic; many very fine roots; many fine tubular pores; distinct continuous clay films on all ped surfaces; peds are coated grayish brown (10YR 5/2) in upper part and dark brown (10YR 4/3) in lower part; mildly alkaline; clear, wavy boundary.
- B3ca—6 to 9 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; moderate, medium and fine, angular blocky structure; hard, friable, sticky and plastic; many fine and very fine roots; many very fine tubular pores; clay film on walls of root channels and pores and on very small concave surfaces of peds; slightly effervescent; common spots of segregated lime, mildly alkaline; clear, wavy boundary.

Cca1—9 to 60 inches, light brownish-gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, sticky, plastic; many very fine roots; common very fine tubular pores; strongly effervescent; many, coarse, soft nodular lime segregations; strongly alkaline.

The A horizon is clay loam or silty clay loam. The B2t horizon ranges from 30 to 38 percent clay and from 20 to 40 percent fine and medium coarse sand. The content of calcium carbonate equivalent in the Cca horizon ranges from 20 to 35 percent.

**Toluca clay loam, 0 to 2 percent slopes (T<sub>0</sub>).**—This soil is on fans and terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Toluca clay loam and 5 percent included Heldt, McRae, and Fort Collins soils. Areas of the included soils are irregular in shape and about 5 acres in size. Heldt soils are along old, abandoned streams and on valley bottom lands. McRae soils are at the foot of sloping areas. Fort Collins soils are in swales.

The drainage pattern is dendritic. Stream channels in places have cut into the deep alluvium. Runoff is medium, and the hazard of erosion is slight. This soil is used mainly for row crops, small grain, and hay. A very small acreage is used for pasture and range. Capability unit I-1, irrigated and IIIc-1, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Toluca clay loam, 2 to 4 percent slopes (T<sub>p</sub>).**—This gently sloping and undulating soil is on fans and terraces. Runoff is medium, and the hazard of erosion is slight.

About 95 percent of the acreage is used row crops, small grain, and alfalfa. The rest is range and irrigated pasture. Capability unit IIe-1, irrigated and IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Toluca clay loam, 4 to 8 percent slopes (T<sub>r</sub>).**—This soil is on fans and stream terraces. Runoff is medium, and the hazard of erosion is slight. About 90 percent of the acreage is used for small grain, alfalfa hay, and pasture. The rest is range. Capability unit IIIe-1, irrigated and IIIe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Toluca clay loam, 8 to 15 percent slopes (T<sub>s</sub>).**—This soil is on fans and foot slopes. Runoff is medium, and the hazard of erosion is moderate. This soil is used for pasture, small grain, alfalfa hay, and range. Capability unit IVe-1, irrigated and IVe-4, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

**Toluca-Midway complex, moderately steep (T<sub>T</sub>).**—This complex consists of moderately steep and hilly soils on uplands. It is about 70 percent Toluca clay loam on smooth divides and midlength slopes, 25 percent steep Midway clay loam on the sides of drainageways and in convex areas, and 5 percent included Travessilla soil and Sandstone outcrop. The inclusions are on the apex of narrow ridges and divides in irregularly shaped areas less than 5 acres in size.

Stream channels are smooth and U-shaped, and they show deep cutting in a few places. The drainage pattern is dendritic. Runoff is rapid, and the hazard of erosion is moderate.

The entire acreage is range. Capability unit VIe-1, dryland. Toluca soil in Clayey range site, 10 to 14 inches precipitation, and windbreak group 1. Midway soil in

Shallow range site, 10 to 14 inches precipitation, and windbreak group 3.

**Toluca-Rock outcrop complex, sloping (T<sub>U</sub>).**—This complex consists of strongly sloping and rolling soils on uplands. It is about 80 percent Toluca clay loam and 20 percent Rock outcrop. The outcrop occurs throughout the unit in reeflike areas 50 to 100 feet wide. The Toluca clay loam is the deep soil between the reefs of rock.

Runoff is slow, and the hazard of erosion is slight. The drainage pattern is dendritic. Drainageways are narrow and deep, and channels have cut deeply into the bedrock. The entire acreage is range. Capability unit VIe-1, dryland. Toluca soils in Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

## Tonra Series

The Tonra series consists of deep, gently sloping, well-drained soils. These soils formed in alluvium. Annual precipitation is 5 to 9 inches. The mean annual soil temperature is 48° to 50° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is light brownish-gray gravelly silty clay loam 3 inches thick. The subsoil is 20 inches thick. The upper 8 inches is brown gravelly clay loam, and the lower 12 inches is light brownish-gray clay loam. The substratum is 29 inches thick. The upper 6 inches is very pale brown coarse sandy clay loam, and the lower 23 inches is coarse sand, gravel, and cobbles.

The available water capacity is low or moderate, and permeability is moderate. These soils are for irrigated crops, pasture, and alfalfa hay.

Representative profile of Tonra gravelly silty clay loam, 1,320 feet east and 1,100 feet north of SW. corner of sec. 5, T. 7 S., R. 23 E.

Ap—0 to 3 inches, light brownish-gray (10YR 6/2) gravelly silty clay loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; soft, friable, sticky and plastic; many very fine roots; slightly effervescent; moderately alkaline; clear boundary.

B21—3 to 11 inches, brown (10YR 5/3) gravelly clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium and fine, angular blocky structure; hard, friable, sticky and plastic; many very fine roots; very few pores; strongly effervescent; strongly alkaline; gradual boundary.

B22—11 to 23 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; common very fine roots; many very fine pores; few pebbles; strongly effervescent; strongly alkaline; gradual boundary.

C1ca—23 to 29 inches, very pale brown (10YR 8/3) coarse sandy clay loam, light gray (10YR 7/2) moist; massive; soft, friable, sticky and plastic; few very fine roots; many very fine pores; few pebbles; strongly effervescent; lime segregations and lime-coated pebbles; strongly alkaline.

IIC2—29 to 52 inches, lime-coated coarse sand, gravel, and cobbles.

Depth to sand, gravel, and cobbles ranges from 27 to 38 inches. Gravel in the A, B, and Cca horizons ranges from 15 to 20 percent of the volume. The B horizon is slightly to strongly effervescent. The Cca horizon is 10 to 20 percent cobbles and 20 to 30 percent calcium carbonate equivalent, excluding coarse fragments.

**Tonra gravelly silty clay loam, 2 to 4 percent slopes** (Tv).—This soil is on stream terraces. A typical area is about 95 percent Tonra gravelly silty clay loam and 5 percent included Heldt and Haverson soils. The included soils are in swales in irregularly shaped tracts less than 5 acres in size.

Runoff is slow, and the hazard of erosion is slight. The drainage pattern is dendritic. About 95 percent of the acreage is used for irrigated pasture and alfalfa hay. The rest is used for irrigated small grain and row crops. Capability unit IIe-1, irrigated; windbreak group 7.

### Torchlight Series

The Torchlight series consists of deep, sloping, well-drained soils. These soils formed in highly alkaline, saline, and gypsiferous residuum. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 47° to 49° F., and the frost-free period is 110 to 120 days. The natural vegetation is strawberry sage, Gardner saltbush, greasewood, and alkali-tolerant grasses.

In a representative profile the surface layer is grayish-brown clay about 4 inches thick. The underlying material is 9 inches of light olive-brown clay over 47 inches of olive clay.

The available water capacity is moderate, and permeability is slow. The entire acreage is range.

Representative profile of Torchlight clay, 1,500 feet west and 500 feet north of SE. corner of sec. 6, T. 8 S., R. 24 E.

A—0 to 4 inches, grayish-brown (2.5Y 5/2) clay, light olive brown (2.5Y 5/4) moist; moderate, very fine, granular structure; hard, friable, sticky and very plastic; few fine roots; many very fine pores; strongly effervescent; strongly alkaline; abrupt, smooth boundary.

C1ca—4 to 13 inches, light olive-brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, blocky; extremely hard, friable, sticky and very plastic; many very fine roots compressed on ped surfaces; many fine and very fine pores; violently effervescent; clusters of gypsum crystals; very strongly alkaline; gradual boundary.

C2cs—13 to 60 inches, olive (5Y 4/3) clay, coated with olive (5Y 4/4) moist; massive; extremely hard, firm, very sticky and very plastic; few compressed fine roots; few very fine pores; violently effervescent; many nests, seams, and pockets of lime and gypsum crystals; very strongly alkaline.

Content of clay ranges from 40 to 60 percent. Exchangeable sodium ranges from 15 to 25 percent and is concentrated mostly in the C2cs horizon. The solum is strongly calcareous throughout. The Ccs horizon ranges from 5Y to 10YR in hue.

**Torchlight clay, sloping** (TW).—This soil is on alluvial fans. It has the profile described as representative of the series.

A typical area is about 95 percent Torchlight clay, and 5 percent included Stutzman, Bowbac, and Lismas soils. Areas of these included soils are irregular in shape and less than 5 acres in size. The Lismas soils are near drainageways and on narrow divides. Stutzman and Bowbac soils occur as islands throughout the mapping unit.

The drainage pattern is dendritic, and stream channels have cut deeply into the bedrock. Runoff is rapid, and the hazard of erosion is moderate. This soil is used only for grazing. Capability unit VI-1, dryland; Dense clay range site, 5 to 9 inches precipitation; windbreak group 11.

### Trapper Series

The Trapper series consists of deep, strongly sloping, well-drained soils. These soils formed in residuum weathered from siltstone and sandstone. Annual precipitation is 20 inches. The mean annual soil temperature ranges from 37° to 42° F., and the frost-free period is 40 to 50 days. The natural vegetation is mixed grasses and thick stands of yellow pine and alpine fir.

The surface layer is grayish-brown and pale-brown silt loam about 4 inches thick. The subsoil is brown and pale-brown silty clay loam about 23 inches thick. The substratum is 23 inches or more of white silty clay loam.

The available water capacity is moderate or low, and permeability is moderate. These soils are used for range and recreation. All the acreage is in range grass, yellow pines, and thickets of alpine.

Representative profile of Trapper silt loam, 10 feet west and 10 feet south of the NE. corner of sec. 7, T. 8 S., R. 27 E.

A11—0 to 2 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; very dark grayish-brown coating on peds; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; many fine and very fine roots and interstitial pores; 1 percent subangular stones and fragments; slightly acid; clear boundary.

A12—2 to 4 inches, pale-brown (10YR 6/3) silt loam, dark brown (10YR 3/3) moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; many very fine roots and pores; 1 percent subangular stone fragments; slightly acid; clear boundary.

B21t—4 to 9 inches, brown (10YR 5/3) silty clay loam, yellowish brown (10YR 5/4) moist and coating on peds dark grayish brown (10YR 4/2) moist; compound structure of moderate, medium, prismatic to moderate, medium and fine, subangular blocky; hard, friable, sticky and plastic; many very fine roots and tubular pores; 1 percent subangular stone fragments; neutral; clear boundary.

B22t—9 to 16 inches, pale-brown (10YR 6/3) and brown (10YR 5/3) silty clay loam, dark yellowish brown (10YR 4/4) moist; moderate, medium and fine, subangular blocky structure; hard, friable, sticky, plastic; few very fine roots and tubular pores; 1 percent subangular stone fragments; neutral; clear boundary.

B3—16 to 27 inches, brown (10YR 5/3) silty clay loam mottled with very pale brown (10YR 8/3), dark yellowish brown (10YR 3/4) moist; massive; hard, friable, sticky and plastic; common very fine roots and tubular pores; 10 percent subangular rock fragments; neutral; abrupt boundary.

Cca—27 to 50 inches, white (10YR 8/2) silty clay loam, light gray (10YR 7/2) moist; massive; slightly hard, friable, sticky and plastic; few roots and tubular pores; 15 percent rock fragments; strongly calcareous, lime casts on underside of stones.

R—50 inches, hard sandstone and siltstone.

Depth to siltstone and white sandstone ranges from 50 to 60 inches.

**Trapper soils, sloping** (TX).—These strongly sloping soils are on smooth alpine mountains. They have a profile similar to the one described as representative of the series, but in places the surface layer is clay loam, fine sandy loam, or loam.

A typical area is about 85 to 95 percent Trapper soils. Small areas of Windham and Duncom soils are included with these soils. They make up no more than 15 percent of any mapped area.

The drainage pattern is dendritic. Stream channels are smooth and U-shaped. In some places they have cut into

the bedrock. The hazard of erosion is slight, and runoff is medium.

These soils are used for summer grazing, recreation, and wildlife. Capability unit VIe-1, dryland; Silty range site, 15 to 19 inches precipitation; windbreak group 6.

### Travessilla Series

The Travessilla series consists of shallow, gently sloping, well-drained soils. These soils formed in calcareous, moderately coarse textured to medium textured sandstone. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 50° to 57° F., and the frost-free period is 110 to 130 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is light brownish-gray silt loam in the upper 2 inches and light yellowish-brown silt loam in the lower 6 inches. The underlying material is 10 inches of light brownish-gray silt loam. Hard sandstone is at a depth of about 8 inches.

The available water capacity is very low, and permeability is rapid. The entire acreage is range.

Representative profile of Travessilla silt loam, sloping, 100 feet west and 300 feet north of SE. corner of sec. 32, T. 8 S., R. 25 E.

A11—0 to 2 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist and coatings of dark grayish brown (10YR 4/2) moist; weak, fine, granular structure parting to single grain; soft, friable, nonsticky and nonplastic; many fine and very fine roots; common pores; neutral; clear, wavy boundary.

A12—2 to 8 inches, light yellowish-brown (10YR 6/4) silt loam, brown (10YR 5/3) moist and coatings of yellowish brown (10YR 5/4) moist; massive; soft, friable, nonsticky and nonplastic; many very fine roots; common pores; neutral; gradual boundary.

C—8 to 18 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; massive; many matted fine roots; strongly effervescent; strongly alkaline; abrupt boundary.

R—18 inches, gray, hard sandstone, lime coated on upper surface.

Depth to hard sandstone and sandy shale ranges from 14 to 20 inches. Coarse stone fragments are throughout the soil in some places, but are less than 30 percent of the volume.

**Travessilla silt loam, sloping (TY).**—This soil is on uplands. It has the profile described as representative of the series. Slopes are 4 to 8 percent.

A typical area is about 95 percent Travessilla silt loam and 5 percent included Lismas and Midway soils. These included soils are on narrow ridges and divides in areas of partly barren clay.

The runoff is medium, and the hazard of erosion is slight. The drainage pattern is dendritic and stream channels are deeply cut. This soil is used only for grazing. Capability unit VIa-1, dryland; Shallow range site, 10 to 14 inches precipitation; windbreak group 3.

### Twin Creek Series

The Twin Creek series consists of deep, sloping, well-drained soils. These soils formed in alluvium on valley floors. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 41° to 43° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is brown silty clay loam about 8 inches thick. The subsoil is dark-brown silty clay loam about 5 inches thick. The substratum extends to a depth of 60 inches and more. It is dark-brown gravelly silt loam in the upper 15 inches and brown channery loam in the lower part.

The available water capacity is moderate or high, and permeability is moderate. Most of the acreage is range. A small acreage is used for alfalfa hay, small grain, and pasture.

Representative profile of Twin Creek silty clay loam in SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 10, T. 6 S., R. 24 E.

A11—0 to 8 inches, brown (7.5YR 5/2) silty clay loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; soft, friable, sticky and plastic; many fine and very fine roots; many fine and very fine pores; neutral; gradual, smooth boundary.

B2—8 to 13 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; weak, fine and medium, angular blocky structure; soft, friable, sticky and plastic; many fine and very fine roots and pores; 2 percent red sandstone fragments; neutral; clear, wavy boundary.

C1ca—13 to 28 inches, dark-brown (7.5YR 4/2) gravelly silt loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; strongly effervescent; common threads and seams of segregated lime; moderately alkaline; gradual boundary.

C2—28 to 60 inches, brown (7.5YR 5/4) channery loam, massive; hard, friable, nonsticky and nonplastic; strongly effervescent; 35 percent lime-coated sandstone fragments; moderately alkaline; abrupt boundary.

Depth to bedrock ranges from 48 to more than 60 inches. The C horizon is 5 to 30 percent coarse fragments.

**Twin Creek silty clay loam, 4 to 8 percent slopes (Tz).**—This soil is on stream terraces along drainageways in narrow valleys. This soil has the profile described as representative of the series.

A typical area is about 95 percent Twin Creek soils and 5 percent included Abac and Peritsa soils. Twin Creek and Abac soils are on convex ridges and sides of valleys; Peritsa soils are in swales.

Runoff is medium, and the hazard of erosion is slight. Stream channels have cut deeply into the sedimentary beds.

About 85 percent of the acreage is range. The rest is used for dryfarmed alfalfa hay, pasture, wheat, and barley. Capability unit IIIe-2, dryland; Clayey range site, 10 to 14 inches precipitation; windbreak group 1.

### Vona Series

The Vona series consists of deep, nearly level to strongly sloping, well-drained soils. These soils formed in alluvium and wind-laid material. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 48° to 52° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown fine sandy loam about 6 inches thick. The subsoil is 16 inches thick. The upper 9 inches is dark grayish-brown sandy loam, and the lower 7 inches is brown sandy loam. The upper 10 inches of the substratum is brown sandy loam, the next 8 inches is light-gray sandy loam, and the lower 20 inches is very gravelly sandy loam.

The available water capacity is low or moderate, and permeability is moderately rapid. These soils are used for row crops, small grain, hay, pasture, and range.

Representative profile of Vona fine sandy loam, 2,300 feet west and 1,800 feet north of SE. corner of sec. 18, T. 4 S., R. 23 E.

- Ap—0 to 6 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; many fine roots and pores; neutral; clear, smooth boundary.
- B21t—6 to 15 inches, dark grayish-brown (10YR 4/2) heavy sandy loam, dark brown (10YR 4/3) moist and coatings of dark grayish brown (10YR 4/2) moist; weak prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; many fine and very fine roots; common fine and very fine pores; many clear and coated fine sand grains; root channels and sand grains bridged with clay films; neutral; clear boundary.
- B22t—15 to 22 inches, brown (10YR 5/3) heavy sandy loam, yellowish brown (10YR 5/6) moist and coatings of dark grayish brown (10YR 4/2) moist; weak prismatic structure parting to moderate, medium, angular blocky; hard, friable, sticky and plastic; distinct clay bridgings; many very fine roots and pores; slightly effervescent; mildly alkaline; gradual boundary.
- C1ca—22 to 32 inches, brown (10YR 5/3) sandy loam mottled with light gray (10YR 7/2), grayish brown (10YR 5/2) moist and coatings of light yellowish brown (10YR 6/4) moist; massive; soft, friable, slightly sticky and nonplastic; many very fine roots and tubular pores; common distinct threads and specks of segregated lime; strongly effervescent; moderately alkaline; gradual boundary.
- C2cs—32 to 40 inches, light-gray (10YR 7/2) sandy loam, light yellowish brown (10YR 6/4) moist; massive; soft, friable, slightly sticky and nonplastic; few very fine roots; common distinct lime segregations mixed with gypsum crystals; strongly effervescent; strongly alkaline; abrupt boundary.
- IIC3—40 to 60 inches, very gravelly sandy loam, loose.

Depth to gravel ranges from 35 to 45 inches. Some profiles do not have a horizon of gypsum accumulation.

**Vona fine sandy loam, 0 to 2 percent slopes (Vn).**—This soil is on terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Vona fine sandy loam and 5 percent included Fort Collins and Olney soils. Areas of the included soils are irregular in shape and about 5 acres in size. They are near the edges of terraces.

Stream channels generally are smooth and U-shaped, and in places they have cut deeply into the alluvium. Runoff is slow, and the hazard of erosion is slight. This soil is used mainly for irrigated row crops, small grain, and hay. Capability unit IIs-1, irrigated; windbreak group 5.

**Vona fine sandy loam, 2 to 4 percent slopes (Vo).**—This gently sloping and undulating soil is on terraces. Runoff is slow, and the hazard of erosion is moderate. This soil is used for row crops, small grain, and alfalfa. Capability unit IIe-1, irrigated; windbreak group 5.

**Vona fine sandy loam, 4 to 8 percent slopes (Vp).**—This soil is on terraces and fans. Runoff is medium, and the hazard of erosion is moderate. This soil is used mostly for dryfarmed small grain, alfalfa hay, and range. Capability unit IIIe-4, dryland; Sandy range site, 10 to 14 inches precipitation; windbreak group 5.

**Vona fine sandy loam, 8 to 15 percent slopes (Vr).**—This strongly sloping and rolling soil is on fans. Runoff is moderate, and the hazard of erosion is slight. Nearly all the acreage is range. A small acreage is used for small grain, alfalfa hay, and pasture. Capability unit IVe-4, dryland; Sandy range site, 10 to 14 inches precipitation; windbreak group 5.

**Vona fine sandy loam, wet, 0 to 2 percent slopes (Vs).**—This soil is in swales or on terraces. During the irrigation season this soil becomes wet from seepage water from soils in higher lying areas. Runoff is slow, and the hazard of erosion is slight. This soil is used for irrigated pasture. Capability unit IIw-1, irrigated; windbreak group 5.

## Wayden Series

The Wayden series consists of shallow, hilly and steep, well-drained soils. These soils formed in material weathered from clayey, silty, and sandy shale. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 43° to 45° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grasses, forbs, and shrubs and a few scattered juniper trees.

In a representative profile the surface layer is grayish-brown clay loam about 6 inches thick. The underlying material consists of about 8 inches of light brownish-gray clay loam and about 6 inches of weathered clay shale. Unweathered shale is at a depth of about 20 inches.

The available water capacity is very low or low; permeability is slow. The entire acreage is range.

Representative profile of Wayden clay loam, 750 feet east and 500 feet south of NW. corner of sec. 27, T. 3 S., R. 21 E.

- A—0 to 6 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) moist; fine crumb structure; hard, firm, sticky and plastic; many fine and very fine roots and pores; slightly effervescent; mildly alkaline; abrupt, wavy boundary.
- C1—6 to 14 inches, light brownish-gray (2.5Y 6/2) clay loam that has some shale fragments, grayish brown (2.5Y 5/2) moist; hard, firm, sticky and plastic; few matted fine roots; common distinct lime segregations; strongly effervescent; strongly alkaline; clear boundary.
- C2cs—14 to 20 inches, weathered clay shale; pockets of gypsum crystals between shale layers.
- C3—20 inches, shale.

Depth to shale ranges from 10 to 20 inches. The solum is silty clay, silty clay loam, or clay that is 35 to 50 percent clay.

**Wayden-Cabba association, hilly (WA).**—The soils in this association are on uplands. The Wayden soil has the profile described as representative of its series.

This association is about 70 percent Wayden soils, 25 percent Cabba soils, and 5 percent included Rentsac and Absarokee soils. The Wayden soil is on smooth side slopes and in swales. The Cabba soil is in convex areas. The included soils are on ridges and divides in irregularly shaped areas 10 acres or less in size.

Runoff is medium, and the hazard of erosion is slight. Stream channels are cut deeply, and in places they have cut deeply into the bedrock. The drainage pattern is dendritic.

The soils of this association are used for grazing. Capability unit VIe-1, dryland; Shallow range site, 15 to 19 inches precipitation; windbreak group 3.

**Wayden-Cabba association, steep (WC).**—The soils in this association are on uplands. Runoff is medium to rapid, and the hazard of erosion is moderate. These soils are used for grazing. Capability unit VIIe-1, dryland; Shallow range site, 15 to 19 inches precipitation; windbreak group 3.

**Wayden-Castner association, steep (WD).**—The soils in this association are on uplands. This association is about 70 percent Wayden soils, 25 percent Castner soils, and 5 percent outcrops of sandstone and shale. The Wayden soil is on smooth side slopes, and the Castner soil is on convex ridges and narrow divides. Sandstone outcrop occurs either as dikes or ledges that are tens of feet thick.

Runoff is rapid, and the hazard of erosion is moderate. Drainageways are deep and form a dendritic pattern. The stream channels have cut deeply into the bedrock.

The soils of this association are used only for grazing. Capability unit VIe-1, dryland; Shallow range site, 15 to 19 inches precipitation; windbreak group 3.

### Windham Series

The Windham series consists of deep, strongly sloping to steep, well-drained soils. These soils formed in gravelly and loamy material weathered mainly from limestone. Annual precipitation is 15 to 19 inches. The mean annual soil temperature is 44° to 46° F., and the frost-free period is 90 to 110 days. The natural vegetation is mixed grass, forbs, shrubs, and scattered pine trees.

In a representative profile the surface layer is dark grayish-brown cobbly clay loam and gravelly loam about 8 inches thick. The underlying material is light brownish-gray gravelly loam and very pale brown very gravelly loam and very gravelly clay loam to a depth of 60 inches.

The available water capacity is low or very low, and permeability is moderately slow. These soils are used only for summer pasture.

Representative profile of the Windham cobbly clay loam, sloping, 2,500 feet east and 100 feet south of NW. corner of sec. 24, T. 7 S., R. 25 E.

A11—0 to 5 inches, dark grayish-brown (10YR 4/2) cobbly clay loam, very dark brown (10YR 2/2) moist; weak, fine, crumb structure; soft, very friable, non-sticky and nonplastic; common fine and very fine roots and pores; slightly effervescent; mildly alkaline; 30 percent limestone cobbles; clear, smooth boundary.

A12—5 to 8 inches, dark grayish-brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common fine and very fine roots; many very fine pores; strongly effervescent; moderately alkaline; 40 percent limestone gravel and cobbles; clear, wavy boundary.

C1—8 to 14 inches, light brownish-gray (10YR 6/2) gravelly loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky and plastic; few fine and very fine roots and pores; strongly effervescent; strongly alkaline; 45 percent limestone gravel and cobbles; clear, wavy boundary.

C2ca—14 to 22 inches, very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) moist; massive; hard, friable, slightly sticky and plastic; few very fine roots and pores; violently effervescent; strongly alkaline; lime coatings on pebbles and few lime segregations; 50 percent limestone gravel and cobbles; clear, wavy boundary.

C3ca—22 to 37 inches, very pale brown (10YR 7/3) very gravelly loam, pale brown (10YR 6/3) moist; massive; loose, friable, slightly sticky and slightly plastic; few very fine roots and pores; strongly effervescent lime coatings on pebbles; 60 percent limestone gravel and cobbles; gradual boundary.

C4—37 to 60 inches, very pale brown (10YR 7/3) very gravelly clay loam, light brownish gray (10YR 6/2) moist; massive; hard, friable, sticky and plastic; strongly effervescent; strongly alkaline; lime coatings on pebbles; 55 percent limestone pebbles and cobbles.

About 30 to 60 percent of the surface is covered with limestone fragments that range from  $\frac{1}{16}$  inch to 20 inches in diameter. Mainly, they are 2 to 6 inches in diameter. In the A horizon the content of gravel ranges from 15 to 40 percent.

**Windham cobbly clay loam, sloping (WE).**—This soil is on foot slopes and fan terraces. It has the profile described as representative of the series. Slopes range from 10 to 20 percent.

A typical area is about 95 percent Windham soil and 5 percent included Teton and Hanson soils. The Teton and Hanson soils are steep and north facing.

Runoff is medium, and the hazard of erosion is slight. The entire acreage is range. Capability unit VIe-1, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 1.

**Windham cobbly clay loam, steep (WH).**—This soil is on foot slopes and fan terraces. Slopes are 30 to 45 percent. Runoff is medium, and the hazard of erosion is slight. The entire acreage is range. Capability unit VIe-1, dryland; Clayey range site, 15 to 19 inches precipitation; windbreak group 1.

### Woodrock Series

The Woodrock series consists of moderately deep, hilly and steep, well-drained soils on uplands. These soils formed in material weathered from granite. Annual precipitation is 20 to 25 inches. The mean annual soil temperature ranges from 43° to 47° F., and the frost-free period ranges from 50 to 90 days. The natural vegetation is mixed grasses, forbs, shrubs, aspen, and pine trees.

In a representative profile the surface layer is very dark grayish-brown clay loam about 3 inches thick. The subsoil is 27 inches thick. The upper 13 inches is light-gray clay loam, the next 8 inches is pale-brown sandy clay loam, and the lowest 6 inches is very pale brown sandy loam. Massive weathered granitic bedrock is at a depth of 30 inches.

The available water capacity is low, and permeability is moderate. These soils are used primarily for summer grazing.

Representative profile of Woodrock clay loam in an area of Woodrock-Rock outcrop association, steep, 1,320 feet west and 200 feet north of SE. corner of sec. 13, T. 7 S., R. 19 E.

O— $\frac{1}{4}$  inch to 0, decomposing leaves, twigs, and grasses.

A1—0 to 3 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark gray (10YR 3/1) moist and coatings of black (10YR 2/1) moist; weak blocky structure that separates to weak, fine, granular; slightly hard, friable, slightly sticky and plastic; many very fine and few medium roots; common worm casts; neutral; clear boundary.

A&B—3 to 16 inches, light-gray (10YR 7/2) clay loam, pale brown (10YR 6/3) moist; moderate, medium and fine, blocky structure; slightly hard, friable, sticky and plastic; many very fine roots and pores; neutral; gradual boundary.

B2t—16 to 24 inches, pale-brown (10YR 6/3) sandy clay loam, yellowish brown (10YR 5/6) moist and coatings of pale brown (10YR 6/3) moist; moderate, coarse, blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and few medium roots matted between blocks; many clear and stained coarse quartz sand grains on faces of blocks; sand grains bridged with clay in the interior of blocks; neutral; gradual boundary.

B3—24 to 30 inches, very pale brown (10YR 8/3) sandy loam, yellowish brown (10YR 5/6) moist; massive; hard, friable, nonsticky and nonplastic; few very fine and medium roots; common clay bridges between sand grains; neutral; gradual boundary.

C—30 to 60 inches, strongly weathered bedrock.

Coarse fragments in the soil range from 2 to 15 percent of the volume. The B2t horizon is loam, sandy clay loam, or clay loam. The entire profile is noncalcareous. Depth to weathered bedrock ranges from 20 to 40 inches.

#### Woodrock-Rock outcrop association, steep (WK).—

This association is on mountainsides. The profile of the Woodrock soils is the one described as representative of the series.

This mapping unit is about 35 percent Woodrock soils, 60 percent Rock outcrop, and 5 percent included Bearmouth and Maurice soils. The included soils are smoother and less strongly sloping than Woodrock soils or Rock outcrop. They are in irregularly shaped areas less than 15 acres in size.

The streamways are wooded and form a dendritic drainage pattern. Stream channels have cut into the bedrock in places. Runoff is slow, and the hazard of erosion is slight. This mapping unit is used for grazing livestock, for wildlife, and for winter recreation. Woodrock soil in capability unit VIIe-1; Rock outcrop in capability unit VIIIs-1.

**Woodrock-Bynum association, hilly (WN).—**This association consists of Woodrock clay loam and Bynum sandy clay loam. A typical area is about 50 percent Woodrock soils on smooth medium length side slopes and in swales and 40 percent Bynum soils on rounded convex ridges and knobs throughout the mapping unit. Included in mapping are the Hanson, Adel, and Red-lodge soils on fan terraces and along the narrow stream valleys in irregularly shaped areas 10 acres or less in size.

The drainage pattern is dendritic. Stream channels are smooth and U-shaped and show little stream cutting because of the willow and aspen growth along the banks. Runoff is medium, and the hazard of erosion is slight.

The soils of this association are mainly covered by aspen groves and pine trees. Small meadow and open park areas are in grass. The trees are mainly on the Woodrock soils throughout the association. This mapping unit is used for summer grazing. Capability unit VIe-1, dryland; Clayey range site, 15 to 19 inch precipitation; and windbreak group 3.

## Work Series

The Work series consists of deep, gently sloping, well-drained soils. These soils formed in old alluvium. Annual precipitation is 15 to 19 inches. The mean annual soil

temperature is 45° to 47° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown clay loam about 4 inches thick. The subsoil is dark grayish-brown and brown silty clay loam about 24 inches thick. The substratum is very pale brown clay loam that extends to a depth of 62 inches and more.

The available water capacity is high, and permeability is moderate. These soils are used for small grain, alfalfa hay, pasture, and range.

Representative profile of Work clay loam, 1,500 feet south and 700 feet west of N¼ corner of sec. 22, T. 6 S., R. 21 E.

A1—0 to 2 inches, clay loam that is grayish brown (2.5Y 5/2) on bottom of plates and light brownish gray (2.5Y 6/2) on top of plates, very dark grayish brown (2.5Y 3/2) moist; weak, thin, platy structure parting to weak, fine, granular structure; soft, friable, sticky and plastic; many fine and very fine roots and pores; neutral; clear, wavy boundary.

AB—2 to 4 inches, clay loam that is grayish brown (2.5Y 5/2) on top of plates and dark grayish brown (2.5Y 4/2) on bottom of plates, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, platy structure; slightly hard, friable, sticky and plastic; many fine and very fine roots; common very fine pores; neutral; clear boundary.

B21t—4 to 12 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, very dark grayish brown (2.5Y 3/2) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; many fine and very fine roots and pores; small quartz grains clear and stained; clay films bridging sand grains; prominent clay films; neutral; clear boundary.

B22t—12 to 25 inches, brown (10YR 5/3) silty clay loam, dark grayish brown (10YR 4/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, angular blocky; slightly hard, friable, sticky and plastic; few fine and very fine roots and pores; patchy clay films; neutral; clear boundary.

B3ca—25 to 28 inches, brown (10YR 5/3) silty clay loam, dark grayish brown (10YR 4/2) moist; moderate, medium and fine, angular blocky structure; slightly hard, friable, sticky and plastic; few fine and very fine roots; common distinct threads of lime; strongly effervescent; moderately alkaline; abrupt boundary.

C1ca—28 to 62 inches, very pale brown (10YR 7/3) clay loam, yellowish brown (10YR 5/4) moist; massive; soft, friable, sticky and plastic; many fine threads, seams, and soft lime segregations; 10 to 15 percent gravel; pebbles coated with lime; violently effervescent; strongly alkaline.

The B horizon is about 36 to 40 percent clay. The Cca horizon has common to many soft nodules, threads, or masses of segregated lime.

**Work clay loam, 4 to 8 percent slopes (Wo).—**This soil is on alluvial fans and terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Work clay loam and 5 percent included Martinsdale and Heath soils. Martinsdale soils are in the convex areas that traverse the unit, and Heath soils are in the deeper swales.

Runoff is medium, and the hazard of erosion is slight. The drainage pattern is dendritic. Stream channels have cut deeply into the alluvial material. This soil is used mostly for small grain, alfalfa hay, and pasture. A small acreage is range. Capability unit IIIe-2, dryland; Clayey

range site, 15 to 19 inches precipitation; windbreak group 1.

### Wormser Series

The Wormser series consists of moderately deep, gently sloping, well-drained soils. These soils formed in residuum from stratified calcareous sandstone and shale. Annual precipitation is 10 to 14 inches. The mean annual soil temperature is 43° to 45° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is grayish-brown loam about 5 inches thick. The subsoil is 18 inches thick. The upper 9 inches is dark grayish-brown clay loam, and the lower 9 inches is brown clay loam. The substratum is light brownish-gray fine sandy loam about 15 inches thick. Sandstone and shale bedrock is at a depth of 38 inches.

The available water capacity is low or moderate, and permeability is moderate. These soils are used for cultivated crops, alfalfa hay, pasture, and range.

Representative profile of Wormser loam, 1,000 feet west and 100 feet north of SE. corner of sec. 24, T. 5 S., R. 23 E.

- A1—0 to 5 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak, fine, granular structure; soft, friable, sticky and nonplastic; many fine roots and tubular pores; neutral; clear, wavy boundary.
- B2t—5 to 14 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate prismatic structure parting to strong, medium and fine, angular blocky; hard, friable, sticky and plastic; prominent clay films; common very fine roots; many very fine and few fine tubular pores; neutral; gradual boundary.
- B3ca—14 to 23 inches, brown (10YR 5/3) light clay loam, dark brown (10YR 4/3) moist; moderate prismatic structure parting to moderate, medium and fine, angular blocky; hard, friable, sticky and plastic; prominent clay films and few specks and threads of segregated lime, slightly effervescent; moderately alkaline; clear, wavy boundary.
- C1ca—23 to 38 inches, light brownish-gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; massive; soft, friable, nonsticky and nonplastic; few very fine roots; few fine pores; common seams and nests of segregated lime; strongly effervescent; strongly alkaline; gradual boundary.
- R—38 inches, hard indurated sandstone and shale.

Depth to sandstone and shale ranges from 30 to 40 inches. The B2t horizon is 35 to 45 percent clay, which is 10 to 20 percent more clay than is in the A horizon.

**Wormser loam, 4 to 8 percent slopes (Wr).**—This soil is on uplands. It has profile described as representative of the series.

A typical area is about 90 percent Wormser loam and 10 percent included McRae and Nunn soils. The included soils are in swales and low positions in irregularly shaped areas less than 5 acres in size. The drainage pattern is dendritic, and drainageways are smooth and U-shaped. Streams have cut channels only in some places. Runoff is moderate, and the hazard of erosion is slight. This soil is used mainly for small grain, alfalfa hay, and pasture. A small acreage is grazed. Capability unit IIIe-4, dryland; Silty range site, 10 to 14 inches precipitation; windbreak group 2.

### Yegen Series

The Yegen series consists of deep, gently sloping and strongly sloping, well-drained soils. These soils formed in limy alluvium. Annual precipitation is 10 to 14 inches. The mean annual soil temperature ranges from 43° to 47° F., and the frost-free period is 110 to 120 days. The natural vegetation is mixed grasses, forbs, and shrubs.

In a representative profile the surface layer is dark grayish-brown fine sandy loam about 5 inches thick. The subsoil is 10 inches thick. The upper 6 inches is brown sandy clay loam, and the lower 4 inches is grayish-brown sandy clay loam. The substratum is white sandy loam or fine sandy loam that extends to a depth of 60 inches or more.

The available water capacity is moderate or high, and permeability is moderate. These soils are used for cultivated crops, alfalfa hay, and pasture.

Representative profile of Yegen fine sandy loam, 1,000 feet west and 200 feet north of the SE. corner of sec. 19, T. 4 S., R. 22 E.

- Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak, fine, blocky structure parting to weak, fine, granular; soft, friable, nonsticky and nonplastic; few very fine roots and pores; noncalcareous; mildly alkaline; clear, smooth boundary.
- B2t—5 to 11 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate, medium, prismatic structure parting to moderate, medium and fine, angular blocky; hard, friable, slightly sticky and nonplastic; few fine and very fine roots; common very fine pores; noncalcareous; mildly alkaline; gradual boundary.
- B3—11 to 15 inches, grayish-brown (2.5Y 5/2) sandy clay loam, dark grayish brown (2.5Y 4/2) moist; weak, medium, prismatic structure parting to moderate, medium and fine, angular blocky; hard, friable, slightly sticky and slightly plastic; few very fine roots and pores; noncalcareous; mildly alkaline; clear, wavy boundary.
- C1ca—15 to 26 inches, white (2.5Y 8/2) heavy sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, sticky and nonplastic; few very fine roots; common distinct films of lime; strongly effervescent; strongly alkaline; gradual boundary.
- C2—26 to 60 inches, white (2.5Y 8/2) fine sandy loam, grayish brown (2.5Y 5/2) moist; massive; soft, friable, nonsticky and nonplastic; stratified lenses of sandy loam and fine sandy loam ½ to ¾ inch thick; violently effervescent; strongly alkaline.

The B2t horizon is 20 to 35 percent clay, which is 5 to 10 percent more clay than is in the Ap horizon.

**Yegen fine sandy loam, 2 to 4 percent slopes (Ye).**—This soil is on fans and stream terraces. It has the profile described as representative of the series.

A typical area is about 95 percent Yegen fine sandy loam and 5 percent included Martinsdale soils. The Martinsdale soil is on small, narrow, convex ridges throughout the mapping unit.

The drainage pattern is dendritic. Stream channels have cut into the bedrock in places. Runoff is slow, and the hazard of erosion is slight.

All the acreage is used for irrigated small grain, hay, and pasture. Capability unit IIe-1, irrigated; windbreak group 5.

**Yegen fine sandy loam, 4 to 8 percent slopes (Yf).**—This soil is on fans and stream terraces. Runoff is slow, and the hazard of erosion is slight. All the acreage is

used for irrigated small grain, alfalfa, and pasture. Capability unit IIIe-1, irrigated; windbreak group 5.

**Yegen fine sandy loam, 8 to 15 percent slopes (Yg).**— This soil is on fans. Runoff is slow, and the hazard of erosion is slight. All the acreage is used for irrigated pasture and hay. Capability unit IVE-1, irrigated; windbreak group 5.

## *Use and Management of the Soils*

This section contains information about soil properties that are significant in engineering and limitations of soils to be considered in community development and recreation. It groups the soils according to their suitability for windbreaks, crops and pasture, and range and explains how the soils can be managed for those purposes. It explains the system of capability classification used by the Soil Conservation Service and gives estimated yields of the principal irrigated and dryland crops. The capability classification of each soil mapped in the Area is shown in the "Guide to Mapping Units." This section also tells about wildlife that inhabit the Area.

## *Engineering Uses of the Soils*

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in varying degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for low buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 2 and 3, which show respectively, several estimated

soil properties significant in engineering and interpretations for various engineering uses.

This information, however, does not eliminate need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used by soil scientists have special meanings in soil science that may not be familiar to engineers. These terms are defined in the Glossary.

### *Engineering classification systems*

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (7) used by the SCS engineers, the Department of Defense, and others, and the AASHO system adopted by the American Association of State Highway Officials (1).

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are 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 are designated by symbols for both classes; for example, ML-CL.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A-7, are clay soils that have low strength when wet and are the poorest soils for subgrade.

The estimated AASHO classification, without group index numbers, is given in table 2 for all soils mapped in the survey area.

### *Soil properties significant in engineering*

Several estimated soil properties significant in engineering are given in table 2. These estimates are made for representative soil profiles, by layers sufficiently different to have different significance in soil engineering. The estimates are based on field observations made in the course of mapping and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in the table.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in the table in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt,

TABLE 2.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of

Soil series and map symbols	Depth to bed-rock	Depth to seasonal high water table	Depth from surface	Classification		
				Dominant USDA texture or material	Unified <sup>1</sup>	AASHO <sup>2</sup>
*Abac: AA, AB For Twin Creek part of AA and Windham part of AB, see their respective series.	Inches <20	Inches >60	Inches 0-20 >20	Channery loam or loam... Sandstone.	GM or ML	A-4
*Absarokee: Ac, Ad, Ae, Af, Ag, Ah, Ak, Am. For Cabba part of Af and Ag, Shane part of Ah, and Sinnigam part of Ak and Am, see their respective series.	35-40	>60	0-35 >35	Clay... Shale.	CL	A-6
Adel: An, Ao	>60	>60	0-30 30-60	Silty clay loam... Gravelly clay loam	OL or OL-ML SC	A-6 A-6
Alice: Ar, As	>40	>60	0-45 >45	Fine sandy loam... Sandstone.	SM	A-4
Allentine: At	>60	>60	0-60	Clay	CH	A-7
Alluvial land: Au. No valid estimates can be made. Onsite investigation needed.						
Armington Mapped only with Lap soils.	48-60	>60	0-60	Clay	CH or CH-MH	A-7
Bearmouth Mapped only with Maurice soils.	>60	24-60	0-60	Very gravelly and cobbly loamy sand.	GW or SW	A-1
*Bowbac: Bb, Bc, Bd, Bh, Bm, BT For Harvey part of Bh, Travessilla part of Bm, and Torchlight part of BT, see their respective series.	20-40	>60	0-23 23	Clay loam or silty clay loam. Sandstone.	ML or CL	A-6
Bynum Mapped only with Heath, Thiel, and Woodrock soils.	20-40	>60	0-30 30	Sandy clay loam or clay loam. Shale.	SC	A-6
*Cabba: CA For Rentsac part, see Rentsac series.	<20	>60	0-18 18	Silty clay loam or clay loam. Shale.	ML or CL	A-4 or A-6
Castner Mapped only with Reeder and Wayden soils.	<20	>60	0-18 18	Channery and flaggy loam or silt loam. Sandstone.	GM	A-1
Charlos: Cb, Cc, Cd, Ce	>60	24-60	0-30 30-60	Gravelly clay loam... Gravelly sand	SC or CL SW or SP	A-4 or A-6 A-1
Colby: Cf, Cg, Ch	>60	>60	0-60	Silt loam	ML or CL	A-4 or A-6
*Duncom: DG, DH For Hanson part of DH, see Hanson series.	<20	>60	0-16 16	Gravelly loam... Limestone.	GM	A-4
Fort Collins: Fc, Fd, Fe	>60	20-60	0-24 24-60	Clay loam... Fine sandy loam	CL SM	A-6 A-4
*Glenberg: Gb	>60	>48	0-24 24-60	Fine sandy loam... Sand and gravel	SM GW or SW	A-4 A-1
Gh For Haverson part, see Haverson series.	>60	>48	0-60	Fine sandy loam	SM	A-4

See footnotes at end of table.

*significant in engineering*

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the this table. The symbol < means less than; the symbol > means more than]

Percentage more than 3 inches	Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
5-10	65-85	60-80	50-70	35-60	<i>Inches per hour</i> 0.6-2.0	<i>Inches per inch of soil</i> 0.10-0.14	pH 7.4-9.0	Low.
-----	80-100	80-95	75-90	65-85	0.6-2.0	0.12-0.18	6.6-8.4	Moderate.
0-5	100	95-100	90-100	75-95	0.6-2.0	0.25-0.30	6.1-7.8	Low.
5-10	75-85	50-75	45-60	35-50	0.6-2.0	0.11-0.15	7.4-7.8	Low.
-----	100	100	75-85	35-50	2.0-6.0	0.10-0.15	6.6-7.8	Low.
-----	100	100	95-100	70-80	<0.06	0.10-0.14	7.9-9.0	High.
-----	85-100	80-100	75-100	70-100	<0.06	0.10-0.14	7.4-8.4	Moderate.
25-35	45-75	25-45	12-35	0-5	>20.0	<0.04	6.6-7.3	Low.
-----	100	100	95-100	70-85	0.6-2.0	0.14-0.18	7.4-8.4	Moderate.
-----	90-100	90-100	70-90	35-50	0.6-2.0	0.14-0.18	7.4-8.4	Low.
-----	100	95-100	90-100	70-85	0.2-0.6	0.12-0.20	7.9-9.0	Moderate.
15-35	30-60	25-50	20-50	12-25	2.0-6.0	0.10-0.14	6.6-8.4	Low.
5-10	80-90	50-70	40-50	35-50	0.6-2.0	0.14-0.18	5.6-6.5	Low.
20-40	50-80	15-35	5-15	0-5	>20	<0.04	5.6-7.3	Low.
-----	100	100	90-100	70-90	0.6-2.0	0.16-0.20	7.9-8.4	Low.
20-40	30-60	25-50	20-50	12-25	0.6-2.0	0.10-0.14	7.4-8.4	Low.
-----	100	100	80-100	70-80	0.6-2.0	0.14-0.18	7.4-9.0	Low.
-----	100	100	70-85	35-50	2.0-6.0	0.10-0.15	8.5-9.0	Low.
-----	100	100	70-85	35-50	2.0-20.0	0.10-0.15	7.9-8.4	Low.
-----	40-60	30-50	15-35	0-5	>20	<0.04	8.5-9.0	Low.
-----	100	100	70-85	35-50	6.0-20.0	0.10-0.15	7.4-9.0	Low.

TABLE 2.—*Estimates of soil properties*

Soil series and map symbols	Depth to bed-rock	Depth to seasonal high water table	Depth from surface	Classification		
				Dominant USDA texture or material	Unified <sup>1</sup>	AASHO <sup>2</sup>
*Hanson: Ha, HB, HC, HD, HE..... For Duncom part of HE, see Duncom series.	Inches >60	Inches >60	Inches 0-60	Very stony and cobbly clay loam.	GC	A-1
Harvey: Hf, Hg, Hh, Hk.....	>60	>60	0-60	Silty clay loam.....	CL	A-6
*Haverson: Hm, Hn..... For Heldt part of Hn, see Heldt series.	>60	>60	0-60	Loam.....	ML or CL	A-4
*Heath: Ho, Hp, HR..... For Bynum part of HR, see Bynum series.	>60	>60	0-36 36-60	Silty clay loam..... Very shaly clay loam.....	CL SC	A-6 A-2
Heldt: Hs, Ht, Hu, Hv, Hw.....	>60	>60	0-60	Clay loam or silty clay loam.	CL	A-6
Hydro: Hy.....	>60	>60	0-60	Silty clay loam.....	CL	A-6
Kyle: Kc, Kd, Ke, Kf.....	>60	>60	0-60	Clay.....	CH	A-7
La Fonda: La, Lb.....	>60	>60	0-53 53-72	Loam, clay loam, or silty clay loam. Very gravelly loam.....	CL or ML GM	A-4 or A-6 A-1
Lambeth: Lc.....	>40	>60	0-36 36-42 42-60	Silt loam..... Very fine sandy loam..... Sandstone.	ML SM	A-4 A-4
*Lap: LD, LE, LF..... For Armington part of LD and Windham part of LF, see their respective series. No valid estimates can be made for Rock outcrop part of LE.	<20	>60	0-18 18	Very gravelly loam..... Limestone.	GM	A-1
Larim: Lg.....	>60	>60	0-60	Very gravelly sand.....	GW or SW	A-1
Limestone outcrop: LH, No valid estimates can be made.						
*Lisam: Lm, LN..... For Marias part of Lm and LN, see Marias series.	<20	>60	0-14 14	Clay..... Shale and sandstone.	CH	A-7
Lismas: LO.....	<20	>60	0-4 4	Clay..... Shale.	CH	A-7
Lohler: Lp, Lr, Ls.....	>60	40-60	0-60	Silty clay or clay loam...	CL	A-6 or A-7
*Macar: Ma, Mb..... For Cabba part of Ma and Mb, see Cabba series.	>60	>60	0-60	Clay loam.....	CL or ML	A-4 or A-6
Marias: Mc, Md.....	>60	>60	0-60	Clay.....	CL or CH	A-7
Marsh: Me. No valid estimates can be made. Onsite investigation needed.						
Martinsdale: Mf, Mg.....	>60	>60	0-26 26-60	Clay loam..... Gravelly clay loam.....	ML or CL GM or GC	A-4 of A-6 A-4 or A-6
*Maurice: MH, MK, Mm..... For Bearmouth part of Mm, see Bearmouth series.	>60	24-60	0-13 13-60	Stony loam..... Very gravelly fine sandy loam.	ML or GM GM	A-4 A-1

See footnotes at end of table.

significant in engineering—Continued

Percentage more than 3 inches	Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
50-60	15-50	20-35	15-30	12-25	<i>Inches per hour</i> 0.2-0.6	<i>Inches per inch of soil</i> 0.04-0.10	<i>pH</i> 6.6-8.4	Low.
-----	95-100	85-100	75-100	60-90	0.6-2.0	0.15-0.18	7.9-8.4	Moderate.
-----	100	100	80-90	50-80	0.6-2.0	0.15-0.18	7.9-8.4	Low.
-----	100	90-100	80-90	60-90	0.6-2.0	0.16-0.20	6.6-7.8	Moderate.
-----	85-95	25-50	20-50	15-35	0.6-2.0	0.06-0.10	7.4-7.8	Low.
-----	100	100	90-100	70-95	0.06-0.2	0.15-0.18	7.4-9.0	Moderate.
-----	100	100	80-90	70-90	0.06-0.2	0.15-0.18	6.1-9.0	Moderate.
-----	100	100	90-100	90-100	<0.06	0.10-0.14	7.4-9.0	High.
-----	90-100	90-100	75-100	50-80	0.6-2.0	0.15-0.18	7.4-8.4	Low.
25-40	40-60	35-50	30-45	20-35	0.6-2.0	0.03-0.07	8.5-9.0	Low.
-----	100	100	90-100	70-90	0.06-0.2	0.16-0.20	7.4-8.4	Low.
-----	90-100	85-95	70-85	35-50	0.6-2.0	0.10-0.15	8.5-9.0	Low.
40-60	15-45	15-40	15-35	12-25	0.6-2.0	0.04-0.08	7.4-8.4	Low.
30-45	40-60	15-25	10-20	0-5	2.0-6.0	<0.04	6.6-7.3	Low.
-----	100	100	90-100	80-90	<0.06	0.10-0.14	7.9-9.0	High.
-----	100	100	90-100	80-90	<0.06	0.10-0.14	>9.0	High.
-----	100	100	85-100	70-90	0.2-0.6	0.15-0.18	6.6-7.8	Moderate.
-----	100	100	85-100	70-90	0.6-2.0	0.15-0.18	7.4-9.0	Moderate.
-----	100	100	90-100	85-95	<0.06	0.12-0.15	7.9-9.0	High.
-----	90-100	85-100	75-100	60-80	0.6-2.0	0.14-0.18	6.6-8.4	Low.
25-50	60-70	50-65	45-60	35-50	0.6-2.0	0.08-0.14	8.5-9.0	Low.
0-50	60-100	50-100	40-95	40-75	6.0-20	0.10-0.20	6.6-7.3	Low.
45-60	40-60	35-50	20-45	12-25	6.0-20	0.04-0.10	7.4-8.4	Low.

TABLE 2.—*Estimates of soil properties*

Soil series and map symbols	Depth to bed-rock	Depth to seasonal high water table	Depth from surface	Classification		
				Dominant USDA texture or material	Unified <sup>1</sup>	AASHO <sup>2</sup>
Mayflower: MN.....	Inches 30-40	Inches >60	Inches 0-38 38	Clay loam or silty clay loam. Shale.	ML or CL	A-4 or A-6
McRae: Mo.....	>60	>60	0-60	Clay loam.....	ML or CL	A-4 or A-6
*Midway: MR, MT..... For Travessilla part of MR and MT, see Travessilla series.	<20	>60	0-14 14	Clay loam or silty clay loam. Shale.	CL, ML, or MH	A-6 or A-7
Nelson: Ne.....	29-36	>60	0-30 30	Fine sandy loam..... Sandstone.	SM	A-4
Neville: Nf, Ng.....	>60	>60	0-60	Clay loam or silty clay loam.	ML or CL	A-4 or A-6
Nihill: NH.....	>60	>60	0-60	Very gravelly loam.....	GW-GM or GM	A-1
Nunn: Nk, Nm, Nn.....	>60	>60	0-62	Silty clay loam or clay loam.	CL	A-6
Olney: Oe, Of.....	>60	>60	0-20 20-59	Fine sandy loam or clay loam. Very gravelly sandy loam.	SC or ML GW-GM	A-4 or A-6 A-1
Peritsa: Pe.....	20-40	>60	0-40 40	Silty clay loam..... Shale.	ML or CL	A-4 or A-6
*Razor: Ra, Rb..... For Thedalund part of Rb, see Thedalund series.	28-37	>60	0-28 28	Clay loam..... Shale.	CL	A-6
*Redlodge: Rc, Rd..... For Adel part of Rc and Rd, see Adel series.	>60	<20	0-25 25-60	Silty clay loam or clay loam..... Clay.....	OH or OH-CL CL or CH	A-6 or A-7 A-6 or A-7
*Reeder: RE..... For Castner part, see Castner series.	30-40	>60	0-30 30	Clay loam or loam..... Sandstone and shale.	ML or CL	A-4 or A-6
Rentsac: RF, RG..... No valid estimates can be made for Rock outcrop part of RG.	<20	>60	0-20 20	Channery loam..... Sandstone.	GW-GM	A-1
Riverwash: Rh. No valid estimates can be made. Onsite investigation needed.						
Rock outcrop: Rk, RM. No valid estimates can be made for Rock outcrop part of Rk and RM. For Lambeth part of Rk and Travessilla part of RM, see their respective series.						
*Romberg: RN, RO, RP, RS..... For Stutzman part of RS, see Stutzman series. No valid estimates can be made for Shale outcrop part of RP.	>60	>60	0-60	Gravelly, cobbly, and stony clay loam.	GC or SC	A-2
Rottulee: Rt.....	22-35	>60	0-22 22	Silt loam..... Limestone.	ML	A-4
Ryorp: RY.....	32-38	>60	0-34 34	Fine sandy loam..... Sandstone.	SM	A-2 or A-4

See footnotes at end of table.

significant in engineering—Continued

Percentage more than 3 inches	Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
-----	100	80-100	70-100	60-80	<i>Inches per hour</i> 0.06-0.2	<i>Inches per inch of soil</i> 0.16-0.20	pH 7.4-8.4	Moderate.
-----	100	100	85-100	60-80	0.6-2.0	0.15-0.18	7.4-9.0	Moderate.
-----	100	100	90-100	80-90	0.06-0.2	0.14-0.18	7.4-8.4	Moderate.
-----	100	100	85-95	35-50	2.0-6.0	0.10-0.15	7.4-7.8	Low.
-----	100	100	100	85-95	0.6-2.0	0.15-0.18	7.9-9.0	Low.
5-10	40-60	15-35	12-30	10-25	2.0-6.0	0.04-0.10	7.4-9.0	Low.
-----	100	100	90-100	70-95	0.2-0.6	0.15-0.20	6.6-9.0	Moderate.
-----	100	100	75-90	35-60	0.6-2.0	0.10-0.14	6.6-7.8	Low.
-----	30-50	25-40	10-20	5-12	6.0-2.0	0.04-0.06	8.5-9.0	Low.
-----	100	100	95-100	80-95	0.6-2.0	0.16-0.22	6.6-9.0	Moderate.
-----	100	100	90-100	70-80	0.06-0.2	0.14-0.18	6.6-8.4	Moderate.
-----	100	100	90-100	85-95	0.06-0.2	0.20-0.25	7.4-8.4	Moderate.
-----	100	100	90-100	75-95	0.06-0.2	0.12-0.16	7.9-8.4	Moderate.
-----	100	100	90-100	70-80	0.6-2.0	0.14-0.18	6.1-8.4	Low.
30-60	25-40	10-25	10-20	5-12	2.0-6.0	0.04-0.08	7.9-8.4	Low.
30-60	45-70	40-60	35-50	12-35	0.6-2.0	0.04-0.08	6.6-9.0	Low.
-----	95-100	70-90	85-90	60-80	0.6-2.0	0.14-0.20	7.9-9.0	Low.
-----	60-100	60-100	40-85	15-50	6.0-20	0.10-0.15	5.6-6.5	Low.

TABLE 2.—*Estimates of soil properties*

Soil series and map symbols	Depth to bed-rock	Depth to seasonal high water table	Depth from surface	Classification		
				Dominant USDA texture or material	Unified <sup>1</sup>	AASHO <sup>2</sup>
Sandstone outcrop: SA. No valid estimates can be made.	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>			
Sebud: SB-----	>60	>60	0-22 22-62	Very bouldery clay loam Very bouldery coarse sandy clay loam.	GM GM or GC	A-4 or A-6 A-2
Shale outcrop: SC, SD. No valid estimates can be made for Shale outcrop. For Abac part of SD, see Abac series.						
*Shane: Se, Sf, Sg, Sh----- For Cabba part of Sg and Sh, see Cabba series.	30-40	>60	0-7 7-34 34-60	Clay loam----- Clay----- Shale.	ML or CL CH	A-4 or A-6 A-7
Sicklesteets: SK-----	>60	>60	0-30 30-60	Clay loam----- Gravelly silty clay-----	CL CL	A-4 or A-6 A-4 or A-6
Sinnigam: SM, SN-----	8-20	>60	0-20 20	Channery clay loam----- Sandstone.	GC	A-2 or A-6
Spearfish: SO----- No valid estimates can be made for Shale outcrop part.	10-20	>60	0-16 16	Loam----- Sandstone and shale.	ML	A-4
Stormitt: Sp, Sr, Ss, St, SU, SV-----	>60	>60	0-72	Very gravelly or very cobbly silty clay loam.	GC or SC	A-2
Stutzman: SW-----	>60	>60	0-60	Clay loam or silty clay---	CL	A-6
*Tarrete: TA, TB, TC----- For Hanson part of TC, see Hanson series.	>60	>60	0-60	Clay-----	CH or MH-CH	A-7
Teton: TD-----	32-40	>60	0-35 35	Stony clay loam or loam-- Sandstone.	ML or CL	A-4 or A-6
Thedalund: Te, Tf-----	20-40	>60	0-25 25	Clay loam or silt loam-- Shale and sandstone.	ML or CL	A-4 or A-6
*Thiel: Tg, TH----- For Bynum part of TH, see Bynum series.	>60	>60	0-20 20-60	Very cobbly clay loam-- Sand, gravel, and cobbles.	GC GW or SW	A-2 A-1
*Thurlow: Tk, Tl----- For Toluca part of Tl, see Toluca series.	>60	>60	0-60	Silty clay loam or clay loam.	CL	A-6
*Tiban: TM, TN----- For Tarrete part of TN, see Tarrete series.	>60	>60	0-60	Stony, cobbly, and gravelly clay loam or loam.	GM or GC	A-4 or A-6
*Toluca: To, Tp, Tr, Ts, TT, TU----- For Midway part of TT, see Midway series. No valid estimates can be made for Rock outcrop part of TU.	>60	>60	0-60	Clay loam-----	CL or ML	A-6 or A-4
Tonra: Tv-----	>60	>60	0-29 29-60	Gravelly silty clay loam-- Coarse sand, gravel, and cobbles.	CL or ML GW or SW	A-6 A-1
Torchlight: TW-----	>60	>60	0-60	Clay-----	CH	A-7
Trapper: TX-----	50-60	>60	0-50 50	Silty clay loam----- Siltstone and sandstone.	ML, CL, GM, or GC	A-4 or A-6
Travessilla: TY-----	<20	>60	0-18 18	Coarse sandy loam, silt loam, or loam. Sandstone.	GM or SM	A-4.

See footnotes at end of table.

significant in engineering—Continued

Percentage more than 3 inches	Percentage passing sieve—				Permeability  <i>Inches per hour</i>	Available water capacity  <i>Inches per inch of soil</i>	Reaction  <i>pH</i>	Shrink-swell potential
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
55-80 55-80	55-70 50-60	50-65 25-40	40-60 25-40	35-50 15-35	0.6-2.0 0.6-2.0	0.04-0.08 0.04-0.10	6.6-7.8 7.4-7.8	Low. Low.
-----	100	100	90-100	70-90	0.2-0.6	0.16-0.20	6.6-7.8	Moderate.
-----	100	100	100	90-100	<0.06	0.10-0.14	7.4-8.4	High.
10-20 20-35	70-90 70-90	70-90 70-85	65-85 65-80	60-80 50-75	0.2-0.6 0.2-0.6	0.14-0.18 0.14-0.14	6.1-7.8 7.4-8.4	Moderate. Moderate.
40-60	45-70	35-60	30-50	25-50	0.2-0.6	0.04-0.08	6.1-7.8	Low.
-----	90-100	75-100	70-100	50-80	0.6-2.0	0.16-0.20	7.1-9.0	Low.
30-50	40-70	35-50	20-50	15-35	0.6-2.0	0.04-0.10	7.9-9.0	Low.
-----	100	100	90-100	75-95	0.06-0.2	0.15-0.18	7.9-8.4	Moderate.
-----	100	100	100	85-100	0.06-0.2	0.10-0.14	6.6-8.4	Moderate.
-----	100	75-90	60-70	50-65	0.6-2.0	0.15-0.21	6.6-7.3	Low.
-----	100	100	90-100	75-95	0.6-2.0	0.14-0.18	7.9-9.0	Low.
40-60 50-60	35-60 35-60	30-50 25-50	25-45 15-35	15-35 0-5	0.6-2.0 >20	0.04-0.10 <0.04	6.6-7.4 7.9-8.4	Low. Low.
-----	100	100	90-100	70-95	0.2-0.6	0.15-0.18	6.6-9.0	Moderate.
40-60	65-75	60-70	50-65	35-50	0.6-2.0	0.04-0.08	6.6-9.0	Low.
-----	100	100	90-100	70-90	0.6-2.0	0.15-0.18	6.6-9.0	Moderate.
5-15 50-60	85-100 80-95	70-75 70-85	70-75 20-35	65-70 <5	0.6-2.0 >20	0.12-0.18 <0.04	7.9-9.0 8.5-9.0	Low. Low.
-----	100	100	90-100	80-95	0.06-0.2	0.10-0.14	8.5->9.0	High.
5-10	60-100	50-85	45-80	35-75	0.6-2.0	0.10-0.18	6.1-7.3	Low.
-----	55-85	50-80	40-80	35-50	6-20	0.10-0.14	6.6-9.0	Low.

TABLE 2.—*Estimates of soil properties*

Soil series and map symbols	Depth to bed-rock	Depth to seasonal high water table	Depth from surface	Classification		
				Dominant USDA texture or material	Unified <sup>1</sup>	AASHO <sup>2</sup>
Twin Creek: Tz.....	<i>Inches</i> >48	<i>Inches</i> >60	<i>Inches</i> 0-13 13-60	Silty clay loam..... Gravelly silt loam or loam.	CL SM	A-6 A-4
Vona: Vn, Vo, Vp, Vr, Vs.....	>60	24-60	0-40 40	Sandy loam or fine sandy loam. Very gravelly sandy loam.	SM-SC or SM GM-GC	A-4 A-1
*Wayden: WA, WC, WD..... For Cabba part of WA and WC, and Castner part of WD, see their respective series.	<20	>60	0-20 20	Clay loam..... Shale.	CL, ML, or MH	A-4, A-6, or A-7
Windham: WE, WH.....	>60	>60	0-60	Very gravelly loam.....	GM	A-2
*Woodrock: WK, WN..... For Bynum part of WN, see Bynum series. No valid estimates can be made for Rock outcrop part of WK.	20-40	>60	0-30 30	Clay loam..... Weathered granite.	SC or SC-SM	A-2 or A-6
Work: Wo.....	>60	>60	0-60	Silty clay loam.....	ML-CL	A-6
Wormser: Wr.....	30-40	>60	0-23 23-38 38	Clay loam..... Fine sandy loam..... Sandstone.	ML-CL SM or SM-SC	A-6 A-4
Yegen: Ye, Yf, Yg.....	>60	>60	0-15 15-60	Sandy clay loam..... Fine sandy loam.....	SM-SC or SC SM	A-4 A-4

<sup>1</sup> Based on MIL-STD-619B (7).

significant in engineering—Continued

Percentage more than 3 inches	Percentage passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
5-10 10-20	95-100 90-95	95-100 50-70	90-100 45-65	70-90 35-50	<i>Inches per hour</i> 0.6-2.0 0.6-2.0	<i>Inches per inch of soil</i> 0.14-0.21 0.10-0.15	<i>pH</i> 6.6-7.3 7.4-8.4	Moderate. Low.
-----	100	100	90-100	35-50	2.0-6.0	0.10-0.15	6.6-9.0	Low.
5-10	30-50	20-40	15-25	8-12	<20	0.04-0.08	7.9-8.4	Low.
-----	100	100	90-100	70-95	0.06-0.2	0.14-0.18	7.4-9.0	Moderate.
30-40	45-60	20-40	15-35	12-25	0.2-0.6	0.04-0.10	7.4-8.4	Low.
-----	100	75-90	40-60	25-40	0.6-2.0	0.10-0.15	6.6-7.3	Low.
-----	90-100	90-100	90-100	70-80	0.6-2.0	0.15-0.18	6.6-9.0	Moderate.
-----	100	100	90-100	60-80	0.6-2.0	0.14-0.18	6.6-8.4	Moderate.
-----	100	100	90-100	35-50	0.6-2.0	0.10-0.15	8.5-9.0	Low.
-----	100	100	75-90	35-50	0.6-2.0	0.14-0.18	7.4-7.8	Low.
-----	100	100	70-85	35-50	0.6-2.0	0.10-0.15	8.5-9.0	Low.

<sup>2</sup> Based on AASHTO Designation M 145-49 (1).

TABLE 3.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in for referring to other series that

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
*Abac: AA, AB..... For Twin Creek part of AA and Windham part of AB, see their respective series.	Poor: slopes of more than 15 percent.	Unsuitable: fines...	Poor: less than 20 inches deep over sandstone; slopes steeper than 25 percent.	Less than 20 inches deep over sandstone; steep topography.
*Absarokee: Ac, Ad, Ae, Af, Ag, Ah, Ak, Am. For Cabba part of Af and Ag, Shane part of Ah, and Sinnigam part of Ak and Am, see their respective series.	Poor: suitable material less than 8 inches thick.	Unsuitable: fines...	Poor to fair: moderate shrink-swell potential; medium to high plasticity.	Less than 40 inches deep over bedrock.
Adel: An, Ao.....	Fair: silty clay loam.	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential.
Alice: Ar.....	Good.....	Unsuitable: fines...	Fair: moderate frost-action potential.	Moderate frost-action potential.
As.....	Fair: slopes of 8 to 15 percent.	Unsuitable: fines...	Fair: moderate frost-action potential.	Moderate frost-action potential.
Allentine: At.....	Poor: clay texture..	Unsuitable: fines...	Poor: high shrink-swell potential.	High shrink-swell potential; high compressibility.
Alluvial land: Au. No valid interpretations can be made. Onsite investigation required.				
Armington..... Mapped only with Lap soils.	Poor: silty clay and clay surface texture.	Unsuitable: fines...	Poor: high plasticity.	High shrink-swell potential; high compressibility.
Bearmouth..... Mapped only with Maurice soils.	Poor: greater than 15 percent coarse fragments.	Good.....	Good.....	Seasonal high water table.
*Bowbac: Bb, Bc, Bd, Bh, Bm, BT..... For Harvey part of Bh, Travessilla part of Bm, and Torchlight part of BT, see their respective series.	Fair: loamy where slope is 2 to 8 percent; clayey where slope is 8 to 15 percent.	Unsuitable: fines...	Fair: moderate shrink-swell potential.	Moderate shrink-swell potential; 20 to 40 inches deep over bedrock.

*interpretations*

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions appear in the first column of this table]

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Limited amount of material.	Less than 20 inches deep over sandstone.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Not applicable.
Medium stability and fair compaction characteristics; low permeability when compacted.	Less than 40 inches deep over bedrock.	Less than 40 inches deep over bedrock.	Not applicable-----	Difficult to break frozen clods and compact the material.	Excessive cuts can expose bedrock or less fertile material; slopes of 4 to 15 percent in Ad and Ae are highly erodible.
Low shear strength; high frost-action potential.	High organic-matter content in upper 24 to 36 inches.	Not applicable-----	All features favorable if slope is less than 2 percent; moderate erosion hazard if slope is 2 to 4 percent, high erosion hazard if slope is 4 to 8 percent.	Difficult to break frozen clods and compact the material.	Features generally favorable.
Medium stability and medium permeability when compacted.	Moderately rapid permeability.	Not applicable-----	Not applicable-----	Features generally favorable.	Erosion hazard.
Medium stability and medium permeability when compacted.	Moderately rapid permeability.	Not applicable-----	Not applicable-----	Slopes of 8 to 15 percent.	Not applicable.
High shrink-swell potential; low shear strength; high compressibility; poor compaction characteristics.	Features generally favorable.	Very slow permeability.	Very slow permeability; strongly alkaline reaction.	Difficult to excavate when frozen; frozen clods very difficult to break down.	Cuts can expose strongly alkaline subsoil or substratum; high runoff.
Low shear strength; high compressibility; poor compaction characteristics.	Slopes up to 15 percent.	Not applicable-----	Not applicable-----	Plastic when wet; difficult to excavate.	Not applicable.
High permeability when compacted; high stability.	Very rapid permeability; seasonal high water table.	Not applicable-----	Not applicable-----	Features generally favorable.	Not applicable.
Moderate shrink-swell potential; low stability; medium permeability when compacted.	Fractured bedrock at depth of 20 to 40 inches.	Sandstone bedrock within 40 inches of surface.	Sandstone bedrock within 40 inches of surface; low available water capacity; high erosion hazard.	Features generally favorable except where slope is 8 to 15 percent.	Excessive cuts expose bedrock; slopes of 4 to 15 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
Bynum..... Mapped only with Heath, Thiel, and Woodrock soils.	Poor: slopes of more than 15 percent.	Unsuitable: fines...	Poor: steep slopes..	Slopes of more than 15 percent; shale between a depth of 20 and 40 inches.
*Cabba: CA..... For Rentsac part, see Rentsac series.	Poor: less than 20 inches deep over bedrock.	Unsuitable: fines...	Poor: less than 20 inches deep over shale; high frost-action potential.	High frost-action potential; shale within 20 inches of surface; unstable cuts; highly erodible.
Castner..... Mapped only with Reeder and Wayden soils.	Poor: more than 15 percent coarse fragments.	Unsuitable: fines...	Poor: bedrock at depth of less than 20 inches.	Bedrock within 20 inches of surface.
Charlos: Cb, Cc.....	Fair: coarse fragments.	Good below depth of 30 inches.	Fair to depth of 30 inches; moderate frost-action potential; good below depth of 30 inches.	Features generally favorable.
Cd.....	Fair: coarse fragments.	Good below depth of 30 inches.	Fair to depth of 30 inches; moderate frost-action potential; good below depth of 30 inches.	Water table within 20 inches of surface part of year; moderate frost action in upper 20 to 40 inches.
Ce.....	Fair: coarse fragments.	Good below depth of 30 inches.	Fair to depth of 30 inches; moderate frost-action potential; good below depth of 30 inches.	Features generally favorable.
Colby: Cf, Cg, Ch.....	Good if slope is 2 to 8 percent; fair if slope is 8 to 15 percent.	Unsuitable: fines...	Poor: very high frost-action potential.	Very high frost-action potential.
*Duncom: DG, DH..... For Hanson part of DH, see Hanson series.	Poor: more than 15 percent coarse fragments.	Unsuitable: less than 20 inches deep over limestone; too many fines.	Poor: less than 20 inches deep over hard bedrock.	Bedrock at depth of less than 20 inches.

*interpretations—Continued*

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Low permeability when compacted.	Slopes of more than 15 percent.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Not applicable.
Shale within 20 inches of surface; high frost-action potential; low strength.	Bedrock at depth of less than 20 inches.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and to compact the material.	Cuts expose soft shale; erosion hazard.
Limited volume of material; high strength.	Fractured bedrock at depth of less than 20 inches.	Not applicable-----	Not applicable-----	Less than 20 inches deep over bedrock.	Not applicable.
Medium stability and fair compaction characteristics; medium to high permeability when compacted.	Very rapid permeability below depth of 30 inches.	Not applicable-----	Low available water capacity.	All features favorable below depth of 30 inches.	Excessive cuts expose gravel and sand that have very low available water capacity.
Medium stability and fair compaction characteristics; medium to high permeability when compacted.	Very rapid permeability below depth of 30 inches.	Features generally favorable.	Water table within 40 inches of surface during growing season.	All features favorable below depth of 30 inches.	Excessive cuts expose gravel and sand that have very low available water capacity.
Medium stability and fair compaction characteristics; medium to high permeability when compacted.	Very rapid permeability below depth of 30 inches.	Not applicable-----	Not applicable-----	All features favorable below depth of 30 inches.	Excessive cuts expose gravel and sand that have very low available water capacity.
High piping hazard; very high frost-action potential; low permeability when compacted; low stability.	Moderate permeability.	Not applicable-----	Slight erosion hazard if slope is 2 to 4 percent; moderate erosion hazard if slope is 4 to 8 percent; very high erosion hazard if slope is 8 to 15 percent.	Difficult to break frozen clods and compact the material.	Features generally favorable.
Limited volume of material.	Bedrock at depth of less than 20 inches.	Not applicable-----	Not applicable-----	Slopes of 6 to 25 percent.	Not applicable.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
Fort Collins: Fc.....	Good.....	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential.
Fd.....	Good.....	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential.
Fe.....	Poor: moderate to strong salinity; water table within 20 inches of surface during part of year.	Unsuitable: fines...	Poor: high frost-action potential; water table within 20 inches of surface during part of year.	Water table within 20 inches of surface during part of year; high frost-action potential; very high corrosivity.
*Glenberg: Gb.....	Good.....	Good below depth of 24 inches.	Good below depth of 24 inches.	Features generally favorable.
Gh..... For Haverson part, see Haverson series.	Good, but subject to periodic overflow.	Poor: fines.....	Fair: too many fines; moderate frost-action potential.	Subject to periodic overflow.
*Hanson: Ha, HB, HC, HD, HE..... For Duncom part of HE, see Duncom series.	Poor: more than 15 percent coarse fragments.	Unsuitable: fines...	Fair: large volume of fragments larger than 3 inches in diameter.	Large volume of fragments larger than 3 inches in diameter hinder loading and hauling.
Harvey: Hf, Hg, Hh.....	Good if slope is 2 to 8 percent, fair if slope is 8 to 15 percent.	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential.
Hk.....	Poor: more than 15 percent coarse fragments.	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential.
*Haverson: Hm, Hn..... For Heldt part of Hn, see Heldt series.	Fair: silty clay loam texture.	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential.

*interpretations*—Continued

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Medium piping hazard; low permeability when compacted; medium stability.	Moderately rapid permeability.	Not applicable.....	Features generally favorable.	Difficult to break frozen clods and compact the material.	Features generally favorable.
Medium piping hazard; low permeability when compacted; medium stability.	Moderately rapid permeability.	Not applicable.....	Moderate erosion hazard; slopes of 2 to 4 percent.	Difficult to break frozen clods and compact the material.	Features generally favorable.
Medium piping hazard; low permeability when compacted; medium stability.	Water table within 20 inches of surface during part of year.	Features generally favorable.	Water table within 20 inches of surface during most of growing season; moderately to strongly saline.	Frozen clods difficult to break.	Features generally favorable.
Medium to high stability and compacted permeability.	Very rapid permeability below depth of 24 inches.	Features generally favorable.	Low available water capacity.	Features generally favorable.	Features generally favorable.
Medium strength; medium permeability when compacted; medium piping hazard.	Rapid permeability..	Features generally favorable.	Subject to periodic overflow.	Features generally favorable.	Features generally favorable.
Large volume of coarse fragments.	Relief and topography; slope of more than 4 percent.	Not applicable.....	Not applicable.....	Difficult to break frozen clods and compact the material; excessive stones.	Cuts expose subsoil that is high in content of lime and coarse fragments.
Low stability and low permeability when compacted; low piping hazard.	Moderate permeability.	Not applicable.....	Slight erosion hazard if slope is 2 to 4 percent; moderate erosion hazard if slope is 4 to 8 percent; very high erosion hazard if slope is 8 to 15 percent.	Difficult to break frozen clods and compact material.	Cuts expose high content of lime.
Low stability and low permeability when compacted; low piping hazard.	Moderate permeability.	Not applicable.....	Not applicable.....	Difficult to break frozen clods and compact material.	Cuts expose high content of lime.
Medium to low stability; fair compactibility; medium compressibility; medium piping hazard.	Moderate permeability.	Moderate permeability; unstable side slopes.	Features generally favorable.	Difficult to break frozen clods.	Features generally favorable.

TABLE 3.—Engineering

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
*Heath: Ho, Hp-----	Fair: clay loam surface texture; slopes of 8 to 15 percent.	Unsuitable: fines---	Fair: moderate to low shrink-swell potential; moderate frost-action potential.	Moderate shrink-swell potential; moderate frost-action potential.
HR----- For Bynum part, see Bynum series.	Poor: slopes of more than 15 percent.	Unsuitable: fines---	Fair: moderate to low shrink-swell potential; moderate frost-action potential.	Relief and topography; slopes of more than 25 percent.
Heldt: Hs, Ht, Hu, Hv-----	Fair: clay loam or silty clay loam surface layer.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential.
Hw-----	Poor: strong to very strong salinity; water table within 20 inches of surface during most of year.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential; water table within 20 inches of surface during most of year; very high corrosivity.
Hydro: Hy-----	Fair: silty clay loam texture within 8 inches of surface.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential.
Kyle: Kc-----	Poor: clay texture--	Unsuitable: fines---	Poor: high shrink-swell potential.	High shrink-swell potential.
Kd, Ke, Kf-----	Poor: clay texture--	Unsuitable: fines---	Poor: high shrink-swell potential.	High shrink-swell potential.
La Fonda: La, Lb-----	Fair: silty clay loam below depth of 6 inches.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential.
Lambeth: Lc-----	Good-----	Unsuitable: fines---	Poor: very high frost-action potential.	Very high frost-action potential.

## interpretations—Continued

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Medium to low permeability when compacted; moderate shrink-swell potential.	Moderate permeability; slopes of 4 to 15 percent.	Moderate permeability; not applicable if slope is more than 8 percent.	Moderate erosion hazard if slope is less than 8 percent; not applicable if slope is more than 8 percent.	Difficult to break frozen clods and compact the material.	Excessive cuts may expose high content of lime or clayey material; high runoff.
Medium to low permeability when compacted; moderate shrink-swell potential.	Slopes of more than 25 percent.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material; slopes steeper than 25 percent.	Not applicable.
Low shear strength; high frost-action potential; medium compressibility; moderate shrink-swell potential.	Features generally favorable except if slope is more than 4 percent.	Slow permeability; not applicable if slope is more than 4 percent.	Slow permeability; moderate erosion hazard if slope is 4 to 8 percent; not applicable if slope is more than 8 percent.	Difficult to break frozen clods and compact the material.	Features generally favorable.
Low shear strength; high frost-action potential; medium compressibility; moderate shrink-swell potential.	Water table within 20 inches of surface during most of year.	Not applicable-----	Strong or very strong salinity; water table within 20 inches of surface during most of year.	Difficult to break frozen clods and compact the material; water table within 20 inches of surface during most of year.	Features generally favorable.
Moderate shrink-swell potential; high frost-action potential; medium stability.	Slopes of 4 to 8 percent; slow permeability.	Slow permeability---	Not applicable-----	Difficult to break frozen clods and compact the material.	Cuts expose clayey material.
High shrink-swell potential; low compacted permeability; low stability.	Features generally favorable.	Very slow permeability.	Very slow permeability.	Plastic when wet; difficult to excavate and break frozen clods.	Features generally favorable.
High shrink-swell potential; low compacted permeability; low stability.	Slopes of 2 to 15 percent.	Very slow permeability.	Very slow permeability; moderate erosion hazard if slope is 4 to 8 percent; not applicable if slope is more than 8 percent.	Plastic when wet; difficult to excavate and break frozen clods.	Rapid runoff where slope is more than 2 percent.
High frost-action potential; high piping hazard; low stability; poor compaction characteristics.	Moderate permeability.	Moderate permeability; unstable slopes.	Features generally favorable.	Difficult to break frozen clods and compact the material.	Features generally favorable.
Very high frost-action potential; high piping hazard; low stability.	Slow permeability; bedrock at depth of 40 to 60 inches.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Erosion hazard.

TABLE 3.—Engineering

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
*Lap: LD, LE, LF----- For Armington part of LD and Windham part of LF, see their respective series. For Rock outcrop part of LE, see Rock outcrop.	Poor: more than 15 percent coarse fragments.	Unsuitable: fines; small volume.	Poor: less than 20 inches deep over bedrock.	Less than 20 inches deep over hard bedrock; moderately steep and steep slopes.
Larim: Lg-----	Poor: more than 15 percent coarse fragments; sandy texture.	Good-----	Good-----	Features generally favorable.
Limestone outcrop: LH. Unsuitable for all uses except riprapping.				
*Lisam: Lm, LN----- For Marias part of Lm and LN, see Marias series.	Poor: clay texture--	Unsuitable: fines---	Poor: less than 20 inches deep over shale and sandstone; high shrink-swell potential.	Less than 20 inches deep over shale and sandstone bedrock.
Lismas: LO-----	Poor: clay texture--	Unsuitable: fines---	Poor: less than 20 inches deep over shale; high shrink-swell potential.	Less than 20 inches deep over shale.
Lohler: Lp, Lr-----	Fair to poor: silty clay or clay loam texture.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential.
Ls-----	Poor: strong salinity; water table within 40 inches of surface during part of year.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential; water table within 40 inches of surface during part of year; very high corrosivity.
*Macar: Ma, Mb----- For Cabba part, see Cabba series.	Fair: clay loam texture.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential.
Marias: Mc, Md-----	Poor: clay texture--	Unsuitable: fines---	Poor: high shrink-swell potential.	High shrink-swell potential.
Marsh: Me-----	Poor or unsuitable; water table at or near surface.	Poor or unsuitable; water table at or near surface.	Poor or unsuitable; water table at or near surface.	Permanent high water table.
Martinsdale: Mf, Mg-----	Fair: clay loam texture.	Poor or unsuitable: fines.	Fair: moderate frost-action potential.	Moderate frost-action potential.

*interpretations—Continued*

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Limited volume of material; high in content of coarse fragments.	Less than 20 inches deep over hard bedrock.	Not applicable-----	Not applicable-----	Moderately steep and steeper slopes.	Not applicable.
High permeability when compacted; high stability; low piping hazard.	Moderately rapid permeability; slopes of 8 to 15 percent.	Not applicable-----	Not applicable-----	Slopes of 8 to 15 percent.	Not applicable.
High shrink-swell potential; small volume of material.	Less than 20 inches deep over bedrock.	Not applicable-----	Not applicable-----	Plastic when wet; difficult to excavate.	Shallow cuts expose shale.
High shrink-swell potential; small volume of material.	Less than 20 inches deep over bedrock.	Not applicable-----	Not applicable-----	Plastic when wet; difficult to excavate.	Shallow cuts expose shale.
High frost-action potential; medium stability.	Features generally favorable.	Moderately slow permeability.	Moderately slow permeability.	Difficult to break frozen clods and to compact the material.	Features generally favorable.
High frost-action potential; medium stability.	Water table within 40 inches of surface during part of season.	Moderately slow permeability.	Strong salinity; water table within 40 inches of surface during most of growing season.	Difficult to break frozen clods and to compact the material.	Strong salinity; water table within 40 inches of surface during most of growing season.
High frost-action potential; high piping hazard; low stability.	Moderate permeability; slopes of 4 to 15 percent.	Moderate permeability; not applicable if slope is more than 8 percent.	Moderate erosion hazard if slope is 4 to 8 percent; severe erosion hazard if slope is 8 to 15 percent.	Difficult to break frozen clods and to compact the material.	Slopes of 4 to 8 percent; erosion hazard and rapid runoff if slope is 8 to 15 percent.
High shrink-swell potential; high compressibility; low stability.	Slopes of 2 to 15 percent.	Very slow permeability.	Very slow permeability; moderate erosion hazard; slopes of 2 to 8 percent are limiting; steeper slopes not irrigable.	Plastic when wet; difficult to excavate.	Rapid runoff; slopes of 2 to 15 percent.
Unsuitable-----	Permanent high water table.	Wet areas lower than available outlets.	Not applicable-----	Permanent high water table.	Permanent high water table.
Medium stability; medium permeability when compacted.	Moderate permeability; slopes of 2 to 8 percent.	Moderate permeability.	Features generally favorable; moderate erosion hazard if slope is 4 to 8 percent.	Difficult to break frozen clods and to compact the material.	Deep cuts expose material high in content of lime.

TABLE 3.—Engineering

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
*Maurice: MH, MK-----	Poor: stony loam texture.	Unsuitable: fines---	Fair if slope is 15 to 25 percent; poor if slope is 25 to 45 percent.	Slopes of 15 to 45 percent.
Mm----- For Bearmouth part, see Bearmouth series.	Poor: stony loam texture.	Unsuitable: fines---	Water table within 40 inches of surface during most of year.	Water table within 40 inches of surface during most of year.
Mayflower: MN-----	Fair: silty clay loam texture; slopes of 8 to 15 percent.	Unsuitable: fines---	Poor: silty shale at depth of 30 to 40 inches; high frost-action potential; low stability.	High frost-action potential; shale at depth of 30 to 40 inches.
McRae: Mo-----	Good-----	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential.
*Midway: MR, MT----- For Travessilla part of MR and MT, see Travessilla series.	Poor: slopes of more than 15 percent.	Unsuitable: fines---	Poor: high frost-action potential; low stability; less than 20 inches deep over shale; slopes of 15 to 45 percent.	Less than 20 inches deep over shale; highly erodible; slopes of 15 to more than 25 percent.
Nelson: Ne-----	Fair: limited volume of material.	Poor: fines-----	Fair: moderate frost-action potential.	Moderate frost-action potential.
Neville: Nf, Ng-----	Fair: silty clay loam texture.	Unsuitable: fines---	Poor: high frost-action potential.	High frost-action potential.
Nihill: NH-----	Poor: more than 50 percent is coarse fragments; slopes of more than 15 percent.	Fair: fines-----	Good-----	Slopes of 15 to 25 percent.
Nunn: Nk, Nm-----	Fair: silty clay loam surface texture.	Unsuitable: fines---	Poor: high frost-action potential; moderate shrink-swell potential.	High frost-action potential.
Nn-----	Fair: silty clay loam surface texture.	Unsuitable: fines---	Poor: high frost-action potential; moderate shrink-swell potential.	High frost-action potential.

## interpretations—Continued

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Medium stability; medium permeability when compacted.	Rapid permeability; slopes of 15 to 45 percent.	Not applicable-----	Not applicable-----	Slopes of 15 to 45 percent.	Not applicable.
Medium stability; medium permeability when compacted.	Water table within 40 inches of surface during most of year.	Features generally favorable.	Not applicable-----	Seasonal high water table.	Not applicable.
High frost-action potential; low stability; high piping hazard.	Slopes of 8 to 15 percent.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Erosion hazard.
High frost-action potential; low stability; high piping hazard.	Moderate permeability; slopes of 2 to 4 percent.	Moderate permeability; unstable side slopes.	Features generally favorable.	Difficult to break frozen clods and compact the material.	Slight risk of erosion.
High frost-action potential; low stability; limited volume of material.	Slopes of 15 to more than 25 percent.	Not applicable-----	Not applicable-----	Slopes of 15 to 45 percent; plastic when wet.	Not applicable.
Moderate frost-action potential; high piping hazard; medium stability.	Moderately rapid permeability; slopes of 4 to 8 percent.	Not applicable-----	Not applicable-----	Slopes of 4 to 8 percent.	Slopes of 4 to 8 percent.
High frost-action potential; high piping hazard; low stability.	Moderate permeability; slopes of 2 to 4 percent.	Moderate permeability.	Not applicable-----	Difficult to break frozen clods and compact the material.	Features generally favorable.
Fair to good compaction characteristics; low piping hazard; medium permeability when compacted medium to high stability.	Moderately rapid permeability; slopes of 15 to 25 percent.	Not applicable-----	Not applicable-----	Slopes of 15 to 25 percent.	Not applicable.
High frost-action potential; moderate shrink-swell potential; low shear strength; low permeability when compacted.	Features generally favorable.	Moderately slow permeability; unstable side slopes.	Moderately slow permeability.	Difficult to break frozen clods and compact the material.	Features generally favorable.
High frost-action potential; moderate shrink-swell potential; low shear strength; slow permeability when compacted.	Slopes of 4 to 8 percent.	Moderately slow permeability; unstable side slopes.	Moderately slow permeability; moderate erosion hazard; slopes of 4 to 8 percent.	Difficult to break frozen clods and to compact the material.	Rapid runoff; slopes of 4 to 8 percent.

TABLE 3.—Engineering

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
Olney: Oe, Of-----	Good-----	Unsuitable in upper 24 inches, fines; fair below, fines.	Good-----	Features generally favorable.
Peritsa: Pe-----	Fair: silty clay loam surface texture; limited volume of material.	Unsuitable: fines---	Poor: high frost-action potential; 20 to 40 inches deep over shale.	High frost-action potential; 20 to 40 inches deep over shale.
*Razor: Ra-----	Fair: clay loam surface texture; limited volume of material.	Unsuitable: fines---	Poor: high frost-action potential; 20 to 40 inches deep over shale.	High frost-action potential; 20 to 40 inches deep over shale.
Rb----- For Thedalund part, see Thedalund series.	Fair: clay loam surface texture; limited volume of material.	Unsuitable: fines---	Poor: high frost-action potential; 20 to 40 inches deep over shale.	High frost-action potential; 20 to 40 inches deep over shale.
*Redlodge: Rc, Rd----- For Adel part of Rc and Rd, see Adel series.	Poor: water table within 20 inches of surface during most of year.	Unsuitable: fines---	Poor: water table within 20 inches of surface during most of year; high content of organic matter.	Water table within 20 inches of surface during most of year.
*Reeder: RE----- For Castner part, see Castner series.	Fair: limited volume of material.	Unsuitable: fines---	Poor: high frost-action potential; 20 to 40 inches deep over shale and sandstone.	High frost-action potential; 20 to 40 inches deep over shale and sandstone.
*Rentsac: RF-----	Poor: more than 35 percent coarse fragments.	Unsuitable: limited quantity; less than 20 inches deep over sandstone.	Poor: less than 20 inches deep over sandstone.	Less than 20 inches deep over sandstone.
RG----- For Rock outcrop part, see Rock outcrop.	Poor: more than 35 percent coarse fragments.	Unsuitable: limited quantity; less than 20 inches deep over sandstone.	Poor: less than 20 inches deep over sandstone.	Less than 20 inches deep over sandstone.
Riverwash: Rh. Too variable for interpretations. On-site investigation needed.				

## interpretations—Continued

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Good compaction characteristics; medium permeability when compacted; low resistance to piping.	Rapid permeability below depth of 24 inches.	Features generally favorable.	Low available water capacity.	Features generally favorable.	Deep cuts expose very gravelly substratum in places; low available water capacity.
High frost-action potential; medium piping hazard; 20 to 40 inches deep over shale.	20 to 40 inches deep over shale.	Moderate permeability; 20 to 40 inches deep over shale.	Not applicable-----	Difficult to break frozen clods and compact the material.	Deep cuts expose silty shale in places; slopes of 4 to 8 percent.
High frost-action potential; moderate shrink-swell potential; medium compressibility; 20 to 40 inches deep over shale.	20 to 40 inches deep over shale.	Slow permeability; 20 to 40 inches deep over shale.	Not applicable-----	Difficult to break frozen clods and compact the material.	Deep cuts expose shale in places; high runoff; slopes of 4 to 8 percent.
High frost-action potential; moderate shrink-swell potential; medium compressibility; 20 to 40 inches deep over shale.	Features generally favorable.	Slow permeability; 20 to 40 inches deep over shale.	Not applicable-----	Difficult to break frozen clods and compact the material.	Slopes of 4 to 15 percent.
High organic-matter content; moderate shrink-swell potential; water table within 20 inches of surface during most of year.	Water table within 20 inches of surface during most of year.	Slow permeability---	Not applicable-----	Seasonal high water table.	Not applicable.
High frost-action potential; high piping hazard; low stability; 20 to 40 inches deep over shale and sandstone.	20 to 40 inches deep over shale and sandstone.	20 to 40 inches deep over shale and sandstone.	Not applicable-----	Frozen clods difficult to break down.	Deep cuts expose silty shale in places; slopes of 3 to 10 percent.
Limited volume of material; less than 20 inches deep over hard sandstone.	Less than 20 inches deep over bedrock.	Not applicable-----	Not applicable-----	Features generally favorable.	Not applicable.
Limited volume of material; less than inches deep over hard sandstone.	Less than 20 inches deep over bedrock.	Not applicable-----	Not applicable-----	Numerous rock outcrops; slopes of more than 15 percent.	Not applicable.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
*Rock outcrop: Rk, RM. Unsuitable for all uses except for ripping and as a source of other coarse aggregate materials. For Lambeth part of Rk and Travessilla part of RM, see their respective series.				
*Romberg: RN, RO-----	Poor: more than 35 percent coarse fragments.	Poor: fines; large volume of fragments larger than 3 inches.	Poor: large volume of fragments larger than 3 inches.	Large volume of fragments larger than 3 inches.
RP----- For Shale outcrop part, see Shale outcrop.	Poor: more than 35 percent coarse fragments.	Poor: fines; large volume of fragments larger than 3 inches.	Poor: large volume of fragments larger than 3 inches; slopes of 15 to 25 percent.	Large volume of fragments larger than 3 inches.
RS----- For Stutzman part, see Stutzman series.	Poor: more than 35 percent coarse fragments.	Poor: fines; large volume of fragments larger than 3 inches.	Poor: large volume of fragments larger than 3 inches; slopes of 2 to 8 percent.	Large volume of fragments larger than 3 inches.
Rottulee: Rt-----	Poor: limited volume of material.	Unsuitable: fines---	Poor: limestone bedrock at depth of 20 to 40 inches.	Hard limestone within 40 inches of surface.
Ryorp: RY-----	Poor: limited volume of material; steep slopes.	Unsuitable: fines---	Poor: 30 to 40 inches hard sandstone; steep slopes.	Hard sandstone within 40 inches of surface.
Sandstone outcrop: SA. Unsuitable for all uses.				
Sebud: SB-----	Poor: more than 35 percent coarse fragments.	Poor: fines; large volume of fragments larger than 10 inches.	Poor: large volume of coarse fragments larger than 10 inches; slopes of 25 to 45 percent.	Large volume of fragments larger than 10 inches.
*Shale outcrop: SC, SD. No interpretations can be made. Bedrock outcrops at the surface. For Abac part of SD, see Abac series.				
*Shane: Se, Sf, Sg, Sh----- For Cabba part of Sg and Sh, see Cabba series.	Poor: clay within 8 inches of surface.	Unsuitable: fines---	Poor: high shrink-swell potential; shale within 40 inches of surface.	High shrink-swell potential; shale within 40 inches of surface.
Sicklesteets: SK-----	Poor: clay, clay loam, or gravelly texture.	Unsuitable: fines---	Fair: moderate shrink-swell potential; moderate frost-action potential; slopes of 15 to 25 percent.	Moderate shrink-swell potential; moderate frost-action potential; slopes of 15 to 25 percent.

*interpretations—Continued*

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Large volume of fragments larger than 3 inches.	Large volume of fragments larger than 3 inches; slopes of 8 to 15 percent.	Not applicable.....	Not applicable.....	Slopes of 8 to 15 percent; large volume of stones.	Not applicable.
Large volume of fragments larger than 3 inches.	Large volume of fragments larger than 3 inches; slopes of 15 to 25 percent.	Not applicable.....	Not applicable.....	Slopes of 15 to 25 percent; excessive stones.	Not applicable.
Large volume of fragments larger than 3 inches.	Large volume of fragments larger than 3 inches; slopes of 2 to 8 percent.	Not applicable.....	Not applicable.....	Slopes of 2 to 8 percent; excessive stones.	Not applicable.
Low stability; poor compaction characteristics; high frost-action potential.	20 to 40 inches to limestone.	Not applicable.....	Not applicable.....	Difficult to break frozen clods and compact material.	Excessive cuts expose hard rock in places; erosion hazard.
High piping hazard; moderate frost-action potential.	Hard sandstone within 40 inches of surface.	Not applicable.....	Not applicable.....	Slopes of 25 to 45 percent.	Not applicable.
Large volume of fragments larger than 10 inches.	Slopes of 25 to 45 percent; very bouldery.	Not applicable.....	Not applicable.....	Slopes of 25 to 45 percent; very bouldery.	Not applicable.
High shrink-swell potential; low permeability when compacted.	30 to 40 inches deep over bedrock; high shrink-swell potential.	Very slow permeability; shale within 40 inches of surface.	Not applicable.....	Difficult to break frozen clods and compact the material.	Cuts expose clay material; high runoff; slopes of 6 to 15 percent.
Medium stability; low permeability when compacted; low piping hazard.	Slopes of 15 to 25 percent.	Not applicable.....	Not applicable.....	Difficult to excavate when frozen because of coarse fragments.	Not applicable.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
Sinnigam: SM, SN-----	Poor: coarse fragments.	Unsuitable: fines; limited volume of material.	Poor: less than 20 inches deep over bedrock.	Less than 20 inches deep over bedrock.
*Spearfish: SO----- For Shale outcrop part, see Shale outcrop.	Poor: slopes of 15 to 25 percent; less than 20 inches deep over shale and sandstone.	Unsuitable: fines---	Poor: less than 20 inches deep over sandstone and shale; slopes of 15 to 25 percent.	Less than 20 inches deep over sandstone and shale; slopes of 15 to 25 percent.
Stormitt: Sp, Sr, Ss, SV-----	Poor: more than 15 percent gravel.	Unsuitable: fines---	Fair to poor: moderate to high frost-action potential.	Moderate to high frost-action potential.
St-----	Poor: more than 15 percent gravel.	Unsuitable: fines---	Fair to poor: moderate to high frost-action potential.	Moderate to high frost-action potential.
SU-----	Poor: more than 15 percent gravel.	Unsuitable: fines---	Poor: slopes of 25 to 45 percent.	Slopes of 25 to 45 percent.
Stutzman: SW-----	Poor: clay loam or silty clay loam texture.	Unsuitable: fines---	Poor: moderate shrink-swell potential; high frost-action potential.	Moderate shrink-swell potential; high frost-action potential.
*Tarrete: TA, TB-----	Poor: clayey texture.	Unsuitable: fines---	Poor: moderate shrink-swell potential; moderate to high frost-action potential.	Moderate shrink-swell potential; slopes of 15 to 25 percent.
TC----- For Hanson part, see Hanson series.	Poor: clayey texture.	Unsuitable: fines---	Poor: moderate shrink-swell potential; moderate to high frost-action potential.	Slopes of 25 to 45 percent.
Teton: TD-----	Poor: stones; slopes of 15 to 25 percent.	Unsuitable: fines---	Poor: hard sandstone bedrock within 40 inches of surface; slopes of 15 to 25 percent.	Hard sandstone bedrock within 40 inches of surface; slopes of 15 to 25 percent.

## interpretations—Continued

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Less than 20 inches deep over bedrock.	Less than 20 inches deep over bedrock.	Not applicable-----	Not applicable-----	Large volume of coarse fragments.	Not applicable.
Limited volume of material; high frost-action potential.	Relief and topography; slopes of 15 to 25 percent; less than 20 inches deep over bedrock.	Not applicable-----	Not applicable-----	Difficult to break frozen clods; slopes of 15 to 25 percent.	Not applicable.
Moderate to high frost-action potential; medium stability; low permeability when compacted.	Moderate permeability.	Moderate permeability.	Not applicable-----	Features generally favorable; not applicable to units Sr and Ss.	Large volume of coarse fragments.
Moderate to high frost-action potential; medium stability; low permeability when compacted.	Moderate permeability.	Not applicable-----	Not applicable-----	Not applicable-----	Not applicable.
Moderate to high frost-action potential; medium stability; low permeability when compacted.	Slopes of 25 to 45 percent.	Not applicable-----	Not applicable-----	Slopes of 25 to 45 percent.	Not applicable.
Moderate shrink-swell potential; high frost-action potential; medium compressibility; fair compaction characteristics.	Features generally favorable.	Slow permeability---	Slow permeability; slow intake rate.	Difficult to break frozen clods and to compact the material.	Rapid runoff.
Moderate shrink-swell potential; high compressibility; moderate to high frost-action potential; low stability.	Slopes of 15 to 25 percent.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Not applicable.
Moderate shrink-swell potential; high compressibility; moderate to high frost-action potential; low stability.	Slopes of 25 to 45 percent.	Not applicable-----	Not applicable-----	Slopes of 25 to 45 percent.	Not applicable.
High frost-action potential; high piping hazard; high organic matter content; low stability.	Hard bedrock within 40 inches of surface; slopes of 15 to 25 percent.	Not applicable-----	Not applicable-----	Slopes of 15 to 25 percent; stones.	Not applicable.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
Thedalund: Te, Tf.....	Fair: clay loam texture; 20 to 40 inches deep over shale and sandstone.	Unsuitable: fines...	Poor: 20 to 40 inches deep over shale and sandstone; high frost-action potential.	20 to 40 inches deep over shale and sandstone.
*Thiel: Tg.....	Poor: more than 35 percent coarse fragments.	Poor: fines.....	Good.....	Features generally favorable.
TH..... For Bynum part, see Bynum series.	Poor: more than 35 percent coarse fragments.	Poor: fines.....	Poor: slopes of 25 to 45 percent.	Slopes of 25 to 45 percent.
*Thurlow: Tk, Tl..... For Toluca part of Tl, see Toluca series.	Fair: silty clay loam texture.	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential.
*Tiban: TM.....	Poor: more than 35 percent coarse fragments.	Unsuitable: fines...	Poor: large volume of fragments larger than 6 inches.	Large volume of fragments larger than 6 inches; slopes of 15 to 25 percent.
TN..... For Tarrete part, see Tarrete series.	Poor: more than 35 percent coarse fragments.	Unsuitable: fines...	Poor: large volume of fragments larger than 6 inches.	Large volume of fragments larger than 6 inches; slopes of 25 to 45 percent.
*Toluca: To, Tp.....	Fair: clay loam texture.	Unsuitable: fines...	Poor: high frost-action potential; moderate shrink-swell potential.	Moderate shrink-swell potential; high frost-action potential.
Tr.....	Fair: clay loam texture.	Unsuitable: fines...	Poor high frost-action potential; moderate shrink-swell potential.	Moderate shrink-swell potential; high frost-action potential.
Ts, TT, TU..... For Midway part of TT, see Midway series; for Rock outcrop part of TU, see Rock outcrop.	Fair: clay loam texture; slopes of 8 to 15 percent; poor if slope is 15 to 25 percent.	Unsuitable: fines...	Poor: high frost-action potential; moderate shrink-swell potential.	Moderate shrink-swell potential; high frost-action potential; slopes of 8 to 25 percent.
Tonra: Tv.....	Poor gravelly silty clay loam texture.	Unsuitable to depth of 29 inches; good below depth of 29 inches.	Poor to depth of 29 inches; good below depth of 29 inches.	Features generally favorable.

## interpretations—Continued

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
High frost-action potential; low stability; medium piping hazard.	20 to 40 inches deep over bedrock.	20 to 40 inches deep over shale and sandstone.	Not applicable-----	Difficult to break frozen clods and compact the material.	Deep cuts expose bedrock in places; erosion hazard.
Large volume of coarse fragments; low permeability when compacted; medium stability.	Very rapid permeability below depth of 20 inches.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Not applicable.
Large volume of coarse fragments; low permeability when compacted; medium stability.	Very rapid permeability below depth of 20 inches; slopes of 25 to 45 percent.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact material; slopes of 25 to 45 percent.	Not applicable.
Low shear strength; high frost-action potential; medium compressibility; moderate shrink-swell potential.	Slopes of 4 to 8 percent.	Moderately slow permeability.	Not applicable-----	Difficult to break frozen clods and compact the material.	Slopes of 4 to 8 percent.
Large volume of fragments larger than 6 inches.	Moderate permeability; large volume of coarse fragments; slopes of 15 to 25 percent.	Not applicable-----	Not applicable-----	Excessive stones-----	Not applicable.
Large volume of fragments larger than 6 inches.	Slopes of 25 to 45 percent.	Not applicable-----	Not applicable-----	Slopes of 25 to 45 percent; excessive stones.	Not applicable.
Moderate shrink-swell potential; high frost-action potential; low shear strength.	Features generally favorable.	Features generally favorable.	Features generally favorable.	Difficult to break frozen clods and compact the material.	Features generally favorable.
Moderate shrink-swell potential; high frost-action potential; low shear strength.	Features generally favorable.	Features generally favorable.	Moderate erosion hazard; slopes of 4 to 8 percent.	Difficult to break frozen clods and compact the material.	Rapid runoff; slopes of 4 to 8 percent.
Moderate shrink-swell potential; high frost-action potential; low shear strength.	Slopes of 8 to 25 percent.	Not applicable-----	Very high erosion hazard if slope is 8 to 15 percent; not applicable if slope is 15 to 25 percent.	Difficult to break frozen clods and compact the material.	Erosion hazard; rapid runoff; slopes of 8 to 15 percent; not applicable to unit TT.
Surface material has medium stability; no unfavorable features below depth of 29 inches.	Very rapid permeability below depth of 29 inches.	Not applicable-----	Low available water capacity; low intake rate.	Difficult to break frozen clods and compact the material.	Deep cuts expose sand and gravel and in places material that has high content of lime; low available water capacity.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
Torchlight: TW.....	Poor: clay texture; strongly alkaline.	Unsuitable: fines...	Poor: high shrink-swell potential.	High shrink-swell potential; high compressibility.
Trapper: TX.....	Fair: silty clay loam.	Unsuitable: fines...	Poor: high frost-action potential.	High frost-action potential; slopes of 8 to 15 percent.
Travessilla: TY.....	Poor: more than 15 percent coarse fragments.	Unsuitable: fines...	Poor: less than 20 inches deep over sandstone bedrock.	Less than 20 inches deep over sandstone bedrock.
Twin Creek: Tz.....	Poor: gravelly texture.	Unsuitable: fines...	Fair: moderate frost-action potential; more than 30 percent fines.	Moderate frost-action potential.
Vona: Vn, Vo, Vp.....	Good.....	Unsuitable: fines...	Fair: moderate frost-action potential; more than 30 percent fines in upper 40 inches; good below depth of 40 inches.	Features generally favorable.
Vr.....	Fair: slopes of 8 to 15 percent.	Unsuitable: fines...	Fair: moderate frost-action potential; more than 30 percent fines in upper 40 inches; good below depth of 40 inches.	Features generally favorable.
Vs.....	Poor: moderate to strong salinity; water table within 40 inches of surface during growing season.	Unsuitable: fines...	Fair: moderate frost-action potential; more than 30 percent fines in upper 40 inches; good below depth of 40 inches.	Water table within 40 inches of surface during growing season.
*Wayden: WA, WC, WD..... For Cabba part of WA and WC, and Castner part of WD, see their respective series.	Poor: slopes of more than 15 percent.	Unsuitable: fines...	Poor: less than 20 inches deep over shale; slopes of more than 15 percent.	Less than 20 inches deep over shale; slopes of more than 15 percent.
Windham: WE, WH.....	Poor: more than 15 percent coarse fragments; slopes of more than 15 percent.	Unsuitable: fines...	Good to fair: steep in places.	Slopes of more than 15 percent.

## interpretations—Continued

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
High shrink-swell potential.	Slopes of 8 to 15 percent; features generally favorable on slopes of 4 to 8 percent.	Not applicable-----	Not applicable-----	Plastic when wet; difficult to excavate.	Rapid runoff.
High frost-action potential; high piping hazard; low stability.	Slopes of 8 to 15 percent.	Not applicable-----	Not applicable-----	Slopes of 8 to 15 percent.	Not applicable.
Less than 20 inches deep over sandstone bedrock.	Less than 20 inches deep over sandstone bedrock.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Not applicable.
Medium permeability when compacted; medium piping hazard; moderate frost-action potential.	Slopes of 4 to 8 percent.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and compact the material.	Erosion hazard; slopes of 4 to 8 percent.
Medium permeability when compacted; medium stability.	Rapid permeability--	Features generally favorable.	Low available water capacity.	Features generally favorable.	Low available water capacity.
Medium permeability when compacted; medium stability.	Slopes of 8 to 15 percent.	Not applicable-----	Very high erosion hazard; slopes of 8 to 15 percent.	Slopes of 8 to 15 percent.	Erosion hazard; slopes of 8 to 15 percent; low available water capacity.
Medium permeability when compacted; medium stability.	Seasonal high water table.	Features generally favorable.	Seasonal high water table; moderate to strong salinity.	Seasonal high water table.	Low available water capacity.
Limited volume of material.	Slopes of more than 15 percent.	Not applicable-----	Not applicable-----	Difficult to break frozen clods and to compact the material; slopes of more than 15 percent.	Not applicable.
Low to medium piping hazard; fair compaction characteristics; medium stability.	Slopes of more than 15 percent.	Not applicable-----	Not applicable-----	Frozen soil very difficult to excavate; slopes of more than 15 percent.	Not applicable.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—			Soil features affecting—
	Topsoil	Sand and gravel	Fill material subgrade	Highway location
*Woodrock: WK, WN For Rock outcrop part of WK, see Rock outcrop. For Bynum part of WN, see Bynum series.	Poor: slopes of more than 15 percent.	Poor: too many fines in upper part; less than 30 inches deep over unweathered granite.	Poor: less than 30 inches deep over unweathered granite; slopes of more than 25 percent.	Unweathered granite bedrock within depth of 30 inches; relief and topography; slopes of 25 to 70 percent.
Work: Wo	Fair: clay loam texture.	Unsuitable: fines	Poor: high frost-action potential; moderate shrink-swell potential.	High frost-action potential.
Wormser: Wr	Fair: clay loam texture.	Unsuitable: fines	Poor: 30 to 40 inches deep over sandstone.	30 to 40 inches deep over sandstone.
Yegen: Ye, Yf	Good	Unsuitable: fines	Fair: moderate frost-action potential.	Moderate frost-action potential.
Yg	Fair: slopes of 8 to 15 percent.	Unsuitable: fines	Fair: moderate frost-action potential.	Moderate frost-action potential.

*interpretations—Continued*

Soil features affecting—Continued					
Embankments	Ponds and reservoir areas	Agricultural drainage	Irrigation	Winter grading	Grass waterways
Limited volume of material.	Slopes of more than 15 percent.	Not applicable-----	Not applicable-----	Slopes of more than 15 percent.	Not applicable.
High frost-action potential; moderate shrink-swell potential; low stability; high piping hazard.	Features generally favorable.	Features generally favorable.	Not applicable-----	Difficult to break frozen clods and compact the material.	Slopes of 4 to 8 percent.
Moderate to high frost-action potential.	30 to 40 inches deep over sandstone.	30 to 40 inches deep over sandstone.	Not applicable-----	Difficult to break frozen clods and compact the material.	Deep cuts expose bedrock in places; slopes of 4 to 8 percent.
Moderate frost-action potential; high piping hazard.	Features generally favorable if slope is 2 to 4 percent.	Features generally favorable.	Features generally favorable if slope is 2 to 4 percent; moderate erosion hazard if slope is 4 to 8 percent.	Features generally favorable.	Features generally favorable if slope is 2 to 4 percent.
Moderate frost-action potential; high piping hazard.	Slopes of 8 to 15 percent.	Features generally favorable.	Severe erosion hazard; slopes of 8 to 15 percent.	Slopes of 8 to 15 percent.	Erosion hazard; slopes of 8 to 15 percent.

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 the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, gravelly loamy sand.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, especially porosity, structure, and texture. The estimates given do not take into account lateral seepage or such temporary soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A high shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

### **Engineering interpretations**

The interpretations in table 3 are based on the estimated engineering properties of soils as shown in table 2 and on the experience of engineers and soil scientists with the soils of the Carbon County Area. In table 3, ratings summarize the limitation or suitability of the soils for all listed purposes other than for drainage of cropland and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions. For these particular uses, table 3 lists those soil features not to be overlooked in planning.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 3.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; by natural fertility of the material, or response of plants when fertilizer is applied; and by absence of substances toxic to plants. The texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is the damage to the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors

that affect mining of the materials, nor do they indicate quality of the deposit.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and adequately drained and the relative ease of excavating the material at borrow areas.

Embankments require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactability. Presence of stones or organic material in a soil are among the factors that are unfavorable.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that affect rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

### **Use of the Soils for Community Development and Recreation**

Knowledge of soils is necessary in planning, developing, and maintaining areas for community development and recreation. In table 4 the soils of Carbon County Area are rated according to limitations that affect their suitability for these uses.

In the table the soils are rated as having *slight*, *moderate*, or *severe* limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Dwellings, as rated in table 4, are no more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the suitability of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are

wetness, slope, depth to bedrock, and content of stones and rocks.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides or embankments of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties that affect the pond floor and the embankment are considered. Those that affect the pond floor are permeability, organic-matter content, slope, and if the floor needs to be leveled, depth to bedrock. The soil properties that affect the embankment are particle-size distribution, plasticity, liquid limit, and organic-matter content, as interpreted from the Unified soil classification, and the number of stones, if any, which affects the ease of excavation and compaction of the embankment material.

Sanitary land fill refers to the method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Land fill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for land fill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 4 apply only to a depth of about 6 feet. Ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than 6 feet. For some soils, reliable predictions can be made to a depth of 10 or 15 feet. Regardless of ratings and predictions, onsite investigation is needed before a site is selected.

Local roads and streets, as rated in table 4, have an all-weather surface that is expected to carry automobile traffic the year round. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand. Most cuts and fills are less than 6 feet deep. Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and

amount of cut and fill needed to reach an even grade.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subjected to heavy foot traffic. Most of the vehicular traffic is confined to access roads. The best soils are firm when wet but not dusty when dry, are not flooded during the season of use, and do not have slopes or stones that greatly increase the cost of leveling sites or of building access roads.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, no flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Paths and trails are used for local and cross-country travel on foot or on horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded no more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Play areas are used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, no flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

## Use of the Soils for Windbreaks

Tree windbreaks help to reduce the velocity on farms and ranches. Their main purpose is to protect farmsteads against drifting snow and to protect soil from blowing. Windbreaks serve as snow fences in winter and as erosion control plantings and beautification in summer. They also provide shelter for livestock and a source of food and cover for birds and other wildlife.

Windbreaks provide maximum benefits when planted at right angle to the direction of the prevailing wind. The selection of trees and shrubs that grow best on a specific kind of soil is important to insure survival and rapid growth, particularly in dryland plantings. Land preparation, moisture conservation measures, time of planting, and weed control are necessary for successful establishment of a windbreak. Until trees become established on sandy soils, protection against soil blowing is needed. The windbreak should be wide enough to give the protection needed in the area where it is to be planted.

The broadleaf trees and shrubs planted for windbreaks in the Area are American elm, green ash, Siberian elm, golden willow, cottonwood, Russian-olive, boxelder, chokecherry, skunkbush sumac, American plum, buffaloberry, and caragana. Evergreen trees are ponderosa pine, Rocky Mountain juniper, and Colorado blue spruce. The most hardy species are caragana, Russian-olive, Siberian elm, green ash, ponderosa pine, and Rocky

TABLE 4.—Degree and kind of limitation for

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in for referring to other series that

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
*A bac: AA, AB For Twin Creek part of AA, and Windham part of AB, see their respective series.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
*Absarokee: Ac	Moderate: moderate shrink-swell potential; bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.
Ad, Ak For Sinnigam part of Ak, see Sinnigam series.	Moderate: moderate shrink-swell potential; bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.
Ae, Ag, Ah, Am For Cabba part of Ag, Shane part of Ah, and Sinnigam part of Am, see their respective series.	Moderate: moderate shrink-swell potential; bedrock at depth of 20 to 40 inches; slopes of 6 to 15 percent.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.
Af For Cabba part, see Cabba series.	Moderate: moderate shrink-swell potential; bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.
Adel: An, Ao	Slight	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 0 to 8 percent.	Moderate: silty clay loam and clay loam textures.
Alice: Ar	Slight	Severe: bedrock at depth of 40 to more than 60 inches.	Severe: moderately rapid permeability.	Severe: bedrock at depth of 40 inches or more; moderately rapid permeability.
As	Moderate: slopes of 8 to 15 percent.	Severe: bedrock at depth of 40 to more than 60 inches.	Severe: moderately rapid permeability.	Severe: bedrock at depth of 40 inches or more; moderately rapid permeability.
Allentine: At	Severe: high shrink-swell potential.	Severe: very slow permeability.	Moderate: slopes of 2 to 4 percent.	Severe: clay texture.
Alluvial land: Au. No valid rating can be made. Onsite investigation required. <sup>3</sup>				
Armington Mapped only with Lap soils.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent; slow permeability.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.
Bearmouth Mapped only with Maurice soils. See footnotes at end of table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.



TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
<b>*Bowbac:</b> Bb, Bh..... For Harvey part of Bh, see Harvey series.	Moderate: bedrock at depth of 20 to 40 inches; moderate shrink-swell potential.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: clay loam texture; bedrock at depth of 20 to 40 inches.
Bc, Bm, BT..... For Travessilla part of Bm and Torchlight part of BT, see their respective series.	Moderate: bedrock at depth of 20 to 40 inches; moderate shrink-swell potential.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: clay loam texture; bedrock at depth of 20 to 40 inches.
Bd.....	Moderate: bedrock at depth of 20 to 40 inches; moderate shrink-swell potential.	Severe: bedrock at depth of 25 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: clay loam texture; bedrock at depth of 20 to 40 inches.
<b>Bynum</b> ..... Mapped only with Heath, Thiel, and Woodrock soils.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent; bedrock at depth of 25 to 40 inches.	Severe: slopes of more than 15 percent.	Severe: bedrock at depth of 20 to 40 inches.
<b>*Cabba:</b> CA..... For Rentsac part, see Rentsac series.	Severe: moderate shrink-swell potential; bedrock at depth of less than 20 inches.	Severe: slowly permeable shale at depth of less than 20 inches.	Severe: less than 20 inches deep over bedrock.	Severe: less than 20 inches deep over bedrock.
<b>Castner</b> ..... Mapped only in associations with Reeder and Wayden soils.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
<b>Charlos:</b> Cb, Cc.....	Slight.....	Slight <sup>3</sup> .....	Severe: very rapid permeability below depth of 30 inches.	Severe: gravelly sand below depth of 30 inches.
Cd.....	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Ce.....	Slight.....	Slight <sup>3</sup> .....	Severe: very rapid permeability below depth of 30 inches.	Severe: gravelly sand below depth of 30 inches.
<b>Colby:</b> Cf.....	Severe: high frost-action potential.	Moderate: lower end of moderate permeability.	Moderate: moderate permeability; slopes of 2 to 4 percent.	Slight.....
Cg.....	Severe: high frost-action potential.	Moderate: lower end of moderate permeability.	Moderate: moderate permeability; slopes of 4 to 8 percent.	Slight.....
Ch.....	Severe: high frost-action potential.	Moderate: lower end of moderate permeability.	Severe: slopes of 8 to 15 percent.	Slight.....

See footnotes at end of table.

community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Moderate or severe: clay loam texture; bedrock at depth of 20 to 40 inches.	Moderate: moderate shrink-swell potential; bedrock at depth of 20 to 40 inches.	Slight.....	Slight.....	Slight.....	Moderate: slopes of 2 to 4 percent.
Moderate or severe: clay loam texture; bedrock at depth of 20 to 40 inches.	Moderate: moderate shrink-swell potential; bedrock at depth of 20 to 40 inches.	Slight.....	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Moderate or severe: clay loam texture; bedrock at depth of 20 to 40 inches.	Moderate: moderate shrink-swell potential; bedrock at depth of 20 to 40 inches.	Moderate: slopes of 8 to 15 percent.	Slight.....	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Severe: slopes of more than 15 percent; bedrock at depth of 20 to 40 inches.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent; bedrock at depth of 20 to 40 inches.	Moderate or severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.
Severe: less than 20 inches deep over bedrock.	Severe: less than 20 inches deep over bedrock.	Severe: clay loam surface layer; slowly permeable shale at depth of less than 20 inches.	Moderate or severe: clay loam surface layer; slopes of more than 4 percent.	Moderate or severe: clay loam surface layer; slopes of more than 4 percent.	Moderate or severe: slopes of more than 4 percent.
Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Moderate or severe: channery loam surface layer; less than 20 inches deep over bedrock.	Moderate or severe: channery loam surface layer; less than 20 inches deep over bedrock.	Moderate or severe: slopes of more than 15 percent; bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches; slopes of more than 15 percent; channery loam surface layer.
Severe: gravelly sand below depth of 30 inches.	Slight.....	Slight.....	Slight.....	Slight.....	Slight.
Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Severe: gravelly sand below depth of 30 inches.	Slight.....	Moderate: excessive stones.	Moderate: excessive stones.	Moderate: excessive stones.	Moderate: excessive stones.
Slight.....	Severe: subject to frost heave.	Slight.....	Slight.....	Slight.....	Moderate: slopes of 2 to 4 percent.
Slight.....	Severe: subject to frost heave.	Slight.....	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Moderate: slopes of 8 to 15 percent.	Severe: subject to frost heave.	Moderate: slopes of 8 to 15 percent.	Slight.....	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.

TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
*Duncom: DG.....	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
DH..... For Hanson part, see Hanson series.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
Fort Collins: Fc, Fd.....	Slight.....	Slight <sup>3</sup> .....	Severe: moderately rapid permeability below depth of 24 inches.	Severe: moderately rapid permeability below depth of 24 inches.
Fe.....	Severe: seasonal high water table.	Severe: <sup>3</sup> seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
*Glenberg: Gb.....	Slight.....	Slight <sup>3</sup> .....	Severe: very rapid permeability.	Severe: very rapid permeability.
Gh..... For Haverson part, see Haverson series.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
*Hanson: Ha.....	Slight.....	Severe: moderately slow permeability.	Severe: excess coarse fragments.	Severe: very cobbly or very gravelly below depth of 7 inches.
HB.....	Moderate: very stony.	Severe: moderately slow permeability.	Severe: slopes of 8 to 15 percent.	Severe: very cobbly or very gravelly below depth of 7 inches.
HC.....	Severe: extremely stony.	Severe: moderately slow permeability.	Severe: slopes of 8 to 15 percent.	Severe: very cobbly or very gravelly below depth of 7 inches.
HD.....	Severe: slopes of 45 to 70 percent.	Severe: moderately slow permeability.	Severe: slopes of 45 to 70 percent.	Severe: very cobbly or very gravelly below depth of 7 inches.
HE..... For Duncom part, see the Duncom series.	Moderate: slopes of 8 to 15 percent.	Severe: moderately slow permeability.	Severe: slopes of 8 to 15 percent.	Severe: very cobbly or very gravelly below depth of 7 inches.
Harvey: Hf, Hg.....	Moderate: moderate shrink-swell potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 8 percent.	Moderate: silty clay loam texture.
Hh.....	Moderate: moderate shrink-swell potential.	Moderate: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.	Moderate: silty clay loam texture.
Hk.....	Moderate: moderate shrink-swell potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 8 percent.	Moderate: silty clay loam texture.

See footnotes at end of table.

## community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Moderate or severe: slopes of 15 to 25 percent; gravelly.	Slight or moderate: slopes of 15 to 25 percent; gravelly.	Severe: excessive gravels; slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.
Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Slight or moderate: slopes of 8 to 15 percent; gravelly.	Slight or moderate: slopes of 8 to 15 percent; gravelly.	Severe: excessive gravels; slopes of 15 to 25 percent.	Severe: slopes of 8 to 15 percent.
Moderate: clay loam texture.	Moderate: clay loam texture and excessive fines.	Slight.....	Slight.....	Slight.....	Slight if slope is 0 to 2 percent; moderate if slope is 2 to 4 percent.
Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Moderate: sandy and gravelly.	Slight.....	Slight.....	Slight.....	Slight.....	Slight.
Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Severe: very cobbly or very gravelly below depth of 7 inches.	Slight.....	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 4 to 8 percent.
Severe: very cobbly or very gravelly below depth of 7 inches.	Slight.....	Severe: excessive stones.	Severe: excessive stones.	Severe: excessive stones.	Severe: excessive stones.
Severe: very cobbly or very gravelly below depth of 7 inches.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.	Severe: extremely stony.
Severe: very cobbly or very gravelly below depth of 7 inches.	Severe: slopes of 45 to 70 percent.	Severe: slopes of 45 to 70 percent.	Severe: slopes of 45 to 70 percent.	Severe: slopes of 45 to 70 percent.	Severe: slopes of 45 to 70 percent.
Severe: very cobbly or very gravelly below depth of 7 inches.	Moderate: slopes of 8 to 15 percent.	Moderate: slopes of 8 to 15 percent.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Severe: slopes of more than 8 percent.
Slight.....	Moderate: moderate shrink-swell potential.	Slight.....	Slight.....	Slight if slope is 2 to 4 percent; slight or moderate if slope is 4 to 8 percent.	Moderate if slope is 2 to 4 percent; moderate or severe if slope is 4 to 8 percent.
Moderate: slopes of 8 to 15 percent.	Moderate: moderate shrink-swell potential.	Moderate: slopes of 8 to 15 percent.	Slight.....	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Slight.....	Moderate: moderate shrink-swell potential.	Slight.....	Slight.....	Slight.....	Moderate: slopes of 2 to 8 percent.

TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
*Haverson: Hm Hn..... For Heldt part of Hn, see Heldt series.	Severe: high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability.	Slight or moderate: moderate permeability.
*Heath: Ho.....	Moderate: moderate shrink-swell potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 4 to 8 percent.	Moderate: clay loam texture.
Hp.....	Moderate: moderate shrink-swell potential; slopes of 8 to 15 percent.	Moderate: moderate permeability; slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.	Moderate: clay loam texture.
HR..... For Bynum part, see Bynum series.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.
Heldt: Hs.....	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: slow permeability.	Slight.....	Moderate: clay loam or silty clay loam texture.
Ht, Hu.....	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: slow permeability.	Moderate: slopes of 2 to 8 percent.	Moderate: clay loam or silty clay loam texture.
Hv.....	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: slow permeability.	Severe: slopes of 8 to 15 percent.	Moderate: clay loam or silty clay loam texture.
Hw.....	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Hydro: Hy.....	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: slow permeability.	Moderate: slopes of 4 to 8 percent.	Moderate: silty clay loam texture.
Kyle: Kc, Kd, Ke, Kf.....	Severe: high shrink-swell potential.	Severe: very slow permeability.	Slight if slope is 0 to 2 percent; moderate if slope is 2 to 8 percent; severe if slope is more than 8 percent.	Severe: clay texture.
La Fonda: La, Lb.....	Severe: high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 0 to 4 percent.	Moderate: silty clay loam and clay loam texture.
Lambeth: Lc.....	Severe: bedrock at depth of 40 to 60 inches; high frost-action potential.	Severe: moderately slow permeability.	Moderate: slopes of 4 to 8 percent; bedrock at depth of more than 40 inches.	Moderate: bedrock at depth of more than 40 inches.

See footnotes at end of table.

community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Slight.....	Severe: high frost-action potential.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Slight.
Moderate: clay loam texture.	Moderate: moderate shrink-swell potential.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 4 to 8 percent.
Moderate: clay loam texture.	Moderate: moderate shrink-swell potential; slopes of 8 to 15 percent.	Moderate: clay loam surface layer; slopes of 8 to 15 percent.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.
Moderate: clay loam or silty clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: clay loam or silty clay loam surface layer; slow permeability.	Moderate: clay loam or silty clay loam surface layer.	Moderate: clay loam or silty clay loam surface layer.	Moderate: clay loam or silty clay loam surface layer.
Moderate: clay loam or silty clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: clay loam or silty clay loam surface layer; slow permeability.	Moderate: clay loam or silty clay loam surface layer.	Moderate: clay loam or silty clay loam surface layer.	Moderate if slope is 2 to 4 percent; moderate or severe if slope is 4 to 8 percent.
Moderate: slopes of 8 to 15 percent.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: clay loam or silty clay loam surface layer; slow permeability.	Moderate: clay loam or silty clay loam surface layer.	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
Slight or moderate: silty clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: slow permeability.	Slight.....	Slight.....	Moderate or severe: slopes of 4 to 8 percent.
Severe: clay texture.	Severe: high shrink-swell potential.	Severe: clay surface layer; very slow permeability.	Severe: clay surface layer; very slow permeability.	Severe: clay surface layer.	Severe: clay surface layer.
Moderate: clay loam texture.	Severe: high frost-action potential.	Slight.....	Slight.....	Slight.....	Slight if slope is 0 to 2 percent; moderate if slope is 2 to 4 percent.
Moderate: bedrock at depth of more than 40 inches.	Severe: high frost-action potential.	Moderate: moderately slow permeability.	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.

TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
*Lap: LD----- For Armington part, see Armington series.	Severe: bedrock at depth of less than 20 inches; slopes of 15 to 25 percent.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
LE----- For Rock outcrop part, see Rock outcrop.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
LF----- For Windham part, see Windham series.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
Larim: Lg-----	Moderate: slopes of 8 to 15 percent.	Moderate: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent; moderately rapid permeability.	Severe: very gravelly sand.
Limestone outcrop: LH-----	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.
*Lisam: Lm, LN----- For Marias part of Lm and LN, see Marias series.	Severe: high shrink-swell potential; slopes of 28 to 45 percent.	Severe: very slow permeability.	Severe: slopes of 8 to 45 percent.	Severe: clay texture.
Lismas: LO-----	Severe: high shrink-swell potential.	Severe: very slow permeability.	Severe: slopes of 15 to 25 percent.	Severe: clay texture.
Lohler: Lp, Lr-----	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: moderately slow permeability.	Slight if slope is 0 to 2 percent; moderate if slope is 2 to 4 percent.	Moderate: silty clay loam or clay loam textures.
Ls-----	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
*Macar: Ma----- For Cabba part, see Cabba series.	Severe: moderate shrink-swell potential; high frost-action potential.	Slight to moderate: moderate permeability.	Moderate: moderate permeability; slopes of 4 to 8 percent.	Moderate: clay loam texture.
Mb----- For Cabba part, see Cabba series.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: moderate permeability; slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.	Moderate: clay loam texture.
Marias: Mc, Md-----	Severe: high shrink-swell potential.	Severe: very slow permeability.	Moderate if slope is 2 to 8 percent; severe if slope is 8 to 15 percent.	Severe: clay texture.
Marsh: Me-----	Severe: water table at or near surface.	Severe: water table at or near surface.	Severe: water table at or near surface.	Severe: water table at or near surface.

See footnotes at end of table.



TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
Martinsdale: Mf, Mg-----	Moderate: moderate frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 8 percent.	Moderate: clay loam texture.
*Maurice: MH, MK-----	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.
Mm----- For Bearmouth part, see Bearmouth series.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Mayflower: MN-----	Severe: moderate shrink-swell potential; slopes of 8 to 15 percent; high frost-action potential.	Severe: bedrock at depth of 30 to 40 inches.	Severe: bedrock at depth of 30 to 40 inches.	Severe: clay loam texture; bedrock at depth of 30 to 40 inches.
McRae: Mo-----	Severe: moderate shrink-swell potential; high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 4 percent.	Moderate: clay loam texture.
*Midway: MR, MT----- For Travessilla part of MR and MT, see Travessilla series.	Severe: slopes of 15 to 45 percent; bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: slopes of 15 to 45 percent; bedrock at depth of less than 20 inches.	Severe: slopes of 15 to 45 percent; bedrock at depth of less than 20 inches.
Nelson: Ne-----	Moderate: bedrock at depth of 30 to 40 inches.	Severe: sandstone bedrock at depth of 30 to 40 inches.	Severe: sandstone bedrock at depth of 30 to 40 inches.	Moderate: soft sandstone at depth of 30 to 40 inches.
Neville: Nf-----	Severe: high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 2 to 4 percent.	Moderate: silty clay loam texture.
Ng-----	Severe: high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 4 to 8 percent.	Moderate: silty clay loam texture.
Nihill: NH-----	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: very gravelly loam.
Nunn: Nk, Nm, Nn-----	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: moderately slow permeability.	Slight if slope is 0 to 2 percent; moderate if slope is 2 to 8 percent.	Moderate: silty clay loam or clay loam textures.

See footnotes at end of table.

community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Moderate: clay loam texture.	Moderate: moderate frost-action potential.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate if slope is less than 4 percent; clay loam surface layer; moderate or severe if slope is 4 to 8 percent.
Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.
Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Severe: clay loam texture; bedrock at depth of 30 to 40 inches; slopes of 8 to 15 percent.	Severe: moderate shrink-swell potential; slopes of 8 to 15 percent; high frost-action potential.	Moderate: slopes of 8 to 15 percent.	Slight.....	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Moderate: clay loam texture.	Severe: moderate shrink swell; high frost-action potential.	Slight.....	Slight.....	Slight.....	Moderate: slopes of 2 to 4 percent.
Severe: slopes of 15 to 45 percent; bedrock at depth of less than 20 inches.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.	Severe: slopes of 15 to 45 percent.
Moderate: bedrock at depth of 30 to 40 inches.	Moderate: moderate frost-action potential.	Slight.....	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Slight or moderate: clay loam or silty clay loam texture.	Severe: high frost-action potential.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Slight or moderate: clay loam or silty clay loam texture.	Severe: high frost-action potential.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Severe: very gravelly loam.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: coarse fragments cover more than 50 percent of surface.	Severe: slopes of 15 to 25 percent; excessive gravel.	Severe: slopes of 15 to 25 percent; excessive gravel.
Moderate: clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: silty clay loam surface layer; moderately slow permeability.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer; moderate or severe where slope is 4 to 8 percent.

TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
Olney: Oe, Of-----	Slight-----	Slight-----	Severe: rapid permeability below a depth of 20 inches.	Severe: rapid permeability below a depth of 20 inches.
Peritsa: Pe-----	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: soft bedrock at depth of 20 to 40 inches.	Severe: soft bedrock at depth of 20 to 40 inches.	Moderate or severe: silty clay loam texture; soft bedrock at depth of 20 to 40 inches.
*Razor: Ra, Rb----- For Thedalund part of Rb, see the Thedalund series.	Severe: moderate shrink-swell potential; high frost-action potential; bedrock at depth of 28 to 37 inches.	Severe: soft bedrock at depth of 28 to 37 inches.	Severe: soft bedrock at depth of 28 to 37 inches.	Moderate or severe: clay loam texture; soft bedrock at depth of 28 to 37 inches.
*Redlodge: Rc, Rd----- For Adel part of Rc and Rd, see Adel series.	Severe: water table at depth of 20 inches.	Severe: water table at depth of 20 inches. <sup>3</sup>	Severe: water table at depth of 20 inches.	Severe: water table at depth of 20 inches.
*Reeder: RE----- For Castner part, see Castner series.	Severe: bedrock at depth of 20 to 40 inches; high frost-action potential.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.
*Rentsac: RF-----	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
RG----- For Rock outcrop part, see Rock outcrop.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
Riverwash: Rh-----	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.
*Rock outcrop: Rk, RM----- For Lambeth part of Rk and Travessilla part of RM, see their respective series.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.
*Romberg: RN, RO-----	Moderate or severe: very stony or extremely stony.	Moderate: moderate permeability; very stony; slopes of 8 to 15 percent.	Severe: very gravelly, cobbly, and stony.	Severe: excessive stones.
RP----- For Shale outcrop part, see Shale outcrop.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: very gravelly, cobbly, and stony.	Severe: excessive stones.
RS----- For Stutzman part, see Stutzman series.	Moderate: very stony.	Moderate: moderate permeability; very stony.	Severe: very gravelly, cobbly, and stony.	Severe: excessive stones.

See footnotes at end of table.



TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
Rottulee: Rt.....	Moderate: bedrock at depth of 22 to 35 inches.	Severe: bedrock at depth of 22 to 35 inches.	Severe: bedrock at depth of 22 to 35 inches.	Severe: bedrock at depth of 22 to 35 inches.
Ryorp: RY.....	Severe: slopes of 25 to 45 percent.	Severe: bedrock at depth of 32 to 38 inches.	Severe: bedrock at depth of 32 to 38 inches.	Severe: bedrock at depth of 32 to 38 inches.
Sandstone outcrop: SA.....	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.
Sebud: SB.....	Severe: stony and bouldery; slopes of 25 to 45 percent.	Severe: stony and bouldery; slopes of 25 to 45 percent.	Severe: stony and bouldery; slopes of 25 to 45 percent.	Severe: stony and bouldery; slopes of 25 to 45 percent.
*Shale outcrop: SC, SD..... For Abac part of SD, see Abac series.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.
*Shane: Se, Sg.....	Severe: high shrink-swell potential.	Severe: very slow permeability; soft bedrock at depth of 30 to 40 inches.	Severe: soft bedrock at depth of 30 to 40 inches.	Moderate or severe: silty clay loam or clay loam textures; soft bedrock at depth of 30 to 40 inches.
Sf, Sh..... For Cabba part of Sg and Sh, see Cabba series.	Severe: high shrink-swell potential.	Severe: very slow permeability; soft bedrock at depth of 30 to 40 inches.	Severe: soft bedrock at depth of 30 to 40 inches.	Moderate or severe: silty clay loam or clay loam texture; soft bedrock at depth of 30 to 40 inches.
Sicklesteets: SK.....	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.
Sinnigam: SM, SN.....	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
*Spearfish: SO..... For Shale outcrop part, see Shale outcrop.	Severe: slopes of 15 to 25 percent; bedrock at depth of 10 to 20 inches.	Severe: slopes of 15 to 25 percent; bedrock at depth of 10 to 20 inches.	Severe: bedrock at depth of 10 to 20 inches.	Severe: bedrock at depth of 10 to 20 inches.
Stormitt: Sp, Sr, Ss, St, SV.....	Moderate or severe: moderate to high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability.	Severe: excessive coarse fragments.
SU.....	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: excessive coarse fragments.
Stutzman: SW.....	Moderate: moderate shrink-swell potential.	Severe: slow permeability.	Slight.....	Moderate: clay loam or silty clay loam texture.
*Tarrete: TA, TB, TC..... For Hanson part of TC, see Hanson series.	Severe: moderate shrink-swell potential; slopes of 15 to 25 percent.	Severe: slow permeability; slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: clay texture.

See footnotes at end of table.

community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Severe: bedrock at depth of 22 to 35 inches.	Moderate: bedrock at depth of 22 to 35 inches.	Slight.....	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Severe: bedrock at depth of 32 to 38 inches.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.
Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.
Severe: stony and bouldery; slopes of 25 to 45 percent.	Severe: stony and bouldery; slopes of 25 to 45 percent.	Severe: stony and bouldery; slopes of 25 to 45 percent.	Severe: stony and bouldery.	Severe: stony and bouldery; slopes of 25 to 45 percent.	Severe: stony and bouldery; slopes of 25 to 45 percent.
Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.	Severe: bedrock at surface.
Moderate or severe: clay loam texture; bedrock at depth of 30 to 40 inches.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Severe: very slow permeability.
Moderate or severe: clay loam texture; bedrock at depth of 30 to 40 inches.	Severe: high shrink-swell potential.	Severe: very slow permeability.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 8 to 15 percent.	Severe: very slow permeability.
Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Moderate: slopes of 15 to 25 percent.	Moderate or severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.
Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: more than 50 percent coarse fragments near the surface.	Severe: more than 50 percent coarse fragments near the surface.	Severe: excessive coarse fragments on the surface.	Severe: bedrock at depth of less than 20 inches.
Severe: bedrock at depth of 10 to 20 inches.	Severe: bedrock at depth of 10 to 20 inches.	Severe: slopes of 15 to 25 percent.	Moderate or severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent; bedrock at depth of 10 to 20 inches.
Severe: excessive coarse fragments.	Moderate or severe: moderate to high frost-action potential.	Moderate or severe: excessive coarse fragments.	Moderate or severe: excessive coarse fragments.	Moderate or severe: excessive coarse fragments.	Moderate or severe: excessive coarse fragments.
Severe: excessive coarse fragments.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of more than 25 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.
Moderate: clay loam texture.	Moderate: moderate shrink-swell potential.	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.	Severe: silty clay surface layer.
Severe: clay texture.	Severe: moderate shrink-swell potential; slopes of 15 to 25 percent.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.

TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
Teton: TD-----	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent; bedrock at depth of 32 to 40 inches.	Severe: slopes of 15 to 25 percent; bedrock at depth of 32 to 40 inches.	Severe: bedrock at depth of 32 to 40 inches.
Thedalund: Te-----	Severe: high frost-action potential.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: clay loam texture; bedrock at depth of 20 to 40 inches.
Tf-----	Severe: high frost-action potential.	Severe: bedrock at depth of 20 to 40 inches.	Severe: bedrock at depth of 20 to 40 inches.	Severe: clay loam texture; bedrock at depth of 20 to 40 inches.
*Thiel: Tg-----	Slight-----	Slight <sup>3</sup> -----	Severe: very rapid permeability below a depth of 20 inches.	Severe: excessive cobblestones; very rapid permeability.
TH----- For Bynum part, see Bynum series.	Severe: very cobbly; slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: very rapid permeability below a depth of 20 inches.	Severe: excessive cobblestones; very rapid permeability.
*Thurlow: Tk, Tl----- For Toluca part of Tl, see Toluca series.	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: moderately slow permeability.	Moderate: slopes of 4 to 8 percent.	Moderate: clay loam or silty clay loam texture.
*Tiban: TM, TN----- For Tarrete part of TN, see Tarrete series.	Severe: extremely stony.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: excessive stones.
*Toluca: To, Tp-----	Severe: moderate shrink-swell potential; high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: clay loam texture.
Tr-----	Severe: moderate shrink-swell potential; high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability.	Moderate: clay loam texture.
Ts, TU----- For Rock outcrop part of TU, see Rock outcrop.	Severe: moderate shrink-swell potential; high frost-action potential.	Slight or moderate: moderate permeability.	Severe: slopes of 8 to 15 percent; moderate permeability.	Moderate: clay loam texture.
TT----- For Midway part, see Midway series.	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Moderate: clay loam texture.

community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Severe: bedrock at depth of 32 to 40 inches.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: excessive stones.	Severe: excessive stones; slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.
Severe: clay loam texture; bedrock at depth of 20 to 40 inches.	Severe: high frost-action potential.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 4 to 8 percent.
Severe: clay loam texture; bedrock at depth of 20 to 40 inches.	Severe: high frost-action potential.	Moderate: clay loam surface layer; slopes as much as 15 percent.	Moderate: clay loam surface layer.	Moderate or severe: slopes of as much as 15 percent.	Severe: slopes of as much as 15 percent.
Severe: excessive cobblestones.	Slight-----	Severe: excessive cobblestones.	Severe: excessive cobblestones.	Severe: excessive cobblestones.	Severe: excessive cobblestones.
Severe: excessive cobblestones.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent; excessive cobblestones.	Severe: excessive cobblestones.	Severe: excessive cobblestones.	Severe: excessive cobblestones.
Moderate: clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate or severe: slopes of 4 to 8 percent.
Severe: excessive stones.	Severe: excessive stones.	Severe: excessive stones.	Severe: excessive stones.	Severe: excessive stones.	Severe: excessive stones.
Moderate: clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.
Moderate: clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 4 to 8 percent.
Moderate: clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Moderate: clay loam texture.	Severe: moderate shrink-swell potential; high frost-action potential.	Severe: slopes of 15 to 25 percent.	Moderate or severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.

TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
Tonra: Tv-----	Slight-----	Slight-----	Severe: very rapid permeability below depth of 29 inches.	Severe: gravelly and cobbly sand below depth of 29 inches.
Torchlight: TW-----	Severe: high shrink-swell potential.	Severe: slow permeability.	Severe: slopes of more than 7 percent.	Severe: clay texture.
Trapper: TX-----	Severe: bedrock at depth of 50 to 60 inches; high frost-action potential.	Moderate: bedrock at depth of 50 to 60 inches; slopes of 8 to 15 percent.	Severe: bedrock at depth of 50 to 60 inches; slopes of 8 to 15 percent.	Moderate: silty clay loam texture; bedrock at depth of 50 to 60 inches.
Travessilla: TY-----	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.
Twin Creek: Tz-----	Slight-----	Moderate: bedrock at depth of 48 to more than 60 inches.	Moderate: bedrock at depth of 48 to more than 60 inches; slopes of 4 to 8 percent.	Moderate: bedrock at depth of 48 to more than 60 inches.
Vona: Vn, Vo-----	Moderate: moderate frost-action potential.	Slight-----	Severe: very rapid permeability.	Severe: very rapid permeability.
Vp-----	Moderate: moderate frost-action potential.	Slight-----	Severe: very rapid permeability.	Severe: very rapid permeability.
Vr-----	Moderate: moderate frost-action potential.	Moderate: slopes of 8 to 15 percent.	Severe: very rapid permeability.	Severe: very rapid permeability.
Vs-----	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Wayden: WA----- For Cabba part, see Cabba series.	Severe: slopes of 15 to 25 percent.	Severe: soft bedrock at depth of less than 20 inches.	Severe: soft bedrock at depth of less than 20 inches.	Severe: soft bedrock at depth of less than 20 inches.
WC, WD----- For Cabba part of WC and Castner part of WD, see their respective series.	Severe: slopes of 25 to 45 percent.	Severe: soft bedrock at depth of less than 20 inches.	Severe: soft bedrock at depth of less than 20 inches.	Severe: soft bedrock at depth of less than 20 inches.
Windham: WE-----	Moderate: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent; moderately slow permeability.	Severe: slopes of more than 7 percent.	Moderate: very gravelly loam texture.
WH-----	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of more than 7 percent.	Severe: slopes of 25 to 45 percent.

community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Severe: gravelly and cobbly sand below depth of 29 inches.	Slight.....	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Severe: excessive gravel on surface.	Severe: excessive gravel on surface.
Severe: clay texture.	Severe: high shrink-swell potential.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.	Severe: clay surface layer.
Moderate: bedrock at depth of 50 to 60 inches; silty clay loam texture.	Severe: high frost-action potential.	Moderate: slopes of 8 to 15 percent.	Moderate: silty clay loam texture.	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Severe: bedrock at depth of less than 20 inches.	Severe: bedrock at depth of less than 20 inches.	Slight.....	Slight.....	Moderate: bedrock at depth of less than 20 inches.	Moderate or severe: slopes of more than 4 percent; bedrock at depth of less than 20 inches.
Moderate: bedrock at depth of 48 to more than 60 inches.	Slight.....	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate or severe: slopes of 4 to 8 percent.
Slight.....	Moderate: moderate frost-action potential.	Slight.....	Slight.....	Slight.....	Slight.
Slight.....	Moderate: moderate frost-action potential.	Slight.....	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Moderate: slopes of 8 to 15 percent.	Moderate: moderate frost-action potential.	Moderate: slopes of 8 to 15 percent.	Slight.....	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.
Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table.
Severe: slopes of more than 15 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Moderate: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.	Severe: slopes of 15 to 25 percent.
Severe: slopes of more than 15 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.
Severe: slopes of 8 to 15 percent; very gravelly loam texture.	Moderate: slopes of 8 to 15 percent.	Moderate: cobbly clay loam surface layer.	Moderate: cobbly clay loam surface layer.	Severe: slopes of 8 to 15 percent; cobbly clay loam surface layer.	Severe: slopes of 8 to 15 percent.
Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent; cobbly clay loam surface layer.	Severe: slopes of 25 to 45 percent.	Severe: slopes of 25 to 45 percent.

TABLE 4.—Degree and kind of limitation for

Soil series and map symbols	Community development			
	Foundations for low buildings without basements	Septic tank absorption field <sup>1</sup>	Sewage lagoons	Trench type sanitary land fill <sup>2</sup>
*Woodrock: WK, WN For Rock outcrop part of WK, see Rock outcrop. For Bynum part of WN, see Bynum series.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent; bedrock at depth of 20 to 40 inches.
Work: Wo	Severe: moderate shrink-swell potential; high frost-action potential.	Slight or moderate: moderate permeability.	Moderate: moderate permeability; slopes of 4 to 8 percent.	Moderate: silty clay loam texture.
Wormser: Wr	Moderate: bedrock at depth of 30 to 40 inches.	Severe: bedrock at depth of 30 to 40 inches.	Severe: bedrock at depth of 30 to 40 inches.	Severe: bedrock at depth of 30 to 40 inches.
Yegen: Ye	Moderate: moderate frost-action potential.	Slight	Moderate: moderate permeability; slopes of 2 to 4 percent.	Slight
Yf	Moderate: moderate frost-action potential.	Slight	Severe: moderate permeability; slopes of 4 to 8 percent.	Slight
Yg	Moderate: moderate frost-action potential.	Moderate: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.	Slight

<sup>1</sup> Permeability ratings for septic tank filter fields are for material at a depth below 18 inches.

<sup>2</sup> Onsite studies of the underlying strata and the water table and of the hazard of aquifer pollution and drainage into ground water are required for landfills deeper than 5 or 6 feet.

community development and recreation—Continued

Community development—Continued		Recreational facilities			
Cemeteries	Local streets and roads	Picnic areas and campgrounds	Paths and trails	Golf fairways	Play areas
Severe: slopes of more than 15 percent; bedrock at depth of 20 to 40 inches.	Severe: slopes of more than 15 percent.	Severe: slopes of more than 15 percent; bedrock at depth of 20 to 40 inches.	Severe: slopes of more than 15 percent; bedrock at depth of 20 to 40 inches; clay loam surface layer.	Severe: slopes of more than 15 percent; bedrock at depth of 20 to 40 inches.	Severe: slopes of more than 15 percent.
Slight.....	Severe: moderate shrink-swell potential; high frost-action potential.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate: clay loam surface layer.	Moderate or severe: slopes of 4 to 8 percent.
Severe: bedrock at depth of 30 to 40 inches.	Moderate: bedrock at depth of 30 to 40 inches.	Slight.....	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Slight.....	Moderate: moderate frost-action potential.	Slight.....	Slight.....	Slight.....	Moderate: slopes of 2 to 4 percent.
Slight.....	Moderate: moderate frost-action potential.	Slight.....	Slight.....	Slight or moderate: slopes of 4 to 8 percent.	Moderate or severe: slopes of 4 to 8 percent.
Moderate: slopes of 8 to 15 percent.	Moderate: moderate frost-action potential.	Moderate: slopes of 8 to 15 percent.	Slight.....	Moderate or severe: slopes of 8 to 15 percent.	Severe: slopes of 8 to 15 percent.

<sup>3</sup> Possible contamination of water supply in some places.

Mountain juniper. Willows and cottonwoods do best where soils are moist throughout the year. Species that tolerate a slight to moderate amount of salinity or alkalinity are Russian-olive, buffaloberry, cottonwood, golden willow, Siberian elm, and Rocky Mountain juniper.

Soil characteristics that affect windbreak suitability are the amount of and depth to lime, the depth to bedrock, the available water capacity, the number of coarse rock fragments, the permeability, the degree of wetness, and the absence of alkali or salts.

### *Windbreak groups*

The soils of Carbon County Area are placed in eleven windbreak suitability groups. To identify the soils in a windbreak suitability group, refer to the "Guide to Mapping Units" at the back of this survey. Each windbreak suitability group is described, and the species of trees and shrubs most suitable to the group are listed.

#### WINDBREAK GROUP 1

This group consists of deep, friable, nearly level to steep, well-drained soils on stream terraces and fans. Slopes range from 0 to 45 percent. Areas range from 5 to 1,000 acres in size.

Permeability is moderate to slow, and available water capacity is low to high. The erosion hazard is slight where slope is less than 8 percent, and moderate or severe where 8 to 50 percent.

Soils of this group are well suited to caragana, honeysuckle, lilac, chokecherry, American plum, skunkbush sumac, buffaloberry, sand cherry, dogwood, and Russian-olive.

#### WINDBREAK GROUP 2

This group consists of deep and moderately deep, friable, gently sloping to strongly sloping, well-drained soils on uplands. Slopes range from 2 to 15 percent. Areas range from 5 to 500 acres in size.

Permeability is very slow to moderate, and available water capacity is low to high. The erosion hazard is slight or moderate.

Soils of this group are suited to caragana, honeysuckle, lilac, chokecherry, sumac, sand cherry, Nanking cherry, Russian-olive, Siberian crab, Harbin pear, Siberian elm, ponderosa pine, Scotch pine, and Rocky Mountain juniper.

#### WINDBREAK GROUP 3

In this group are strongly sloping to steep, well-drained soils on narrow to broad divides in the uplands. They are 20 inches or less deep over sandstone, hard limestone, and shale bedrock. Slopes are long and short and range from 8 to 45 percent. Areas range from 5 to 1,000 acres in size.

Permeability is very slow to rapid, and available water capacity is low and very low. The erosion hazard is slight.

Soils of this group are suited to caragana, sumac, sand cherry, Russian-olive, Siberian crab, Siberian elm, ponderosa pine, and Rocky Mountain juniper.

#### WINDBREAK GROUP 4

This group consists of deep, nearly level to moderately steep, well-drained soils on fans and hillsides in the uplands. Slopes range from 0 to 25 percent. Areas range from 10 to 1,000 acres in size.

Permeability is very slow, and available water capacity is moderate. The erosion hazard is slight.

Soils of this group are suited to caragana, sumac, sand cherry, Russian-olive, Siberian elm, and Rocky Mountain juniper.

#### WINDBREAK GROUP 5

This group consists of deep, friable, nearly level to strongly sloping, well-drained soils on stream terraces and uplands. Slopes range from 0 to 15 percent. Areas range from 5 to 1,000 acres in size.

Permeability is moderate to rapid, and available water capacity is low to moderate. The erosion hazard is slight.

Soils of this group are suited to caragana, honeysuckle, lilac, chokecherry, American elm, skunkbush sumac, buffaloberry, sand cherry, Nanking cherry, Russian-olive, Siberian crab, Harbin pear, green ash, Siberian elm, ponderosa pine, Colorado blue spruce, Douglas-fir, Scotch pine, and Rocky Mountain juniper.

#### WINDBREAK GROUP 6

This group consists of deep, friable, nearly level to steep, well-drained soils on valley floors and broad divides in the uplands. Slopes are long and short and range from 0 to 45 percent. Areas range from 10 to 1,000 acres in size.

Permeability is slow or moderate, and available water capacity is moderate or high. The erosion hazard is slight.

Soils of this group are suited to caragana, honeysuckle, lilac, chokecherry, American elm, skunkbush sumac, purple willow, buffaloberry, sand cherry, Nanking cherry, dogwood, Russian-olive, Siberian crab, Harbin pear, lodgepole pine, and Rocky Mountain juniper.

#### WINDBREAK GROUP 7

This group consists of deep, friable, well-drained soils on stream terraces and fans. These soils are nearly level to very steep, and slopes range from 0 to 90 percent. Areas range from 20 to 1,000 acres in size.

Permeability is moderate, and available water capacity is low to high. The erosion hazard is slight.

Soils of this group are suited to caragana, honeysuckle, lilac, chokecherry, skunkbush sumac, sand cherry, Nanking cherry, Russian-olive, Siberian crab, Harbin pear, green ash, Siberian elm, ponderosa pine, Scotch pine, and Rocky Mountain juniper.

#### WINDBREAK GROUP 8

In this group are deep, gently sloping to steep, well-drained soils that are stony, cobbly, or bouldery. Areas of these soils range from 50 to 1,000 acres in size.

Permeability is moderate, and the available water capacity is low to high. The erosion hazard is slight.

These soils are suited to caragana, skunkbush sumac, sand cherry, Nanking cherry, Russian-olive, Siberian crab, Siberian elm, ponderosa pine, Scotch pine, and Rocky Mountain juniper.

#### WINDBREAK GROUP 9

This group consists of deep, nearly level and gently sloping, wet and saline, poorly drained soils and Alluvial land. These soils are on stream terraces. Slopes are 0 to 4 percent. Areas range from 5 to 100 acres in size.

Permeability is moderate to slow. The water table is on or near the surface during the irrigation season. The erosion hazard is slight.

These soils are suited to skunkbush sumac, purple willow, buffaloberry, dogwood, Russian-olive, Siberian elm, white willow, golden willow, cottonwood, and aspen trees.

#### WINDBREAK GROUP 10

In this group are deep, level to steep, gravelly, cobbly, or stony, well-drained soils. They are in stream valleys and on terrace edges in the uplands. Slopes range from 0 to 25 percent. Areas range from 5 to 100 acres in size.

Permeability is moderately rapid to very rapid, and available water capacity is very low to low. The erosion hazard is slight.

These soils are suited to caragana, skunkbush sumac, sand cherry, Nanking cherry, Russian-olive, Siberian crab, Siberian elm, ponderosa pine, Scotch pine, and Rocky Mountain juniper.

#### WINDBREAK GROUP 11

In this group are deep, undulating or gently sloping, well-drained, clayey and alkali soils. They are on valley floors and upland slopes. Slopes are 2 to 8 percent. Areas range from 2 to 100 acres in size.

These soils have slow to very slow permeability and moderate and high available water capacity. The erosion hazard is slight.

The soils in this group are unsuitable for windbreaks because they are strongly saline or are high in alkali content.

## Use of the Soils for Cultivated Crops and Pasture

Approximately 17 percent of the Carbon County Area, or about 180,882 acres, is used for small grain, row crops, hay, and ensilage. About 84,000 acres is irrigated. The dryland is used mainly for winter wheat and barley. The irrigated land in the valleys is used for sugar beets, potatoes, corn ensilage, hay, beans, and peas. Residue from the irrigated crops provides supplemental feed for livestock, the main enterprise.

Irrigation water is sufficient for the irrigated crops, but conservation of water is essential to successful farming in the Area.

On the dryland, the cropping system generally followed is small grain and fallow in alternate years. Crop residue is returned to the soil and kept on the surface to protect the soil from soil blowing and water erosion. This system of cropping offers greater stability to the farming enterprise than continuous cropping, because crop failures are less frequent.

Soils in the Carbon County Area are cultivated during the fallow year to kill weeds, to conserve as much of the current year's precipitation as possible for a grain crop the following year, and to conserve available nitrogen in the soil. Soils that are fallowed can be protected from erosion by proper utilization of the crop residue, by tillage that produces a rough or cloddy surface, or by a combination of these. The residue from small grain and cover crops left on the surface protects the soil by reducing the velocity of the wind at the soil surface. A cloddy

or rough surface also reduces the velocity of the wind at the surface, and the soil particles remain in place.

Special care is needed to prevent loss of soil and water through runoff on sloping soil and soils that have a slow intake of water. Contour farming, grassed waterways, and adequate residue on the surface help to keep the soil in place. Organic matter helps to maintain good soil tilth and a moderate rate of water intake and also helps control runoff and conserve moisture. A permanent vegetative cover is needed to protect steep soils against water erosion.

Using irrigated soils and irrigation water in a way that assures high production without waste of water or loss of soil and providing adequate drainage reduce alkali, salinity, waterlogging, and other adverse conditions that are common to irrigated soils.

Most difficulties involved in irrigation can be solved in a practical way if facts are known about the soil, the topography, the water needs, and the suitability of the soils for irrigation. Applying irrigation water in such a way that it wets the roots of plants and the least amount possible is lost through runoff or deep percolation is the objective in conservation irrigation. An irrigator who practices conservation irrigation has control of the water from the time it enters the ditch or pipe until only the small part not used by the crops leaves the field as waste water.

Different methods of irrigation, drainage control, or land leveling are needed on different farms. The available water supply generally can be used more efficiently if delivery schedules and soil management are improved. Crops that add organic matter and commercial fertilizer are ordinarily needed to maintain soil fertility.

Water can be applied to fields either in rows, corrugations, or borders, or by sprinkler irrigation. Excess irrigation water must be removed by shallow surface drains. Drainage is important for salty and wet soils.

### Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive land-forming 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 requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering.

In the capability system, the kinds of soil are grouped at three levels, the capability class, the subclass, and the unit. These levels are described in the following paragraphs.

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, defined as follows:

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife. (None in this survey area)
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.
- Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

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

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-2 or IIIe-4. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management of nonirrigated and irrigated soils is described by capability units in the pages that follow. A soil under irrigation generally needs different management from that needed by the same soil when it is dryfarmed.

For this reason, soils in the Carbon County Area that are suited to irrigation are assigned to a different capability unit if they are irrigated. Some soils are placed in a higher capability class if irrigated because the limitation that placed it into a certain dryland capability class has been removed by applying irrigation water. For example, a soil in capability unit IIIe-4, dryland, may be in capability unit IIe-1, irrigated. To find the names of the soils in a given capability unit, refer to the "Guide to Mapping Units."

In the following pages the capability units are described, and suggestions are given for the use and management of the soils.

#### CAPABILITY UNIT I-1 (IRRIGATED)

This unit consists of deep, well-drained soils that formed in alluvium. These soils are on stream terraces. Slopes are less than 2 percent. The surface layer is loam, clay loam, or silty clay loam 6 to 10 inches thick. The subsoil or substratum is loam to silty clay loam.

The soils of this unit are mildly alkaline to moderately alkaline. Tilth is good, and plant roots penetrate easily to a depth of 48 inches or more. Infiltration and permeability are moderate or moderately slow, and the available water capacity is high. The frost-free period is 110 to 130 days.

These soils are suited to row crops, small grain, alfalfa, and grasses. About 10 percent of the acreage is used for pasture. Crops are easy to establish and maintain, and they respond to applications of fertilizer. The soils are well suited to sprinkler or surface irrigation.

Management is required that maintains or improves productivity and tilth and provides for efficient handling of water. Keeping crop residue at or near the surface conserves moisture for crops. Cover crops help to maintain soil productivity and tilth. Grass waterways are needed in places to carry water from other areas across these soils. Irrigation water for these soils comes from the Clarks Fork River or from Sage Creek.

#### CAPABILITY UNIT IIe-1 (IRRIGATED)

This unit consists of deep, gently sloping and undulating, well-drained soils on stream terraces and fans. Slopes are 2 to 4 percent. The surface layer of these soils is fine sandy loam or clay loam 6 to 10 inches thick. It is underlain by a subsoil or substratum of fine sandy loam to silty clay loam.

The soils are moderately alkaline to strongly alkaline. Tilth is good, and plant roots penetrate easily to a depth of 48 inches or more. Infiltration and permeability are moderately rapid to moderately slow, and available water capacity is moderate to high. The frost-free period is 110 to 130 days.

These soils are suited to all crops grown locally, including grasses and legumes. About 15 percent of the acreage is pasture. Crops are easy to establish and maintain, and they respond to applications of fertilizer. Clean cultivated crops should not be grown year after year because further erosion is a slight hazard. The soils are well suited to sprinkler or surface irrigation. Because of slope, irrigation water should be handled carefully to avoid washing.

Management is required that maintains or improves productivity and tilth and that provides for efficient

handling of water. Keeping crop residue at or near the surface conserves moisture for crops. Cover crops help to maintain soil productivity and tilth. Grass waterways are needed in places to carry water from higher areas across these soils. Irrigation water for these soils comes from the Clarks Fork River or from Sage Creek.

#### CAPABILITY UNIT IIe-2 (DRYLAND)

This unit consists of deep and moderately deep, nearly level to gently sloping and undulating, well-drained soils on upland fans and terraces. Slopes are less than 4 percent. The surface layer of these soils is loam, silt loam, silty clay loam, or clay loam. It is 2 to 6 inches thick over a subsoil or substratum of loam to clay. Shale or sandstone is at a depth of 20 to 40 inches.

These soils have a neutral surface layer and a mildly alkaline to strongly alkaline subsoil and substratum. Tilth is good to excellent, and plant roots penetrate easily to a depth of 36 inches or more. Infiltration and permeability are moderate to very slow and the available water capacity is low to high. The annual precipitation is 15 to 19 inches. The frost-free period is more than 110 days.

These soils are suited to small grain in a crop-fallow system. About 20 percent of the acreage is alfalfa. Yields are high during normal or wet years and low during dry years. Crops are easy to establish and maintain, and they respond to applications of fertilizer. Clean cultivated fields are subject to slight and moderate erosion.

Management is required that maintains or improves productivity, tilth, and erosion control. Keeping crop residue on or near the surface holds moisture for plants. Grass waterways are needed to carry excess runoff water across these soils.

#### CAPABILITY UNIT IIw-1 (IRRIGATED)

This unit consists of nearly level to gently sloping soils on stream terraces. Slopes range from 0 to 6 percent. The surface layer of these soils is fine sandy loam to clay loam 6 to 10 inches thick. It is underlain by a subsoil or substratum of fine sandy loam to silty clay loam.

These soils have accumulations of salts on the surface and in the subsoil. They are subject to seepage from higher areas and irrigation canals. The water table is within 20 inches of the surface during most of the growing season. Infiltration and permeability are moderate or moderately slow, and the available water capacity is moderate or high. The frost-free period is 110 to 130 days.

These soils are suited only to salt-tolerant plants. If drained, and if corrective amendments are applied, they can be used for cultivated crops.

Management is required to improve and maintain productivity and tilth. Drainage is essential if better plants are to be established and high water and salinity eliminated.

#### CAPABILITY UNIT IIe-1 (IRRIGATED)

This unit consists of deep, well-drained soils on stream terraces. Slopes are less than 2 percent. The surface layer of these soils ranges from fine sandy loam to silty clay. It is 6 to 10 inches thick over a subsoil or substratum of fine sandy loam to silty clay.

The soils of this unit have a neutral to mildly alkaline surface layer and a moderately alkaline or strongly alkaline subsoil. Tilth is good, and plant roots penetrate

easily to a depth of 48 inches or more. Infiltration and permeability are rapid to slow, and the available water capacity is moderate to high. The frost-free period is 110 to 130 days.

These soils are suited to crops grown locally, including grasses and legumes. About 10 percent of the acreage is used for pasture. Crops are easily established and maintained and respond to applications of fertilizer. These soils are well suited to sprinkler irrigation.

Management is required that maintains or improves productivity and tilth and that provides for efficient handling of water. Crop residue and cover crops hold moisture near the surface and help to maintain soil productivity and tilth.

#### CAPABILITY UNIT IIe-2 (DRYLAND)

Only Lohler silty clay loam, 0 to 2 percent slopes, is in this unit. This deep nearly level soil is on stream terraces. The surface layer is silty clay loam 4 to 6 inches thick. It is underlain by a subsoil or substratum of silty clay or clay.

The soil has a neutral surface layer and a mildly alkaline to moderately alkaline subsoil and substratum. Tilth is good, and plant roots penetrate easily to a depth of 40 inches or more. Infiltration and permeability are moderately slow and available water capacity is high. Annual precipitation is 15 to 19 inches. The frost-free period is more than 110 days.

This soil is suited to small grain in a crop-fallow system. About 10 percent of the acreage is alfalfa. Yields are high during wet years and low during droughty years. Crops are easily established and maintained, and they respond to applications of fertilizer. The erosion hazard is slight during fallow periods.

Management is required that maintains or improves productivity, tilth, and erosion control. Keeping crop residue on or near the surface holds moisture for plants. Grass waterways are needed in places to carry water from higher areas across this soil.

#### CAPABILITY UNIT IIIe-1 (IRRIGATED)

This unit consists of deep, gently sloping to gently rolling, well-drained soils on fans and uplands. Slopes are dominantly 4 to 8 percent. The surface layer of these soils ranges from fine sandy loam to clay. It is underlain by a subsoil or substratum of fine sandy loam to clay.

The soils of this unit are mildly alkaline. Tilth is good, and plant roots penetrate easily to a depth of 36 inches or more. Infiltration and permeability are moderately rapid to slow, and available water capacity is moderate to high. The frost-free period is 90 to 130 days.

These soils are suited to small grain, alfalfa, and grasses. About 10 percent of the acreage is used for pasture. Crops are easily established and maintained, and they respond to applications of fertilizer. The soils are well suited to sprinkler irrigation. Because of slope, irrigation water should be handled carefully to avoid washing.

Management is required that maintains or improves productivity and tilth and provides for efficient handling of water. Keeping crop residue at or near the surface conserves moisture for crops. Cover crops help maintain soil productivity and tilth. Grass waterways are needed in places to carry excess water and reduce the risk of erosion.

**CAPABILITY UNIT IIIc-2 (DRYLAND)**

This unit consists of deep to shallow, well-drained soils on upland fans. Slopes are 2 to 8 percent. The surface layer of these soils is 4 to 6 inches of loam or silty clay loam. It is underlain by a subsoil or substratum of loam to clay. Shale or sandstone is at a depth of 15 to 40 inches.

The soils of this unit are mildly alkaline to moderately alkaline. Tilth is good, and plant roots penetrate easily to a depth of 36 inches or more. Infiltration and permeability are moderate to very slow, and the available water capacity is very low to high. Annual precipitation is 15 to 19 inches. The frost-free period is 90 to 120 days.

These soils are suited to small grain, alfalfa, and grass. About 16 percent of the acreage is range. Yields are highest in years when moisture is favorable. Crops are easily established and maintained, and they respond to applications of fertilizer.

Management is required that maintains or improves tilth and productivity and reduces the risk of erosion. Keeping crop residue on or near the surface holds moisture for plants. Grass waterways are needed in places to carry water from higher areas across these soils.

**CAPABILITY UNIT IIIc-3 (IRRIGATED)**

This unit consists of deep, well-drained soils on fans and outwash terraces. Slopes are 2 to 8 percent. The surface layer of these soils is 6 to 8 inches of fine sandy loam. It is underlain by a subsoil of loam to clay and a substratum of clay loam, gravelly and cobbly clay loam, or loose sand and gravel.

The soils of this unit have a neutral surface layer and a mildly alkaline to strongly alkaline subsoil and substratum. Tilth is good, and plant roots penetrate easily to a depth of 48 inches or more. Infiltration and permeability are moderate, and available water capacity is low to high. The frost-free period is 90 to 110 days.

These soils are suited to small grain, alfalfa, and grasses. About 95 percent of the acreage is pasture. Crops are easy to establish and maintain, and they respond to applications of fertilizer. Clean cultivated crops should not be grown year after year because the erosion hazard is moderate. These soils are suited to sprinkler irrigation. Because of slope, the control of irrigation water is necessary to avoid washing.

Management is required that maintains or improves productivity and tilth and that provides for efficient handling of water. Proper use of crop residue is essential in keeping moisture near the surface for plants. Cover crops help to maintain tilth and productivity. Grass waterways are needed to reduce the risk of erosion in drainageways.

**CAPABILITY UNIT IIIc-4 (DRYLAND)**

This unit consists of deep to shallow, well-drained soils on uplands, terraces, and fans. Slopes are 2 to 8 percent. The surface layer of these soils is 4 to 6 inches of loam to clay. It is underlain by a subsoil or a substratum of loam to clay texture. In the uplands, shale and sandstone are at a depth of 15 to 40 inches.

The soils of this unit are moderately alkaline to very strongly alkaline. Tilth is fair, and plant roots penetrate the soil easily to a depth of 30 inches or more. Infiltration and permeability are very slow, and available water

capacity is low to high. Annual precipitation is 10 to 14 inches. The frost-free period is 110 to 130 days.

These soils are suited to small grain and grass in a crop-fallow system. About 30 percent of the acreage is range. Yields are very high during years when moisture is favorable. Crops are easy to establish and maintain, and they respond to applications of fertilizer.

Management is required that maintains or improves tilth and productivity and reduces the hazard of erosion. These soils blow easily because they granulate and respond like sand to wind action. Keeping crop residue on or near the surface holds moisture for plants. Grass waterways are needed in places to carry excess water from higher areas across these soils.

**CAPABILITY UNIT IIIw-1 (IRRIGATED)**

Charlos loam, wet, 0 to 2 percent slopes, the only soil in this unit, is on outwash fans and terraces. The surface layer is 6 to 8 inches of loam. It is underlain by a clay loam subsoil. Loose sand and gravel is at a depth of 30 to 40 inches.

This soil is mildly alkaline to moderately alkaline throughout the profile. Tilth is good, and plant roots penetrate easily to a depth of 25 inches or more. Infiltration and permeability are slow to moderate, and available water capacity is moderate or high. The seasonal water table is within a depth of 25 inches during most of the year, except in swales, where it is on or near the surface.

This soil is suited to meadow grasses. If drained it can be used for small grain. Uncontrolled irrigation water collects in swales and low places. About 30 percent of the acreage is poorly drained and is used for pasture. Crops are easy to establish and maintain and respond to applications of fertilizer. Control of irrigation water is needed to avoid washing.

Management is required to maintain or improve productivity and tilth and to provide for efficient use of irrigation water. Keeping crop residue on or near the surface holds moisture for plants. Surface and underground drainage is essential in lowering the water table.

**CAPABILITY UNIT IIIs-1 (IRRIGATED)**

Kyle clay, 0 to 2 percent slopes, the only soil in this unit, is a deep, nearly level, well-drained soil on stream terraces or fans. The surface layer is granular clay 6 to 8 inches thick. It is underlain by a clay subsoil and substratum.

The surface layer of this soil is neutral, and the subsoil and substratum are mildly alkaline to strongly alkaline. Tilth is fair to good, and plant roots penetrate to a depth of 36 inches or more with difficulty. Infiltration and permeability are very slow, and available water capacity is moderate. The frost-free period is 110 to 130 days.

This soil is suited to all crops grown locally, including alfalfa and grass. About 5 percent of the acreage is pasture. Crops are easy to establish and maintain, and they respond to applications of fertilizer. The soil is suited to sprinkler irrigation. Control of irrigation water is necessary to prevent overirrigation and to avoid washing.

Management is required that maintains or improves productivity and tilth and that provides for efficient

handling of water. Proper use of crop residue is necessary to improve tilth and fertility and keep moisture near the surface for plant use. Grass waterways are needed to prevent gullying and to carry excess water across this unit from higher lying areas.

#### CAPABILITY UNIT III<sub>s</sub>-2 (DRYLAND)

This unit consists of deep, nearly level and gently sloping, well-drained soils on high outwash terraces. The surface layer of these soils is loam or stony loam. The subsoil is clay loam. Loose sand and gravel is at a depth of 30 to 40 inches.

Tilth is good, except in stony areas. Plant roots penetrate easily to a depth of 30 inches or more. Infiltration, available water capacity, and permeability are moderate. Annual precipitation is 15 to 19 inches. The frost-free period is 90 to 110 days.

These soils are suited to small grain and grasses and legumes. About 20 percent of the acreage is pasture. Crops are easy to establish and maintain, and they respond to applications of fertilizer.

Management is required that maintains or improves tilth and productivity and reduces hazard of erosion. Removal of surface stones improves tilth. Keeping crop residue on or near the surface prevents soil loss and conserves moisture for plants. Grass waterways are needed in places to convey excess water across these soils.

#### CAPABILITY UNIT III<sub>s</sub>-3 (IRRIGATED)

Only Charlos loam, 0 to 2 percent slopes, is in this unit. This is a deep well-drained soil on high outwash fans and terraces. The surface layer of this soil is loam 6 to 10 inches thick. The subsoil is clay loam. Sand and gravel are at a depth of 30 to 40 inches.

Tilth is good, and plant roots penetrate easily to a depth of 30 inches or more. Infiltration and permeability are moderate and available water capacity is low. The frost-free period is 90 to 110 days.

This soil is suited to small grain, alfalfa, and meadow hay and grasses. About 70 percent of the acreage is used for pasture. Crops are easy to establish and maintain, and they respond to applications of fertilizer. Sprinkler irrigation or surface flooding is suitable. Irrigation water must be controlled to eliminate ponding and excessive seepage to low lying areas and swales.

Management is required that maintains or improves productivity and tilth and that provides for efficient handling of irrigation water. Keeping crop residue on or near the surface is needed to hold moisture for plants. Grass waterways are needed to prevent washings.

#### CAPABILITY UNIT III<sub>s</sub>-4 (DRYLAND)

This unit consists of deep, well-drained soils on stream terraces or fans. The surface layer of these soils is clay loam, silty clay loam, or clay 4 to 6 inches thick. It is underlain by a subsoil or substratum of clay loam or clay.

The surface layer is only slightly, if at all, effervescent, but the subsoil and substratum are strongly effervescent. Tilth is fair to good, and plant roots penetrate easily to a depth of 36 inches or more. Infiltration and permeability are moderately slow to very slow, and available

water capacity is moderate to high. Annual precipitation is 10 to 14 inches. The frost-free period is 110 to 130 days.

These soils are suited to small grain and grass in a crop-fallow system. About 5 percent of the acreage is range. Yields are high in years of favorable moisture. Crops are easy to establish and maintain, and they respond to applications of fertilizer.

Management is required that maintains or improves tilth and productivity and reduces the hazard of erosion. Proper use of crop residue is essential in maintaining vigor and in keeping moisture near the surface for plants. Grass waterways are needed in places to transport excess water from higher areas across these soils.

#### CAPABILITY UNIT III<sub>c</sub>-1 (DRYLAND)

This unit consists of deep, well-drained soils on fans and stream terraces. Slopes are less than 2 percent. The surface layer of these soils is loam or clay loam 4 to 6 inches thick. It is underlain by a subsoil and substratum of clay loam or silty clay loam.

These soils are mildly alkaline to moderately alkaline. Tilth is good, and plant roots penetrate easily to a depth of 40 inches or more. Infiltration and permeability are moderate, and available water capacity is high. Annual precipitation is 10 to 14 inches. The frost-free period is 110 to 130 days.

These soils are suited to small grain and grass. Yields are high in years of favorable moisture. Crops are easy to establish and maintain, and they respond to applications of fertilizer. Lack of moisture is a limiting factor.

Management is required that maintains or improves tilth and productivity and reduces the hazard of erosion. Keeping crop residue on or near the surface prevents soil loss and conserves moisture for plants. Grass waterways are needed in places to convey excess water across these soils.

#### CAPABILITY UNIT IV<sub>e</sub>-1 (IRRIGATED)

This unit consists of deep, well-drained soils on fans and uplands. Slopes are 4 to 15 percent. The surface layer of these soils is fine sandy loam to clay 6 to 9 inches thick. It is underlain by a subsoil or substratum of fine sandy loam to clay.

The soils of this unit are mildly alkaline. Tilth is good, and plant roots penetrate easily to a depth of 36 inches or more. Infiltration and permeability are moderately rapid to slow, and available water capacity is low to high. The frost-free period is 90 to 130 days.

These soils are suited to small grain, alfalfa, and grasses. About 70 percent of the acreage is used for pasture. Crops are easy to establish and maintain, and they respond to applications of fertilizer. Sprinkler irrigation is suitable. Because of steepness, irrigation water should be handled carefully to avoid washing.

Management is required that maintains or improves productivity and tilth and provides for efficient handling of water. Long periods of clean cultivated crops should be avoided because erosion is a hazard. Proper use of crop residue is essential in keeping moisture on or near the surface for plants. Grass waterways are essential in preventing channel cutting where excess water collects.

**CAPABILITY UNIT IVe-2 (DRYLAND)**

This unit consists of deep to shallow, well-drained soils on uplands and fans. Slopes are 8 to 15 percent. The surface layer of these soils is fine sandy loam to silty clay loam 4 to 6 inches thick. It is underlain by a loam to clay subsoil and substratum. In the uplands sandstone or shale is at a depth of 12 to 40 inches.

These soils are moderately alkaline. Tilth is good, and plant roots penetrate the moderately deep and deep soils easily to a depth of 36 inches or more. Roots penetrate the shallow soils to a depth of 12 inches or more and penetrate the sandstone or shale only between layers or through fractures in the bedrock. Infiltration and permeability are moderate to very slow, and available water capacity is very low to high. Annual precipitation is 15 to 19 inches. The frost-free period is 90 to 120 days. Slope and the resulting hazard are limiting factors.

These soils are limited to a permanent cover crop of legumes or grasses. Cultivation should be limited to only the fieldwork needed to reestablish the vegetative cover. About 60 percent of the acreage is range. Grasses and legumes are easy to establish and maintain, and they respond to applications of fertilizer.

Management is required that maintains or improves tilth and productivity and reduces the risk of erosion. Keeping crop residue on or near the surface prevents soil loss and conserves moisture for plants. Grass waterways are needed in places to convey excess water across these soils.

**CAPABILITY UNIT IVe-3 (IRRIGATED)**

Adel silty clay loam, the only soil in this unit, is on fans. Slopes are less than 8 percent. The surface layer is 20 to 36 inches of silty clay loam. It is underlain by loam, gravelly loam, clay loam, or gravelly clay loam.

This soil has a neutral surface layer and a mildly alkaline subsoil. Tilth is good, and plant roots penetrate easily to a depth of 36 inches or more. Infiltration and permeability are moderate, and available water capacity is high. The frost-free period is 60 to 90 days.

This soil is suited to small grain, alfalfa, and grasses. Crops are easy to establish and maintain, and they respond to applications of fertilizer. Surface flooding and sprinkler irrigation are suitable.

Management is required that maintains or improves productivity and tilth and provides for efficient handling of water. Proper use of crop residue is needed to improve tilth and keep moisture near the surface for plants. Grass waterways are needed to prevent gulying of the drainageways.

**CAPABILITY UNIT IVe-4 (DRYLAND)**

This unit consists of deep to shallow, gently sloping and strongly sloping, well-drained soils on fans and uplands. The surface layer of these soils is fine sandy loam, loam, clay loam, silty clay loam, and clay. It overlies a fine sandy loam to clay subsoil and substratum. In places on the uplands, these soils are 12 to 40 inches deep over sandstone or shale.

These soils are moderately alkaline or strongly alkaline. Tilth is fair to good, and plant roots penetrate the moderately deep and deep soils easily to a depth of 30 inches or more. Roots penetrate the shallow soils

easily to a depth of 12 inches or more. They penetrate the sandstone or shale only between the layers or fractures in the bedrock. Infiltration and permeability are moderate or moderately slow, and available water capacity is moderate or low. Annual precipitation is 10 to 14 inches. The frost-free period is 110 to 120 days.

These soils are suited to a permanent cover crop of legumes and grasses. Cultivation should be limited to only the fieldwork needed to reestablish the vegetative cover. About 80 percent of the acreage is range. Slope and erosion are limiting factors. Crops are easy to establish and maintain, and they respond to applications of fertilizer.

Management is required that maintains or improves tilth and productivity and reduces the risk of erosion. Keeping crop residue on and near the surface prevents soil loss and conserves moisture for plants. Grass waterways are needed to prevent washing of the drainageways.

**CAPABILITY UNIT IVe-5 (DRYLAND)**

This unit consists of deep and moderately deep, gently sloping or strongly sloping and rolling, well-drained soils on uplands.

The surface layer of these soils is silt loam or silty clay loam. The subsoil and substratum are clay loam. Shale or sandstone is within a depth of 40 inches.

The soils of this unit have a neutral surface layer and a neutral to mildly alkaline subsoil and substratum. Tilth is good, and plant roots penetrate easily to a depth of 24 inches or more. Infiltration and permeability are moderate or moderately slow, and available water capacity is moderate to high. Annual precipitation is 15 to 24 inches. The frost-free period is 60 to 90 days.

These soils are suited to permanent cover crops. Cultivation should be limited to only the fieldwork needed to reestablish the vegetative cover. Crops are easy to establish and maintain, and they respond to applications of fertilizer. About 95 percent of the acreage is range.

Management is required that maintains or improves tilth and productivity and reduces the risk of erosion. Keeping crop residues on or near the surface prevents soil loss and conserves moisture for plants. Grass waterways are needed to prevent gulying of the drainageways.

**CAPABILITY UNIT IVe-6 (DRYLAND)**

Only Colby silt loams are in this unit. These well-drained loams are on uplands. Slopes are 2 to 15 percent. The surface layer is loam or silt loam. It overlies silt loam or silty clay.

Tilth is good, and plant roots easily penetrate to a depth of 36 inches or more. Infiltration and permeability are moderate, and available water capacity is high. Annual precipitation is 5 to 9 inches. The frost-free period is 110 to 120 days.

These soils are droughty. Lack of moisture is a serious limitation. About 90 percent of the acreage is range. Erosion is a hazard if row crops are grown for long periods. Crops are easy to establish and maintain, and they respond to applications of fertilizer.

Management is required that maintains or improves tilth, the grass cover, and productivity and reduces the

risk of erosion. Proper use of plant residue is essential in maintaining fertility and keeping moisture near the surface for plants. Grass waterways are needed in places to carry excess water across these soils.

#### CAPABILITY UNIT IVe-7 (DRYLAND)

This unit consists of soils of the Stormitt series. These soils are on uplands and fans. Slopes range from 2 to 8 percent. The surface layer is loam or gravelly loam. The subsoil and substratum are gravelly and very gravelly silty clay loam.

Tilth is good, and plant roots easily penetrate to a depth of 48 inches or more. Infiltration and permeability are rapid, and available water capacity is low or very low. Annual precipitation is 10 to 19 inches. The frost-free period is 90 to 110 days.

These soils are suited to limited cultivation and to a permanent-type cover crop. Cultivation should be limited to only the fieldwork needed in reestablishing the vegetative cover. Crops are easily established and maintained, and they respond to applications of fertilizers. About 90 percent of the acreage is range.

Management is required that maintains or improves tilth and productivity and reduces the risk of erosion. Keeping crop residues on or near the surface prevents soil loss and conserves moisture for plants. Grass waterways are essential in preventing gulying of the drainageways.

#### CAPABILITY UNIT VIe-1 (DRYLAND)

This unit consists of deep to shallow, well-drained soils on uplands. Slopes range from 2 to 45 percent. The surface layer is loam, and the subsoil is fine sandy loam to clay. Depth to bedrock or loose sand and gravel ranges from less than 10 inches to more than 60 inches. In some places stones or cobblestones are strewn on the surface.

These soils have a neutral to slightly acid surface layer and a moderately alkaline to strongly alkaline subsoil and substratum. Permeability is very rapid to very slow, and available water capacity is very low to high. Annual precipitation is 5 to 25 inches.

These soils are suitable for range. For applicable management practices, refer to the section "Use of the Soils for Range."

#### CAPABILITY UNIT VIw-1

This unit consists of deep, poorly drained and somewhat poorly drained soils on fans and stream terraces. Slopes are less than 4 percent. The water table is within 20 inches of the surface during all or most of the growing season.

These soils have accumulations of salts on the surface and throughout the subsoil. In some places runoff is ponded. Infiltration and permeability are moderate, and available water capacity is low.

These soils are suitable for range. For applicable management practices, refer to the section "Use of the Soils for Range."

#### CAPABILITY UNIT VIe-1

This unit consists of deep to shallow soils on fan terraces and uplands. Slopes are 0 to 15 percent. The texture of the surface and subsoil layers ranges from loam to clay. Depth to bedrock or to loose sand or sand and gravel ranges from less than 10 inches to more than 60

inches. In many places cobblestones and stones are on the surface and throughout the subsoil.

Infiltration and permeability are very rapid to very slow, and available water capacity is very low to high. Annual precipitation is 5 to 25 inches.

These soils are suitable for range. For applicable management practices, refer to the section "Use of the Soils for Range."

#### CAPABILITY UNIT VIIe-1 (DRYLAND)

This unit consists of deep to shallow, loamy to clayey soils on uplands. Slopes are 25 to 70 percent. In several places these soils have a large number of sandstone fragments on the surface and throughout the subsoil. In some places they are wooded. Infiltration and permeability are moderate to very slow, and the available water capacity is very low to high.

These soils are suitable for range. For applicable management practices, refer to the section "Use of the Soils for Range."

#### CAPABILITY UNIT VIIe-1 (DRYLAND)

This unit consists of deep and moderately deep, extremely stony loamy to clayey, well-drained soils on uplands and fans. Slopes are 2 to 35 percent. Infiltration and permeability are moderate to very slow, and available water capacity is low. Annual precipitation is 5 to 25 inches.

These soils are suitable for range. For applicable management practices, refer to the section "Use of the Soils for Range."

#### CAPABILITY UNIT VIIIw-1 (DRYLAND)

This unit consists only of Marsh, a freshwater marsh subject to flooding from irrigation water. It is not suited to crops or pasture and in its natural condition it does not support trees. It is suitable habitat for migratory birds and small fur-bearing animals.

#### CAPABILITY UNIT VIIIe-1 (DRYLAND)

This unit consists of areas of Riverwash and barren or nearly barren outcrops of limestone, sandstone, and shale.

## Estimated Yields

Table 5 lists for each soil used for crops the estimated average acre yield of the principal dryland and irrigated crops grown in Carbon County Area under a high level of management. The yield figure is an estimated long-time average. Crop failures have been considered in these averages. The estimates are based partly on interviews with farmers and partly on records of the Montana Agricultural Experiment Station and the Agricultural Stabilization and Conservation Service. High level management includes such practices as proper management of crop residue, contour or wind stripcropping, or contour terraces and field shelterbelt plantings, proper seeding rates and dates of planting, applying commercial fertilizer according to soil tests and crop requirements, and proper irrigation methods. Estimated yields are listed in table 5 for soils in irrigated and dryland capability classes I, II, III, and IV.

TABLE 5.—Estimated yields per acre of principal crops under a high level of management

[Dashed lines indicate the crop is not suited to the soil or is not generally grown]

Soil	Corn silage	Wheat		Barley		Oats		Sugar beets	Alfalfa			Grass for hay		Pasture	
	Irrigated	Irrigated	Dry-land	Irrigated	Dry-land	Irrigated	Dry-land	Irrigated	Irrigated	Dry-land	Irrigated	Dry-land	Wet years	Dry years	
	Tons	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Tons	Tons	Tons	Tons	Tons	Lb.	Lb.	
Absarokee clay loam, 2 to 4 percent slopes			30		50					1.5			1,500	900	
Absarokee clay loam, 4 to 8 percent slopes			30		50					1.5			1,500	900	
Absarokee clay loam, 8 to 15 percent slopes			25		40					1.0			1,500	900	
Absarokee-Cabba clay loams, 4 to 8 percent slopes			25		40					1.5			1,500	900	
Absarokee-Cabba clay loams, 8 to 15 percent slopes			20		40					1.5			1,500	900	
Absarokee-Shane clay loams, 6 to 15 percent slopes			25		40					1.0			1,500	900	
Absarokee-Sinnigam clay loams, 4 to 8 percent slopes			25		35					1.5			1,500	900	
Absarokee-Sinnigam clay loams, 8 to 15 percent slopes			20		25					1.0			1,500	900	
Adel silty clay loam, 0 to 4 percent slopes			40		65				4.0	3.0	2.0	1.5	2,800	2,000	
Adel silty clay loam, 4 to 8 percent slopes			40		65				4.0	3.0	2.0	1.5	2,800	2,000	
Charlos loam, 0 to 2 percent slopes		35	25	70	45	90	70		3.0	2.0			2,500	1,800	
Charlos loam, 2 to 8 percent slopes		35	25	70	45	90	70		3.0	2.0			2,500	1,800	
Charlos loam, wet, 0 to 2 percent slopes													2,500	1,800	
Colby silt loam, 2 to 4 percent slopes		60		85		90			4.5				2,000	800	
Colby silt loam, 4 to 8 percent slopes		55		75		90			4.0				2,000	800	
Colby silt loam, 8 to 15 percent slopes									3.5				1,500	700	
Fort Collins loam, 0 to 2 percent slopes	30	60		90		110		22	5.0						
Fort Collins loam, 2 to 4 percent slopes	30	60		90		110		22	5.0						
Fort Collins loam, wet, 0 to 2 percent slopes													2,000	1,500	
Glenberg loam, gravel substratum	20	40		50				15	3.0				2,000	1,500	
Harvey loam, 2 to 4 percent slopes			15		25					1.5			1,500	900	
Harvey loam, 4 to 8 percent slopes			15		25					1.5			1,500	900	
Haverson silty clay loam, 0 to 2 percent slopes	25	60		90				20	5.0				2,500	1,200	
Haverson-Heldt silty clay loams, 0 to 4 percent slopes			20		25					1.5			2,500	1,200	
Heath clay loam, 4 to 8 percent slopes		60	40		60				3.0	2.0	2.0	1.5	2,500	1,800	
Heath clay loam, 8 to 15 percent slopes			35		50					2.0		1.5	2,500	1,800	
Heldt silty clay loam, 0 to 2 percent slopes	30	55	20	90	35	100		22	5.0	2.5	2.0	1.5	2,500	1,500	
Heldt silty clay loam, 2 to 4 percent slopes	30	55	20	90	35	100		20	5.0	2.5	2.0	1.5	2,500	1,500	
Heldt silty clay loam, 4 to 8 percent slopes	30	50	20	70	35	80		18	4.0	2.5			2,500	1,500	
Heldt silty clay loam, 8 to 15 percent slopes			15		25					2.0			1,500	1,500	
Heldt silty clay loam, saline, 0 to 6 percent slopes													2,000	1,200	
Kyle clay, 0 to 2 percent slopes	25	40	25	65	30	85	50	20	4.0	2.0			1,500	900	
Kyle clay, 2 to 4 percent slopes	20	35	25	60	30	75	50	18	4.0	2.0			1,500	900	
Kyle clay, 4 to 8 percent slopes		25	20	55	25				3.0	1.5			1,500	900	
Lohler silty clay loam, 0 to 2 percent slopes		55	30	90	50	90			4.0	2.5	2.0	1.5	2,500	1,500	
Lohler silty clay loam, 2 to 4 percent slopes		55	25	90	50	75			4.0	2.5	2.0	1.5	2,500	1,500	

Lohler silty clay loam, saline, 0 to 4 percent slopes				25		45							2,000	1,200	
Macar-Cabba clay loams, 4 to 8 percent slopes				20		40							1,500	900	
Macar-Cabba clay loams, 8 to 15 percent slopes				30		50							1,500	900	
Marias clay, 2 to 8 percent slopes				25		45							1,500	900	
Marias clay, 8 to 15 percent slopes				60	30	90		40			4.0		2,500	1,800	
Martinsdale clay loam, 2 to 4 percent slopes				50	30	85		40			3.0		2,500	1,800	
Martinsdale clay loam, 4 to 8 percent slopes												2.0	1.5	2,800	2,000
Maurice-Bearmouth complex, 0 to 4 percent slopes														1,500	900
McRae loam, 2 to 4 percent slopes	20	55		20	60	35					5.0	2.5		1,500	900
Neville silty clay loam, 2 to 4 percent slopes				15		25						1.5		1,500	900
Neville silty clay loam, 4 to 8 percent slopes				15		25						1.5		1,500	900
Nunn silty clay loam, 0 to 2 percent slopes	30	60				90		110		22	5.0				
Nunn silty clay loam, 2 to 4 percent slopes	30	60				90		110		20	5.0				
Nunn silty clay loam, 4 to 8 percent slopes				20	70	35					4.0	2.5		2,500	1,800
Olney fine sandy loam, 2 to 4 percent slopes	15	50		20	80	30				20	3.0	1.5		1,500	900
Olney fine sandy loam, 4 to 8 percent slopes		45		20	60	30					2.0	1.5		1,500	900
Razor clay loam, 2 to 8 percent slopes				20		35								2,000	1,000
Razor-Thedalund clay loams, 4 to 15 percent slopes				15		30								2,000	1,000
Redlodge-Adel silty clay loams				30		50					4.0	3.0	2.0	2,800	2,000
Redlodge-Adel silty clay loams, wet														2,800	2,000
Rottulee silt loam, 4 to 8 percent slopes				30		50								1,500	900
Shane clay loam, 4 to 8 percent slopes				30		50					2.0			1,500	900
Shane clay loam, 8 to 15 percent slopes				30		50					2.0			1,500	900
Shane-Cabba clay loams, 4 to 8 percent slopes				25		40					1.5			1,500	900
Shane-Cabba clay loams, 8 to 15 percent slopes				20		40					1.5			1,500	900
Stormitt loam, 2 to 4 percent slopes				10		20								800	600
Stormitt gravelly loam, 4 to 8 percent slopes				10		20								800	600
Stutzman silty clay	20	50			80				20	4.5				800	600
Thedalund clay loam, 4 to 8 percent slopes				20		35								1,500	900
Thedalund clay loam, 8 to 15 percent slopes				15		30								1,500	900
Thurlow silty clay loam, 4 to 8 percent slopes				20		35					2.0			1,500	900
Thurlow-Toluca silty clay loams, 4 to 8 percent slopes				20		35					2.0			1,500	900
Toluca clay loam, 0 to 2 percent slopes	30	60		20	90	35			20	5.0	2.0			1,500	900
Toluca clay loam, 2 to 4 percent slopes	25	60		20	90	35			20	5.0	2.0			1,500	900
Toluca clay loam, 4 to 8 percent slopes	20	55		20	70	35			18	4.0	2.0			1,500	900
Toluca clay loam, 8 to 15 percent slopes		40		15	60	25				3.0	2.0			1,500	900
Tonra gravelly silty clay loam, 2 to 4 percent slopes	20	50			70				20	4.0					
Twin Creek silty clay loam, 4 to 8 percent slopes				20		35					2.0			1,500	900
Vona fine sandy loam, 0 to 2 percent slopes	15	50			70				22	3.0					
Vona fine sandy loam, 2 to 4 percent slopes	15	50			70				20	3.0					
Vona fine sandy loam, 4 to 8 percent slopes				12		20					1.5			1,500	900
Vona fine sandy loam, 8 to 15 percent slopes				10		15					1.5			1,500	900
Vona fine sandy loam, wet, 0 to 2 percent slopes														1,500	900
Work clay loam, 4 to 8 percent slopes				30		50					1.5			1,500	900
Wormser loam, 4 to 8 percent slopes				20		35					1.5			1,500	900
Yegen fine sandy loam, 2 to 4 percent slopes	15	50			80					3.0					
Yegen fine sandy loam, 4 to 8 percent slopes		50			80					3.0					
Yegen fine sandy loam, 8 to 15 percent slopes										2.5					

## Use of the Soils for Range <sup>2</sup>

Rangeland can be defined as an area where soils and climate produce a plant community of native vegetation of sufficient quality and quantity to justify grazing. In the Carbon County Area, native rangeland amounts to about 802,000 acres, or about 75 percent of the total acreage. The raising of cattle and sheep is the main enterprise.

The western part of the survey area is a grassy upland. The soils are hilly and steep and deep to moderately deep and shallow. Elevations range from 3,500 to 7,000 feet. The average annual precipitation is 15 to 24 inches. The frost-free period ranges from 50 to 110 days.

The eastern part of the survey area consists of uplands covered with grass and sagebrush. The soils are hilly and very steep and deep to moderately deep and shallow. Elevations range from 3,000 to 9,000 feet. The average annual precipitation is 5 to 19 inches. The frost-free period in this part ranges from 50 to 130 days.

### Range sites and condition classes

Rangeland is classified into range sites according to the kinds and amounts of native, or climax, vegetation that the soils and climate are capable of producing. Each range site produces a characteristic plant community that is not found on any other site.

Determining the kinds and numbers of plants that can be grown on a specified range site is necessary in planning the management of that site. The total yield of forage varies from year to year depending on the amount of precipitation. In years of high rainfall, the yield is above average and in dry years below average. Approximately 90 percent of the current year's growth can be grazed without damage to the site.

The native plant community can be altered, in both kind and number of plants, by grazing animals. Livestock constantly seek the more palatable, nutritious, and readily available forage plants. According to their response to grazing pressures, native plants are referred to as *decreasers*, *increasers*, and *invaders*. Decreasers and increasers are part of the climax vegetation.

*Decreasers* are species present in the potential plant community that decrease in relative abundance under continued, moderately heavy to heavy grazing. They are the plants most palatable to grazing animals and the first to decline if the site is overgrazed.

*Increasesers* are species present in the potential, or climax, plant community that increase to fill the voids left by the more desirable plants as they decline. Short grasses, and less desirable plants in turn, can be weakened by continued close grazing.

*Invaders* are unpalatable plants, weeds, or exotics that make up less than 2½ percent of the total production of climax vegetation. They invade the site as the more desirable plants are weakened or overgrazed.

Range condition is determined by the extent to which current vegetation is equivalent to the climax vegetation for the site. Range condition is *excellent* if the plant cover is 76 to 100 percent climax vegetation, *good* if 50 to 75 percent, *fair* if 25 to 50 percent, and *poor* if less than 25 percent. Determining range condition provides a basis

for planning and management that will improve a range site. Most ranges in the survey area are in fair to good condition.

### Descriptions of range sites

The range sites of the Carbon County Area are described on the following pages. The description of each range site mentions significant soil characteristics, lists the principal range plants, and gives estimates of the annual yield of herbage to be expected.

To learn the range site for any given soil, refer to the "Guide to Mapping Units."

#### WETLAND RANGE SITE (20 TO 24 INCHES PRECIPITATION)

This range site consists of nearly level and sloping soils that have a surface layer of silty clay loam and a subsoil and substratum of clay loam and clay. The site occupies stream terraces in narrow valleys of uplands in the western part of the survey area. Elevations range from 4,500 to 5,000 feet. Runoff is medium to slow, and available water capacity is high.

The potential plant community is mannagrass, bluejoint reedgrass, sedges, tufted hairgrass, shrubby cinquefoil, perennial forbs, woody plants, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 8,000 pounds of air-dry herbage per acre in moist years and 6,000 pounds per acre in dry years. Approximately 95 percent of this herbage is from plants that furnish forage for cattle.

Under continued heavy grazing by cattle, mannagrass, bluejoint reedgrass, and sedges decrease. Tufted hairgrass, forbs, low sedges, shrubby cinquefoil, and other woody plants increase. If overgrazing is prolonged, foxtail barley, mat muhly, one spike danthonia, Canada thistle, and exotic plants make up a substantial part of the plant cover. The production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred grazing, rotation grazing, and weed control, can be expected to maintain or increase forage production on this site.

#### SUBIRRIGATED RANGE SITE (20 TO 24 INCHES PRECIPITATION)

This range site consists of nearly level and gently sloping soils that have a surface layer of silty clay loam and a subsoil of clay loam or clay. The site occupies stream terraces in narrow valleys of uplands in the western part of the survey area. Elevations range from 4,500 to 5,000 feet.

The water table ranges from a few inches below the surface to as deep as 20 inches. These soils have a moderate intake of water and high available water capacity.

The potential plant community is prairie cordgrass, bluejoint reedgrass, bearded wheatgrass, slender wheatgrass, Canby wheatgrass, sedges, shrubby cinquefoil, tufted hairgrass, perennial forbs, and woody plants.

If this range site is in excellent condition, it produces an estimated 5,500 pounds of air-dry herbage per acre in moist years and 4,000 pounds per acre in dry years. Approximately 99 percent of this herbage is from plants that furnish forage for livestock.

Under continued heavy grazing, prairie cordgrass, bluejoint reedgrass, bearded wheatgrass, and slender wheatgrass decrease and Canby cinquefoil, sedges, tufted

<sup>2</sup> STERLE DALE, range conservationist, Soil Conservation Service, helped prepare this section.

hairgrass, perennial forbs, and woody plants increase. If heavy grazing is prolonged, Kentucky bluegrass, timothy, one-spike danthonia, curlycup gumweed, and annuals, biennials, and exotics make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invading plants.

Proper grazing management, such as deferred-rotation grazing and weed control, can be expected to maintain or increase forage production on this site.

**SALINE LOWLAND RANGE SITE  
(10 TO 14 INCHES PRECIPITATION)**

Stormitt gravelly loam, saline, the only soil in this range site, is nearly level and gently sloping and has a surface layer of gravelly loam and a subsoil and substratum of gravelly silty clay loam. This site is on fans and stream terraces. Elevations range from 4,000 to 4,500 feet. This soil is strongly alkali affected and saline. Runoff is slow, the intake of moisture is moderate, and the available water capacity is low.

The potential plant community is alkali cordgrass, alkali sacaton, sedges, alkali grass, western wheatgrass, squirreltail, mat muhly, saltgrass, greasewood, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 3,200 pounds of air-dry herbage per acre in moist years and 2,200 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that furnish forage for livestock.

Under continued heavy grazing, alkali cordgrass, alkali sacaton, basin wildrye, and alkali grass decrease. Western wheatgrass, squirreltail, mat muhly, saltgrass, and greasewood increase. If overgrazing is prolonged, annual brome, Kentucky bluegrass, foxtail barley, and broom snakeweed make up a substantial part of the annual production. The total production of usable forage is greatly reduced by these invading plants.

Proper grazing management, such as deferred-rotation grazing, brush control, and range seeding, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**SANDY RANGE SITE  
(10 TO 14 INCHES PRECIPITATION)**

This range site consists of nearly level to strongly sloping soils that have a surface layer of gravelly or very gravelly sandy loam or fine sandy loam. The subsoil and substratum are clay loam, sandy loam, or very gravelly sand to clay loam. This site is on fans and stream terraces. Elevations range from 3,500 to 4,500 feet.

Runoff is slow to medium, and the intake of moisture is moderate. The available water capacity ranges from very low to moderate.

The potential plant community is bluebunch wheatgrass, prairie sandreed, Indian ricegrass, woody plants, perennial forbs, western wheatgrass, needle-and-thread, sand dropseed, sedges, and plains muhly.

If this range site is in excellent condition, it produces approximately 1,500 pounds of air-dry herbage per acre in moist years and 900 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that furnish forage for cattle.

Under continued heavy grazing by cattle, bluebunch wheatgrass, prairie sandreed, Indian ricegrass, skunkbush sumac, and forbs decrease. Western wheatgrass,

needle-and-thread, sand dropseed, prairie junegrass, plains reedgrass, plains muhly, threadleaf sedge, silver sagebrush, forbs, and woody plants increase. If overgrazing is prolonged, foxtail barley, curlycup gumweed, broom snakeweed, and annuals make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing and range seeding, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**SANDY RANGE SITE  
(15 TO 19 INCHES PRECIPITATION)**

Alice fine sandy loam, the only soil in this range site, is nearly level to strongly sloping. It has a surface layer of fine sandy loam, a subsoil of fine sandy loam or sandy clay loam, and a substratum of fine sandy loam. This site is on divides and fans in the uplands. Elevations range from 4,000 to 5,000 feet.

Runoff is slow, the intake of moisture is rapid, and the available water capacity is moderate or low.

The potential plant community is basin wildrye, mountain brome, big bluegrass, prairie sandreed, spike fescue, Columbia needlegrass, bearded wheatgrass, perennial forbs, woody plants, western wheatgrass, Idaho fescue, needle-and-thread, timber danthonia, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 2,500 pounds of air-dry herbage per acre in moist years and 1,800 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that furnish forage for cattle and sheep.

Under continued heavy grazing by cattle, basin wildrye, mountain brome, big bluegrass, prairie sandreed, spike fescue, Columbia needlegrass, bluebunch wheatgrass, bearded wheatgrass, perennial forbs, and woody plants decrease. Western wheatgrass, Idaho fescue, needle-and-thread, timber danthonia, forbs, and increaser woody plants increase. If overgrazing is prolonged by cattle or sheep, curlycup gumweed, broom snakeweed, foxtail barley, and annual plants make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invading plants.

Proper grazing management, such as deferred-rotation grazing, range seeding, and weed control, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**SILTY RANGE SITE  
(5 TO 9 INCHES PRECIPITATION)**

This range site consists of gently sloping to strongly sloping, deep silt loams. It is on fans, foot slopes, and broad divides. Elevations range from 3,500 to 4,500 feet.

The soils are well drained and moderately permeable. They have moderate intake of water, low to high available water capacity, and slow or medium runoff.

The potential plant community is needle-and-thread, bluebunch wheatgrass, bud sagebrush, birdsfoot sagebrush, squirreltail, Sandberg bluegrass, blue grama, threadleaf sedge, big sagebrush, perennial forbs, western wheatgrass, and woody plants.

If this range site is in excellent condition, it produces approximately 800 pounds per acre of air-dry herbage in moist years and 600 pounds per acre in dry years. Ap-

proximately 80 percent of this herbage is from plants that furnish forage for livestock.

Under continued heavy grazing, needle-and-thread, bluebunch wheatgrass, bud sagebrush, fourwing saltbush, and squirreltail decrease. Sandberg bluegrass, blue grama, threadleaf sedge, big sagebrush, birdsfoot sagebrush, and various perennial forbs and woody plants increase. If overgrazing is prolonged, broom snakeweed, curlycup gumweed, foxtail barley, cactus, halogeton and annuals, biennials, and exotics make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invading plants.

Response to management is slow on this site because rainfall is low. Nevertheless, deferred-rotation grazing and brush control can help maintain or increase forage production and reduce the risk of erosion. Range seeding should be considered only as a last resort in restoring areas where the site has been severely overgrazed.

**SILTY RANGE SITE**  
(10 TO 14 INCHES PRECIPITATION)

This range site consists of nearly level to strongly sloping soils that have a loamy and silty surface layer and a subsoil of silty clay loam or clay loam. It is on fans, stream terraces, and foot slopes. Elevations range from 3,000 to 4,500 feet.

These soils are deep and well drained. They have a moderate intake of water, moderate to high available water capacity, and slow to rapid permeability. Runoff is slow to rapid.

The potential plant community is little bluestem, green needlegrass, bluebunch wheatgrass, woody plants, dry-land sedges, perennial forbs, western wheatgrass, needle-and-thread, plains reedgrass, big sagebrush, and blue grama.

If this range site is in excellent condition, it produces approximately 1,500 pounds of air-dry herbage per acre in moist years and 900 pounds per acre in dry years. About 90 percent of this herbage is from plants that furnish forage for livestock.

Under continued heavy grazing, prairie sandreed, spike fescue, green needlegrass, bluebunch wheatgrass, skunk-bush sumac, mountainmahogany, and perennial forbs decrease. Western wheatgrass, Idaho fescue, needle-and-thread, plains reedgrass, prairie junegrass, blue grama, big sagebrush, silver sagebrush, and other forbs and woody plants increase. If overgrazing is prolonged, Kentucky bluegrass, needleleaf sedge, curlycup gumweed, brome snakeweed, leafy spurge, knotweed, rabbitbrush, and other annuals, biennials, and exotics make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invading plants.

Proper grazing management, such as deferred-rotation grazing, brush control, and range seeding, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**SILTY RANGE SITE**  
(15 TO 19 INCHES PRECIPITATION)

This range site consists of gently sloping to steep soils that have a thick loamy surface layer and a loamy to clayey subsoil and substratum. This site is on uplands. Elevations range from 6,000 to 9,000 feet.

In some areas these soils are stony or very stony. They have a moderate intake of water and low to high available water capacity. Runoff is slow to rapid.

The potential plant community is spike fescue, green needlegrass, bluebunch grass, perennial forbs, western wheatgrass, Idaho fescue, needle-and-thread, annual forbs, woody plants, and annual grasses.

If this range is in excellent condition, it produces an estimated 2,000 pounds of air-dry herbage per acre in moist years and 1,500 pounds per acre in dry years.

Under heavy overgrazing, spike fescue, green needlegrass, bluebunch wheatgrass, perennial forbs, and some woody plants decrease. Western wheatgrass, Idaho fescue, needle-and-thread, timber danthonia, big sagebrush, forbs, and some woody plants increase. If overgrazing is prolonged, Kentucky bluegrass, needleleaf sedge, curlycup gumweed, broom snakeweed, leafy spurge, spotted knapweed, and annuals, biennials, and exotics make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invading plants.

Proper grazing management, such as deferred-rotation grazing and brush control, can be expected to maintain or increase forage production and reduce the risk of erosion on this site. Range seeding can restore severely overgrazed areas, but generally this practice should not be considered in areas where slopes are greater than 15 percent.

**CLAYEY RANGE SITE**  
(10 TO 14 INCHES PRECIPITATION)

This range site consists of nearly level to strongly sloping silty clay loams, clays, and clay loams. It is on upland divides and foot slopes. Elevations range from 3,200 to 4,500 feet.

The soils are deep to moderately deep and well drained. Permeability is very slow, intake rate is moderate, and available water capacity is low to high. Runoff is slow to rapid.

The potential plant community is green needlegrass, bluebunch wheatgrass, western wheatgrass, woody plants, plains reedgrass, Sandberg bluegrass, big sagebrush, perennial forbs, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 1,500 pounds of air-dry herbage per acre in moist years and 900 pounds per acre in dry years. Approximately 95 percent of this herbage is from plants that provide forage for cattle and sheep.

Under continued heavy grazing by cattle, green needlegrass and bluebunch wheatgrass decrease. Western wheatgrass, Idaho fescue, plains reedgrass, Sandberg bluegrass, big sagebrush, and various perennial forbs increase. If overgrazing is prolonged, tumblegrass, curly gumweed, broom snakeweed, foxtail barley, annual fescues and other annuals, and biennial herbaceous forms make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing and brush control, can be expected to maintain or increase forage production and reduce the risk of erosion on this site. Range seeding can restore severely overgrazed areas, but generally this practice should not be considered in areas where slopes are greater than 15 percent.

CLAYEY RANGE SITE  
(15 TO 19 INCHES PRECIPITATION)

This range site consists of gently sloping and strongly sloping soils that have a surface layer of clay loam or silty clay loam and a subsoil of clay or clay loam. It is on upland divides and fans. Elevations range from 4,500 to 6,500 feet.

Runoff is slow to medium, and moisture intake is moderately slow. The available water capacity is low to high.

The potential plant community is green needlegrass, Canby bluegrass, bluebunch wheatgrass, basin wildrye, western wheatgrass, Idaho fescue, plains reedgrass, big sagebrush, perennial forbs, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 2,500 pounds of air-dry herbage per acre in moist years and 1,800 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that provide forage for cattle or sheep.

Under continued heavy grazing by cattle or sheep, green needlegrass, little bluestem, bluebunch wheatgrass, and basin wildrye decrease. Western wheatgrass, Idaho fescue, plains reedgrass, big sagebrush, and various perennial forbs and woody plants increase. If overgrazing is prolonged, Kentucky bluegrass, foxtail barley, needleleaf sedge, curlycup gumweed, broom snakeweed, spotted knapweed, leafy spurge, Canada thistle, rabbitbrush, annual fescues, and other biennial and exotic plants make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing and brush control, can be expected to maintain or increase forage production and reduce the risk of erosion on this site. Range seeding can restore severely overgrazed areas, but generally this practice should not be considered in areas where slopes are greater than 15 percent.

CLAYEY RANGE SITE  
(20 TO 24 INCHES PRECIPITATION)

This range site consists of strongly sloping and steep soils that have a surface layer and substratum of clay loam or sandy clay loam. It is on uplands. Elevations range from 4,500 to 6,000 feet.

Runoff is slow to medium, and moisture intake is moderate. The available water capacity is low to high.

The potential plant community is spike fescue, bearded wheatgrass, slender wheatgrass, basin wildrye, mountain brome, Columbia needlegrass, forbs, Idaho fescue, Letterman needlegrass, prairie junegrass, Canby bluegrass, big sagebrush, and annual weeds and grasses.

If this range site is in excellent condition, it produces approximately 2,500 pounds of air-dry herbage per acre in moist years and 900 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that provide forage for cattle and sheep.

Under continued heavy grazing by cattle or sheep, spike fescue, bearded wheatgrass, slender wheatgrass, basin wildrye, mountain brome, Columbia needlegrass, and perennial forbs and woody plants decrease. Idaho fescue, Letterman needlegrass, prairie junegrass, Canby bluegrass, forbs, and big sagebrush increase. If overgrazing is prolonged, cheatgrass, Kentucky bluegrass, timothy, one-spiked danthonia, foxtail barley, curlycup

gumweed, broom snakeweed, wyethia, leafy spurge, knapweed, and other annual, biennial, and exotic plants make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing and weed control can be expected to maintain or increase forage production and reduce the risk of erosion on this site. Range seeding can restore severely overgrazed areas, but generally this practice should not be considered in areas where slopes are greater than 15 percent.

STONY RANGE SITE  
(15 TO 19 INCHES PRECIPITATION)

This range site consists of gently sloping to very steep soils that have a surface layer of stony loam and subsoil and substratum of clay loam to gravelly clay loam. It is on fans, terraces, and divides. Elevations range from 4,000 to 7,000 feet.

The intake of water is moderate to slow and available water capacity is low. Runoff is slow to medium.

The potential plant community is basin wildrye, prairie sandreed, green needlegrass, bluebunch wheatgrass, perennial forbs, western wheatgrass, Idaho fescue, needle-and-thread, woody plants, Canby bluegrass, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces an estimated 1,800 pounds of air-dry herbage per acre in moist years and 1,400 pounds in dry years.

Under continued heavy grazing, basin wildrye, prairie sandreed, green needlegrass, bluebunch wheatgrass, and woody plants decrease. Western wheatgrass, Idaho fescue, needle-and-thread, timber danthonia, Sandberg bluegrass, shrubby cinquefoil, and forbs increase. If heavy grazing is prolonged, cheatgrass, Kentucky bluegrass, blue grama, broom snakeweed, curlycup gumweed, one-spiked danthonia, and other annuals, biennials, and exotics make up a substantial part of the plant cover. These invading plants greatly reduce the total production of usable forage.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production and reduce the risk of erosion on this site. Numerous stones on the surface or steep slopes generally preclude the operation of equipment required in range seeding or brush control.

STONY RANGE SITE  
(10 TO 14 INCHES PRECIPITATION)

This range site consists of nearly level to steep soils that have an extremely stony surface layer and very stony and gravelly subsoil and substratum. It is on fans and stream terraces. Elevations range from 4,000 to 7,000 feet.

The intake of moisture is moderate to slow, and available water capacity is low to high. Runoff is slow to rapid.

The potential plant community is bluebunch wheatgrass, perennial forbs, woody plants, western wheatgrass, needle-and-thread, prairie junegrass, plains muhly, forb increasers, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 1,000 pounds of air-dry herbage per acre in moist years and 700 pounds per acre in dry

years. Approximately 80 percent of the herbage is from plants that provide forage for cattle and sheep.

Under continued heavy grazing by cattle and sheep, bluebunch wheatgrass, green needlegrass, winterfat, prairie sandreed, perennial forbs, and woody plants decrease. Western wheatgrass, needle-and-thread, prairie junegrass, plains muhly, big sagebrush, Sandberg bluegrass, and forbs increase. If overgrazing is prolonged, curlycup gumweed, foxtail barley, broom snakeweed, and annual plants make up a substantial part of the plant cover. The total production of usable herbage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production and reduce the risk of erosion on this site. Numerous stones on the surface or steep slopes generally preclude operation of equipment required in range seeding or brush control.

**LIMY RANGE SITE  
(5 TO 9 INCHES PRECIPITATION)**

Harvey loam, the only soil in this range site, is gently sloping and has a surface layer of loam and underlying material of silty clay loam. This site is on stream terraces.

Permeability is moderate, available water capacity is high, and runoff is slow or medium. The hazard of erosion is slight.

The potential plant community is bluebunch wheatgrass, green needlegrass, needle-and-thread, western wheatgrass, Sandberg bluegrass, blue grama, threadleaf sedge, woody plants, black sagebrush, and other sagebrush.

If this range site is in excellent condition, it produces approximately 700 pounds of air-dry herbage per acre in moist years and 400 pounds per acre in dry years. Approximately 90 percent of the herbage is from plants that provide forage for cattle and sheep.

Under continued heavy grazing by cattle and sheep, bluebunch wheatgrass, green needlegrass, needle-and-thread, and western wheatgrass decrease. Sandberg bluegrass, blue grama, threadleaf sedge, big sagebrush, silver sagebrush, black sagebrush, and birdsfoot sagebrush increase. If overgrazing is prolonged, curlycup gumweed, Kentucky bluegrass, foxtail barley, broom snakeweed, and annual plants make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing and brush control, can be expected to maintain or increase forage production and reduce the risk of erosion on this site. Range seeding should be considered only as a last resort in restoring areas where the site has been severely overgrazed.

**LIMY RANGE SITE  
(10 TO 14 INCHES PRECIPITATION)**

This range site consists of nearly level to steep soils that have a surface layer of gravelly loam or loam and subsoil and substratum of very gravelly loam or gravelly silty clay loam. It is on stream terraces and fans. Elevations range from 3,500 to 4,500 feet.

Runoff is slow to medium, and intake of moisture is moderate. The available water capacity is very low.

The potential plant community is bluebunch wheatgrass, perennial forbs, woody plants, western wheatgrass,

needle-and-thread, prairie junegrass, plains muhly, forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 1,000 pounds of air-dry herbage per acre in moist years and 700 pounds per acre in dry years. Approximately 80 percent of this herbage is from plants that provide forage for cattle and sheep.

Under continued heavy grazing by cattle or sheep, bluebunch wheatgrass, green needlegrass, winterfat, prairie sandreed, perennial forbs, and woody plants decrease. Western wheatgrass, needle-and-thread, prairie junegrass, plains muhly, big sagebrush, Sandberg bluegrass, and forbs increase. If overgrazing is prolonged, curlycup gumweed, foxtail barley, broom snakeweed, and annual plants make up a substantial part of the plant cover. The total production of usable herbage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing, brush control, and range seeding, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**SHALLOW TO CLAY RANGE SITE  
(10 TO 14 INCHES PRECIPITATION)**

This range site consists of strongly sloping and steep clays that are no more than 20 inches thick over shale. It is on uplands. Elevations range from 3,500 to 5,000 feet.

These soils are well drained and very slowly permeable. Intake of water is moderate, available water capacity is very low, and runoff is rapid.

The potential plant community is western wheatgrass, bluebunch wheatgrass, forbs, green needlegrass, woody plants, plains reedgrass, Sandberg bluegrass, big sagebrush, and annual grasses.

If this range site is in excellent condition, it produces approximately 700 pounds of air-dry herbage per acre in moist years and 300 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that provide forage for livestock.

Under continued heavy grazing, western wheatgrass, bluebunch wheatgrass, little bluestem, green needlegrass, and perennial forbs decrease. Idaho fescue, plains reedgrass, Sandberg bluegrass, big sagebrush, forbs, and woody plants increase. If overgrazing is prolonged, Kentucky bluegrass, foxtail barley, red threeawn, needleleaf sedge, curlycup gumweed, broom snakeweed, annual bromes, and fescues make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invading plants.

Proper grazing management, such as deferred-rotation grazing and brush control, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**SHALLOW TO GRAVEL RANGE SITE  
(15 TO 19 INCHES PRECIPITATION)**

Only Alluvial land is in this range site. It is nearly level or gently sloping, is gravelly and loamy, and does not have distinct soil horizons. This site is on stream terraces and narrow valley floors. Elevations range from 3,500 to 4,500 feet. The available water capacity is low.

The potential plant community is bluebunch wheatgrass, woody plants, western wheatgrass, Idaho fescue,

needle-and-thread, forbs, prairie junegrass, blue grama, Sandberg bluegrass, and annual grasses.

If this range site is in excellent condition, it produces approximately 1,500 pounds of air-dry herbage per acre in moist years and 800 pounds per acre in dry years. Approximately 95 percent of this herbage is from plants that provide forage for livestock.

Under continued heavy grazing, bluebunch wheatgrass, basin wildrye, perennial forbs, and woody plants decrease. Western wheatgrass, Idaho fescue, needle-and-thread, timber danthonia, prairie junegrass, blue grama, Sandberg bluegrass, snowberry willows, aspen trees, and forbs increase. If overgrazing is prolonged, foxtail barley, Kentucky bluegrass, needleleaf sedge, curlycup gumweed, broom snakeweed, and woody plants make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invading plants.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production on this site. Mechanical disturbance on the site may result in accelerated erosion by scouring during stream overflow.

**SHALLOW RANGE SITE  
(10 TO 14 INCHES PRECIPITATION)**

This range site consists of gently sloping to steep loams, silt loams, or clay loams no more than 20 inches deep over shale or hard sandstone. It is on bedrock plains in the uplands. Elevations range from 3,000 to 5,000 feet.

The soils are well drained and have slow to rapid permeability. Runoff is medium and rapid, water intake is moderate, and available water capacity is very low or low.

The potential plant community is bluebunch wheatgrass, Indian ricegrass, perennial forbs, western wheatgrass, needle-and-thread, prairie junegrass, plains reedgrass, plains muhly, and blue grama.

If this range site is in excellent condition, it produces approximately 1,000 pounds of air-dry herbage per acre in moist years and 700 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that provide forage for livestock.

Under continued heavy grazing, bluebunch wheatgrass, Indian ricegrass, green needlegrass, and perennial forbs decrease. Western wheatgrass, needle-and-thread, prairie junegrass, plains reedgrass, plains muhly, blue grama, Sandberg bluegrass, and forbs increase. If overgrazing is prolonged, Kentucky bluegrass, foxtail barley, red three-awn, needleleaf sedge, curlycup gumweed, broom snake-weed, annual bromes, and fescues make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by the invading plants.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**SHALLOW RANGE SITE  
(15 TO 19 INCHES PRECIPITATION)**

This range site consists of gently sloping to steep loams, clay loams, silt loams, channery loams, or channery clay loams no more than 20 inches deep over shale and hard sandstone or limestone. The site is on bedrock plains in the uplands. Elevations range from 3,500 to 5,000 feet.

The soils are well drained and have slow to rapid permeability. Water intake is moderate to rapid, available

water capacity is low or very low, and runoff is slow to rapid.

The potential plant community is prairie sandreed, green needlegrass, bluebunch wheatgrass, woody plants, sedges, perennial forbs, western wheatgrass, Idaho fescue, needle-and-thread, prairie junegrass, Sandberg bluegrass, annual forbs, and annual grasses.

If this range site is in excellent condition, it produces approximately 1,800 pounds of air-dry herbage per acre in moist years and 1,400 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that provide forage for livestock.

Under continued heavy grazing, basin wildrye, prairie sandreed, green needlegrass, bluebunch wheatgrass, bearded wheatgrass, Canby bluegrass, sun sedge, and perennial forbs decrease. Western wheatgrass, Idaho fescue, needle-and-thread, prairie junegrass, Sandberg bluegrass, big sagebrush, forbs, and woody plants increase. If overgrazing is prolonged, Kentucky bluegrass, foxtail barley, red threeawn, curlycup gumweed, broom snake-weed, annual bromes, and fescues make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by the invading plants.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**DENSE CLAY RANGE SITE  
(5 TO 9 INCHES PRECIPITATION)**

Torchlight clay, the only soil in this range site, is mainly strongly sloping, is dense, and is strongly alkaline to very strongly alkaline throughout. The surface layer consists of a crust  $\frac{1}{2}$  to  $\frac{3}{4}$  inch thick over moderate to strong, very fine granular clay. It is underlain by moderate, medium, prismatic clay that extends to a depth of 13 inches. Below this is massive clay. This site is on fans and foot slopes.

Runoff is rapid, and permeability is slow. The available water capacity is moderate.

The potential plant community is western wheatgrass, green needlegrass, fourwing saltbush, Nuttall saltbush, Sandberg bluegrass, birdsfoot sagebrush, black sagebrush, forbs, woody plants, and annual grasses.

If this range site is in excellent condition, it produces approximately 600 pounds of air-dry herbage in moist years and 300 pounds per acre in dry years. Approximately 95 percent of this herbage is from plants that provide forage for sheep and cattle.

Under continued heavy grazing, western wheatgrass, green needlegrass, fourwing saltbush, and Nuttall saltbush decrease. Sandberg bluegrass, birdsfoot sagebrush, low sagebrush, rabbitbrush, horsebrush, and other woody plants increase. Curlycup gumweed, foxtail barley, broom snakeweed, annuals, and bromes make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

**DENSE CLAY RANGE SITE  
(10 TO 14 INCHES PRECIPITATION)**

Only Allentine clay loam, 2 to 4 percent slopes, is in this range site. It is a gently sloping soil that has a surface layer of clay loam and subsoil and substratum of

clay loam or clay. This site occupies fans, stream terraces, and valley floors. Elevations range from 3,500 to 4,000 feet.

Runoff is medium, intake of moisture is moderately slow, and available water capacity is moderate.

The potential plant community is western wheatgrass, green needlegrass, plains reedgrass, Sandberg bluegrass, squirreltail, forbs, annual grasses, and big sagebrush.

If this range site is in excellent condition, it produces approximately 900 pounds of air-dry herbage per acre in moist years and 600 pounds per acre in dry years. Approximately 90 percent of this herbage is from plants that provide forage for cattle and sheep.

Under continued heavy grazing by cattle or sheep, western wheatgrass, green needlegrass, and winterfat decrease. Plains reedgrass, Sandberg bluegrass, squirreltail, saltgrass, and forbs increase. If overgrazing is prolonged, foxtail barley, curlycup gumweed, broom snake-weed, and annuals make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

#### THIN BREAKS RANGE SITE (10 TO 14 INCHES PRECIPITATION)

This range site consists of steep or very steep areas of limestone, sandstone, and shale outcrops and a few narrow, winding remnant ridges and benches, in a stairstep effect, of shallow soils. Soils on the ridges and benches between the outcrops afford the only grazing on this site.

Runoff is rapid, and the intake of water is very slow. Available water holding capacity is low, and the hazard of erosion is severe.

The potential plant community is bluebunch wheatgrass, green needlegrass, western wheatgrass, forbs, woody plants, big sagebrush, and needle-and-thread.

If this range site is in excellent condition, it produces an estimated 800 pounds of air-dry herbage per acre in moist years and 500 pounds per acre in dry years. Approximately 80 percent of this herbage is from plants that provide forage for livestock.

Under continued heavy grazing by livestock, bluebunch wheatgrass, green needlegrass, western wheatgrass, forbs, and some woody plants decrease. Big sagebrush, juniper, forbs, and other woody plants increase. If heavy grazing is prolonged, annuals and forbs make up a substantial part of the plant cover. The total production of usable forage is greatly reduced by these invaders.

Proper grazing management, such as deferred-rotation grazing, can be expected to maintain or increase forage production and reduce the risk of erosion on this site.

### Use of the Soils for Wildlife <sup>3</sup>

Big game animals in Carbon County Area are antelope, bear, bighorn sheep, mule and white-tailed deer, elk, and Rocky Mountain goats. The Rocky Mountain goats are an introduced species in the Area; the rest are native. All but antelope are in the wooded or mountainous areas of the county.

<sup>3</sup> Louis M. Moos, biologist, Soil Conservation Service, helped prepare this section.

Native upland game birds are the blue, ruffed, sage, and sharp-tailed grouse. Introduced species are gray (Hungarian) partridge, chukar partridge, ring-necked pheasant, and Merriam's turkey. Pheasants, gray partridge, and chukar are associated with open cropland or nearby grassland habitat. Sage grouse are in rangeland areas having a cover of sagebrush. Blue and ruffed grouse are mountain species. Sharp-tailed grouse require some woody cover in the habitat, especially in winter.

Important waterfowl are Canada geese and ducks. Mallard ducks are the most plentiful. In smaller numbers are blue-winged and green-winged teal, pintail, shoveler, widgeon, and common mergansers and golden-eye. Ducks require marshes and farm ponds for breeding areas. They usually nest near water or marshy areas. Canada geese, common merganser, and common and Barrow's goldeneye are usually associated with river or creek areas.

Fur-bearing animals in the Area are marten, mink, muskrat, otter, and beaver. Predators are coyote, red fox, mountain lion, weasel, skunk, bobcat, owls, hawks, and eagles. Golden eagles nest in the Area. Nongame species are rock chucks, pocket gophers, ground squirrels, pine squirrels, chipmunks, raccoons, porcupines and cottontail, jack, and snowshoe rabbits.

The Area provides habitat for numerous species of song and insectivorous birds. Some birds are permanent residents, some are summer residents and raise their young in the Area, and some migrate through the Area in spring and fall. A few species are present only in winter. All are an important part of the fauna of the county.

Fish in the Area generally are cold water species, including brook, brown, cutthroat, golden, and rainbow trout. Brook, golden, and gray trout generally are in high mountain lakes. The new reservoir on the Big Horn River contains crappie, lake trout, perch, and walleye. Species best suited for stocking farm ponds are brook and rainbow trout.

### Formation and Classification of the Soils

This section describes the factors of soil formation and explains how these factors have affected the soils of the Carbon County Area. It also defines the system of classification currently used and classifies the soils in the survey area according to that system.

### Factors of Soil Formation

Soil is a natural body on the earth's surface in which plants can grow. In the Carbon County Area, it consists mainly of mineral material, air, and water and is only about 1 to 4 percent organic material. The major factors that cause differences in soil properties, even within short distances in the same locality, result from the integrated effect of climate and living matter acting on earthy parent material as conditioned by relief over long periods of time. The influence of each soil-forming factor on the soils of this survey area is described on the pages that follow.

### *Climate*

Climate, an active force in the formation of soils, is determined mainly by temperature and precipitation. Erosion and alternate freezing and heating cause rocks to break into smaller fragments that usually continue to weather at a faster rate. The weathered material is further broken down by chemical reactions. In the Carbon County Area, precipitation ranges from less than 6 inches annually, in the driest part, to more than 24 inches in the wettest part. Temperatures are low in all sections of the survey area in winter, but differ significantly at different elevations in spring, summer, and autumn. In the driest and warmest parts of the survey area are soils of the Aridisol order, such as those of the Bowbac series. In cooler, moister parts are soils of the Mollisol order, such as those in the Redlodge series.

### *Living organisms*

Living organisms also are active in the formation of soils. Organic matter is the main source of the dark color in the surface layer. Fungi and algae are among the earliest inhabitants of rock material that contribute to the weathering of rocks. As the rocks weather, soils gradually begin to form. Grasses, shrubs, and trees eventually grow and support animal life and other kinds of plants.

The kinds of plants and animals present largely determine the kinds and amount of organic matter added to the soil and how this matter is incorporated with the mineral part of the soil. Roots, rodents, and insects penetrate the soil and influence its structure. Leaves, roots, and whole plants remain in the surface layer where they are changed to humus by micro-organisms, chemicals in the soil, and insects.

The vegetation in the survey area ranges from short and mid grasses and shrubs in most areas to ponderosa pine and juniper trees in the mountains.

### *Parent material*

Soils of the Carbon County Area formed from a variety of parent materials. Some formed in residuum weathered from sandstone, shale, limestone, and granite. Others formed in alluvium weathered from these materials. Castner and Travessilla soils formed in residuum weathered from sandstone. Midway and Razor soils formed in residuum weathered from clayey shale. Lap and Hanson soils formed in residuum weathered from limestone. Woodrock soils formed in residuum weathered from granite. Fort Collins, Glenberg, Lohler, and Martinsdale soils formed in alluvium weathered from a variety of materials. Some soils in the survey area, for example, the Allentine and Hydro soils, acquired excess amounts of salt and sodium from their parent material. The salts and sodium make these soils saline or alkaline and limit the kinds and numbers of plants that can be grown.

### *Topography*

Topography, or relief, through its effect on drainage and erosion has had an important effect on soil formation in the Carbon County Area. In the eroded uplands, runoff water has carved deep valleys that have many branches into the bedrock. The rugged relief contracts sharply with

the smooth, low relief of the terraces and flood plains in the river valleys.

In the uplands, erosion continues at a rate generally proportional to the steepness of slope. The depth of soil over bedrock and the number and distinctness of soil horizons are directly related to the rate of erosion. Where erosion is rapid, most of the soil material is removed before distinct soil horizons can form. An example is the Midway soil, which is moderately steep or steep, has little or no profile differentiation, and is shallow over shale bedrock. In the less steep areas, soils such as those of the Nunn series formed. These soils are nearly level or gently sloping, have strong profile differentiation, and are deep over bedrock.

### *Time*

The effect of time on soil formation in the Carbon County Area is more pronounced on the gently sloping uplands than on the recent flood plains.

Soils are sometimes referred to as young or mature. The age of a soil is measured in part by the thickness of the A horizon, the content of organic matter and of clay, the depth to which soluble materials are leached, and the form and distribution of calcium carbonate, gypsum, and other salts in the soil.

Lohler silty clay loam, a soil of the Entisol order, is an example of a young soil. It formed in alluvium on a flood plain adjacent to a flowing stream. It contains little organic matter and therefore has not formed a distinct A horizon, and it has little or no clay accumulation or translocation of carbonates and has not formed a B2 horizon or Cca horizons.

Work soils formed in parent material similar to but much older than that of Lohler silty clay loam. They formed in old alluvium on uplands and are mature soils of the Mollisol order. They contain enough organic matter to have a dark-colored A horizon. Also, they have a distinct clay accumulation in a B2t horizon, and nearly all the carbonates have been leached from the A and B horizons.

### **Classification of the Soils**

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (4) and later revised (3). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in March 1967 and September 1968 (6). This system is under continual study, and readers interested in the development of the system should refer to the available literature (2).

Table 6 shows the classification of each of the soil series represented in the Carbon County Area according to the current system. This system defines classes in terms of observable or measurable properties of soils. The properties chosen are primarily those that permit the grouping of soils that are similar in genesis. The classification is designed to encompass all soils. It has six categories. Beginning with most inclusive, they are the order, suborder, great group, subgroup, family and series. These are briefly defined in the following paragraphs.

TABLE 6.—*Soil series classified according to the current system of classification*

Series	Family	Suborder	Order
Abac	Loamy, mixed (calcareous), frigid, shallow	Typic Ustorthents	Entisols.
Absarokee	Fine, montmorillonitic	Typic Argiborolls	Mollisols.
Adel	Fine-loamy, mixed	Pachic Cryoborolls	Mollisols.
Allentine	Fine, montmorillonitic, mesic	Haplustollic Natrargids	Aridisols.
Alice	Coarse-loamy, mixed, mesic	Aridic Haplustolls	Mollisols.
Armington	Very fine, mixed	Vertic Haploborolls	Mollisols.
Bearmouth	Sandy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Bowbac	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.
Bynum	Fine-loamy, mixed	Typic Cryoborolls	Mollisols.
Cabba	Loamy, mixed (calcareous), frigid, shallow	Typic Ustorthents	Entisols.
Castner	Loamy-skeletal, mixed	Lithic Haploborolls	Mollisols.
Charles	Fine-loamy over sandy or sandy-skeletal, mixed	Argic Cryoborolls	Mollisols.
Colby	Fine-silty, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Duncom <sup>1</sup>	Loamy-skeletal, carbonatic	Lithic Cryoborolls	Mollisols.
Fort Collins	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.
Glenberg	Coarse-loamy, mixed (calcareous), mesic	Ustic Torrifluvents	Entisols.
Hanson	Loamy-skeletal, carbonatic	Calcic Cryoborolls	Mollisols.
Harvey	Fine-loamy, mixed, mesic	Ustollic Calciorthids	Aridisols.
Haverson	Fine-loamy, mixed (calcareous), mesic	Ustic Torrifluvents	Entisols.
Heath	Fine, montmorillonitic	Argic Cryoborolls	Mollisols.
Heldt	Fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
Hydro	Fine, montmorillonitic, mesic	Glossic Ustollic Natrargids	Aridisols.
Kyle	Very fine, montmorillonitic, mesic	Ustertic Camborthids	Aridisols.
La Fonda	Fine-loamy, mixed, mesic	Ustollic Camborthids	Aridisols.
Lambeth	Fine-silty, mixed (calcareous), frigid	Ustic Torriorthents	Entisols.
Lap	Loamy-skeletal, carbonatic	Lithic Calciborolls	Mollisols.
Larim	Loamy-skeletal, mixed, mesic	Ustollic Haplargids	Aridisols.
Lisam	Clayey, montmorillonitic, nonacid, frigid, shallow	Ustic Torriorthents	Entisols.
Lismas	Clayey, montmorillonitic (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Lohler	Fine, montmorillonitic (calcareous), frigid	Typic Ustifluvents	Entisols.
Macar	Fine-loamy, mixed, frigid	Typic Ustochrepts	Inceptisols.
Marias	Fine, montmorillonitic (calcareous), frigid	Ustertic Torriorthents	Entisols.
Martinsdale	Fine-loamy, mixed	Typic Argiborolls	Mollisols.
Maurice	Loamy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Mayflower	Fine, montmorillonitic	Argic Pachic Cryoborolls	Mollisols.
McRae	Fine-loamy, mixed, mesic	Ustollic Camborthids	Aridisols.
Midway	Clayey, montmorillonitic (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Nelson	Coarse-loamy, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Neville	Fine-loamy, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Nihill	Loamy-skeletal, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Nunn	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Olney	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.
Peritsa	Fine-silty, mixed	Typic Haploborolls	Mollisols.
Razor	Fine, montmorillonitic, mesic	Ustollic Camborthids	Aridisols.
Redlodge	Fine, mixed	Cumulic Cryaquolls	Mollisols.
Reeder	Fine-loamy, mixed	Typic Argiborolls	Mollisols.
Rentsac	Loamy-skeletal, mixed (calcareous), frigid	Lithic Ustic Torriorthents	Entisols.
Romberg	Loamy-skeletal, mixed, mesic	Ustollic Haplargids	Aridisols.
Rottulee	Fine-loamy, mixed	Typic Haploborolls	Mollisols.
Ryorp	Coarse-loamy, mixed	Typic Cryochrepts	Inceptisols.
Sebud	Loamy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Shane	Very fine, montmorillonitic	Abruptic Argiborolls	Mollisols.
Sicklesteets	Fine, mixed	Typic Cryoborolls	Alfisols.
Sinnigam	Clayey-skeletal, mixed	Lithic Argiborolls	Mollisols.
Spearfish	Loamy, mixed (calcareous), mesic, shallow	Ustic Torriorthents	Entisols.
Stormitt	Loamy-skeletal, carbonatic, mesic	Ustollic Calciorthids	Aridisols.
Stutzman	Fine, montmorillonitic (calcareous), mesic	Typic Torriorthents	Entisols.
Tarrete	Very fine, mixed	Vertic Cryoborolls	Mollisols.
Tarrete <sup>2</sup>	Very fine, mixed	Argic Cryoborolls	Mollisols.
Teton	Fine-loamy, mixed	Typic Cryoborolls	Mollisols.
Thedalund	Fine-loamy, mixed (calcareous), mesic	Ustic Torriorthents	Entisols.
Thiel	Loamy-skeletal, mixed	Argic Cryoborolls	Mollisols.
Thurlow	Fine, montmorillonitic, mesic	Ustollic Haplargids	Aridisols.
Tiban	Loamy-skeletal, mixed	Typic Cryoborolls	Mollisols.
Toluca	Fine-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.
Tonra	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Ustollic Calciorthids	Aridisols.
Torchlight	Fine, montmorillonitic (calcareous), mesic	Vertic Torriorthents	Entisols.
Trapper	Fine-loamy, mixed	Typic Cryoborolls	Alfisols.
Travessilla	Loamy, mixed (calcareous), mesic	Lithic Ustic Torriorthents	Entisols.
Twin Creek	Fine-loamy, mixed	Typic Haploborolls	Mollisols.
Vona	Coarse-loamy, mixed, mesic	Ustollic Haplargids	Aridisols.

See footnotes at end of table.

TABLE 6.—Soil series classified according to the current system of classification—Continued

Series	Family	Suborder	Order
Wayden.....	Clayey, montmorillonitic (calcareous), frigid, shallow.....	Typic Ustorthents.....	Entisols.
Windham.....	Loamy-skeletal, carbonatic.....	Typic Calciborolls.....	Mollisols.
Woodrock.....	Fine-loamy, mixed.....	Typic Cryoborolls.....	Alfisols.
Work.....	Fine, montmorillonitic.....	Typic Argiborolls.....	Mollisols.
Wormser.....	Fine, montmorillonitic, mesic.....	Aridic Argiustolls.....	Mollisols.
Yegen.....	Fine-loamy, mixed.....	Typic Argiborolls.....	Mollisols.

<sup>1</sup> The Duncom soils in this survey area are taxadjuncts to the Duncom series. They contain more coarse fragments than is defined as the range for the series.

<sup>2</sup> The Tarrete soils in this survey area are taxadjuncts to the Tarrete series. The classification shown is that of the taxadjunct, not of the series.

**Order.**—Ten soil orders are recognized. The differentiae for the orders are based on the kind and degree of the dominant sets of soil forming processes that have gone on. Each order is named with a word of three or four syllables ending in *sol*. An example is Mollisol.

**Suborder.**—Each order is divided into suborders that are based primarily on properties that influence soil genesis and that are important to plant growth, or were selected to reflect what seemed to be the most important variables within the orders. The names of suborders have exactly two syllables. The last syllable indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

**Great group.**—Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons, soil moisture and temperature regimes, and in base status. The names of great groups have three or four syllables and end with the name of a suborder. A prefix added to the name suggests something about the properties of the soil. An example is Cryaquoll (*Cry*, meaning cold, plus *aquoll*, the suborder of Mollisols that have an aquic moisture regime).

**Subgroup.**—Each great group is divided into three kinds of subgroups: The central (typic) concept of the great groups (not necessarily the most extensive subgroup); the intergrades, or transitional forms to other orders, suborders, or great groups; and extragrade subgroups that have some properties that are representative of the great groups but that do not indicate transitions to any other known kind of soil. The names of subgroups are derived by placing one or more adjectives before the name of the great group. The adjective Typic is used for the subgroup that is thought to typify the great group. An example is Typic Cryaquolls.

**Family.**—Families are established within each subgroup, primarily on the basis of properties important to the growth of plants or properties significant in engineering. Among the properties considered are particle-size distribution, mineral content, reaction, soil temperature, thickness of horizons, consistence, permeability, and slope. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for particle size, mineral content, reaction, and so on, that are used as family differentiae. An example is Type Ustorthents—loamy, mixed (calcareous), frigid, shallow.

**Series.**—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and arrangement in the profile. A series is given the name of a geographic location near the place where that series was first observed and mapped. (See the section "How This Survey Was Made.")

## General Nature of the Area

Carbon County was created March 4, 1895, from parts of Park and Yellowstone Counties. Red Lodge became the county seat in a general election of 1896. The survey area consists of that part of Carbon County north and east of the Beartooth Mountains. It has a land area of 1,675 square miles and a population of 8,317. About 3,525 live on farms, and 4,795 live in towns or villages. The population ranges from 15 to 452 persons in the smaller communities to 824 in Bridger and 2,278 in Red Lodge.

Coal mining in the Area began in 1877 near Red Lodge and Bear Creek and ended with the use of diesel and electric trains. Numerous small communities sprang up around the coal mines and near the more fertile soils in the valleys. Coal was the major source of income until 1957 when the coal mines closed.

Between 1900 and 1915, oil was discovered in Elk Basin and Dry Creek. Numerous pipelines cross the county delivering oil and gas chiefly to foundries outside the Area and to the various communities in the Area.

Stock raising became a major enterprise in the early 1900's. Cash crops were raised mainly to supplement income from livestock. Since the closing of the coal mines, livestock raising and cash crops have become major sources of income in the Area.

Small communities were settled throughout the Clarks Fork Valley and Rock Creek and Rosebud Valleys. The area is served by a railroad, two major highways, and two secondary highways. The highways are all weather roads. Billings, a major shipping and industrial area, is about a 1½-hour drive from the Area.

In summer, numerous recreational facilities are available, mainly dude ranches, fishing and boating areas, and mountain retreats. Yellowstone National Park is about a 2-hour drive from the Area. Areas for winter sports, such

as skiing, ice fishing, skating, and snowmobile and cutter racing, are numerous.

Farming is the most important source of income to the residents of the survey area. Livestock production, once the dominant farming activity, is still carried on to a great extent. The trend is toward smaller farms, however, and diversified farming has gained in importance as irrigation projects have developed.

### Climate <sup>4</sup>

The Carbon County Area has a continental climate, modified by the pattern and contours of the mountains,

<sup>4</sup> Prepared by GRAYSON V. CORDELL, JR., climatologist for Montana, National Weather Service, U.S. Department of Commerce, Helena.

valleys, and plains. Elevation and the direction of slopes affect both precipitation and temperature. Tables 7, 8, and 9 show temperature and precipitation data, average monthly and annual amounts of snowfall at several weather stations, and the probabilities of freezing temperatures on specified dates.

Precipitation varies, particularly across the mountainous parts of the county. Annual averages range from a maximum of about 70 inches near the headwaters of the East Rosebud and Clarks Fork Rivers to less than 6 inches along the Clarks Fork south-southwest of Belfry. Only about 30 miles separate these two areas. The Belfry section of the Clarks Fork Valley, in the "rain shadow" of the very high mountains, is probably the driest section of Montana. Northward from the mountains precipitation also decreases to less than 14 inches near the Yellowstone River.

TABLE 7.—Temperature and precipitation data

Bridger, 1942-1969; elevation 3,680 feet

Month	Temperature					Precipitation							
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average monthly total	1 year in 10 will have—		2 years in 10 will have—		3 years in 10 will have—		4 years in 10 will have—	
						Less than—	More than—	Less than—	More than—	Less than—	More than—	Less than—	More than—
	<i>F.</i>	<i>F.</i>	<i>F.</i>	<i>F.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
January	34	11	54	-15	0.5	0.1	1.1	0.3	0.8	0.3	0.5	0.4	0.4
February	41	17	60	-7	.3	.1	.6	.2	.5	.2	.4	.2	.4
March	47	21	69	-3	.6	.3	1.2	.3	.9	.4	.8	.4	.6
April	61	32	79	17	1.4	.2	2.8	.5	2.1	.8	1.7	1.0	1.3
May	70	41	87	28	1.7	.6	2.6	1.0	2.5	1.1	1.9	1.4	1.8
June	77	48	94	36	2.3	.5	5.1	.8	3.5	1.4	2.7	1.7	2.3
July	88	53	99	43	.6	.2	1.5	.2	1.1	.4	.9	.5	.6
August	87	51	98	40	.8	.1	2.2	.2	1.4	.4	1.0	.4	.8
September	75	43	92	30	1.2	.2	2.6	.5	1.7	.6	1.4	.8	1.2
October	65	35	82	20	.8	.2	2.0	.2	1.3	.3	1.0	.5	.8
November	47	25	66	2	.6	.1	1.2	.3	1.0	.4	.7	.4	.6
December	39	17	57	-8	.4	.1	.8	.2	.5	.3	.5	.4	.4
Year	61	33	<sup>1</sup> 100	<sup>2</sup> -21	11.2	7.5	15.8	8.9	14.1	9.7	12.5	10.1	12.0

Red Lodge, 1940-1969; elevation 5,575 feet

January	33	11	53	-15	1.2	0.2	3.0	0.6	1.8	0.7	1.5	0.8	1.0
February	36	14	55	-9	1.0	.3	2.1	.6	1.7	.6	.9	.7	.7
March	40	17	60	-7	1.9	.8	3.2	1.1	2.8	1.4	2.2	1.6	1.6
April	51	28	70	11	3.4	1.0	6.5	1.6	5.1	2.1	4.8	2.5	4.6
May	61	37	78	23	3.3	1.6	5.9	1.9	3.9	2.7	3.9	3.0	3.3
June	67	43	84	32	3.5	1.1	6.8	1.6	5.5	2.0	4.5	2.8	3.7
July	79	50	90	38	1.3	.4	3.4	.6	1.7	.7	1.5	.9	1.1
August	77	49	90	36	1.2	.4	2.0	.6	1.9	.8	1.4	1.0	1.3
September	66	41	84	26	2.2	.7	4.5	1.0	2.7	1.4	2.4	1.7	2.3
October	57	33	75	17	1.3	.3	2.8	.4	2.1	.6	1.8	1.2	1.4
November	43	22	61	0	1.6	.2	2.7	.6	2.3	.9	2.0	1.2	1.8
December	37	16	55	-7	.9	.3	1.5	.5	1.2	.6	1.1	.8	.9
Year	54	30	<sup>1</sup> 92	<sup>2</sup> -23	22.8	17.8	27.8	19.4	26.4	20.0	24.0	21.7	23.9

<sup>1</sup> Average annual highest temperature.

<sup>2</sup> Average annual lowest temperature.

TABLE 8.—Average monthly and annual snowfall

Station	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
Bridger.....	7	5	7	5	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	1	2	4	6	37
Edgar (9 SE)....	10	9	14	14	4	1	( <sup>1</sup> )	( <sup>1</sup> )	1	6	10	10	79
Joliet.....	10	7	10	8	1	( <sup>1</sup> )	0	( <sup>1</sup> )	( <sup>1</sup> )	2	7	9	54
Red Lodge.....	17	13	22	22	5	1	0	0	3	7	15	14	119

<sup>1</sup> Trace.

TABLE 9.—Probability of last freezing temperatures in spring and first in fall

Station	Probability	Dates for given probability and temperature		
		24° F. or lower	28° F. or lower	32° F. or lower
Bridger.....	<i>Spring:</i> 1 year in 10 later than.....	May 3	May 17	June 6
Red Lodge.....	1 year in 10 later than.....	May 20	June 1	June 22
Bridger.....	2 years in 10 later than.....	April 27	May 11	May 31
Red Lodge.....	2 years in 10 later than.....	May 14	May 26	June 16
Bridger.....	5 years in 10 later than.....	April 16	April 30	May 20
Red Lodge.....	5 years in 10 later than.....	May 3	May 15	June 5
Bridger.....	<i>Fall:</i> 1 year in 10 earlier than.....	October 2	September 14	September 7
Red Lodge.....	1 year in 10 earlier than.....	September 22	September 11	September 2
Bridger.....	2 years in 10 earlier than.....	October 7	September 20	September 12
Red Lodge.....	2 years in 10 earlier than.....	September 27	September 16	September 7
Bridger.....	5 years in 10 earlier than.....	October 18	October 1	September 23
Red Lodge.....	5 years in 10 earlier than.....	October 7	September 26	September 17

During the cold season nearly all precipitation falls as snow. At the lower elevations snow seldom remains on the ground long, but in the mountains and foothills it begins accumulating in November in most years and reaches its greatest depth and water content in April or early May. The melting of these mountain snowpacks in spring and early in summer contributes to the stable and usually plentiful runoff in most years in the survey area and in the other parts of the Northern Rocky Mountain country. This runoff assures a plentiful supply of water along all principal drainageways in midsummer when water needs are greatest. Occasionally, heavy rains late in May or June coincide with periods of peak runoff, and about 1 year in 10 this combination causes some stream overflow.

Steady rains can occur in any year during the April to June period, but precipitation in summer is almost always showery. Cold season snows tend to be heaviest late in fall or early in spring. For example, the heaviest snowfall at Red Lodge occurs in March and April. Average annual snowfall in the mountains is estimated at several hundred inches. It decreases to less than 50 inches a year in the lower northern parts of the survey area. About the first of May at the higher elevations, the average depth of snow is 150 inches.

The range in temperature across the Carbon County Area is fairly large. Average temperature in the moun-

tain country southwest of Red Lodge is probably less than 40° F. Along the Yellowstone River, it reaches about 47°. Summertime warmth is fairly steady and seldom reaches an oppressive level. At Red Lodge, for example, in a sample 30-year period, the temperature rose to 90° or higher on an average of only 3 days per year, but at lower elevations the average was as much as 20 to 25 days. Also at Red Lodge, during the same 30 years, the temperature dropped to zero or lower on an average of only 26 days a year. The frost-free season at Red Lodge is about 104 days, from June 5 to September 17, but along the Yellowstone River, it can extend to 130 days. For hardier crops that can withstand a temperature as low as 24° for short periods, the growing season is as long as 180 days in the more favorable locations. At Bridger, for example, the last occurrence of 32°, or lower, in spring can be expected June 6 or later and the first in fall on September 7 or earlier, 1 year in 10.

Much of the area is favorably situated and affected by the chinook winds of the Northern Rockies. When this wind develops following a winter cold spell, the temperature can rise to as much as 40° to 50° F. in less than a day. An invasion of extremely cold Arctic air seldom lasts more than 3 days. In some of the mountain valleys, chinook winds develop considerable force, and occasionally gusts stronger than 75 miles per hour occur in

local, more exposed areas. Although severe storms are not common, hailstorms, high winds, heavy snows, freezing rain and sleet, and small tornadoes have been observed at intervals of several years somewhere in the Carbon County Area. Hail of damaging strength or size occurs about 1 year in 10 at lower elevations.

### Transportation and Recreational Facilities

The survey area has a good system of roads. It is traversed by State and Federal Highways Nos. 212, 310, and 397 between Laurel, Montana, and towns in Wyoming to the south. Railway service is available from Laurel, Montana, across the Area and south to Lovell, Wyoming. A branch line terminates at Red Lodge, Montana. Two airports in the survey area, one at Bridger and one at Red Lodge, accommodate small aircraft. Bus service is available to all towns in the Area.

The survey area provides a wide range of recreational facilities for fishing, hunting, boating, skiing, and other summer and winter sports. The scenic Beartooth Highway to Yellowstone Park crosses the Area and provides access to facilities for tourists who enjoy summer camping and outdoor living. Camping facilities are excellent throughout the Carbon County Area. Most of the outdoor recreation is in the timbered, mountainous part.

### Relief and Geology

The Carbon County Area has a land area of 1,072,247 acres, or about 1,675 square miles. Elevations range from 3,300 feet to more than 10,000 feet.

The major streams are the Clarks Fork of the Yellowstone River, which enters the Area from Wyoming on the south and flows in a northerly direction to the Yellowstone. Rock Creek originates in the Beartooth Mountains to the southwest of the area and flows in a northerly direction to Clarks Fork. Rosebud Creek drains the western part and flows in a northerly direction to the Yellowstone River.

Exposures of late Paleozoic and Mesozoic Formations in the survey area form a semicircle around the Beartooth Mountains and the Pryor Mountains. These formations outcrop in a series of steep scarps facing the valleys, which are eroding into the shale at the foot of the scarps.

The bottoms in stream valleys are deep alluvium, nearly level to strongly sloping, and one-quarter mile to 3 miles wide. They cross the survey area in a north-easterly direction.

The uplands east of Rock Creek consist of steep slopes, smooth anticlines of medium length, and tabular divides. To the west of Rock Creek is a series of glaciated terraces and moraines that give way to smooth, rounded, steep hills and narrow divides. The drainage pattern is dendritic. Clarks Fork, Rock Creek, and Rosebud Creek are the main trunk streams.

The 16 major geologic formations in the Carbon County Area are Madison Limestone, Amsden Formation, Tensleep Sandstone, Embar Limestone, Chugwater Formation, Sundance Formation, Morrison Formation, Cloverly Formation, Colorado Shale, Mowry Shale, Frontier Formation, Carlile Formation, Niobrara Shale, Claggett Formation, Bearpaw Shale, Eagle Sandstone,

and Lennep Sandstone. Some local glaciation has occurred in the Beartooth Mountains in the southwest corner. The sediment deposited in the valleys is the source material for the soils that make up the larger irrigated acreages.

### Natural Resources

The most valuable natural resources in the survey area are soil, water, minerals, and timber. The production of cash crops and livestock make soil the major and most extensive natural resource. Water is very important to the Carbon County Area for growing irrigated crops. It also offers excellent recreational facilities and is vital to the livestock enterprise. Oil and natural gas are major natural resources. Oil for refining is a major source of income. Coal is abundant in the Carbon County Area, but the need for coal is limited. Most homes of the Area are heated by gas, oil, or coal. Lumbering is a small enterprise because the timberland is so steep.

### Literature Cited

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- (2) SIMONSON, ROY W. 1962. SOIL CLASSIFICATION IN THE UNITED STATES. Sci. 137: 1,027-1,034, illus.
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### Glossary

**Alkali soil.** Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

**Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

**Available water capacity** (also termed 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 capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The terms and inches of water recognized in this survey are as follows:

	<i>Inches per inch of soil</i>
Very low -----	less than 3
Low -----	3-6
Moderate -----	6-9
High -----	less than 9

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

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

**Clay film.** A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

*Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

*Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

*Sticky.*—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

*Hard.*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

*Soft.*—When dry, breaks into powder or individual grains under very slight pressure.

*Cemented.*—Hard and brittle; little affected by moistening.

**Depth, soil.** Depth to a layer that restricts movement of water and roots. Depth classes recognized in this survey are:

	<i>Inches</i>
Shallow -----	less than 20
Moderately deep-----	20-40
Deep -----	less than 40

**Flood plain.** Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

*O horizon.*—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

*A horizon.*—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

*C horizon.*—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

*R layer.*—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

**Permeability.** The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid.*

**pH value.** A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

**Reaction, soil.** The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	<i>pH</i>		<i>pH</i>
Extremely acid---	Below 4.5	Neutral -----	6.6 to 7.3
Very strongly acid--	4.5 to 5.0	Mildly alkaline-----	7.4 to 7.8
Strongly acid-----	5.1 to 5.5	Moderately alkaline--	7.9 to 8.4
Medium acid-----	5.6 to 6.0	Strongly alkaline----	8.5 to 9.0
Slightly acid-----	6.1 to 6.5	Very strongly alkaline -----	9.1 and higher

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Saline soil.** A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

**Sand.** Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.00 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

**Silt.** Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

**Slope class.** The slope classes used in this survey are as follows:

	<i>Percent</i>
Nearly level-----	0-2
Gently sloping (undulating)-----	2-8
Strongly sloping (sloping or rolling)-----	8-15
Moderately steep (hilly)-----	15-25
Steep -----	25-45
Very steep-----	less than 45

**Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

**Terrace (geological).** An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Topsoil.** A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

**Upland (geology).** Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. All windbreak groups are described on pages 114 and 115. Other information is given in tables as follows:

Acreage and extent, table 1, page 5.  
 Engineering uses of the soils, table 2,  
 page 56, and table 3, page 66.

Soil limitations for community facilities,  
 table 4, page 92.  
 Estimated yields, table 5, page 122.

Map symbol	Mapping unit	Page	Capability unit		Range site	Page	Name	Page	Windbreak group
			Irrigated	Dryland					
AA	Abac-Twin Creek complex, steep-----	7	-----	-----	VIe-1	121	-----	-----	---
	Abac part-----	--	-----	-----	-----	-----	Shallow, 15 to 19 inches precipitation	129	3
	Twin Creek part-----	--	-----	-----	-----	-----	Silty, 15 to 19 inches precipitation	126	1
AB	Abac-Windham association, steep-----	7	-----	-----	VIe-1	121	-----	-----	---
	Abac part-----	--	-----	-----	-----	-----	Shallow, 15 to 19 inches precipitation	129	3
	Windham part-----	--	-----	-----	-----	-----	Silty, 15 to 19 inches precipitation	126	1
Ac	Absarokee clay loam, 2 to 4 percent slopes-----	8	-----	-----	IIE-2	117	Clayey, 15 to 19 inches precipitation	127	2
Ad	Absarokee clay loam, 4 to 8 percent slopes-----	8	-----	-----	IIIe-2	117	Clayey, 15 to 19 inches precipitation	127	2
Ae	Absarokee clay loam, 8 to 15 percent slopes-----	8	-----	-----	IVe-2	117	Clayey, 15 to 19 inches precipitation	127	2
Af	Absarokee-Cabba clay loams, 4 to 8 percent slopes-----	8	-----	-----	IIIe-2	118	-----	-----	---
	Absarokee part-----	--	-----	-----	-----	-----	Clayey, 15 to 19 inches precipitation	127	2
	Cabba part-----	--	-----	-----	-----	-----	Shallow, 15 to 19 inches precipitation	129	3
Ag	Absarokee-Cabba clay loams, 8 to 15 percent slopes-----	8	-----	-----	IVe-2	120	-----	-----	---
	Absarokee part-----	--	-----	-----	-----	-----	Clayey, 15 to 19 inches precipitation	127	2
	Cabba part-----	--	-----	-----	-----	-----	Shallow, 15 to 19 inches precipitation	129	3
Ah	Absarokee-Shane clay loams, 6 to 15 percent slopes-----	8	-----	-----	IVe-2	120	Clayey, 15 to 19 inches precipitation	127	2
Ak	Absarokee-Sinnigam clay loams, 4 to 8 percent slopes-----	9	-----	-----	IIIe-2	118	-----	-----	---
	Absarokee part-----	--	-----	-----	-----	-----	Clayey, 15 to 19 inches precipitation	127	2
	Sinnigam part-----	--	-----	-----	-----	-----	Shallow, 15 to 19 inches precipitation	129	3
Am	Absarokee-Sinnigam clay loams, 8 to 15 percent slopes-----	9	-----	-----	IVe-2	120	-----	-----	---
	Absarokee part-----	--	-----	-----	-----	-----	Clayey, 15 to 19 inches precipitation	127	2
	Sinnigam part-----	--	-----	-----	-----	-----	Shallow, 15 to 19 inches precipitation	129	3
An	Adel silty clay loam, 0 to 4 percent slopes-----	9	IVe-3	120	IVe-5	120	Clayey, 15 to 19 inches precipitation	127	6

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site	Name	Page	Windbreak group	
			Irrigated	Dryland					
Ao	Adel silty clay loam, 4 to 8 percent slopes-----	9	IVe-3	120	IVe-5	120	Clayey, 15 to 19 inches precipitation	127	6
Ar	Alice fine sandy loam, 0 to 8 percent slopes-----	10	-----	----	IVe-2	120	Sandy, 15 to 19 inches precipitation	125	5
As	Alice fine sandy loam, 8 to 15 percent slopes-----	10	-----	----	IVe-2	120	Sandy, 15 to 19 inches precipitation	125	5
At	Allentine clay loam, 2 to 4 percent slopes-----	10	-----	----	VIIs-1	121	Dense Clay, 10 to 14 inches precipitation	129	11
Au	Alluvial land-----	10	-----	----	VIIs-1	121	Shallow to Gravel, 15 to 19 inches precipitation	128	9
Bb	Bowbac loam, 2 to 4 percent slopes-----	12	-----	----	VIe-1	121	Silty, 5 to 9 inches precipitation	125	2
Bc	Bowbac loam, 4 to 8 percent slopes-----	12	-----	----	VIe-1	121	Silty, 5 to 9 inches precipitation	125	2
Bd	Bowbac loam, 8 to 15 percent slopes-----	12	-----	----	VIe-1	121	Silty, 5 to 9 inches precipitation	125	2
Bh	Bowbac-Harvey loams, 2 to 4 percent slopes-----	12	-----	----	VIe-1	121	-----	----	----
	Bowbac part-----	--	-----	----	-----	----	Silty, 5 to 9 inches precipitation	125	2
	Harvey part-----	--	-----	----	-----	----	Limy, 5 to 9 inches precipitation	128	7
Bm	Bowbac-Travessilla complex, 4 to 8 percent slopes-----	12	-----	----	VIIs-1	121	-----	----	----
	Bowbac part-----	--	-----	----	-----	----	Silty, 5 to 9 inches precipitation	125	2
	Travessilla part-----	--	-----	----	-----	----	Shallow, 10 to 14 inches precipitation	129	3
BT	Bowbac-Torchlight association, undulating-----	12	-----	----	VIIs-1	121	-----	----	----
	Bowbac part-----	--	-----	----	-----	----	Silty, 5 to 9 inches precipitation	125	2
	Torchlight part-----	--	-----	----	-----	----	Dense Clay, 5 to 9 inches precipitation	129	11
CA	Cabba-Rentsac complex, rolling-----	13	-----	----	VIIs-1	121	Shallow, 15 to 19 inches precipitation	129	3
Cb	Charlos loam, 0 to 2 percent slopes-----	14	IIIIs-3	119	IIIIs-2	119	Silty, 15 to 19 inches precipitation	126	1
Cc	Charlos loam, 2 to 8 percent slopes-----	14	IIIe-3	118	IIIe-2	118	Silty, 15 to 19 inches precipitation	126	1
Cd	Charlos loam, wet, 0 to 2 percent slopes-----	14	IIIw-1	118	-----	----	-----	----	9
Ce	Charlos stony loam, 0 to 4 percent slopes-----	14	-----	----	IIIIs-2	119	Silty, 15 to 19 inches precipitation	126	1
Cf	Colby silt loam, 2 to 4 percent slopes-----	15	IIe-1	116	IVe-6	120	Silty, 5 to 9 inches precipitation	125	1

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site	Name	Page	Windbreak group	
			Irrigated	Dryland					
Cg	Colby silt loam, 4 to 8 percent slopes-----	15	IIIe-1	117	IVe-6	120	Silty, 5 to 9 inches precipitation	125	1
Ch	Colby silt loam, 8 to 15 percent slopes-----	15	IVe-1	119	IVe-6	120	Silty, 5 to 9 inches precipitation	125	1
DG	Duncom gravelly silt loam, hilly-----	15	-----	----	VIIs-1	121	Shallow, 15 to 19 inches precipitation	129	3
DH	Duncom-Hanson association, rolling-----	15	-----	----	VIIs-1	121	-----	----	----
	Duncom part-----	--	-----	----	-----	----	Shallow, 15 to 19 inches precipitation	129	3
	Hanson part-----	--	-----	----	-----	----	Silty, 15 to 19 inches precipitation	126	8
Fc	Fort Collins loam, 0 to 2 percent slopes-----	16	I-1	116	-----	----	-----	----	1
Fd	Fort Collins loam, 2 to 4 percent slopes-----	16	IIe-1	116	-----	----	-----	----	1
Fe	Fort Collins loam, wet, 0 to 2 percent slopes-----	16	IIw-1	117	-----	----	Subirrigated, 20 to 24 inches precipitation	124	9
Gb	Glenberg loam, gravel substratum-----	17	IIIs-1	117	-----	----	-----	----	1
Gh	Glenberg-Haverson complex-----	16	-----	----	IIIe-4	118	Silty, 10 to 14 inches precipitation	126	1
la	Hanson clay loam, 4 to 8 percent slopes-----	17	-----	----	IIIe-2	118	Clayey, 15 to 19 inches precipitation	127	1
HB	Hanson very stony loam, rolling-----	17	-----	----	VIIs-1	121	Clayey, 15 to 19 inches precipitation	127	8
HC	Hanson extremely stony loam, sloping-----	17	-----	----	VIIIs-1	121	Stony, 15 to 19 inches precipitation	127	8
HD	Hanson association, very steep-----	17	-----	----	VIIe-1	121	Clayey, 15 to 19 inches precipitation	127	8
HE	Hanson-Duncom association, rolling-----	18	-----	----	VIIIs-1	121	-----	----	----
	Hanson part-----	--	-----	----	-----	----	Stony, 15 to 19 inches precipitation	127	8
	Duncom part-----	--	-----	----	-----	----	Shallow, 15 to 19 inches precipitation	129	3
Hf	Harvey loam, 2 to 4 percent slopes-----	19	-----	----	IIIe-4	118	Limy, 10 to 14 inches precipitation	128	7
Hg	Harvey loam, 4 to 8 percent slopes-----	19	-----	----	IIIe-4	118	Limy, 10 to 14 inches precipitation	128	7
Hh	Harvey loam, 8 to 15 percent slopes-----	19	-----	----	IVe-4	120	Limy, 10 to 14 inches precipitation	128	7
Hk	Harvey stony loam, 2 to 8 percent slopes-----	19	-----	----	IIIe-4	118	Limy, 10 to 14 inches precipitation	128	7
Hm	Haverson silty clay loam, 0 to 2 percent slopes-----	20	I-1	116	-----	----	-----	----	1

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak group		
			Irrigated	Dryland					
			Symbol	Page	Symbol	Page	Name	Page	Number
SB	Sebud very bouldery loam, steep-----	39	-----	----	VIIIs-1	121	Stony, 15 to 19 inches precipitation	127	8
SC	Shale outcrop-----	39	-----	----	VIIIIs-1	121	-----	----	---
SD	Shale outcrop-Abac complex, very steep-----	39	-----	----	VIIe-1	121	-----	----	---
	Shale outcrop part-----	--	-----	----			-----	----	---
	Abac part-----	--	-----	----			Shallow, 10 to 14 inches precipitation	129	3
Se	Shane clay loam, 4 to 8 percent slopes-----	40	-----	----	IIIe-2	118	Clayey, 15 to 19 inches precipitation	127	2
Sf	Shane clay loam, 8 to 15 percent slopes-----	40	-----	----	IVe-2	120	Clayey, 15 to 19 inches precipitation	127	2
Sg	Shane-Cabba clay loams, 4 to 8 percent slopes-----	40	-----	----	IIIe-2	118	-----	----	---
	Shane part-----	--	-----	----			Clayey, 15 to 19 inches precipitation	127	2
	Cabba part-----	--	-----	----			Shallow, 15 to 19 inches precipitation	129	3
Sh	Shane-Cabba clay loams, 8 to 15 percent slopes-----	40	-----	----	IVe-2	120	-----	----	---
	Shane part-----	--	-----	----			Clayey, 15 to 19 inches precipitation	127	2
	Cabba part-----	--	-----	----			Shallow, 15 to 19 inches precipitation	129	3
SK	Sicklesteets loam, moderately steep-----	40	-----	----	VIe-1	121	-----	----	---
SM	Sinnigam channery clay loam, sloping-----	41	-----	----	VIIs-1	121	Shallow, 15 to 19 inches precipitation	129	3
SN	Sinnigam channery clay loam, moderately steep-----	41	-----	----	VIe-1	121	Shallow, 15 to 19 inches precipitation	129	3
SO	Spearfish-Shale outcrop complex, hilly-----	41	-----	----	VIe-1	121	-----	----	---
	Spearfish part-----	--	-----	----			Shallow, 10 to 14 inches precipitation	129	3
	Shale outcrop part-----	--	-----	----			-----	----	---
Sp	Stormitt loam, 2 to 4 percent slopes-----	42	-----	----	IVe-7	121	Limy, 10 to 14 inches precipitation	128	7
Sr	Stormitt gravelly loam, 4 to 8 percent slopes-----	42	-----	----	IVe-7	121	Limy, 10 to 14 inches precipitation	128	7
Ss	Stormitt gravelly loam, saline, 0 to 4 percent slopes-----	42	-----	----	VIW-1	121	Saline Lowland, 10 to 14 inches precipitation	125	9
St	Stormitt stony loam, 0 to 8 percent slopes-----	42	-----	----	VIIs-1	121	Limy, 10 to 14 inches precipitation	128	7
SU	Stormitt stony loam, steep---	42	-----	----	VIe-1	121	Limy, 10 to 14 inches precipitation	128	7
SV	Stormitt complex, undulating-	42	-----	----	VIIIs-1	121	Stony, 10 to 14 inches precipitation	127	7

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak group		
			Irrigated	Dryland					
			Symbol	Page	Symbol	Page	Name	Page	Number
SW	Stutzman silty clay-----	43	IIs-2	117	-----	----	-----	----	1
TA	Tarrete loam, moderately steep-----	43	-----	----	VIe-1	121	Silty, 15 to 19 inches precipitation	126	6
TB	Tarrete clay, moderately steep-----	43	-----	----	VIe-1	121	Clayey, 15 to 19 inches precipitation	127	4
TC	Tarrete-Hanson association, steep-----	44	-----	----	VIe-1	121	Clayey, 15 to 19 inches precipitation	127	4
TD	Teton stony loam, moderately steep-----	45	-----	----	VIe-1	121	Silty, 15 to 19 inches precipitation	126	2
Te	Thedalund clay loam, 4 to 8 percent slopes-----	45	-----	----	IIIe-4	118	Clayey, 10 to 14 inches precipitation	126	2
Tf	Thedalund clay loam, 8 to 15 percent slopes-----	45	-----	----	IVe-4	120	Clayey, 10 to 14 inches precipitation	126	2
Tg	Thiel cobbly clay loam, 4 to 8 percent slopes-----	46	-----	----	VIIs-1	121	Silty, 15 to 19 inches precipitation	126	8
TH	Thiel-Bynum association, steep-----	46	-----	----	VIIe-1	121	Silty, 15 to 19 inches precipitation	126	3
Tk	Thurlow silty clay loam, 4 to 8 percent slopes-----	46	-----	----	IIIe-4	118	Clayey, 10 to 14 inches precipitation	126	1
Tl	Thurlow-Toluca silty clay loams, 4 to 8 percent slopes-----	46	-----	----	IIIe-4	118	Clayey, 10 to 14 inches precipitation	126	1
TM	Tiban extremely stony loam, moderately steep-----	47	-----	----	VIIIs-1	121	Stony, 15 to 19 inches precipitation	127	8
TN	Tiban-Tarrete association, steep-----	47	-----	----	VIIe-1	121	-----	----	----
	Tiban part-----	--	-----	----	-----	----	Stony, 15 to 19 inches precipitation	127	8
	Tarrete part-----	--	-----	----	-----	----	Clayey, 15 to 19 inches precipitation	127	4
To	Toluca clay loam, 0 to 2 percent slopes-----	48	I-1	116	IIIc-1	119	Clayey, 10 to 14 inches precipitation	126	1
Tp	Toluca clay loam, 2 to 4 percent slopes-----	48	IIe-1	116	IIIe-4	118	Clayey, 10 to 14 inches precipitation	126	1
Tr	Toluca clay loam, 4 to 8 percent slopes-----	48	IIIe-1	117	IIIe-4	118	Clayey, 10 to 14 inches precipitation	126	1
Ts	Toluca clay loam, 8 to 15 percent slopes-----	48	IVe-1	119	IVe-4	120	Clayey, 10 to 14 inches precipitation	126	1
TT	Toluca-Midway complex, moderately steep-----	48	-----	----	-----	----	-----	----	----
	Toluca part-----	--	-----	----	VIe-1	121	Clayey, 10 to 14 inches precipitation	126	1
	Midway part-----	--	-----	----	VIe-1	121	Shallow, 10 to 14 inches precipitation	129	3

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Range site		Windbreak group		
			Irrigated	Dryland					
			Symbol	Page	Symbol	Page	Name	Page	Number
TU	Toluca-Rock outcrop complex, sloping----- Toluca part-----	48	-----	----	VIIs-1	121	-----	-----	---
	Rock outcrop part-----	--	-----	----	-----	----	-----	-----	---
Tv	Tonra gravelly silty clay loam, 2 to 4 percent slopes-----	49	IIe-1	116	-----	----	-----	-----	7
TW	Torchlight clay, sloping----	49	-----	----	VIIs-1	121	Dense Clay, 5 to 9 inches precipitation	129	11
TX	Trapper soils, sloping-----	49	-----	----	VIe-1	121	Silty, 15 to 19 inches precipitation	126	6
TY	Travessilla silt loam, sloping-----	50	-----	----	VIIs-1	121	Shallow, 10 to 14 inches precipitation	129	3
Tz	Twin Creek silty clay loam, 4 to 8 percent slopes----	50	-----	----	IIIe-2	118	Clayey, 10 to 14 inches precipitation	126	1
Vn	Vona fine sandy loam, 0 to 2 percent slopes-----	51	IIIs-1	117	-----	----	-----	-----	5
Vo	Vona fine sandy loam, 2 to 4 percent slopes-----	51	IIe-1	116	-----	----	-----	-----	5
Vp	Vona fine sandy loam, 4 to 8 percent slopes-----	51	-----	----	IIIe-4	118	Sandy, 10 to 14 inches precipitation	125	5
Vr	Vona fine sandy loam, 8 to 15 percent slopes-----	51	-----	----	IVe-4	120	Sandy, 10 to 14 inches precipitation	125	5
Vs	Vona fine sandy loam, wet, 0 to 2 percent slopes----	51	IIw-1	117	-----	----	-----	-----	5
WA	Wayden-Cabba association, hilly-----	51	-----	----	VIe-1	121	Shallow, 15 to 19 inches precipitation	129	3
WC	Wayden-Cabba association, steep-----	52	-----	----	VIIe-1	121	Shallow, 15 to 19 inches precipitation	129	3
WD	Wayden-Castner association, steep-----	52	-----	----	VIe-1	121	Shallow, 15 to 19 inches precipitation	129	3
WE	Windham cobbly clay loam, sloping-----	52	-----	----	VIIs-1	121	Clayey, 15 to 19 inches precipitation	127	1
WH	Windham cobbly clay loam, steep-----	52	-----	----	VIe-1	121	Clayey, 15 to 19 inches precipitation	127	1
WK	Woodrock-Rock outcrop association, steep----- Woodrock part----- Rock outcrop part-----	53	-----	----	-----	----	-----	-----	---
		--	-----	----	VIIe-1	121	-----	-----	---
		--	-----	----	VIIIs-1	121	-----	-----	---
WN	Woodrock-Bynum association, hilly----- Woodrock part----- Bynum part-----	53	-----	----	-----	----	-----	-----	---
		--	-----	----	VIe-1	121	-----	-----	---
		--	-----	----	-----	----	Clayey, 15 to 19 inches precipitation	127	3
Wo	Work clay loam, 4 to 8 percent slopes-----	53	-----	----	IIIe-2	118	Clayey, 15 to 19 inches precipitation	127	1

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Symbol	Page	Name	Page	Number
			Irrigated	Dryland					
Wr	Wormser loam, 4 to 8 percent slopes-----	54	-----	----	IIIe-4	118	Silty, 10 to 14 inches precipitation	126	2
Ye	Yegen fine sandy loam, 2 to 4 percent slopes-----	54	IYe-1	116	-----	----	-----	----	5
Yf	Yegen fine sandy loam, 4 to 8 percent slopes-----	54	IIIe-1	117	-----	----	-----	----	5
Yg	Yegen fine sandy loam, 8 to 15 percent slopes-----	55	IVe-1	119	-----	----	-----	----	5

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