Series 1957, No. 22

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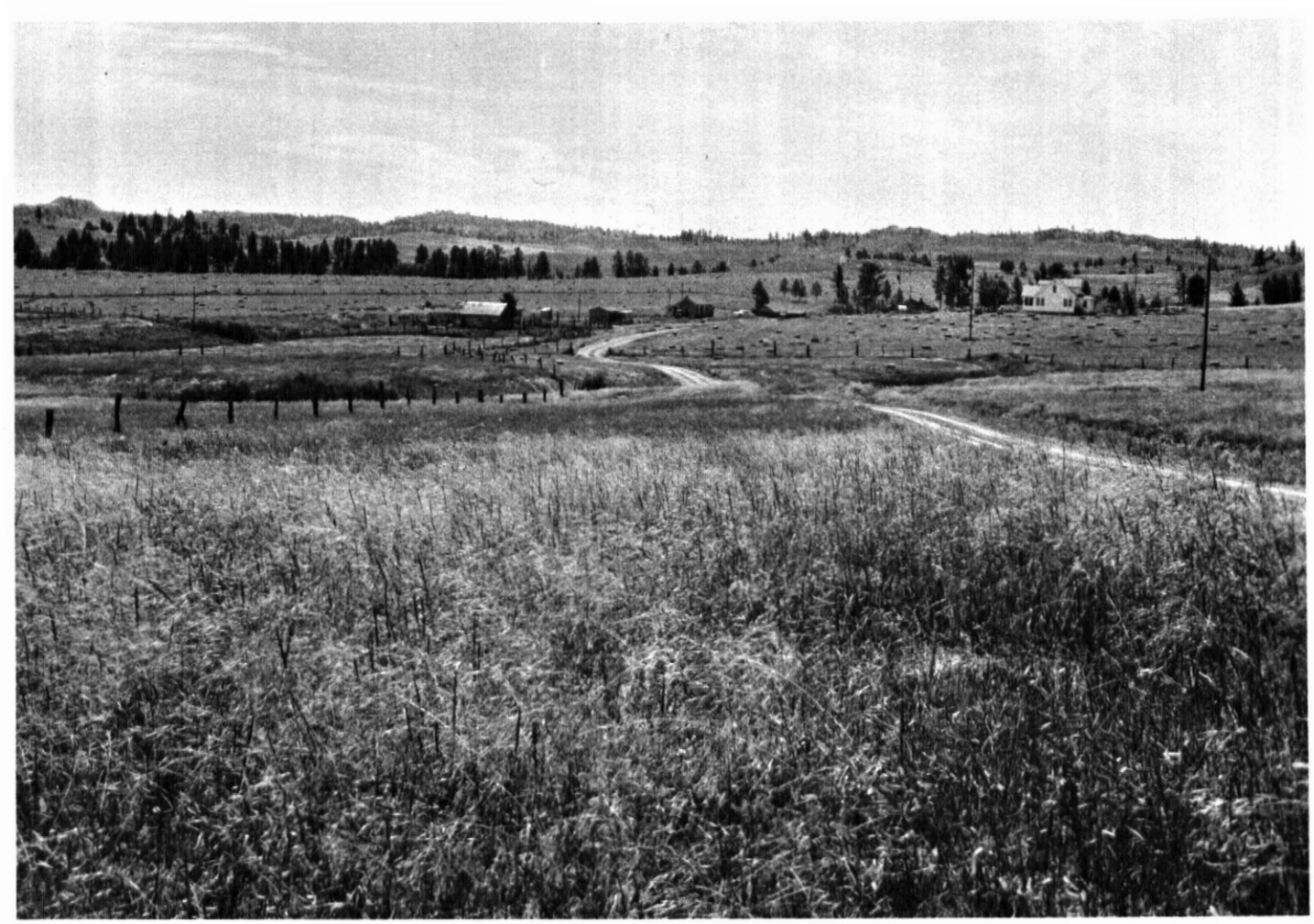
SOIL SURVEY

Treasure County Montana



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

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Treasure County contains information that can be applied in managing farms, ranches, and windbreaks; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

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

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. 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 in the report. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the capability unit, windbreak group, and range site in which the soil has been placed.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. 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 in the soil descriptions and in the discussions of the interpretative groupings.

Foresters and others can refer to the section "Windbreaks and Native Woodlands," where the soils of the county are grouped according to their suitability for planting trees in windbreaks.

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

Engineers and builders will find under "Engineering Properties and Uses of the Soils" tables that give engineering descriptions of the soils in the county and that name soil features affecting engineering practices and structures.

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

Students, teachers, and others will find information about soils and their management in various parts of the text.

Newcomers in Treasure County 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 "Additional Facts About the County."

* * * * *

Fieldwork for this survey was completed in 1957. Unless otherwise indicated, all statements in this report refer to conditions in the county at the time the survey was in progress. This survey of Treasure County was made as part of the technical assistance furnished by the Soil Conservation Service to the Treasure County Soil Conservation District.

Cover picture.—Bainville soils on gentle slopes, McRae soils in more nearly level areas, and Shale outcrop in background. Thin Breaks range site.

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SOIL SURVEY OF TREASURE COUNTY, MONTANA

BY RONALD L. MOSHIER AND ARMER G. FIELDER, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE MONTANA AGRICULTURAL EXPERIMENT STATION

TREASURE COUNTY is in the east-central part of Montana in the semiarid plains. Distance by air from Hysham, the county seat, to the principal cities in the western part of the State are shown in figure 1. The county covers an area of 629,760 acres, or 984 square miles, and is the fourth smallest county in the State. It is about 30 miles wide from east to west at its widest part and about 45 miles long from north to south. The county is agricultural. Raising livestock is the main enterprise, but growing irrigated crops and nonirrigated cereal grain is also important.

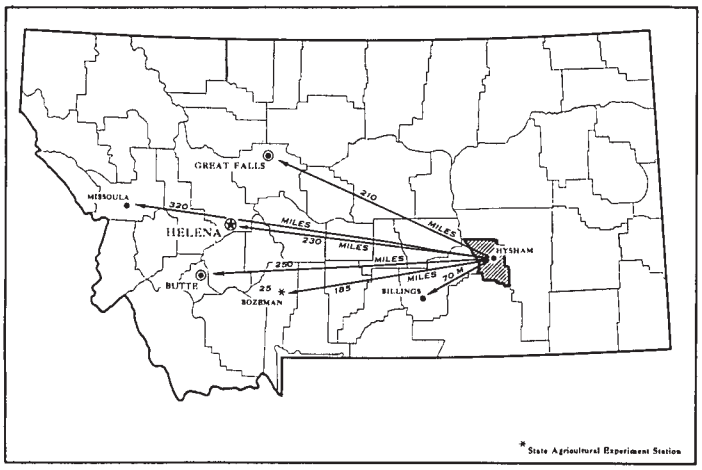

Figure 1.—**Location of Treasure County in Montana.**

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Treasure County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; 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 roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide uniform procedures. To use this report efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

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. Havre and Lohmiller, 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 go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Havre loam and Havre clay loam are two soil types in the Havre series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Bainville loam, 8 to 15 percent slopes, is one of several phases of Bainville loam, a soil type that ranges from rolling to steep.

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 greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. 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 type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed and so small in size that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Bainville-Midway complex, 8 to 15 percent slopes. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Riverwash or Shale outcrop, and are called land types rather than soils.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that makes it readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, and engineers. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. Based on the yield and practice tables and other data, the soil scientists set up trial groups, and test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists 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 present methods of use and management.

General Soil Map

In Treasure County there are differences in topography, kinds of plants, and other features that are obvious, and also differences in the patterns of soils that are less easily seen. By drawing lines around these patterns of soils, a general soil map of the area can be made. Each pattern is called a soil association. As a rule, each association contains a few major soils and several minor ones in a pattern that is characteristic but not strictly uniform. Because of the relief, the depth and nature of bedrock, and other features, the soils within any association are likely to differ greatly within short distances. Thus, a general soil map does not show the kind of soil at any particular place, but it shows patterns made up of soils of different kinds.

Soil associations are named for the major soil series in them, but soils of other series may occur in the association. Also, soils of a major series in one association may occur in any other association, but in a different pattern.

The general soil map is useful to those who want a general idea of the soils in a county or other large area, to those who want to make broad comparisons of the soils in different parts of the county, and to those who want to know the possible location of large areas of better soils that are suitable for cultivation or other use. The ten soil associations, or kinds of soil patterns in Treasure County, are shown on the colored map at the back of this report. These associations are in four kinds of broad landscapes: soils of irrigated bottom lands and terraces; soils of high terraces; soils of rolling to rough, broken uplands on soft shale; and soils of rolling to hilly uplands on clay shale.

Soils of Irrigated Bottom Lands and Terraces

The soils in the two soil associations on irrigated bottom lands and terraces formed in material deposited by the Bighorn and Yellowstone Rivers and by their tributaries. They are the principal irrigated soils in the county. The material deposited by the tributaries is in fans and is less variable in texture than that deposited by the rivers.

1. Havre-Lohmiller-Glendive association: Deep, light-colored loams, clay loams, and sandy loams on bottom lands and fans along the Bighorn and Yellowstone Rivers

The Havre soils, the most extensive in this association, are loams that are nearly level on bottom lands and gently sloping on some of the smaller fans. These soils make up 50 percent of the association and are in areas 5 to 200 acres in size.

The Lohmiller soils are clay loams that generally occur on the more nearly level slopes in areas 3 to 100 acres in size. These soils are also on some gently sloping fans. The largest areas of Lohmiller soils are on large fans near the town of Bighorn and at the mouth of Buckingham Coulee. These soils make up about 30 percent of the association.

The Glendive soils are sandy loams that occur in small, mainly brushy tracts along the Bighorn and Yellowstone Rivers. The areas generally are less than 20 acres in size. In most places slopes are less than 1 percent, but the small fans have slopes up to 2 percent. Glendive soils account for about 10 percent of the association.

The remaining 10 percent of the association is in Banks, Hysham, Laurel, Sage, Bowdoin, and Marias soils. The shallow Banks soils occur in brushy areas along the rivers. The Hysham soils have a small acreage and are strongly alkaline. Scattered throughout the association, in seeps 2 to 40 acres in size, are strongly saline Laurel and Sage soils. The largest single area of Laurel soils is just east of Hysham. In small, local areas are the Bowdoin soils and the saline-alkaline Marias soils.

This association makes up about 3 percent of the county. From 60 to 70 percent of the association is used for diversified cropping under irrigation, and additional areas could be irrigated. Still in native pasture are areas of the Havre, Lohmiller, Laurel, and Sage soils, as well as the brushy areas of the Glendive soils. Some of the most productive irrigated soils in the county are in this association. They are used for sugarbeets, corn, small grain, alfalfa, and other crops.

2. Nunn-Fort Collins-Cherry association: Deep, well-drained loams, clay loams, and clays on Hysham Bench and adjacent fans

The clayey Nunn soils are dominant in this soil association. They occur on the nearly level Hysham Bench and gently sloping adjacent fans. These soils make up about 35 percent of the association and occur in areas 10 to more than 300 acres in size.

The Fort Collins soils are loams. They occur on nearly level higher terraces along Sarpy Creek and in one large area just south of Hysham. Fort Collins soils make up less than 30 percent of this association.

The clayey Cherry soils occur mainly on nearly level or gently sloping fans just below Hysham Bench. Cherry soils make up about 20 percent of the association and are in areas of 10 to more than 50 acres.

The remaining 15 percent of the association consists of Marias, Havre, McRae, Beckton, Nunn, and Lohmiller soils. The Marias soils have a crusty surface and consist of saline-alkali clay. They occur just south and east of Hysham in an area of about 300 acres. The loamy Havre soils lie on nearly level, narrow bottom lands along Sarpy and Box Elder Creeks. The Havre soils occur also with the loamy McRae soils on gently sloping fans at the mouth of Box Elder Creek and on the fans just east of Myers. The clayey Beckton soils are inextensive in this association, and they occur only with the Nunn soils. The Lohmiller soils occur with Havre soils along the steep, eroded edges of Hysham Bench.

This association occupies about 1 percent of the county. Except for the steep edges of Hysham Bench, and for some of the steeper fans just below the main canal, the soils are used for irrigated crops. The main crops are sugarbeets, corn, small grain, and alfalfa. The steep edges of the bench are used for grazing. In this association are some of the most productive soils in the county.

Soils of High Terraces

The soils of the two soil associations on high terraces were formed in material deposited by wind and water. The wind-deposited material contains a high proportion of silt and very fine sand. This material was blown mainly from the outwash or from the weathered mantle of the surrounding soft shale. The water-laid material was deposited by a river that, at one time, flowed at the level of the high terraces, or this material was deposited as debris when the higher, older terraces were eroded. The depth to gravel varies.

3. Gilt Edge-Arvada association: Deep, well-drained soils with a claypan on nearly level high terraces of the Yellowstone River

The Gilt Edge soils of this soil association have a grayish loam or clay loam surface layer and a columnar clay subsoil. In some areas they occur with Arvada soils and account for the major part of the acreage. In other places they occur alone in tracts 10 to more than 200 acres in size. Nearly level or gently sloping Gilt Edge soils make up about 60 percent of this association.

The Arvada soils are clayey and nearly barren. These nearly level to sloping soils are in scattered areas of less than one-quarter acre throughout larger areas of the Gilt Edge soils. Arvada soils make up about 25 percent of the association. They are best suited to grazing, but forage production is low.

The remaining 15 percent of this association is made up of Hoven, Shonkin, Lismas, Midway, and Nihill soils. The clayey Hoven and loamy Shonkin soils are in shallow undrained basins and swales of less than 2 acres. Hoven soils are in areas as large as 5 acres and are saline, strongly alkaline, and barren. The clayey Lismas and Midway soils and the gravelly Nihill soils are on the steep breaks of the terraces.

This association makes up about 3 percent of the county. It is used only for grazing. Small areas were cultivated, but they have reverted to grass. About 55 percent of this association is suitable for nonirrigated farming.

4. Wanetta-Hesper association: Deep and moderately deep, loamy soils on nearly level to sloping high gravel terraces of the Yellowstone River

The dominant soils in this association are the Wanetta. These loamy soils are on the gently sloping first terraces above the Yellowstone River. They are 22 to 42 inches deep over loose sand and gravel. Wanetta soils make up about 50 percent of the association and occur in areas 40 to 200 acres or more in size. Although these soils are somewhat droughty, they are well suited to nonirrigated farming.

The deep, loamy Hesper soils are on gently sloping higher benches in the southern part of the county. They do not occur with the Wanetta soils. These soils amount to about 30 percent of this association. They are well suited to irrigated farming. Most areas are grazed, but some are used as cropland.

Many other soils make up the remaining 20 percent of this association. In the shallow undrained basins, gray Shonkin soils occur with the Wanetta and Hesper soils in areas less than 5 acres in size. Nearly level or gently sloping Treasure soils are sandy loams that occur on slopes of less than 8 percent in areas as large as 100 acres. In places the shallow gravelly Beaverton soils are associated with the Wanetta soils. Deep loams and clay loams lie in the valley of Sarpy Creek—the Fort Collins, McRae, and Nunn soils on the fans and terraces, and the Havre and Lohmiller soils on the bottom lands. These soils provide additional areas for cultivation. Wild hay and some alfalfa for hay or seed are grown on the bottom lands and are irrigated by floodwater or by waterspreading. Also in the association are very shallow gravelly soils on the terrace edges and eroded benches.

This association makes up about 5 percent of the county. Most of it is used for grazing. Except for the very steep, broken areas and the areas in very sandy or very gravelly soils, most of this association is suitable for nonirrigated farming. Some areas are used to produce small grain.

Soils of Rolling to Rough, Broken Uplands on Soft Shale

Four soil associations in the rough, broken uplands are made up of soils over the soft shale that occurs throughout the county. These soils formed in a weathered mantle and vary in depth. Together these four soil associations are more extensive than any other group of soil associations in the county.

5. Flasher-Bainville association: Moderately deep, dark-colored, sandy soils and moderately deep to shallow, light-colored, loamy soils on strongly rolling to hilly uplands in the southern part of the county

The Flasher soils, which make up about 60 percent of this association, are dark colored, moderately deep, and sandy. In some places these sloping to steep soils occur in areas 5 to 100 acres or more in size and occupy 85 to 90 percent of the landscape. In contrast, Flasher soils amount to less than 20 percent of the area where they occur on the crests and ridges with Bainville soils. Slopes range from 4 to 35 percent. Some areas of the Flasher soils are cultivated.

The Bainville soils are moderately deep to shallow, light colored, and loamy. They make up about 30 percent of this association. These sloping to steep soils occur in areas of 10 to 40 acres or more, and in these areas they make up 70 to 80 percent of the land. They also occur on ridges and crests in areas of Flasher soils, but in these areas they amount to only about 15 percent of the land. In small local areas, shale crops out and covers as much as 30 percent of the areas mapped as Bainville soils. The slopes of these soils range from 8 to more than 50 percent.

In the remaining 10 percent of this association are Fort Collins, Nunn, McRae, Havre, Lohmiller, and other deep soils. The Fort Collins, Nunn, and McRae soils are on gently sloping to strongly sloping fans, and the Havre and Lohmiller soils are in the narrow valleys of streams. These minor soils are the most suitable in the association for nonirrigated crops. Some areas are used for small grain and alfalfa.

This association amounts to about 5 percent of the county. Nearly all of it is used for grazing. Only about 10 to 20 percent of this association is suitable for nonirrigated crops.

6. Bainville-Midway association: Moderately deep to shallow, light-colored loams and clay loams on rolling to rough, broken uplands

The Bainville soils of this soil association are loams, and the Midway soils are clay loams. Together these soils make up about 70 percent of this association. In some areas either of these sloping to steep soils may amount to as much as 80 percent of the landscape. Slopes of these soils range from 8 to 65 percent or more. These soils are used mostly for grazing.

Many soils make up the remaining 20 to 30 percent of this association. Cushman loams and Renohill clay loams are gently sloping or strongly sloping. They are in areas that range from a few acres to 100 acres or more. Some of these areas are used for nonirrigated small grain.

The Winnett soils have a claypan and are used mainly for grazing, but a few small areas are used for nonirrigated crops. These soils are in areas of less than 1 acre to 100 acres or more. They occur as practically pure areas of Winnett soils or are closely intermingled with other soils.

On the fans and terraces that have slopes of 1 to 20 percent are Nunn clay loams or the deep, well-drained, loamy Briggsdale, Fort Collins, or McRae soils. Havre loams and Lohmiller clay loams are in the narrow valleys of streams. The deep, loamy Hesper soils on level to rolling high terraces occur in areas of 5 to 30 acres or more. They account for most of the nonirrigated cropland in this association and are used for small grain and alfalfa.

Hilly gravelly land is on the edges of the higher terraces and in large single areas south of the Yellowstone River.

This association occupies about 53 percent of the county. In about 90 percent of the association the soils are too steep and too shallow for cultivation and are used mainly for grazing. Only the smoother uplands, the bottom lands, and the terraces are cultivated. Along some streams, alfalfa is grown for seed or hay and is irrigated by floodwaters.

7. Bainville-Cushman-Tullock association: Shallow to moderately deep loams and sandy loams on undulating to strongly rolling uplands north of the Yellowstone River

The most extensive soils in this association are the Bainville. These soils are light colored, shallow to moderately deep loams in rolling to rough, broken areas that have slopes ranging from 4 to 50 percent or more. Shale commonly crops out in the rough, broken areas along the deeper streams and at the upper end of the drainageways. Some areas of almost pure Bainville soil are 10 to more than 400 acres in size. Bainville soils, however, are also closely intermingled with gently sloping to strongly sloping Cushman soils. Bainville soils make up about 50 percent of this association. They are used primarily for grazing, but small areas have been farmed, and a few areas that are intermingled with Cushman soils are still farmed with those soils.

The Cushman soils are moderately deep loams. These gently sloping or strongly sloping soils occur in areas as much as 100 acres or more in size. The Cushman soils make up about 15 percent of this association. Most of the acreage is used for grazing. Large areas have been farmed, and some of these are used for nonirrigated small grain.

The Tullock soils are moderately deep, light colored, and sandy. They occur in areas of more than 200 acres. On the ridges and knolls they are closely intermingled with the Bainville or the Cushman soils. Tullock soils make up about 10 percent of the association. They are used mainly for grazing, but some areas have been farmed and a few still are being farmed.

The remaining 25 percent of this association consists of many other soils and of shale outcrops. The nearly black Fattig soils are in the northwestern corner of the county. The Travessilla soils are shallow over sandstone and are scattered throughout the association in almost pure areas and in areas where they are closely intermingled with Cushman or Fattig soils. Briggsdale, Fort Collins, Nunn, and Treasure soils are on fans that have slopes of less than 10 percent. On these fans are some of the best soils in the county for nonirrigated crops. These soils are farmed or have been farmed. Havre and Lohmiller soils are in the narrow valleys and, in some places, are used for alfalfa or grass hay and are irrigated by flooding or by waterspreading.

This association, most of which is grazed, amounts to about 10 percent of the county. Nonirrigated small grain is grown mainly on the deeper soils of the fans and on the Cushman or other of the better soils of the uplands.

8. Terry-Treasure-Tullock association: Deep and moderately deep, sandy soils on undulating or rolling uplands

Approximately half of this association consists of Terry soils. These are moderately deep soils on undulating uplands.

The Treasure soils, next to the Terry soils in total acreage, are deep sandy loams that have a sandy clay loam subsoil. They are on nearly level or gently sloping fans. Treasure soils make up about 30 percent of this association.

The light-colored, sandy Tullock soils are mainly on ridges and crests, closely intermingled with the Terry soils. Tullock soils make up about 10 percent of the association.

The remaining 10 percent of this association consists of Bainville loams, shallow Travessilla soils, and a few outcrops of sandstone.

This association makes up about 1 percent of the county. Most of it is grazed. Some nonirrigated crops are grown in places on the Terry and Treasure soils, which are well suited for cultivation.

Soils of Rolling to Hilly Uplands on Clay Shale

Two soil associations are in the rolling to hilly uplands underlain by beds of gray shale. This shale was deposited in an ancient ocean many millions of years ago. These beds were exposed when many hundreds of feet of material were stripped from their top by some kind of geologic activity. The soils formed on the shale beds are clays.

9. Marias-Pierre-Hoven association: Deep and moderately deep, saline-alkali and saline clays on fans, terraces, and uplands north of the Yellowstone River

In this association, the Marias soils, saline-alkali—deep, crusty clays—are on undulating uplands and gently sloping fans. These soils are in areas a few acres to 400 acres or more in size; they make up about 50 percent of the association.

The Pierre soils, saline-alkali—crusty clays that are moderately deep over shale—occupy about 25 percent of this association. These soils are on the rolling to moderately steep uplands. They occur mainly with the Marias soils, saline-alkali, and the shallow Lismas clay. The Pierre soils of this association are used only for grazing.

The Hoven soils are saline and nearly barren. They occur mainly on nearly level or gently sloping fans and terraces, and they are in areas ranging from a few acres to 400 acres or more. Hoven soils also occur in barren spots that are scattered throughout areas of the Marias and the Pierre soils, saline-alkali. Hoven soils make up about 15 percent of this association. They produce only a small amount of native forage.

The remaining 10 percent of this association consists mostly of Lismas, Arvada, Havre, Lohmiller, and Bowdoin soils. The Lismas soils are in steep, rough areas, and the Arvada soils are on fans and terraces. Havre, Bowdoin, and Lohmiller soils occur in the narrow valleys of small streams. Shale crops out in places, especially in areas of Lismas soils.

This association amounts to about 15 percent of the county and is used for grazing. Grazing is the best use, though yields of native forage are low.

10. Pierre-Lismas association: Moderately deep and shallow, granular clays on shale uplands south of the Yellowstone River

The dominant soils in this association are the Pierre. These soils are granular clays that are moderately deep over shale. They are rolling to sloping and occur in areas 10 to 300 acres or more in size. Pierre soils make up about 60 percent of this association. They produce a large amount of forage, but they are not well suited for cultivation. In this association Pierre soils are used only for grazing.

The Lismas soils are clays that are shallow over shale. They are in the steeper, more hilly areas or in the rough, broken areas. Tracts are as large as 400 acres or more. Lismas soils are also on ridges and crests, where they are closely intermingled with the Pierre soils. Lismas soils make up about 25 percent of this association. These soils are used only for grazing, which is their best use.

The remaining 15 percent of this association consists mostly of Bainville, Midway, Fort Collins, Nunn, Havre, and Lohmiller soils. Remnants of soils on high gravel terraces or of Bainville and Midway soils are scattered in areas as much as 10 acres in size. Deep Fort Collins loams, deep Nunn clays, or similar soils occur on terraces and fans along Sarpy Creek and some of its larger tributaries. Some of these areas are 100 acres or more in size. Havre and Lohmiller soils are on the flood plains and fans of Sarpy Creek and other streams.

This association makes up about 4 percent of the county. It is used mostly for grazing, but some areas on fans and terraces are used for nonirrigated crops. Also cultivated are the soils on the flood plains of Sarpy Creek, where alfalfa grown for hay or seed is irrigated by flooding.

Descriptions of the Soils

This section describes the soil series (groups of soils) and single soils (mapping units) of Treasure County. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure in this section is first to describe the soil series and then the mapping units in the series. Thus to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Badlands and Shale outcrop are miscellaneous land types and do not belong to a soil series but, nevertheless, are listed in alphabetic order along with the series.

Following the name of each mapping unit, there 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 are the capability unit and the range site in which the mapping unit has been placed. The pages on which each capability unit and each range site are described can be found by referring to the "Guide to Mapping Units" at the back of this report.

Soil scientists, engineers, students, and others who want detailed descriptions of the soil series should turn to the section "Formation and Classification of Soils." Many terms used in the soil descriptions and other sections are defined in the Glossary.

Arvada Series

The Arvada series consists of deep, well-drained, alkali soils that developed in loam and clay loam alluvium. These soils normally have a surface layer of light-gray loam that is 6 inches thick and is underlain by an upper

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

Map symbol	Soil	Area	Extent
		Acres	*Percent*
Ar	Arvada loam, 0 to 3 percent slopes	140	(1)
Av	Arvada complex	1, 901	0 3
Ax	Arvada-Laurel complex	6, 345	1 0
Ba	Badlands	540	(1)
Bb	Bainville loam, 8 to 15 percent slopes	10, 887	1 7
Bc	Bainville loam, 15 to 35 percent slopes	18, 538	2 9
Bf	Bainville-Tullock complex	3, 514	6
Bm	Bainville-Midway complex, 8 to 15 percent slopes	2, 302	.4
Bn	Bainville-Midway complex, 15 to 35 percent slopes	16, 619	2 6
Bo	Bainville-Shale outcrop complex	15, 425	2 4
Bs	Banks soils	2, 089	.3
Bt	Beaverton gravelly loam	704	.1
Bu	Bew clay loam	308	(1)
Bw	Bowdoin clay	730	.1
Bx	Briggsdale loam, 2 to 4 percent slopes	2, 131	.3
By	Briggsdale loam, 4 to 8 percent slopes	38	(1)
Ca	Cherry clay, 0 to 1 percent slopes	135	(1)
Cb	Cherry clay, 1 to 3 percent slopes	308	(1)
Cc	Cherry clay, 3 to 8 percent slopes	159	(1)
Cd	Cherry clay, moderately deep, 0 to 1 percent slopes	345	(1)
Cf	Cherry clay, moderately deep, 1 to 3 percent slopes	247	(1)
Cg	Cherry clay, moderately deep, 3 to 8 percent slopes	87	(1)
Ch	Cherry clay loam, 0 to 1 percent slopes	634	.1
Ck	Cherry clay loam, 1 to 3 percent slopes	248	(1)
Cm	Cherry clay loam, shallow, 0 to 1 percent slopes	497	(1)
Cn	Cherry-Laurel clay loams	307	(1)
Cp	Cushman loam, 2 to 4 percent slopes	1, 977	.3
Cr	Cushman loam, 4 to 8 percent slopes	9, 495	1 5
Cs	Cushman loam, 8 to 15 percent slopes	82	(1)
Ct	Cushman-Bainville loams, 4 to 8 percent slopes	3, 945	.6
Cu	Cushman-Bainville loams, 8 to 15 percent slopes	1, 028	.2
Cv	Cushman-Terry fine sandy loams, 2 to 8 percent slopes	3, 442	.5
Cw	Cushman-Tullock complex, 8 to 15 percent slopes	4, 269	7
Cx	Cushman-Travessilla loams, 2 to 8 percent slopes	4, 856	8
Cy	Cushman-Winnett complex	1, 621	3
Dw	Dwyer fine sand	485	(1)
Ed	Edgar loam, 1 to 8 percent slopes	779	1
Eg	Edgar loam, 8 to 15 percent slopes	2, 110	.3
Fa	Fattig loam	372	(1)
Fc	Fattig-Travessilla complex	1, 535	.2
Ff	Flasher fine sandy loam, 4 to 20 percent slopes	4, 922	.8
Fh	Flasher fine sandy loam, 20 to 35 percent slopes	2, 800	.4
Fm	Flasher loamy fine sand	2, 839	.4
Fn	Fort Collins loam, 0 to 1 percent slopes	705	.1
Fo	Fort Collins loam, 1 to 4 percent slopes	2, 178	.3
Fr	Fort Collins loam, 4 to 8 percent slopes	8, 958	1 4
Fs	Fort Collins loam, sandy substratum, 0 to 1 percent slopes	56	(1)
Ft	Fort Collins loam, sandy substratum, 1 to 3 percent slopes	309	(1)
Ga	Gilt Edge clay loam	2, 743	0. 4
Gb	Gilt Edge-Arvada complex	6, 299	1 0
Gc	Glendive clay	98	(1)
Gg	Glendive clay loam	106	(1)
Gh	Glendive fine sandy loam	1, 196	2
Gm	Glendive fine sandy loam, fans	648	1
Gn	Glendive fine sandy loam, shallow	113	(1)
Go	Glendive loam	753	.1
Gs	Glendive loamy fine sand	246	(1)
Gv	Glendive and Banks soils	3, 115	5
Ha	Havre clay	477	(1)
Hb	Havre clay, saline	615	(1)
Hc	Havre clay loam	1, 765	3
Hd	Havre clay loam, high	398	(1)
Hf	Havre clay loam, saline	896	1
Hg	Havre loam	13, 531	2 1
Hh	Havre loam, high	846	1
Hl	Havre loam, moderately deep	86	(1)
Hm	Havre loam, saline	3, 526	.6
Hn	Havre and Glendive soils	1, 971	.3
Ho	Havre and Lohmiller soils	4, 744	.8
Hp	Havre and Lohmiller soils, 8 to 15 percent slopes	545	(1)
Hr	Havre and Lohmiller soils, 15 to 35 percent slopes	3, 085	5
Hs	Havre and Lohmiller soils, saline	6, 147	1 0
Ht	Havre-Hysham loams	319	(1)
Hu	Hesper loam, 1 to 4 percent slopes	1, 837	.3
Hv	Hesper loam, 4 to 8 percent slopes	4, 590	7
Hw	Hilly gravelly land	6, 465	1 0
Hx	Hoven clay	2, 471	4
Hy	Hoven and McKenzie soils	20, 405	3 2
Hz	Hysham-Havre loams	245	(1)
La	Laurel clay loam	1, 020	2
Lb	Laurel loam	597	(1)
Lc	Lismas clay	5, 857	9
Ld	Lismas-Pierre clays, saline-alkali	11, 736	1. 9
Lf	Lismas-Midway complex	11, 242	1 9
Lg	Lismas-Shale outcrop complex	5, 674	.9
Lh	Lohmiller clay	995	.2
Lm	Lohmiller clay, high	154	(1)
Ln	Lohmiller clay, wet	143	(1)
Lo	Lohmiller clay loam	222	(1)
Lr	Lohmiller clay loam, 1 to 3 percent slopes	122	(1)
Ls	Lohmiller clay loam, fans, 0 to 1 percent slopes	950	2
Lt	Lohmiller clay loam, high	286	(1)
Lu	Lohmiller-Hysham clays	1, 205	.2
Ly	Lohmiller-Hysham clay loams	902	1
Ma	Marias clay, saline-alkali, 0 to 1 percent slopes	1, 119	2
Mb	Marias clay, saline-alkali, 1 to 10 percent slopes	5, 695	9
Mc	Marias clay, fans, saline-alkali	12, 458	2 0
Md	Marias-Hoven clays, saline	12, 427	2 0
Me	Marias-Pierre clays, saline-alkali	173	(1)
Mf	Marias and Promise clays	750	.1
Mk	McRae loam	3, 856	6
Ml	McRae-Bainville loams, 8 to 20 percent slopes	19, 828	3 1
Mm	McRae-Bainville loams, 20 to 35 percent slopes	2, 103	.3
Mn	McRae and Havre loams, 0 to 1 percent slopes	670	.1
Mo	McRae and Havre loams, 1 to 4 percent slopes	5, 705	.9
Mp	McRae and Havre loams, 4 to 8 percent slopes	4, 429	.7
Mr	Midway clay loam, 8 to 15 percent slopes	4, 647	.7

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

Map symbol	Soil	Area	Extent	Map symbol	Soil	Area	Extent
		Acres	*Percent*			*Acres*	*Percent*
Ms	Midway clay loam, 15 to 35 percent slopes	40, 639	6. 5	Sk	Shonkin loam	1, 616	0. 3
Mt	Midway-Bainville complex	78, 648	12. 6	Tf	Terry-Tullock fine sandy loams	3, 107	. 5
Mu	Midway-Nihill gravelly loams	23, 823	3. 8	Tm	Terry-Treasure fine sandy loams	2, 528	. 4
Mv	Midway-Shale outcrop complex	29, 001	4. 6	Tn	Terry-Winnett complex	1, 152	. 2
Na	Nihill gravelly loam	5, 820	. 9	Tp	Travessilla-Tullock fine sandy loams	9, 945	1. 6
Nc	Nunn clay, 0 to 1 percent slopes	470	(1)	Tr	Travessilla-Rock outcrop complex	3, 173	. 5
Nd	Nunn clay, 1 to 3 percent slopes	236	(1)	Ts	Treasure fine sandy loam, 2 to 4 percent slopes	60	(1)
Nm	Nunn clay, 3 to 8 percent slopes	88	(1)	Tu	Treasure fine sandy loam, 4 to 8 percent slopes	3, 952	. 6
Nn	Nunn clay loam, 0 to 1 percent slopes	1, 545	. 2	Tv	Tullock fine sandy loam, 4 to 20 percent slopes	5, 664	. 9
No	Nunn clay loam, 1 to 3 percent slopes	2, 416	. 4	Wb	Wanetta loam, 1 to 4 percent slopes	269	(1)
Nu	Nunn clay loam, 3 to 8 percent slopes	5, 091	. 8	Wc	Wanetta loam, 4 to 8 percent slopes	29	(1)
Nx	Nunn-Beckton complex, 0 to 1 percent slopes	569	(1)	Wd	Wanetta loam, deep, 0 to 2 percent slopes	1, 672	. 3
Pa	Pierre clay	625	(1)	Wm	Wanetta loam, deep, 2 to 4 percent slopes	5, 966	. 9
Pc	Pierre-Lismas clays	12, 650	2. 0	Wn	Wanetta loam, deep, 4 to 8 percent slopes	135	(1)
Pk	Pierre-Lismas clays, saline-alkali	24, 284	4. 0	Wr	Wibaux-Rock outcrop complex	108	(1)
Rn	Renohill clay loam	1, 378	. 2	Wt	Winnett complex	5, 635	. 9
Rw	Riverwash	1, 321	. 2	Wx	Winnett-Fattig complex	1, 015	. 2
Sa	Sage clay	297	(1)				
Sc	Sage silty clay	257	(1)				
Sh	Shale outcrop	5, 389	. 9		Total	629, 760	100. 0

[1] Less than 0.1 percent.

subsoil of strongly alkaline clay. The lower subsoil is strongly saline and strongly alkaline clay loam. Below a depth of 10 to 14 inches, the subsoil is limy and is spotted and seamed with salts and gypsum.

The surface layer ranges from ½ inch to 7 inches in thickness. The upper subsoil is neutral to very strongly alkaline and ranges from heavy clay loam to clay. The lower subsoil is nonsaline to very strongly saline and alkaline and ranges from loam to clay. These soils take in water slowly but have high water-holding capacity. They have very low natural fertility and contain less than the average amount of organic matter.

The Arvada soils occur with the Beckton, Gilt Edge, and Laurel soils. They are more strongly alkaline and more saline than the Beckton and Gilt Edge soils and are not so wet and saline as the Laurel soils.

Arvada loam, 0 to 3 percent slopes (Ar).—This soil is on nearly level to gently sloping fans and terraces. About 10 percent of the acreage mapped as this soil is Laurel clay loam in nearly barren "puff spots" or slight depressions of varying size. Arvada loam has the profile described for the series. In areas with a surface layer less than 4 inches thick, the plants are similar to those on the Clayey range site.

This soil is used mostly for grazing and, unless irrigated, is best suited to that use. It produces a large amount of native forage under good management. Waterspreading increases yields considerably where it is suitable. A few small areas are irrigated. If this soil is irrigated for many years, it continues to produce low yields of all crops, but it does show some improvement if management is good. Under irrigation, it is most suitable for salt-tolerant and alkali-tolerant hay or pasture. (Capability unit IVs–1, irrigated; VIe–3, nonirrigated; Silty range site)

Arvada complex (Av) (1 to 6 percent slopes).—This mapping unit is on gently sloping and sloping fans. In about 70 to 80 percent of the area mapped, the surface layer is light brownish-gray loam 4 to 6 inches thick. This layer grades to grayish, platy or blocky heavy loam or light clay loam that is also 4 to 6 inches thick and is underlain by brown, blocky, noncalcareous heavy clay loam or light clay. From a depth of 14 inches to as much as 40 inches, the subsoil is lighter colored, calcareous loam spotted with white lime, and this grades with depth to calcareous loam that is streaked and spotted with gypsum. This part of Arvada soils lacks the strong salinity and alkalinity of the soil described for the series. Soils that are similar to the soil described for the Arvada series make up 15 to 25 percent of the complex. Laurel clay loam is in the slightly depressional spots and makes up less than 5 percent of this mapping unit. The Laurel soils in this complex are like those soils in the Arvada-Laurel complex.

The soils in this complex have been cultivated, but most of the acreage is now used for grazing. These soils are suitable for nonirrigated crops and for hay or pasture that is grown with an occasional grain crop. Because spots are saline and alkali, crops grow unevenly. These soils produce average or below average yields of all nonirrigated crops. (Capability unit VIe–3, nonirrigated; Silty range site)

Arvada-Laurel complex (Ax) (1 to 8 percent slopes).—This mapping unit is on nearly level terraces and sloping fans. It is made up of 75 to 80 percent Arvada loam and clay loam and 20 to 25 percent Laurel clay loam. Laurel clay loam is barren or nearly barren and is scattered throughout the unit in spots of varying size and shape. Arvada loam and clay loam are in the vegetated areas.

In this mapping unit the Arvada soils have a surface layer 2 to 5 inches thick. The Laurel clay loam in this mapping unit lacks the salt crust and the wetness described for the Laurel series. The Laurel soil has a gray, glazed surface layer, ¼ to 1 inch thick, that is underlain by an upper subsoil of strongly alkaline, yellowish-brown, blocky clay 2 to 5 inches thick. Below a depth of 4 to 8 inches, the subsoil is strongly saline and contains many seams and specks of salts and gypsum.

The soils in this complex are used only for grazing, which is their best use. Yields of native forage are low, but in suitable places, they can be increased considerably by waterspreading. (Capability unit VIs–2, irrigated; VIs–4, nonirrigated; Panspots range site)

Badlands

Badlands (Ba) consists of shale uplands that have been deeply dissected and severely eroded by streams. Slopes range from 10 to 60 percent or more. The relief is very steep, rough, and broken, but there are rounded ridges, some cone-shaped buttes, and level to sloping fans. In some of the valleys, streams have cut deeply. Shale outcrop makes up 70 to 80 percent of the mapping unit, and soils amount to 20 to 30 percent. The shale is barren on the very steep south- and west-facing slopes, but Bainville loam, Lismas clay, and Midway clay loam are on the north- and east-facing slopes and support vegetation. In the valleys and on the slopes below the steeper areas are the Arvada, Hoven, Laurel, Sage, or Winnett soils, or Marias soils, saline-alkali. Two or more of these kinds of soil generally occur in the valleys.

This mapping unit produces a small amount of forage. (Capability unit VIIs–5, nonirrigated; Badlands range site)

Bainville Series

The Bainville series consists of shallow to moderately deep, light-colored, calcareous loams that formed in place from weakly consolidated shale. These soils have a surface layer of light brownish-gray loam or silt loam generally about 4 inches thick. This layer is only slightly darker colored than the yellowish subsoil of strongly calcareous, massive loam or silt loam. In most places the shale is at a depth of about 26 inches.

The surface layer ranges from 0 to 4 inches in thickness, and the depth to the shale ranges from 5 to 30 inches. These soils take in water readily, but they have low or very low water-holding capacity. Natural fertility is low, and organic-matter content is very low.

The Bainville soils occur with the Cushman, Flasher, Midway, and Tullock soils. They lack the brown, noncalcareous upper subsoil of the Cushman soils and the spots of the lime in the lower subsoil. The subsoil of the Bainville soils is finer textured than that of the Flasher and Tullock soils. The Bainville soils do not contain as much clay in their subsoil as the Midway soils. They are used mainly for grazing.

Bainville loam, 8 to 15 percent slopes (Bb).—This soil is on rolling uplands both north and south of the Yellowstone River. Slopes as steep as 25 percent are in some mapped areas along drainageways and on some of the sharper knolls and ridges. About 80 to 90 percent of the mapped acreage consists of Bainville loam and silt loam.

Many other soils make up the remaining 10 to 20 percent of the acreage mapped as this soil. Midway clay loam, Tullock fine sandy loam, or other soils are on the top of some ridges and crests in areas less than 1 acre in size. McRae loams, Fort Collins loams, or Briggsdale loams are in areas of 1 to 5 acres on small fans or terraces with slopes of less than 10 percent. Havre and Lohmiller soils lie in stream valleys less than 100 feet wide.

In most places, this soil ranges from 22 to 30 inches in depth to shale, but on the top of knolls or ridges, shale is at a depth of less than 12 inches.

This soil is used mainly for grazing, which is its best use. Small areas have been and continue to be farmed. These areas are farmed along with larger areas of deeper, more productive soils. Under good range management, this soil produces a large amount of native forage. Depleted range can be reseeded, or it recovers with rest. (Capability unit VIe–3, nonirrigated; Silty range site)

Bainville loam, 15 to 35 percent slopes (Bc).—This soil is on rolling to hilly uplands throughout the county. Slopes are more than 35 percent along some of the more deeply cut drainageways and on some of the shorter slopes below the crests and ridges. "Catsteps" are common on the steeper slopes. In depth to shale, this soil ranges from less than 10 inches on the crests and ridges to about 24 inches on the lower ends of the longer, smoother slopes. This soil is steeper, rougher, and more dissected by streams than Bainville loam, 8 to 15 percent slopes.

Of the acreage mapped as this soil, other soils make up about 20 to 30 percent. Midway, Flasher, or Tullock soils are on the ridgetops in areas less than 2 acres in size. Fort Collins loam, McRae loam, or Nunn clay loam is on the fans with slopes of 2 to 12 percent in areas of less than 10 acres. Havre and Lohmiller soils are in the stream valleys less than 200 feet wide. Shale or sandstone crops out on some of the ridgetops.

This soil produces a large amount of native grasses and is used only for grazing, which is its best use. Some of the small fans have been used as cropland. Depleted areas of grass can be improved by reseeding and by regulating grazing. (Capability unit VIe–4, nonirrigated; Thin silty range site)

Bainville-Tullock complex (Bf) (15 to 35 percent slopes).—This complex is on rolling to hilly uplands. The slopes are mainly between 15 and 35 percent, but some slopes are as steep as 40 percent along some of the deeper stream courses and on some of the short slopes below the narrower crest or ridges.

Bainville loam makes up about 60 to 70 percent of this complex; Tullock fine sandy loam, about 20 to 25 percent; and other soils, about 5 to 10 percent. Tullock fine sandy loam is generally on the top of the ridges, crests, and knolls in areas less than 2 acres in size, and Bainville loam is on the smooth side slopes below the Tullock soils. Sandstone crops out in a few places. McRae loam and Fort Collins loam, the main soils on the fans, occur on slopes of 2 to 10 percent in areas less than 5 acres in size.

This complex is used only for grazing because grazing is its best use. It produces a large amount of native forage if management is good. The risk of erosion is severe where a good cover is not maintained. Depleted areas respond to reseeding, or, if management is good, they re-

cover in a short period. (Capability unit VIe–4, nonirrigated; Bainville soil: Thin Silty range site; Tullock soil: Thin Sandy range site)

Bainville-Midway complex, 8 to 15 percent slopes (Bm).—This complex is on rolling uplands throughout the county but is mainly south of the Yellowstone River. Slopes are generally long and smooth. In small areas slopes are more than 15 percent or less than 8 percent.

Bainville loam makes up about 50 to 60 percent of this complex; Midway clay loam, about 25 to 35 percent; and other soils, 10 to 15 percent. The Bainville and Midway soils occur on any part of a slope, or they occupy an entire slope, in some places as much as 20 acres. Flasher fine sandy loam, Lismas clay, or Tullock fine sandy loam is on the top of some of the ridges and crests in areas less than 2 acres in size. Arvada clay loam, Briggsdale loam, Fort Collins loam, or McRae loam is on the fans or in the swales in areas less than 5 acres in size.

In depth to shale, the Bainville and Midway soils range from about 10 inches on the ridges and crests to about 30 inches on the lower ends of the longer slopes.

This complex is used almost entirely for grazing, and it is best suited to that use. A few areas have been farmed, and a few are used for nonirrigated crops. Under good management, much native forage is produced. (Capability unit VIe–3, nonirrigated; Bainville soil: Silty range site; Midway soil: Clayey range site)

Bainville-Midway complex, 15 to 35 percent slopes (Bn).—This complex is on hilly uplands. Some areas, especially those along deep drainageways, have slopes of more than 35 percent.

Bainville loam and silt loam make up about 30 to 50 percent of this complex; Midway clay loam, about 30 to 50 percent; and other soils, 20 to 30 percent. Flasher fine sandy loam, Tullock fine sandy loam, Lismas clay, and Travessilla loam are in areas less than 5 acres in size, generally on the top of knolls and ridges. Arvada loam and clay loam, Fort Collins loam, McRae loam, or Nunn clay loam occurs on fans and foot slopes that have slopes ranging from 2 to 20 percent. They occupy areas as large as 10 acres. Havre loam or Lohmiller clay loam is in narrow valleys of streams. Shale or sandstone crops out on the top of some of the crests or ridges.

In depth to shale, Bainville loam and Midway clay loam range from less than 10 inches on the top of ridges to about 24 inches at the lower end of slopes.

This complex is used entirely for grazing, which is its best use. The risk of erosion is severe if management is not good. Depleted forage cover can be improved by seeding. Under good management, a moderate amount of native forage is produced. (Capability unit VIe–4, nonirrigated; Bainville soil: Thin Silty range site; Midway soil: Thin Clayey range site)

Bainville-Shale outcrop complex (Bo) (30 to 70 percent slopes).—This complex is in rough, broken, deeply dissected areas at the upper ends of drainageways and on very steep side walls of stream valleys. Between the drainageways, the ridges and crests are narrow and knifelike and have side slopes of 30 to 70 percent or more. The slopes on the south and west exposures are nearly vertical in many places. Included in this complex are small areas of uplands having slopes of less than 30 percent and fans and narrow valleys having slopes of less than 15 percent.

The soils in this complex vary greatly within small areas or on a single slope. Soil texture and depth to shale or other bedrock vary within short distances, depending on the kind of bedrock. Many soils intermingle, but Bainville loam and silt loam make up 50 to 60 percent of the mapping unit. Barren or nearly barren outcrops of shale make up about 20 to 30 percent. These outcrops generally occur on the nearly vertical south- and west-facing slopes in areas of less than one-fourth acre. Areas of shale outcrop as large as 5 acres occur in some places. Other soils, ledges of sandstone, or clinker beds make up the remaining acreage. Havre loam, McRae loam, or Fort Collins loam is in areas as large as 10 acres on the fans with slopes of less than 15 percent. Havre and Lohmiller soils are on some of these fans and are also on the narrow bottom land along streams. Ledges of sandstone or clinker beds are not common in this complex, but they do occur in a few small areas.

This complex is used only for grazing, and its yields of forage are low. Good range management prevents the depletion of grass cover and excessive erosion. (Capability unit VIIe–2, nonirrigated; Thin Breaks range site)

Banks Series

The Banks series consists of shallow, light-colored sand to loam that is underlain by loose sand or sand and gravel at a depth of 8 to 14 inches. These soils have very low water-holding capacity and natural fertility.

The Banks soils occur with the Glendive and Havre soils but are sandier and shallower to gravel or loose materials. They lack the brown, blocky clay loam subsoil and the layer of lime that are in the Beaverton soils.

Banks soils (Bs) (less than 1 percent slopes).—These shallow soils are on the flood plains of the Yellowstone and Bighorn Rivers. They are in the lowest areas adjacent to the main and overflow channels and are on most of the smaller islands within the main channel. Although some areas are subject to annual overflow, most areas are so high that they are flooded only during ice jams. The surface of these soils is rough, and overflow channels of varying depth and width are common.

These soils vary extremely in texture and in depth to loose gravel. In places, they are gravelly throughout.

Included in mapped areas are small areas of Havre or Glendive soils, less than 2 acres in size, or of Riverwash in the narrow overflow channels. These included soils make up less than 10 percent of the acreage mapped.

Banks soils mainly support scattered to dense stands of cottonwoods and brush that have an understory of grass and other vegetation. They are used only for grazing, which is their best use. If properly managed, these soils produce high yields of forage. In dense areas of brush and trees, the grass cover is not so thick as it is in sparse areas. Clearing brush increases the total yield of forage. Depleted pasture can be improved by reseeding. Yields can be increased by waterspreading or by irrigation. (Capability unit VIs–1, irrigated; VIs–3, nonirrigated; Shallow to Gravel range site)

Beaverton Series

The Beaverton series consists of soils that formed in a thin mantle of loam over loose sand and gravel. These

soils have a surface layer of grayish-brown gravelly loam 3 to 4 inches thick. The upper subsoil consists of 5 to 8 inches of noncalcareous, brown, blocky gravelly clay loam. The lower subsoil is lighter colored below a depth of 10 to 14 inches and consists of calcareous gravelly loam that grades to loose sand and gravel at a depth of 12 to 18 inches (fig. 2). These soils take in water readily but have very low water-holding capacity. They have high natural fertility and the average amount of organic matter.

The Beaverton soils are shallower to the loose gravel than the Wanetta soils, which are 22 to 42 inches deep over gravel. They are not so gravelly as the Nihill soil. Range is the best use for Beaverton soils.

Beaverton gravelly loam (Bt) (1 to 3 percent slopes).—This soil is on nearly level high terraces north of the Yellowstone River. It has a profile like the one described for the Beaverton series. Beaverton loam makes up about 15 percent of the mapped acreage and Wanetta loam about 5 percent. The Beaverton loam is in areas not more than 1 acre in size.

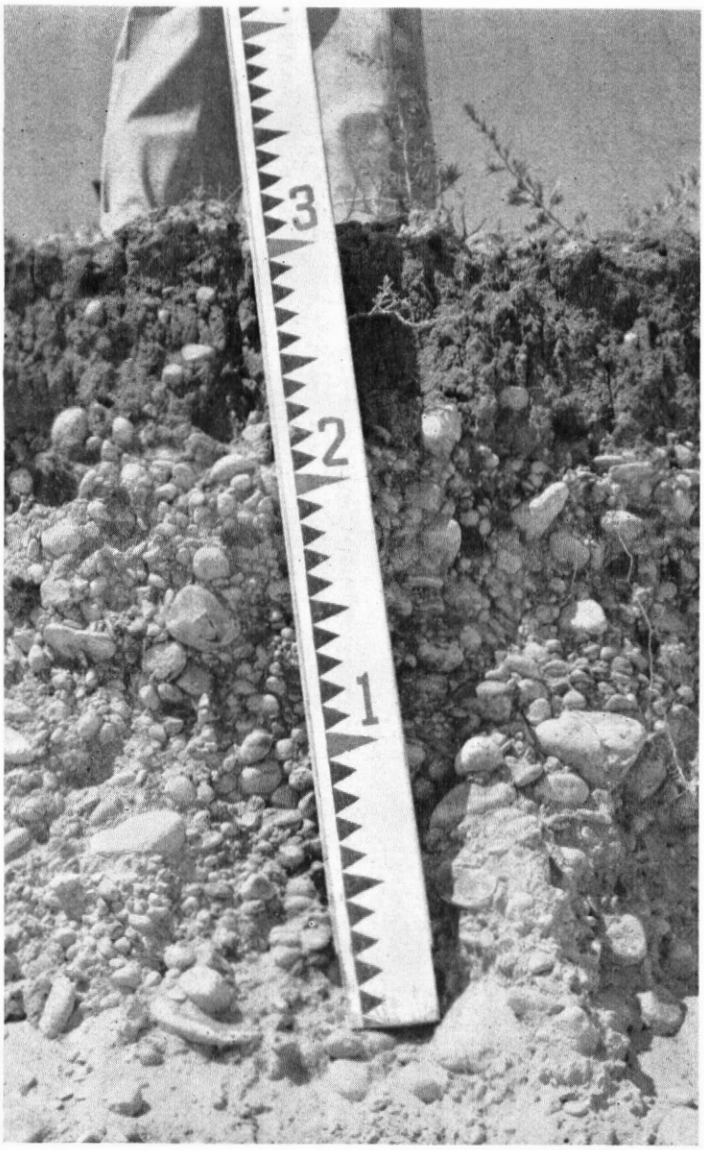

Figure 2.—**Beaverton gravelly loam showing the loose gravel at depth of 14 inches.**

Beaverton gravelly loam is used mainly for grazing, but there are small areas that are cropped along with other soils. Because the water-holding capacity is very low, this soil is not well suited to nonirrigated crops. It is best used for grazing. Under good management, moderate yields of native forage are produced. Depleted plant cover can be improved by reseeding. (Capability unit VIs–3, nonirrigated; Shallow to Gravel range site)

Beckton Series

The Beckton series consists of soils that formed from loam or clay loam material. These soils have a light brownish-gray clay loam surface layer. The upper subsoil—olive-brown, noncalcareous, blocky silty clay—has a grayish cast in the top 2 to 4 inches. Below a depth of 12 to 16 inches is a lighter colored lower subsoil. It consists of calcareous silty clay loam with white spots of lime extending from 18 or 20 inches to about 40 inches. The material below 40 inches is stratified loam to clay loam streaked or splotched with gypsum.

The surface layer is loam in some places. The upper subsoil is browner than that described, and contains less clay in some places.

These soils take in water readily and have high water-holding capacity. Natural fertility is high, but the content of organic matter is below the average.

The Beckton soils occur with the Arvada, Briggsdale, and Nunn soils. They lack the strongly alkaline, denser upper subsoil and the strongly saline lower subsoil of the Arvada soils. Beckton soils have a grayer surface layer and upper subsoil than the Briggsdale and Nunn soils and, unlike those soils, contain gypsum in the lower subsoil.

In this county Beckton soils are mapped only in a complex with Nunn soils.

Bew Series

The Bew series consists of deep, well-drained soils that formed from clay material. These soils have a brown, granular clay loam surface layer about 5 to 6 inches thick and a brown, noncalcareous, blocky clay upper subsoil. The lower subsoil is lighter colored, calcareous clay with white spots of lime. It extends from a depth of 16 to 20 inches to between 30 and 40 inches. Below about 48 inches, the material is clay, stratified loam, or gravelly loam. In many places white spots of gypsum are deep below the lime. These soils take in water slowly and have high water-holding capacity. They have high natural fertility and contain the average amount of organic matter.

The Bew soils contain more clay throughout than the Nunn soils. Unlike the Gilt Edge soils, Bew soils do not have a gray surface layer and a dense, columnar upper subsoil. Their upper subsoil is brown and noncalcareous, whereas the Marias soils are calcareous throughout.

Bew clay loam (Bu) (1 to 3 percent slopes).—This soil is on gently undulating high terraces north of the Yellowstone River. Of the acreage mapped as this soil, Shonkin loam and Hoven clay make up less than 5 percent. They are in the shallow, flat, undrained depressions or in the

level swales in areas less than 2 acres in size. Bew clay loam is the soil described for the series.

This soil has been farmed, but now it is used only for grazing. It is well suited to continuous nonirrigated crops. Yields of all kinds of crops are above average. (Capability unit IIIe–4, nonirrigated; Clayey range site)

Bowdoin Series

This series consists of deep, well-drained heavy clays that are massive (structureless). In places a few streaks of gypsum occur below 16 inches. During the drier parts of the year, cracks 1 inch to 3 inches wide commonly extend from the surface to a depth of as much as 3 feet. This soil has high water-holding capacity and natural fertility. It is hard to plow and work.

This soil is denser and more clayey throughout than Marias or Promise soils. It lacks the salinity and alkalinity of the Marias soils, saline-alkali.

Bowdoin clay (Bw) (less than 1 percent slopes).—This soil is in the low areas of the level terraces and bottom land. Vegetation similar to that on the Overflow range site grows in areas that are flooded by the side drainageways in some years. The depth to coarser textured material ranges from 32 to 48 inches or more.

This soil is used for both irrigated crops and for grazing. Unless irrigated, it is best used for native pasture. Under irrigation, its best use is for hay, pasture, and small grain. This soil is difficult to plow and manage because the content of clay is high. It produces high yields of native pasture, which can be increased by waterspreading. (Capability unit IVs–3, irrigated; VIe–3, nonirrigated; Clayey range site)

Briggsdale Series

The Briggsdale series consists of deep, well-drained soils that formed from loam material. The surface layer of these soils is 2 to 4 inches of light brownish-gray loam that is underlain by an upper subsoil consisting of 10 to 14 inches of brown, blocky, noncalcareous heavy clay loam or light clay. A lighter colored lower subsoil, below a depth of 14 to 18 inches, is calcareous loam or light clay loam with white spots of lime extending to a depth of 30 inches or more. These soils take in water readily and have high water-holding capacity. Their natural fertility is high, and they contain the average amount of organic matter.

The Briggsdale soils contain more clay in their upper subsoil than the Fort Collins soils, but they are not so clayey throughout as the Bew soils. Briggsdale soils lack the grayish upper layers that occur in the Beckton soils.

Briggsdale loam, 2 to 4 percent slopes (Bx).—This soil is on gently sloping fans and in nearly level swales of the uplands. Of the acreage mapped as this soil, 5 to 10 percent is Arvada loam, Beckton loam, Beckton clay loam, or Cushman loam, which occur either singly or in combination in areas less than 2 acres in size. This soil is the one described for the series.

This soil is used as nonirrigated cropland and for grazing. It is well suited for continuous cultivation but is somewhat susceptible to erosion. Yields of nonirrigated crops are average or above average. (Capability unit IIIc–1, nonirrigated; Silty range site)

Briggsdale loam, 4 to 8 percent slopes (By).—This soil is on sloping fans in the uplands. Except that it is steeper, it is like Briggsdale loam, 2 to 4 percent slopes. In some places shale is within 5 feet of the surface.

This soil is used mainly for grazing, but small areas are cropped. It is well suited for continuous nonirrigated cultivation, but the risk of erosion is moderate. Yields of all crops are average or above average. (Capability unit IIIe–2, nonirrigated; Silty range site)

Cherry Series

The Cherry series consists of deep, well-drained, clayey soils that formed from clay loam material. These soils normally have a grayish-brown, granular clay loam surface layer, an olive-brown, blocky, noncalcareous clay loam upper subsoil, and a calcareous clay loam lower subsoil. A few white spots of lime extend from a depth of 10 inches to about 30 inches. In places loam or silt loam material underlies these soils at a depth of as little as 14 inches. These soils take in water readily and have high water-holding capacity. They have high natural fertility but contain amounts of organic matter below the average.

The Cherry soils formed from the same kind of material as Lohmiller and Nunn soils, but the olive-brown upper subsoil of the Cherry soils is noncalcareous, and the Lohmiller soils are calcareous throughout. In the upper subsoil, Cherry soils are not so clayey as the Nunn soils nor so strong in structure.

Cherry clay loam, 0 to 1 percent slopes (Ch).—This soil is on level terraces. It is like the soil described for the series.

This soil is used only as irrigated cropland and is well suited to that use. It produces above average yields of all irrigated crops. (Capability unit I–1, irrigated)

Cherry clay loam, 1 to 3 percent slopes (Ck).—This soil is on gently sloping fans. Except that it is more sloping, it is like Cherry clay loam, 0 to 1 percent slopes. Below the irrigation canals, slopes are mainly between 1 and 2 percent, but slopes between 2 and 4 percent do occur.

Most of this soil is used as irrigated cropland, but the areas above the canals are used for grazing and as nonirrigated cropland. The soil is well suited to irrigated and nonirrigated crops grown continuously. Slopes of more than 2 percent are not well suited to row crops under irrigation, because there is a severe risk of erosion. This soil produces above average yields of all crops. (Capability unit IIe–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Cherry clay loam, shallow, 0 to 1 percent slopes (Cm).—This soil is on level terraces. It is underlain by loam, silt loam, and sandy loam material at a depth of 14 to 20 inches, but in other features it is similar to the Cherry clay loam described for the series.

This soil is used only as irrigated cropland, and it is well suited to that use. It produces above average yields of all crops. (Capability unit I–1, irrigated)

Cherry-Laurel clay loams (Cn) (less than 1 percent slopes).—This complex is on level terraces. It is made up of about 75 to 85 percent Cherry clay loam and about 15 to 25 percent Laurel clay loam. Laurel clay loam is in hard, crusty spots of varying size on which plants do not grow very well. The Cherry clay loam in this complex is similar to the soil described for the series except that it

contains a few more salts in the lower subsoil. The Laurel clay loam is similar to the Laurel soil in Arvada-Laurel complex.

This complex is used as irrigated cropland and for grazing. It is well suited to irrigated crops. Yields of most of them are good, but on the spots of Laurel clay loam yields are lower than on the rest of the complex. Nonirrigated areas produce low yields of crops and are best suited to hay and pasture. (Capability unit IIs–3, irrigated; IVs–5, nonirrigated; Clayey range site)

Cherry clay, 0 to 1 percent slopes (Ca).—This soil is on level terraces and fans. It contains more clay in the upper 14 to 18 inches than the soil described for the Cherry series. It has a granular light clay surface layer and a blocky light clay upper subsoil. The lower subsoil is clay loam below a depth of 14 to 18 inches. It takes in water slowly and cracks when it dries.

This soil is used only as irrigated cropland, and it is well suited to that use. It produces above average yields of all adapted crops, but plowing and working the soil are difficult. (Capability unit IIs–2, irrigated)

Cherry clay, 1 to 3 percent slopes (Cb).—This soil is on gently sloping fans. It is more sloping than Cherry clay, 0 to 1 percent slopes, but is like that soil in other features.

This soil is used as irrigated and nonirrigated cropland and for grazing. It is well suited to continuous cultivation. Because the texture is clay, some crops are not well suited to irrigated areas. All crops commonly grown in the county have average or above average yields on nonirrigated lands. Both wind and water erosion are somewhat likely. (Capability unit IIIe–1, irrigated; IIIe–4, nonirrigated; Clayey range site)

Cherry clay, 3 to 8 percent slopes (Cc).—This soil is on steeper fans just below the shale uplands. It is steeper than Cherry clay, 1 to 3 percent slopes, but is like that soil in other features. Under the irrigation canal that runs through areas of this soil, the slopes are generally less than 7 percent, but the foot slopes above the canal are as much as 10 percent in places.

This soil has a grayer surface layer and subsoil than the soil described for the series, and in the lower subsoil there are more layers of different texture. A few pebbles or a few shale chips occur in some areas.

This soil is used as irrigated and nonirrigated cropland and for grazing. It is not well suited to continuous cropping under irrigation, because the risk of water erosion is severe. The best use is for hay and pasture. This soil is well suited to continuous nonirrigated crops, but both wind and water erosion are somewhat likely. Yields are average or above average for nonirrigated crops and about average for irrigated crops. (Capability unit IVe–2, irrigated; IIIe–5, nonirrigated; Clayey range site)

Cherry clay, moderately deep, 0 to 1 percent slopes (Cd).—This soil is on level terraces. Except that it is underlain by sandier material below a depth of 22 to 26 inches, this soil is similar to Cherry clay, 0 to 1 percent slopes.

This soil is used only as irrigated cropland, and it is well suited to this use. It produces above average yields of all adapted crops. (Capability unit IIs–2, irrigated)

Cherry clay, moderately deep, 1 to 3 percent slopes (Cf).—This soil is on gently sloping fans. Except that it is more sloping, it is like Cherry clay, moderately deep, 0 to 1 percent slopes.

This soil is used as irrigated and nonirrigated cropland and for grazing. It is well suited to continuous cultivation and produces average or above average yields of all adapted crops. Both wind and water erosion are somewhat likely. (Capability unit IIIe–1, irrigated; IIIe–4, nonirrigated; Clayey range site)

Cherry clay, moderately deep, 3 to 8 percent slopes (Cg).—This soil is on sloping fans. It is similar to Cherry clay, moderately deep, 1 to 3 percent slopes, in most respects. It differs mainly in being steeper. Above the irrigation canal, slopes of as much as 10 percent occur in places in areas of 1 or 2 acres. In some areas the sandier material is as close as 16 inches to the surface. A few pebbles are on the surface and in the subsoil in areas below the gravel terraces. A few shale chips are also in the subsoil in areas on the fans north of the Yellowstone River.

This soil is well suited to continuous nonirrigated crops. Under irrigation, it is best suited to hay and pasture because of the slopes. Yields are average or above average for nonirrigated crops and about average for irrigated crops. (Capability unit IVe–2, irrigated; IIIe–5, nonirrigated; Clayey range site)

Cushman Series

The Cushman series consists of soils formed in materials weathered from the underlying weakly consolidated shale or sandstone. These soils normally have a grayish-brown loam surface layer 2 to 4 inches thick; an upper subsoil of brown, noncalcareous, prismatic clay loam 4 to 6 inches thick; and a lighter colored, calcareous loam lower subsoil spotted with white lime. The weakly consolidated shale or sandstone is at a depth of 16 to 32 inches. The noncalcareous part of these soils is 6 to 8 inches thick and, under cultivation, is entirely or almost entirely mixed into the plow layer. In places, however, these soils are calcareous at the surface. Water is taken in readily but is stored in only moderate amounts because shale is near the surface. Natural fertility is high, and the content of organic matter is about average.

The Cushman soils occur mainly with the Bainville, Terry, Travessilla, and Winnett soils. They are deeper to bedrock than the Bainville and Travessilla soils, which do not have a brown, noncalcareous upper subsoil nor spots of lime in their lower subsoil. Cushman soils are not so sandy throughout as are the Terry soils. They lack the compact, clayey upper subsoil and the saline lower subsoil of the Winnett soils. They are not so clayey as the Renohill soils.

Cushman loam, 2 to 4 percent slopes (Cp).—This soil is mostly north of the Yellowstone River in the gently undulating uplands. It has a profile like the one described for the Cushman series.

Of the acreage mapped as this soil, Bainville loam accounts for about 5 to 10 percent and occurs in areas less than one-quarter acre in size. Cushman loam is on the smooth mid and lower parts of the slopes, and Bainville loam makes up the buckskin-colored spots on the top of narrow crests, ridges, and knobs above the Cushman soil. Briggsdale loam, Fort Collins loam, or McRae loam is on small fans or in narrow swales in areas of less than 3 acres. Winnett loam, in areas of less than 2 acres, also occurs.

This soil is used for both grazing and nonirrigated cropping. It is well suited to continuous nonirrigated cultiva-

tion, but the risk of erosion is moderate. In occasional years, rainfall is below average. This soil produces average or above average yields in most years. (Capability unit IIIc–1, nonirrigated; Silty range site)

Cushman loam, 4 to 8 percent slopes (Cr).—This soil is on undulating uplands. It has the profile described for the Cushman series. Slopes are more than 8 percent along some of the deeper drainageways and just below some of the sharper crests or ridges. Slopes of less than 4 percent are in narrow swales and drainageways and on small fans.

Of the acreage mapped as this soil, Bainville loam makes up about 10 to 15 percent and other soils about 5 percent. Bainville loam is on the ridges and crests in buckskin-colored spots less than 1 acre in size. Briggsdale loam, Fort Collins loam, or McRae loam is in areas of less than 5 acres on small fans and the lower parts of the longer slopes. In some parts of the county, this unit includes a few areas of Midway clay loam or Renohill clay loam less than 2 acres in size.

This soil is used for both grazing and nonirrigated cropping. It is well suited for continuous cultivation, but the risk of wind and water erosion is moderate. In most years it produces average or above average yields. (Capability unit IIIe–2, nonirrigated; Silty range site)

Cushman loam, 8 to 15 percent slopes (Cs).—This soil is on rolling uplands. Included in mapped areas are slopes of less than 8 percent along narrow drainageways and in swales, on small fans, and on the lower parts of the longer slopes. Slopes of more than 15 percent are on some of the sharper ridges and knolls and along some streams.

Of the acreage mapped as this soil, Bainville loam makes up about 10 to 20 percent and other soils about 10 percent. Bainville loam occurs on buckskin-colored ridges and crests in areas up to 1 acre in size. Briggsdale loam or McRae loam are in areas of as much as 3 acres on small fans and in swales.

This soil has an upper subsoil of heavy loam rather than one of clay loam as is described for the Cushman series. In only a few places is the noncalcareous part of the profile above the white spots of lime more than 8 inches thick. The depth to shale ranges from about 20 to 26 inches.

This soil is used mainly for grazing, but some areas have been cultivated or are now cultivated. It is not well suited for continuous nonirrigated cultivation, because the risk of erosion is high. Hay or pasture is the best use, but crops can be grown for a few years in succession. In most years yields are average or below average. (Capability unit IVe–3, nonirrigated; Silty range site)

Cushman-Bainville loams, 4 to 8 percent slopes (Ct).—This complex is on undulating uplands. It is similar to the unit mapped as Cushman loam, 4 to 8 percent slopes, but contains more Bainville loam. Cushman loam is on the smooth side slopes below the ridges and crests and makes up about 65 to 75 percent of the complex. Bainville loam is on the buckskin-colored ridges, crests, and knolls in areas of less than 2 acres in size and makes up about 15 to 25 percent of the complex. All other soils make up about 10 percent. Briggsdale loam, Fort Collins loam, or McRae loam is on the small fans or in swales, in areas less than 3 acres in size. Also included in this mapping unit are Tullock fine sandy loam on some of the ridges and crests and Winnett loam on slopes and at the head of drainageways. These soils are in areas of less than 1 acre. Both the Cushman and the Bainville loams are like the soil described for their respective series.

This complex is used as nonirrigated cropland and for grazing. It is well suited for continuous cultivation, but there is some risk of both wind and water erosion. Yields on this complex are lower than those on Cushman loam, 4 to 8 percent slopes, because the percentage of Bainville loam is higher. (Capability unit IIIe–2, nonirrigated; Silty range site)

Cushman-Bainville loams, 8 to 15 percent slopes (Cu).—These soils are on rolling to strongly sloping uplands. Their topography is similar to that of the unit mapped as Cushman loam, 8 to 15 percent slopes, but they contain a higher percentage of Bainville loam on the narrow buckskin-colored ridges and crests. Cushman loam is on the side slopes below these ridges and crests and makes up about 50 to 60 percent of the complex. Bainville loam makes up about 20 to 30 percent and occurs in areas as much as 3 acres in size. About 10 percent of the complex consists of Briggsdale, McRae, Tullock, and Winnett soils. Briggsdale loam and McRae loam are in areas less than 3 acres in size on small fans and in narrow swales. Tullock fine sandy loam or Winnett loam is in areas of less than 1 acre on some of the small ridges. A few small spots of Travessilla loam occur on some of the ridges.

These soils are used mainly for grazing, but some areas are in nonirrigated crops. Other areas have been farmed and abandoned. Continuous cultivation is not a good use, because the risk of erosion is high. These soils are best suited as range or for hay or pasture. Because the percentage of Bainville loam is high, crop yields are below average. (Capability unit IVe–3, nonirrigated; Silty range site)

Cushman-Terry fine sandy loams, 2 to 8 percent slopes (Cv).—This complex is on undulating and rolling uplands north of the Yellowstone River. It is made up of about 60 to 70 percent Cushman fine sandy loam, about 20 to 30 percent Terry fine sandy loam, and, on ridges, about 10 percent of Bainville loam, Travessilla sandy loam, Tullock fine sandy loam, or other soils. Briggsdale loam or Treasure fine sandy loam occurs in narrow swales or on fans in areas less than 2 acres in size.

This mapping unit is used for nonirrigated crops and for grazing. Some areas have been farmed but have reverted to grass. Continuous nonirrigated cropping is a suitable use, but there is a high risk of wind erosion. In most years yields are average or above average. (Capability unit IIIe–6, nonirrigated; Sandy range site)

Cushman-Tullock complex, 8 to 15 percent slopes (Cw).—This complex is on strongly rolling uplands. Cushman loam is on the side slopes below the ridges and crests and makes up about 60 to 70 percent of the mapped acreage. About 15 to 25 percent is in areas of Tullock fine sandy loam less than 2 acres in size on the top of the narrow ridges, crests, and knolls. Bainville loam makes up about 10 percent and is on some of the ridges, crests, and knolls. Briggsdale loam or Treasure fine sandy loam makes up about 5 percent and occurs in areas less than 2 acres in size in the swales, at the head of drainageways, and on the lower parts of the longer, smoother slopes.

This complex is used mainly for grazing, but some areas are or have been farmed. It is not well suited as continuous nonirrigated cropland, because the risk of erosion is high. It is best suited to hay or pasture and an occasional

year of cultivation. Yields of all crops are average or below average. (Capability unit IVe–3, nonirrigated; Cushman soil: Silty range site; Tullock soil: Sandy range site)

Cushman-Travessilla loams, 2 to 8 percent slopes (Cx).—This complex is on undulating uplands. It is made up of about 65 to 75 percent Cushman loam, about 20 to 30 percent Travessilla loam, and about 5 percent of other soils. The shallow Travessilla loam occurs on the crests and ridges in areas of as much as 2 acres. Hard sandstone crops out of the Travessilla loam in a few places. Cushman loam generally occurs on the side slopes below the crests. Winnett soils are in swales and at the head of drainageways, and Shonkin loam is in the small basins less than 2 acres in size. Occurring in places are a few small knolls of Bainville loam less than 1 acre in size.

In this mapping unit Cushman loam has a heavy loam rather than a clay loam upper subsoil and is underlain by hard sandstone below a depth of 14 to 22 inches. Travessilla loam is 8 to 14 inches deep to the sandstone.

These soils are used only for grazing, which is the best use. They are not well suited for continuous nonirrigated cultivation, because the soils are shallow. They are suited to hay or pasture and an occasional crop of small grain. Yields of crops are below average, particularly on Travessilla loam. (Capability unit IVe–6, nonirrigated; Cushman soil: Silty range site; Travessilla loam: Shallow Limy range site)

Cushman-Winnett complex (Cy) (2 to 8 percent slopes).—This complex is on undulating shale uplands. It is made up of about 60 to 75 percent Cushman loam, about 15 to 30 percent Winnett loam and clay loam, and about 10 percent other soils. Winnett loam and clay loam, in areas less than 2 acres in size, occur with a few nearly barren saline pits of varying size and shape. The other soils most common in this complex are Arvada loam or clay loam on small fans and Bainville loam or Midway clay loam on ridges and crests.

In this mapping unit Cushman loam contains more clay in the upper subsoil and is deeper to lime than the soil described for the Cushman series. The Winnett soils have a columnar or blocky upper subsoil.

This complex is used mainly for grazing, but a few small areas are farmed. Some areas have been farmed and abandoned. Continuous nonirrigated crops are not well suited. The best use is for hay or pasture and an occasional crop of small grain. In most years yields are below average. (Capability unit IVe–5, nonirrigated; Silty range site)

Dwyer Series

The Dwyer series consists of light-colored, calcareous fine sands that are loose and deep. In the top 2 to 4 inches, these soils are slightly darker colored than they are below, but fine sand extends from the surface to a depth of more than 60 inches. In some areas these soils are slightly coarser textured than normal and have a few pebbles on the surface and in the subsoil. They take in water very rapidly but have very low water-holding capacity and are droughty. Natural fertility is very low, and the content of organic matter is small. Wind erodes these soils easily.

Dwyer fine sand (Dw) (5 to 15 percent slopes).—The largest areas of this soil are in Pease Bottom where sand from the Yellowstone River was blown into dunes, which are now vegetated. Pease Bottom is on the north side of Yellowstone River, about 7 miles northwest of Hysham. In these areas the mapped areas are almost pure Dwyer fine sand. In other areas mapped as this soil, however, Treasure, Glendive, and other soils in the swales and low areas make up about 10 percent. In these swales and low areas, the fine sand is coarser than it is elsewhere and there are a few pebbles.

This soil is used only for grazing, which is its best use. It blows very easily if the plant cover is removed. Depleted range can be improved or restored by reseeding. (Capability unit VIe–2, nonirrigated; Sands range site)

Edgar Series

The Edgar series consists of deep, well-drained loams. These soils have a grayish-brown, granular loam surface layer, an upper subsoil of light olive-brown, calcareous, prismatic loam, and a lighter colored, calcareous loam lower subsoil. Many spots of white lime begin at a depth of 12 to 14 inches and extend down to as much as 40 inches. In most places the loam continues down to a depth of 5 feet or more, but in places gravelly material begins at less than 40 inches. These soils take in water readily and have high water-holding capacity. They have high natural fertility and contain the average amount of organic matter.

Edgar soils formed from the same kinds of loamy materials as the Briggsdale, Fort Collins, and McRae soils, but not so much clay is in the upper subsoil of the Edgar soils as is in that of the Briggsdale and Fort Collins soils. Also, Edgar soils are shallower to the lime. They have a browner upper subsoil than the McRae soils and contain more spots of white lime. They are not so clayey in their surface layer and subsoil as the Cherry soils.

Edgar loam, 1 to 8 percent slopes (Ed).—This soil is on undulating and sloping high benches. Dominant slopes are less than 6 percent, but in some places one-fourth of the acreage mapped is on slopes of 6 to 8 percent. This soil has the profile described for the Edgar series, but in most places a few pebbles are scattered on the surface and are in the subsoil. In places the plow layer is calcareous. About 5 to 10 percent of the acreage mapped as this soil consists of included soils on light-colored knobs and ridges, in level swales, and at the head of drainageways.

This soil is used as nonirrigated cropland and for grazing. It is well suited for continuous cultivation, but there are some risks of both wind and water erosion. It produces average or above average yields of crops. (Capability unit IIIe–2, nonirrigated; Silty range site)

Edgar loam, 8 to 15 percent slopes (Eg).—This soil is on strongly rolling and strongly sloping uplands. Included in some places are areas that have slopes of as much as 20 percent. Of the mapped acreage, 10 to 20 percent consists of light-colored calcareous soils on buckskin-colored ridges and knobs that are less than 1 acre in size and of Fort Collins loam or Hesper loam in narrow swales and at the head of drainageways. Pebbles lie on the ridges. This soil has a profile like the one described for the Edgar series.

This soil is used as nonirrigated cropland and for grazing. It is not well suited for continuous cultivation, because slopes are steep and water erosion is a severe risk. It is best suited to hay or pasture and an occasional crop

of small grain. Yields of suitable crops are favorable. (Capability unit IVe–3; nonirrigated; Silty range site)

Fattig Series

The Fattig series consists of dark-colored, well-drained soils that formed from underlying dark-colored shale. These soils have a 3- to 5-inch loam surface layer that is almost black. Their upper subsoil consists of dark-colored, blocky, noncalcareous heavy clay loam or light clay 20 to 30 inches thick. The lower subsoil is light-colored, calcareous clay loam spotted with white lime. It is underlain by shale at a depth ranging from 30 to 42 inches. These soils have good water-holding capacity and high natural fertility. The organic-matter content is high.

The Fattig soils are darker and contain more clay in their subsoil than the Cushman soils and are deeper to lime. They are darker and shallower to shale than the Briggsdale soils. Fattig soils do not have the compact clay upper subsoil that occurs in the Winnett soils.

Fattig loam (Fa) (2 to 6 percent slopes).—This soil has only a small acreage in the county. It is on undulating uplands in the northwestern part. Short slopes of as much as 10 percent surround some of the basins and border some of the deeper streams. Fattig loam is the soil described for the series.

Of the acreage mapped as this soil, other soils make up about 10 to 15 percent. Winnett loam and clay loam are in the swales and depressions, Travessilla loam is on some of the ridges, and Shonkin loam or Hoven clay is in the small undrained basins. Generally, the Winnett soils and Travessilla loam are in areas less than 2 acres in size, and the Shonkin loam or Hoven clay is in areas of less than 1 acre.

This soil is used only for grazing, but it is well suited for continuous nonirrigated cultivation. The risk of wind erosion is moderate. Yields of crops are average or above average. (Capability unit IIIc–1, nonirrigated; Silty range site)

Fattig-Travessilla complex (Fc) (4 to 8 percent slopes).—This complex is on undulating and rolling uplands in the northwestern part of the county. Slopes of less than 4 percent occur in swales, on ridges and crests, and in nearly level basins. Slopes of more than 8 percent are around most of the basins and along many of the small streams. Fattig loam makes up about 60 to 70 percent of the mapped acreage; Travessilla loam, about 20 to 30 percent; and other soils 10 to 15 percent. Fattig loam is on the smooth side slopes below ridges and crests occupied by Travessilla loam. A few flat fragments of sandstone occur in the Travessilla loam in places. The other soils in this complex are Winnett loam and clay loam in areas less than 2 acres in size, Shonkin loam or Hoven clay in undrained basins of less than 1 acre, and Briggsdale loam in narrow swales. Fattig loam is similar to the soil described for the Fattig series, except in some places where it is underlain by sandstone at a depth of less than 30 inches. Travessilla loam is 8 to 16 inches deep over the sandstone.

This complex is used only for grazing and is best for hay or pasture. It is suitable for limited use as nonirrigated cropland. Yields are below average because of the fairly large percentage of Travessilla soils. (Capability unit IVe–6, nonirrigated; Fattig soil: Silty range site; Travessilla loam: Shallow Limy range site)

Flasher Series

The Flasher series consists of dark-colored sandy soils that formed from underlying weakly consolidated sandstone. These soils have a grayish-brown fine sandy loam or loamy fine sand surface layer 6 to 10 inches thick. Their subsoil consists of pale-yellow, calcareous, structureless loamy sand. The underlying sandstone is at a depth of 10 to 40 inches. These soils take in water rapidly but have low water-holding capacity. They have low natural fertility but are above average in organic-matter content. Wind erosion is a severe hazard.

The Flasher soils have a darker colored surface layer and a sandier subsoil than the Bainville soils. They have a thicker, darker colored surface layer than the Tullock soils.

Flasher fine sandy loam, 4 to 20 percent slopes (Ff).—This soil is on rolling uplands in the southern part of the county. About 65 percent of the mapped acreage has slopes of 6 to 15 percent; about 10 percent, slopes of less than 6 percent; and about 25 percent, slopes of 12 to 20 percent. This soil ranges in thickness from about 15 inches on the crests and sharper ridges to as much as 40 inches at the lower ends of the long side slopes and in areas that have slopes of less than 15 percent.

Of the acreage mapped as this soil, about 5 percent is Flasher loamy fine sand, about 5 to 10 percent is Bainville loam, and about 5 percent is other soils. The Bainville loam occupies some of the narrow ridges and knolls. It and Flasher loamy fine sand are in areas less than 1 acre in size. The other soils are in areas less than 2 acres in size and include Terry fine sandy loam, Glendive fine sandy loam, and McRae loam. McRae loam is in swales and on small fans.

This soil is used both for grazing and as nonirrigated cropland. Crops can be grown in some years, but hay or pasture is the best use because the soil is droughty and blows readily. Low yields of most crops are produced. Intensive conservation practices are needed to control blowing. (Capability unit IVe–4, nonirrigated; Sandy range site)

Flasher fine sandy loam, 20 to 35 percent slopes (Fh).—This soil is in open stands of pine trees on hilly uplands in the southern part of the county. It ranges from about 10 to 30 inches over the sandstone and has a surface layer thinner than that of Flasher fine sandy loam, 4 to 20 percent slopes. The drainage pattern is well established. Valleys are deep and smooth, and the divides between them are rounded. Slopes of less than 20 percent are on the valley floors, the small fans, and the lower parts of long slopes. A few slopes of more than 35 percent occur along the deepest stream valleys and on some of the sharper ridges and knobs.

Of the acreage mapped as this soil, Flasher loamy fine sand makes up about 5 percent, Tullock fine sandy loam and loamy fine sand make up about 10 percent, Bainville loam makes up about 10 to 15 percent, and Havre loam, Glendive fine sandy loam, and McRae loam together make up about 5 percent. The Bainville loam is on many of the knobs. The Havre and Glendive soils are along streams on bottoms less than 100 feet wide, and the McRae

soils are on fans in areas of less than 5 acres. Sandstone crops out in a few widely scattered places on the ridges and the steep slopes along streams.

This soil is used only for grazing, which is its best use. Good management is needed for preventing excessive damage to plant cover and for producing high yields of forage. Depleted range can be improved by reseeding. (Capability unit VIe–4, nonirrigrated; Thin Sandy range site)

Flasher loamy fine sand (Fm) (6 to 20 percent slopes).—This soil occurs mainly in the southern part of the county. It is on rolling sandy uplands.

Of the acreage mapped as this soil, Dwyer fine sand makes up about 10 percent, and Bainville loam makes up about 10 percent. Large outcrops of sandstone are widely scattered throughout the mapped areas. Areas as much as 50 acres in size have been severely reworked by the wind and are choppy or hummocky (fig. 3). In these areas as much as 25 percent of the acreage is Dwyer fine sand.

Flasher loamy fine sand has a grayish-brown loamy fine sand surface layer that is 8 to 14 inches thick and is underlain by a subsoil of calcareous, pale-yellow loamy sand or fine sand. Weakly consolidated sandstone occurs at a depth of 26 to 42 inches.

This soil is used mainly for grazing, which is its best use. A few small areas have been farmed, and a few are farmed today along with larger areas of other soils. Good management is needed to prevent excessive damage to plant cover because the soil blows very easily if the cover is removed or disturbed. Yields of native grasses are high if management is good. Depleted range can be restored or improved by reseeding. (Capability unit VIe–2, nonirrigated; Sands range site)

Fort Collins Series

The Fort Collins series consists of deep, well-drained soils that formed in loamy materials. These soils have a grayish-brown loam surface layer. The upper subsoil consists of 6 to 10 inches of brown or olive-brown, noncalcareous, prismatic clay loam. Below a depth of 10 to 14 inches the lighter colored lower subsoil is calcareous loam spotted with white lime that extends to a depth of 30 to 40 inches. These soils take in water readily and have high water-holding capacity. Natural fertility is high, and the content of organic matter is average.

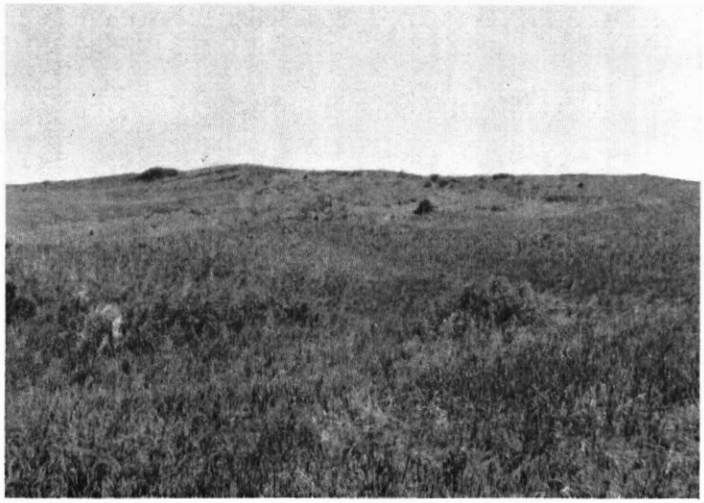

Figure 3.—**Flasher loamy fine sand showing a small blowout in the background. The vegetation is mainly sand reedgrass, skunkbush, and needle-and-thread. Sands range site.**

In the surface layer and subsoil, the Fort Collins soils are not so clayey as are the Nunn soils. Fort Collins soils have less clay in their upper subsoil than the Briggsdale soils, which formed in the same kind of material. Fort Collins soils have more clay in their upper subsoil than the Edgar and McRae soils. They are not underlain by shale within 40 inches of the surface, as are the Cushman soils.

Fort Collins loam, 0 to 1 percent slopes (Fn).—This soil is on level terraces. It has the profile like the one described for the Fort Collins series except that the material below a depth of 26 inches is more clayey. In irrigated areas all or nearly all the brown clay loam in the upper subsoil has been mixed into the plow layer by plowing to a depth of 8 to 12 inches and leveling. As a result of the mixing, this soil is calcareous in the plow layer in many places, or there is no brown upper subsoil. Less than 10 percent of the acreage mapped as this soil is Nunn clay loam, Fort Collins clay loam, or other soils.

This soil is used as irrigated and nonirrigated cropland and for grazing. It is well suited for continuous cultivation and is one of the most productive soils in the county. It is only slightly susceptible to erosion. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Silty range site)

Fort Collins loam, 1 to 4 percent slopes (Fo).—This soil is on gently sloping fans throughout the county. It is similar to Fort Collins loam, 0 to 1 percent slopes, but is slightly more sloping. Its profile is like the one described for the series.

About 5 to 10 percent of the acreage mapped as this soil is Arvada loam or clay loam and Beckton loam. These soils occur on fans, in valleys, and on uplands in areas less than 1 acre in size.

This soil is used as irrigated and nonirrigated cropland and for grazing. The less sloping areas are well suited for continuous cultivation, but areas having slopes of more than 2 percent are not well suited to row crops, because the risk of wind or water erosion is too high. On the more gently sloping areas, yields are average or above average and the risk of erosion is only moderate. (Capability unit IIe–1, irrigated; IIIc–1, nonirrigated; Silty range site)

Fort Collins loam, 4 to 8 percent slopes (Fr).—This soil is on sloping fans. Included in some mapped areas just below the uplands is a narrow band that has slopes of as much as 10 to 12 percent.

Of the acreage mapped as this soil, about 10 to 15 percent consists of Arvada, Beckton, McRae, and other soils. In places Arvada or Beckton loam occurs on fans of the uplands in areas less than 1 acre in size. McRae loam, in areas less than 2 acres in size, is included on the crests and on the upper part of some fans. Narrow strips of Havre and Lohmiller soils on narrow bottom lands and steep side slopes along narrow streams are included where streams have dissected this soil.

This soil has a subsoil that is more variable than the one described for the Fort Collins series. In places the upper subsoil is heavy loam, rather than the clay loam described, and the lower subsoil contains more layers of varied texture.

This soil is used as irrigated and nonirrigated cropland and for grazing, but it is not well suited to row crops. The risk of water erosion is high because of the strong slopes. Under irrigation, this soil is best suited to hay and pasture grown in a cropping system that includes an occasional crop of small grain. Yields are average or above average. (Capability unit IVe–1, irrigated; IIIe–2, nonirrigated; Silty range site)

Fort Collins loam, sandy substratum, 0 to 1 percent slopes (Fs).—This soil is on level terraces of the Hysham Bench. Except for the sandy substratum at a depth of 22 to 26 inches, this soil has a profile similar to the one described as representative of the Fort Collins series. Where plowing has been deepest, the surface layer is light clay loam.

This soil is used only as irrigated cropland and is well suited to that use. It produces above average yields of crops. (Capability unit I–1, irrigated)

Fort Collins loam, sandy substratum, 1 to 3 percent slopes (Ft).—This gently sloping soil is on the Hysham Bench in leveelike areas. Dominant slopes are between 1 and 2 percent.

This soil is used only as irrigated cropland. It is well suited to that use, though there is some risk of erosion. It produces above average yields of crops. (Capability unit IIe–1, irrigated)

Gilt Edge Series

The Gilt Edge series consists of deep, well-drained soils that formed from clay material and have a claypan. The surface layer of these soils is pale-brown or light-gray, platy loam or clay loam, 5 inches thick, that is underlain abruptly by an 8- to 12-inch upper subsoil consisting of brown, columnar clay. The lower subsoil is lighter colored, blocky, calcareous clay that is spotted white with lime from 14 to 16 inches down to 24 or 30 inches and has spots of gypsum below. In places coarse-textured material occurs below 40 inches. The surface layer ranges from 2 to 6 inches in thickness, and in some places the upper subsoil is blocky rather than columnar. These soils take in water slowly but have high water-holding capacity. They have high natural fertility but below average organic-matter content in the surface layer.

The Gilt Edge soils lack the strong alkalinity and strong salinity of the Arvada soils. They are better drained than the Hoven soils and have a thicker surface layer and a less compact subsoil. The Gilt Edge soils have a denser subsoil than the Bew soils.

Gilt Edge clay loam (Ga) (1 to 3 percent slopes).—This soil is on nearly level to gently undulating high benches. Slopes are short and smooth. Slopes of as much as 6 percent are included along drainageways. Gilt Edge clay loam and loam make up about 90 percent of the mapped acreage, and Arvada clay, Hoven clay, and other soils make up about 10 percent. The Gilt Edge soils are in areas well covered with grass. Arvada clay is in barren or nearly barren areas in the narrow swales or in scattered spots a few feet across. Hoven clay lies in the shallow undrained basins less than 1 acre in size.

This soil is used only for grazing, but some of it has been farmed and later abandoned. It is suited for continuous nonirrigated cultivation, and it produces average or below average yields in most years. There is some risk of wind erosion. Areas having a surface layer less than 2 inches thick and areas formerly cultivated produce vegetation similar to that of the Clayey range site. (Capability unit IIIs–2, nonirrigated; Silty range site)

Gilt Edge-Arvada complex (Gb) (1 to 4 percent slopes).—This soil is on nearly level to gently undulating high benches. Included in some of the more rolling areas and along the shallow drainageways are slopes of as much as 6 to 8 percent.

Gilt Edge clay loam and loam make up about 50 to 60 percent of the mapped acreage; Arvada clay, about 30 to 40 percent; and Hoven clay, Winnett clay, and other soils, about 10 percent. Gilt Edge clay loam and loam are in the higher areas well covered with grass that are 2 to 5 acres in size. Arvada clay is in scattered, slightly depressional, nearly barren areas of less than 1 acre. Hoven clay lies in flat undrained basins less than 2 acres in size. Some of the higher areas of ½ acre to 2 acres are occupied by Winnett clay.

The Gilt Edge soils have the profile described for the series. The surface layer of Arvada clay consists of ½ to 1 inch of light-gray loam, and it is underlain by blocky clay. In this complex the Arvada soils are not strongly alkaline and strongly saline as is the soil described for the Arvada series.

This complex of soils is used only for grazing, which is its best use. A few areas have been farmed and abandoned. Depleted or destroyed plant cover can be improved or restored by reseeding. (Capability unit VIs–4, nonirrigated; Panspots range site)

Glendive Series

The Glendive series consists of generally well-drained, deep soils that formed in alluvium and are light colored and calcareous. The soils most representative of this series have a light brownish-gray, calcareous fine sandy loam surface layer and, to a depth of 30 inches or more, a light yellowish-brown, calcareous fine sandy loam subsoil. Below a depth of 30 to 40 inches, the material is sandier than that above, and in places loose sand and gravel occur at a depth of as little as 14 inches. These soils take in water rapidly but hold only a moderate amount of it. They have moderately high natural fertility and a low content of organic matter.

These soils occur with the Banks, Havre, and Lohmiller soils. They are not so sandy in their subsoil as the Banks soils and are not so clayey as the Havre and Lohmiller soils. Glendive soils do not have a yellowish-brown sandy clay loam subsoil like that in the Treasure soils.

Glendive fine sandy loam (Gh) (less than 1 percent slopes).—This soil is on the level bottom land in the valleys of the Yellowstone and Bighorn Rivers and on the level fans at the mouth of Buckingham Coulee. On some fans slopes of up to 2 percent are included. In places loam or loose sand underlies this soil below a depth of 30 inches. Most areas of this soil that are not farmed have a rough surface. A few spots are saline, particularly those in native pasture on top of the slightly high areas in the irrigated valleys.

This soil is used mainly as irrigated cropland and for grazing. It is well suited to irrigated crops but not to nonirrigated crops. It blows easily because its surface layer is fine sandy loam. Irrigated areas under a high level of soil

and water management produce average or above average yields of most crops, but yields are below average in nonirrigated areas. (Capability unit IIs–1, irrigated; IVe–4, nonirrigated; Sandy range site)

Glendive fine sandy loam, fans (Gm) (2 to 8 percent slopes).—This soil is on the fans in the upland valleys. Slopes are mostly from 3 to 8 percent, but some of as much as 10 percent are included in places. In most areas this soil is calcareous at the surface, but on some of the larger fans it is noncalcareous in the upper 5 to 10 inches and is spotted with lime below. This soil is more sloping than Glendive fine sandy loam and lacks the sandier subsoil below a depth of 30 inches. Of the acreage mapped as this soil, 10 to 20 percent is other soils.

This soil is suitable for nonirrigated cultivation. It blows easily because it is sandy and droughty. Yields are below average in most years. (Capability unit IVe–4, nonirrigated; Sandy range site)

Glendive fine sandy loam, shallow (Gn) (less than 1 percent slopes).—This soil is on level bottom land and low terraces. It is of small extent in this county. Unlike Glendive fine sandy loam, it has loose sand and gravel at a depth of 14 to 22 inches. Water-holding capacity is very low, and natural fertility is low.

This soil is used only as irrigated cropland. Because it is shallow, it should be irrigated with care. Its best use is for hay or pasture. Yields of the adapted crops are low. (Capability unit IVs–4, irrigated)

Glendive clay (Gc) (less than 1 percent slopes).—This soil is on the level fan at the mouth of Muggins Creek. Unlike the fine sandy loam described as representative of the Glendive series, this soil has a clay surface layer, 10 to 14 inches thick, and a sandy loam or loamy sand subsoil. In some areas mapped as this soil, the surface layer is silty clay. Small seeped spots that are saline occur in a few places. This soil takes in water slowly but holds it in moderate amounts. It is hard to plow and to work. Wind erosion is a problem at times because the surface layer is fine and granular.

This soil is used only as irrigated cropland. It produces above average yields of most crops if soil and water are managed well. (Capability unit IIs–2, irrigated)

Glendive clay loam (Gg) (less than 1 percent slopes) — This soil is on the level fan at the mouth of Muggins Creek. Unlike the fine sandy loam described as representative of the Glendive series, this soil has a clay loam surface layer, 8 to 12 inches thick, that is underlain by a sandy subsoil. In some mapped areas the surface layer is silty clay loam. Also included are a few salty seeped spots.

This soil is used only as irrigated cropland. It produces above average yields of all crops if the management of soil and water is good. (Capability unit IIs–1, irrigated)

Glendive loam (Go) (less than 1 percent slopes).—This soil is on level bottom land. Unlike the fine sandy loam described as representative of the Glendive series, this soil has a loam surface layer, 10 to 14 inches thick, and a sandy loam subsoil. In nonirrigated areas, this soil has a rough surface and there are some salts in the slightly higher areas.

Included in areas mapped as this soil are small areas of Glendive clay loam, Glendive fine sandy loam, or Havre loam. The Glendive clay loam or the Havre loam is in the lower areas, and the Glendive fine sandy loam is in the slightly higher areas. These included areas make up less than 10 percent of the mapped acreage.

This soil is used as irrigated cropland and for grazing. It produces average or above average yields of most crops. (Capability unit IIs–1, irrigated; Silty range site)

Glendive loamy fine sand (Gs) (less than 2 percent slopes).—This soil is on level bottom land and on nearly level fans at the mouth of Buckingham Coulee. On the bottom land, slopes are less than one-half percent and, in unirrigated areas, have a rough surface. On the fans the slopes are less than 2 percent. Unlike the fine sandy loam described as representative of the Glendive series, this soil has a loamy fine sand rather than a fine sandy loam surface layer and subsoil. In some parts of brushy pasture, loose sand and gravel underlie this soil within 36 inches of the surface. Water enters the soil very rapidly, but water-holding capacity is low. Also low are natural fertility and organic-matter content. Because the surface layer is sandy, severe wind erosion is likely.

This soil is suitable as irrigated cropland. It is not well suited as nonirrigated cropland, because the risk of wind erosion is very high and the soil is very droughty. Under irrigation yields of most crops are about average if the management of soil and water is intensive. (Capability unit IIIs–1, irrigated; VIe–2, nonirrigated; Sands range site)

Glendive and Banks soils (Gv) (less than 1 percent slopes).—This mapping unit occurs in the thickly wooded or brush-covered bottom land along the Yellowstone and Bighorn Rivers and on some of the islands in the wider channels. Within short distances the texture of the surface layer and subsoil, as well as the depth of the soils, has variations common in Glendive soils and in Banks soils. Dominant in mapped areas are Glendive loam and fine sandy loam and Banks loam, fine sandy loam, and loamy fine sand.

The Glendive soils occur in areas 2 to 5 acres in size and make up 60 to 70 percent of the mapped acreage. Glendive loamy sand is in some of the higher areas. The Banks soils, in areas of 2 acres or less, are scattered throughout and make up 15 to 25 percent of the mapped acreage. They also occur in narrow bands along the larger and deeper overflow channels and near the main channel. Havre loam and clay loam and other soils make up 10 to 15 percent of the mapped acreage. The Havre soils are in low areas.

Most of the surface of these soils is rough. Channels are few to many; the shallow ones are more closely spaced than the deep, wider channels. Between the deep channels are areas of 1 to 5 acres or more consisting of Glendive and Havre soils that are smooth enough to farm if they are cleared and leveled. Because the cost of development is high, farming probably will be only on the smoother, less densely wooded areas. Consequently, most of the acreage in these soils probably will be used for pasture. If farming is planned, more detailed studies are needed for sorting out the best areas. (Capability unit VIs–3, nonirrigated; Glendive soil: Sandy range site; Banks soil: Shallow to Gravel range site)

Havre Series

The Havre series consists of deep, well-drained, light-colored, calcareous loams, clay loams, and clays that

formed from alluvium. The soils most representative of this series have a light brownish-gray, calcareous loam or silt loam surface layer and a light yellowish-brown, calcareous loam or silt loam subsoil. Havre soils are calcareous throughout. Between the surface layer and the subsoil, there is little or no difference in color. These soils take in water readily and have high water-holding capacity. Natural fertility is high, but the content of organic matter is low.

The Havre soils occur with the Glendive, Laurel, Lohmiller, and McRae soils. They are not so sandy as the Glendive soil and do not contain as much clay as the Lohmiller soils. Havre soils are not so wet as the Laurel soils nor so strongly saline. They do not have the brownish upper subsoil of the McRae soils or the threads of lime in the lower subsoil.

Havre loam (Hg) (less than 1 percent slopes).—This is the most extensive Havre soil in the county. It is on level bottom land and low terraces. It has the profile described as representative of the Havre series. In the valleys of Sarpy Creek and Tullock Creek, the surface layer and upper subsoil consist of very thin layers, mainly of silt loam. In places, particularly those still in pasture, this soil contains a few salts, but not enough to affect crops. In some of the native pasture, the surface is rough. At times during the cropping season, the water table is within 3 feet of the surface. In places this soil is more sandy below a depth of 24 to 30 inches than the soil described for the series, and it is underlain by loose gravel below 48 inches.

This soil is used as both irrigated and nonirrigated cropland and for grazing. Yields of nonirrigated crops are average. If the management of soil and water is good, yields of irrigated crops are above average. Parts of some of the smaller valleys are flooded at times or are irrigated by waterspreading. In these areas the vegetation is similar to that on the Overflow range site. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Silty range site)

Havre loam, high (Hh) (less than 1 percent slopes).—This soil is on level terraces. It has a profile similar to the one described for the Havre series. It is higher and better drained than Havre loam and does not have a water table within 5 feet of the surface during the growing season.

This soil is well suited as both irrigated and nonirrigated cropland and is used for those purposes and for grazing. It is one of the most productive soils in the county. Yields of all crops are above average if the management of soil and water is good. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Silty range site)

Havre loam, moderately deep (Hl) (less than 1 percent slopes).—This soil is inextensive in the county. It is shallower and droughtier than Havre loam, for loose, porous sand and gravel occur at a depth of 22 to 30 inches. Some salts occur in the areas of native pasture, but under irrigation they can be removed readily.

This soil is used only as irrigated cropland. Under irrigation it produces average or above average yields of all crops if management is good. (Capability unit IIs–1, irrigated)

Havre loam, saline (Hm) (less than 1 percent slopes).—This soil is on level bottom land. Unlike Havre loam, it contains a moderate amount of salts. About 5 to 10 percent of the mapped acreage is Hysham loam. Laurel loam or clay loam occurs in seeped areas that are less than 1 acre in size. In some areas of native pasture, this soil is rough and has channels that are 20 to 30 feet wide and as much as 5 or 6 feet deep. Salt crusts on top of some of the slightly high areas. In irrigated areas the water table is within 5 feet of the surface or less during part of the cropping season.

This soil is used as irrigated cropland and for grazing. It is suited to both irrigated and nonirrigated crops. Under irrigation, average yields of most crops common in the county can be produced. Because yields of crops are low in nonirrigated areas of this saline soil, it is best used for hay or pasture. In the small valleys of tributary streams, parts of this soil are flooded in some years. In the flooded areas and where there is waterspreading, the vegetation is similar to that on the Overflow range site. (Capability unit IIs–3, irrigated; IVs–5, nonirrigated; Silty range site)

Havre-Hysham loams (Ht) (less than 1 percent slopes).—This mapping unit is on the high, well-drained fan along Alkali Creek. It is about 60 to 80 percent Havre loam and about 20 to 40 percent Hysham loam. The Hysham loam is scattered throughout the mapped areas as hard, gray alkali spots of varied size and shape. On these spots most crops are sparse or stunted, but on the areas of Havre loam the growth of crops is good (fig. 4). The alkali spots improve through the years if they are managed with care (fig. 5). The Havre loam in this complex contains a slightly larger amount of salts in the subsoil than is typical of Havre soils, but not enough to reduce yields much.

These soils are used mainly for grazing, but some of the acreage is used for irrigated or nonirrigated cropland. Yields of some irrigated crops are average and of others are below average. These soils are not well suited as nonirrigated cropland, because there is too much Hysham loam. Grazing, improved pasture, or hay is the best use. (Capability unit IIs–3, irrigated; IVs–5, nonirrigated; Silty range site)

Havre clay loam (Hc) (less than 1 percent slopes).—This soil is on level bottom land. It is similar to the Havre loam described for the series except that it has 8 to 12 inches of clay loam over the loam subsoil. Included

Figure 4.—**Uneven growth of a 3-year-old stand of alfalfa on Havre-Hysham loams under irrigation. Growth is good on the Havre loam but is poor on the spots of Hysham loam.**

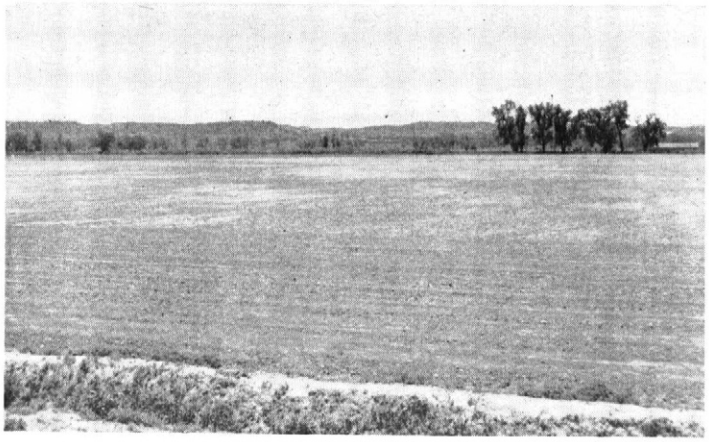

Figure 5.—**A newly leveled field of Havre-Hysham loams that shows the gray spots of Hysham loam having exposed salts.**

in the mapped acreage are areas that have a silty clay loam surface layer. Under irrigation, a few spots are salty or seeped. The water table is generally below a depth of 5 feet in irrigated areas.

This soil is used as both irrigated and nonirrigated cropland and for grazing. It is well suited to irrigated and nonirrigated crops. Yields of all crops are above average if management of soil and water is good. On parts of this soil in the small valleys that are flooded or are used for waterspreading, the vegetation is similar to that on the Overflow range site. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Havre clay loam, high (Hd) (less than 1 percent slopes).—This soil is on level terraces. It is higher and better drained than Havre clay loam, and unlike Havre loam, high, it has only 10 to 14 inches of clay loam over the loam subsoil. Included in the mapped acreage are some areas that have a silty clay loam surface layer. In places a few threads of lime occur below the plow layer. The water table is below a depth of 5 feet during the cropping season.

This soil is used mainly for irrigated crops, but small areas are still in native grass. It is one of the most productive soils in the county for both irrigated and nonirrigated crops. Yields of all crops are above average if the management of soil and water is good. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Havre clay loam, saline (Hf) (less than 1 percent slopes).—This soil is on level bottom land. It has the same kind of surface layer and subsoil as Havre clay loam, but unlike that soil, it has enough salts to reduce the yields of some crops. Included in mapped areas are small spots of Hysham clay loam. Also included are seeped, saline spots less than one-fourth acre in size. In irrigated valleys some areas of this soil that are still in pasture are rough and have salt crusted on top of the higher areas. At times during the cropping season the water level in the irrigated valleys is within 3 feet of the surface, and in the nonirrigated valleys it is below 5 feet.

This soil is used mainly for irrigated crops and for grazing, but it is fairly suitable for both irrigated and nonirrigated crops. Irrigated areas produce about average yields of most crops, and nonirrigated areas produce low yields of all crops and are better suited to hay and pasture. In some of the small valleys where parts of this soil are flooded or are used for waterspreading, the vegetation is similar to that of the Overflow range site. (Capability unit IIs–3, irrigated; IVs–5, nonirrigated; Clayey range site)

Havre clay (Ha) (less than 1 percent slopes).—This soil is on level bottom land. It is similar to Havre loam but has 8 to 12 inches of clay over the loam and silt loam subsoil. The water table is within 3 feet of the surface at times during the growing season.

Included in mapped areas are areas that have a silty clay loam surface layer. Also included, and making up about 10 percent of the mapped acreage, are areas of Lohmiller clay and Havre clay loam. In most irrigated areas there are a few salty, seeped spots less than one-half acre in size.

This soil is well suited as both irrigated and nonirrigated cropland. It produces above average yields of most crops, but it is hard to plow and to work. (Capability unit IIs–2, irrigated; IIIe–4, nonirrigated; Clayey range site)

Havre clay, saline (Hb) (less than 1 percent slopes).—This soil is on level bottom land. It is similar to Havre clay but is so saline that the selection of crops is affected, as well as the yields of those crops. Included in many places, in areas less than one-quarter acre in size, are small hard spots of Hysham clay or wet saline areas crusted with salt. The water table is within 3 feet of the surface at times during the irrigation season. In nonirrigated areas the water table is below 5 feet.

This soil is suitable as both irrigated and nonirrigated cropland. Yields are average for irrigated crops and are below average for nonirrigated crops. This soil is hard to plow and work. (Capability unit IIs–3, irrigated; IVs–5, nonirrigated; Clayey range site)

Havre and Glendive soils (Hn) (less than 1 percent slopes).—This mapping unit is in wooded or brushy areas. These areas are on bottom land along the Yellowstone and Bighorn Rivers and on islands in the rivers. The mapping unit is made up mostly of Havre loam, Glendive loam, and Glendive fine sandy loam. Havre loam makes up 60 to 70 percent and is in areas of 5 acres or more. Glendive loam and fine sandy loam make up 20 to 35 percent and are in areas of 1 acre or more. Glendive loamy fine sand; Glendive fine sandy loam, shallow; Havre loam, moderately deep; and Bank soils make up the remaining 5 to 10 percent and are in areas less than 1 acre in size. Most areas of these soils are rough; they are cut by many channels of varied width and depth. These rough areas need considerable leveling and land conditioning before they can be irrigated. Some areas up to 10 acres in size are smooth and can be farmed without too much deep leveling.

These soils are used only as pasture, but they are suited to both irrigated and nonirrigated crops. (Havre soils: capability unit I–1, irrigated; IIIc–1, nonirrigated; Silty range site; Glendive soils: capability unit IIs–1, irrigated; IVe–4, nonirrigated; Sandy range site)

Havre and Lohmiller soils (Ho) (less than 1 percent slopes).—This mapping unit is in narrow valleys of dry streams. It is made up mostly of Havre loam, Havre clay loam, Havre clay, Lohmiller clay loam, and Lohmiller clay. Included in small areas are Glendive sandy loam or Bowdoin clay. Also included are steep parts of the valley walls. Havre soils, Lohmiller soils, or both, occur in parts

of the valleys. Most of the bottom lands in these valleys are less than 100 feet wide, and some of them are cut so much by channels that they cannot be used for farming. Some parts of these valleys are flooded during periods when runoff is rapid. In some places level areas up to 5 acres or more in size are suitable for hay that can be watered by flood irrigation or by waterspreading. In these places the vegetation is similar to that on an Overflow range site.

These soils are best used as range. They produce a large amount of native forage under good management. (Capability unit VIe–3, nonirrigated; Havre soils: Silty range site; Lohmiller soils: Clayey range site)

Havre and Lohmiller soils, 8 to 15 percent slopes (Hp).—This mapping unit is along the eroded and dissected edges of the Hysham Bench. It is made up of Havre loam, Havre clay loam, Lohmiller clay loam, Lohmiller clay, and small inclusions of Glendive fine sandy loam, Hysham loam, and Hysham clay loam. From top to bottom of the slopes, the surface layer varies within short distances. The Havre and Lohmiller soils are more variable than the soils described as typical of the Havre and Lohmiller series, and they have a lower content of organic matter in the surface layer and subsoil. These soils are not so productive as the Havre and Lohmiller soils that are more nearly level.

These soils are not well suited for cultivation and are best used for hay or pasture. (Capability unit VIe–1, irrigated; IVe–3, nonirrigated; Havre soils: Silty range site; Lohmiller soils: Clayey range site)

Havre and Lohmiller soils, 15 to 35 percent slopes (Hr).—This mapping unit is along the steep and very steep eroded edges of fans and terraces. It is steeper and rougher than Havre and Lohmiller soils, 8 to 15 percent slopes, and it includes more barren or nearly barren areas. In about 40 to 50 percent of the mapping unit, slopes are more than 35 percent. Areas of one-half acre or less of barren vertical walls are common along the deep drainageways and on the slopes flanking the bottom land. Small spots of saline or alkali soils are included.

This mapping unit is used only for grazing, which is its best use. Because slopes are steep, the risk of erosion is severe if vegetation is depleted. Under good management, the volume of native forage is good. Depleted range can be restored by reseeding. (Capability unit VIe–4, nonirrigated; Havre soils: Thin Silty range site; Lohmiller soils: Thin Clayey range site)

Havre and Lohmiller soils, saline (Hs) (less than 1 percent slopes).—This mapping unit is on the narrow bottom land of streams in the uplands. It is similar to Havre and Lohmiller soils but is so saline or alkaline that the choice of suitable plants is affected. In most places the vegetation is saltgrass and greasewood. Included areas of Hysham loam or Hysham clay loam make up more than 20 percent of the mapping unit.

The valleys in which the mapping unit occurs are generally less than 200 feet wide. Many of them are rough, for they are cut by many channels. In other valleys the bottom land is smooth and suitable for hay if water is applied by flood irrigation or by waterspreading.

These soils are used mostly for grazing. Some hay is raised in areas where water is applied by waterspreading. The volume of forage is high. (Capability unit VIe–3, nonirrigated; Havre soils: Silty range site; Lohmiller soils: Clayey range site)

Hesper Series

The Hesper series consists of deep, well-drained, silty soils that formed in material containing a high percentage of silt and very fine sand. The silty material was deposited on the highest benches, mainly by wind. These soils have a grayish-brown loam or silt loam surface layer 3 to 4 inches thick. It is underlain by an upper subsoil consisting of 8 to 12 inches of brown, noncalcareous, blocky heavy silty clay loam. Beginning at 14 to 18 inches and extending to as much as 40 inches, the material is lighter colored, calcareous silt loam or loam spotted with white lime. Below 40 inches or more is calcareous loam, silt loam, or very fine sandy loam. On the high benches in the upper part of Beaver Creek and Horse Creek drainage systems, these soils have a slightly darker colored surface layer and are more silty than they are on the benches nearest the Yellowstone Valley. They are more sandy on these benches, and a few pebbles are on the surface. These soils take in water readily and have high water-holding capacity. Natural fertility is high, and the content of organic matter is average.

The Hesper soils are more silty throughout than the Briggsdale, Wanetta, and Edgar soils, and they contain more clay in their upper subsoil than the Wanetta and Edgar soils. Unlike the Wanetta soils, they are not underlain by loose sand and gravel.

Hesper loam, 1 to 4 percent slopes (Hu).—This soil is on gently sloping or gently undulating, high upland benches south of the Yellowstone River. It has the profile described as representative of the Hesper series.

The acreage mapped as this soil is 90 percent or more Hesper loam and silt loam, and the rest is other soils. Included in places is Gilt Edge clay loam or loam in areas up to 2 acres in size. In most areas mapped as this soil, Shonkin loam or Hoven clay is included in a few undrained depressions less than one-quarter acre in size. A few fragments of scoria the size of stones are on the benches at the head of Bear Creek. In places strongly calcareous gravelly loam or clay loam underlies this soil within 5 feet of the surface. On some crests and knolls, the depth to lime is as little as 8 inches.

This soil is used as nonirrigated cropland and for grazing. It is one of the most productive nonirrigated soils in the county. In fields that are summer fallowed, yields of crops are average or above average. (Capability unit IIIc–1, nonirrigated; Silty range site)

Hesper loam, 4 to 8 percent slopes (Hv).—This soil is on sloping or undulating, high upland benches south of the Yellowstone River. Included in mapped areas are small, shallow, undrained depressions of Shonkin loam or Hoven clay that are fewer in number and more widely spaced than those included with Hesper loam, 1 to 4 percent slopes. Also, on ridges and knolls, there is a larger acreage of soils that are shallow to lime. On the benches near the Yellowstone Valley, pebbles are on top of some of the ridges and knolls in areas less than one-half acre in size.

This soil is used as nonirrigated cropland and for grazing. It is well suited as nonirrigated cropland, but there is some risk of erosion. If it is summer fallowed, it pro-

duces average or above average yields of crops. (Capability unit IIIe–2, nonirrigated; Silty range site)

Hilly Gravelly Land

Hilly gravelly land (Hw) is on the steep dissected edges and eroded remnants of high terraces. It is mostly in the southern part of the county. Slopes range from 10 to 40 percent. Very gravelly sandy loams or loamy sands make up 90 percent of this land. In some places Bainville or Midway soils make up the rest and occur on steep slopes below the gravel deposits. The very gravelly sandy loams or loamy sands are underlain by loose sand or sand and gravel at a depth of 8 to 12 inches. Lime crusts the pieces of gravel. Hesper loam or Wanetta loam are on some of the smooth, narrow crests or ridges in areas of less than 2 acres.

This soil is used only for grazing. It produces only a small amount of native forage, even if management is good (fig. 6). (Capability unit VIIs–2, nonirrigated; Gravel range site)

Hoven Series

The Hoven series consists of dense clays that are saline in some places and nonsaline in others. The nonsaline clays consist of material that has been washed into undrained basins and other depressions. Their surface layer is light-gray loam 1 to 3 inches thick, and their subsoil is compact, blocky clay with grayish and brownish mottles in the lower part. In most years water ponds on the nonsaline soils for a few days to a few weeks, but the soils dry out later. Stands of vegetation are excellent in the nonsaline areas.

The saline Hoven soils are deep, strongly alkaline and very strongly alkaline, and barren or nearly barren. On the surface they have a layer of light-gray loam only 1/8 to 1/3 inch thick. It is underlain by strongly alkaline, compact, structureless clay that is spotted with gypsum at a depth of 4 to 8 inches. These spots extend to a depth of 30 to 40 inches. The pH of saline Hoven soils is 8.8 or more throughout the profile.

Hoven soils take in water very slowly but have high or very high water-holding capacity. Natural fertility is moderate or very low.

Hoven soils in the basins have a thinner surface layer and a more compact, grayer subsoil than Shonkin soils. The saline Hoven soils are more barren than the saline-alkali Marias and Pierre soils and have a more compact, denser subsoil. A salt crust has not formed on the dry saline Hoven soils. The Sage soils, in contrast, have a thin crust of salt on the surface and a high water table most of the year.

Hoven clay (Hx) (less than 1 percent slopes).—This soil does not contain enough salts to be called saline. It is in flat, undrained basins. Water stands for the longest periods in some of the lower parts of the larger basins. These areas are as large as 1 acre, and they lack vegetation or support only water-loving plants. Included in mapped areas are small areas of Arvada clay or Shonkin loam.

This soil is used only for grazing, which is its best use. It produces a large amount of grasses in most years. (Capability unit VIw–3, nonirrigated; Overflow range site)

Hoven and McKenzie soils (Hy) (0 to 4 percent slopes).—This mapping unit consists of barren clays on level and sloping fans and terraces. It is mainly in areas north of the Yellowstone River. About 90 to 95 percent of the acreage consists of McKenzie clay and of Hoven soil that is clayey but more saline than Hoven clay in the basins. Arvada clay, Sage silty clay, and Marias clay, saline-alkali, either singly or together, make up the remaining 5 to 10 percent and occur in areas as much as 1 acre in size. About 70 to 80 percent of the surface is barren. The vegetation that does grow is in closely-spaced clumps a few feet across or is widely scattered in areas as much as one-quarter acre in size (fig. 7).

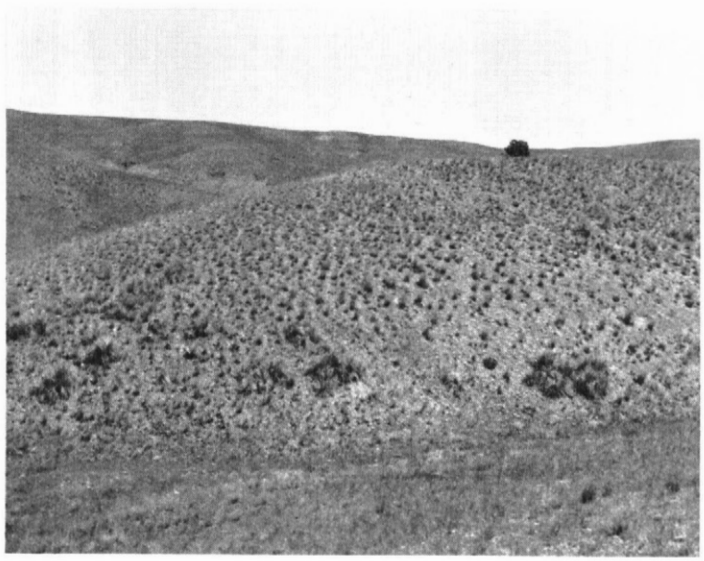

Figure 6.—**Hilly gravelly land on the steep eroded edges of high gravelly terraces. The vegetation is mainly yucca and bluebunch wheatgrass. Gravel range site.**

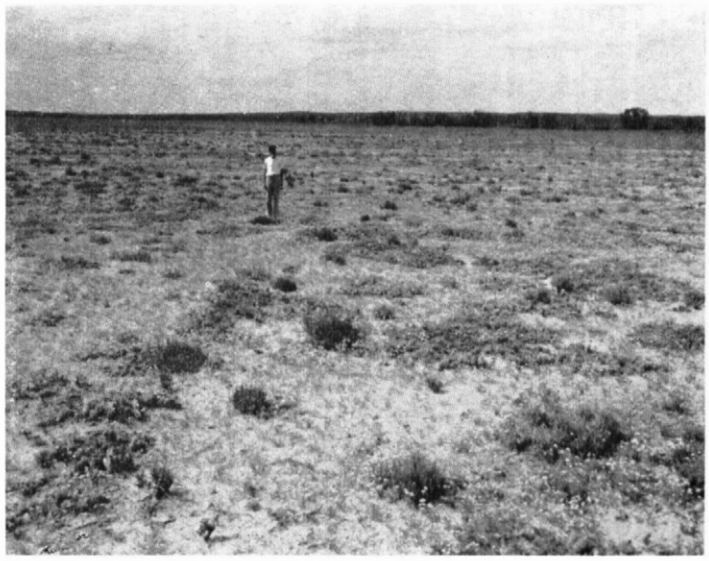

Figure 7.—**Hoven and McKenzie soils are mostly barren, but there are clumps and sparse patches of greasewood, Gardner saltbush, Sandberg bluegrass, western wheatgrass, and pricklypear cactus. Saline Upland range site.**

This complex is used only for grazing, which is its best use. The total yield of forage is very low, even if range management is good. Waterspreading in suitable places improves the native forage. (Capability unit VIIs–4, nonirrigated; Saline Upland range site)

Hysham Series

The Hysham series consists of deep, well-drained, alkali loams and clay loams that are calcareous and light colored. In grassland these soils have a light grayish-brown loam surface layer 2 or 3 inches thick. Their upper subsoil is light yellowish-brown, very hard, columnar or blocky loam or clay loam 6 to 8 inches thick. It is calcareous and strongly alkaline. Below a depth of 8 to 10 inches, the lower subsoil is strongly alkaline loam or clay loam that is softer than the material above and has a few streaks and specks of salts. In cultivated fields Hysham soils are in hard, cloddy spots that generally are in poor tilth and are poorly suited to most crops. These soils take in water very slowly but have high water-holding capacity. Natural fertility is low. Productivity and workability can be improved by managing these soils intensively for several years.

The Hysham soils occur with the Havre and Lohmiller soils but, unlike them, are alkali and contain large amounts of salts. Hysham soils do not have the grayish surface layer and the clay subsoil that are in the Arvada soils.

Hysham-Havre loams (Hz) (less than 2 percent slopes).—These soils are on the level fan along Alkali Creek. They have a higher percentage of Hysham loam than have Havre-Hysham loams. They are made up of about 60 to 80 percent Hysham loam and 20 to 40 percent Havre loam. Hysham loam occurs in hard spots of varied size and shape and supports poor stands of most crops, but Havre loam supports good stands. Most crops, therefore, grow unevenly in fields of these soils. Only crops tolerant of alkali should be grown on these soils (fig. 8).

These soils are used mainly for grazing. They are suited to irrigated crops but not to nonirrigated crops. Yields of most crops are below average. (Capability unit IVs–1, irrigated; VIe–3, nonirrigated; Silty range site)

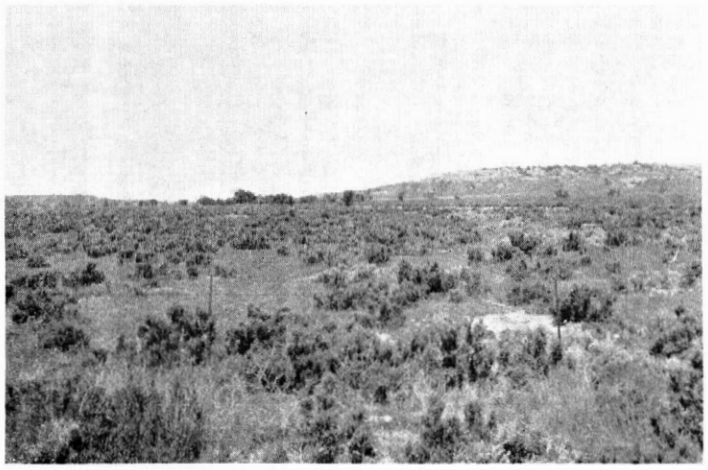

Figure 8.—**Typical vegetation on Hysham-Havre loams, mainly greasewood, big sagebrush, and western wheatgrass.**

Laurel Series

The Laurel series consists of deep, wet loams and clay loams that are very strongly saline and alkali. Salts thinly crust these soils in spots or over the entire surface. The upper 14 to 20 inches is grayish-brown, granular loam or clay loam containing an abundance of accumulated salts and gypsum that make the soil fluffy. Stratified materials as coarse textured as loamy fine sand occur below a depth of 30 inches. The concentration of salts decreases with increasing depth but is high throughout the profile. Most of the year the water table is within 5 feet of the surface and, in some places, rises to within 2 feet during the irrigation season. These soils support only salt-tolerant plants.

These soils occur with the Arvada, Cherry, and Sage soils. Laurel soils are wetter and more saline than the Arvada soils and are not so clayey in the subsoil. Unlike the nonsaline Cherry soils, Laurel soils are saline and alkali. They have a loam and clay loam subsoil, whereas the Sage soils have a clay subsoil.

Laurel clay loam (La) (less than 1 percent slopes).—This soil is on level terraces and fans. It has a light-gray loam surface layer about 1 to 2 inches thick. At a depth of 6 to 8 inches, its strongly alkaline, blocky, clayey upper subsoil grades to a lower subsoil of strongly saline, granular clay loam that contains many spots of salts and gypsum. At a depth of 12 to 16 inches, the clay loam is massive and strongly alkaline. It contains an abundance of salts and gypsum that decreases with increasing depth. Stratified loam and sandy loam occur at a depth below 30 to 40 inches. In most places the water table is below 5 feet. In other places this soil is seeped and wet and has a thin crust of salt in spots or over the entire surface. The areas of this seeped soil range from ½ acre to 10 acres.

Most areas of this soil are improved by artificial drainage, particularly those in the wetter areas. Some reclamation is needed before crops can be grown under irrigation, but full reclamation is not possible or necessary. After 10 years or more of reclamation, only limited cropping is feasible. (Capability unit IVw–1, irrigated; VIw–2, nonirrigated; Saline Subirrigated range site)

Laurel loam (Lb) (less than 4 percent slopes).—This soil is on level bottom land and low terraces. It is similar to Laurel clay loam but is loam throughout the profile. In places the soil is not seeped and crusted with salt on the surface. The dry areas of this soil resemble areas of Hysham loam. Included with this soil on slopes of as much as 5 percent are areas up to 5 acres in size. These areas are on fans just below Hysham Bench.

If this soil is drained and reclaimed, it produces low yields of adapted crops for many years, but without drainage and reclamation, this soil is not suitable for cultivation. Improving this soil takes 10 years or more, but complete reclamation is not possible. (Capability unit IVw–1, irrigated; VIw–2, nonirrigated; Saline Subirrigated range site)

Lismas Series

The Lismas series consists of shallow clays that formed in place from platy clay shale. These soils have a clay surface layer and subsoil. The surface layer is granular or crusty, and the subsoil is massive. Bedded shale occurs

at a depth of 6 to 16 inches. These soils are slightly to strongly alkaline.

The Lismas soils occur with the Midway and Pierre soils. They have a thin, crusty surface layer in areas where they occur with Pierre soils that are saline-alkali. Lismas soils are more clayey than the Midway soils and are shallower to the underlying shale than the Pierre soils.

Lismas clay (lc) (15 to 40 percent slopes).—This soil is on hilly uplands south of the Yellowstone River. In a few included areas slopes are more than 40 percent, and in others they are less than 15 percent. Included in the mapped acreage are Pierre clay and other soils. Pierre clay makes up about 10 to 20 percent of the mapped acreage, and other soils amount to about 10 percent. Lismas clay is on convex ridges and crests and on the upper and middle parts of the steeper slopes. Pierre clay is on the lower parts of some of the smoother slopes of less than 20 percent. Other included soils are Marias clay, saline-alkali, on some of the fans less than 5 acres in size; Havre and Lohmiller soils on the narrow bottom lands along streams; and small areas of Hilly gravelly land on some of the crests. In places shale crops out in areas less than one-fourth acre in size. On the slopes below the gravel benches, pebbles are scattered on the surface of this soil.

Lismas clay has a granular surface layer and is only slightly or moderately alkaline, whereas Lismas-Pierre clays, saline-alkali, have a crusty surface layer and are strongly alkaline. In most places depth to shale is more than 10 inches, but it is as little as 6 inches on the narrow crests.

This soil is used only for grazing, which is its best use. Under good management, it produces a moderate amount of native forage. Depleted plant cover can be improved or restored by reseeding. (Capability unit VIIs–1, nonirrigated; Shallow Clay range site)

Lismas-Pierre clays, saline-alkali (ld) (15 to 35 percent slopes).—These soils are on hilly to dissected shale uplands north of the Yellowstone River. In some small included areas slopes are more than 35 percent, and in others they are less than 15 percent. The mapped acreage is made up of about 50 to 60 percent Lismas clay, saline-alkali; about 30 to 40 percent Pierre clay, saline-alkali; and about 10 percent other soils. The other soils are Marias clay, saline-alkali, in swales or on fans of less than 5 acres in size; Hoven clay, saline, on the barren flats and in the valleys; and small areas of Shale outcrop less than one-fourth acre in size. Lismas clay, saline-alkali, is on the ridges and crests on the upper parts of the slopes and on the steeper, more dissected parts of the unit. Pierre clay, saline-alkali, is on the lower and smoother parts, generally on slopes of less than 25 percent.

In this mapping unit, Lismas clay has a crusty surface and is strongly alkaline. Salts and gypsum have accumulated in the upper part of weathered shale.

These soils are used only for grazing. Grazing is their best use, but even under good management yields of native forage are low. Depleted range can be improved by reseeding. (Lismas clay, saline-alkali: capability unit VIIs–1, nonirrigated; Shallow Clay range site; Pierre clay, saline-alkali: capability unit VIs–4, nonirrigated; Dense Clay range site)

Lismas-Midway complex (lf) (15 to 35 percent slopes).—This complex is on hilly shale uplands in the southern part of the county. In small included areas slopes are 3 to 10 percent. The mapped areas are made up of about 40 to 60 percent Lismas clay, about 30 to 50 percent Midway clay loam, and about 10 percent other soils. Lismas clay and Midway clay loam occur closely intermingled with each other on the slopes. On many of the crests and knolls areas less than 1 acre in size consist of Bainville loam, Bainville silt loam, or Tullock fine sandy loam. Marias clay and Marias clay, saline-alkali, are in the narrow valleys and on fans. In places shale crops out in areas of less than one-half acre.

This complex is used only for grazing, which is its best use. Much native forage can be produced if management is good. Depleted range can be improved by reseeding. (Capability unit VIe–4, nonirrigated; Thin Clayey range site)

Lismas-Shale outcrop complex (lg) (20 to 50 percent slopes).—This complex occurs both north and south of the Yellowstone River. It is rough, broken, and dissected. Lismas clay makes up about 60 to 70 percent of the complex; Shale outcrop, about 25 to 35 percent; and Pierre, Hoven, Marias, and other soils, about 5 percent. South of the river the Lismas clay has a granular surface layer, and north of the river it has a crusty surface layer and is strongly alkaline.

This complex is used only for grazing. It produces only a small amount of forage, even under good management. (Capability unit VIIs–5, nonirrigated; Shale range site)

Lohmiller Series

The Lohmiller series consists of deep, well-drained soils that are light colored and calcareous. In most places these soils have a pale-olive, granular clay loam or clay surface layer. A similarly colored clay loam and silty clay loam subsoil extends to a depth of 20 to 40 inches or more and is underlain by stratified loam, silt loam, or sandy loam. These soils take in water slowly and have high water-holding capacity. Natural fertility is high, but the supply of organic matter is very low.

The Lohmiller soils occur with the Cherry, Havre, and Hysham soils. They do not have a brownish subsoil as do the Cherry soils. Lohmiller soils have more clay in their subsoil than the Havre soils but less than the Bowdoin soils. They are not strongly alkaline, as are the Hysham soils.

Lohmiller clay loam (lo) (less than 1 percent slopes).—This soil is on level bottom land. It consists of 18 to 26 inches of clay loam underlain by loam, silt loam, and very fine sandy loam. Except that it is on bottom land rather than low terraces, it is similar to Lohmiller clay loam, high. On the bottom land the water table is within 3 feet of the surface at times during the irrigation season. In places a few seeped saline spots occur that are less than one-half acre in size.

This soil is well suited to irrigated and nonirrigated crops, and it produces yields of irrigated crops that are above average. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Lohmiller clay loam, 1 to 3 percent slopes (lr).—This soil is slightly more sloping than Lohmiller clay loam but is like that soil in other respects. The largest single area of this soil is on gently sloping fans near the town of Bighorn. Slopes are between 1 and 2 percent below the irrigation canals but are about 3 percent above them. The pro-

file of this soil is similar to the one described for the Lohmiller series, but the stratified loamy material is at a depth of only 16 to 20 inches in most places. In some areas on top of fans the clay loam surface layer is only 12 inches thick. These areas are up to 2 acres in size.

This soil is well suited to both irrigated and nonirrigated crops, and it produces yields that are average or above average. It is slightly more susceptible to erosion than the nearly level Lohmiller soils. (Capability unit IIe–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Lohmiller clay loam, fans, 0 to 1 percent slopes (Ls).—This soil is on level or nearly level fans. It has slightly less water-holding capacity than the soil described for the Lohmiller series because the clay loam surface layer and subsoil are only 16 to 24 inches thick and the sandier material is nearer the surface. This soil is similar to Lohmiller clay loam, high, but is on fans rather than low terraces and is shallower to sandier materials.

This soil is well suited to irrigated and nonirrigated crops. Yields of these crops are above average. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Lohmiller clay loam, high (Lt) (less than 1 percent slopes).—This soil is on level terraces and the lower end of the long fans. It has the profile described for the Lohmiller series.

This soil is well suited as irrigated and nonirrigated cropland. It produces above average yields of crops if the management of soil and water is good. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Lohmiller-Hysham clay loams (Ly) (less than 1 percent slopes).—These soils are on the level bottom land and terraces. Of the mapped acreage, about 75 to 85 percent is Lohmiller clay loam and 15 to 25 percent is Hysham clay loam. Hysham clay loam is scattered in hard, cloddy spots of varied shapes that are less than one-half acre in size. Lohmiller clay loam is like the soil described as representative of the Lohmiller series, but its lower subsoil contains slightly more salts. Hysham clay loam is finer textured than Hysham loam to a depth of 16 to 22 inches but is the same as Hysham loam below that depth. In places the clay loam is only 10 to 12 inches thick. In the spots of Hysham clay loam, water is taken in slowly and the hard crusty surface layer retards germination and emergence of plants. Crops grow better on the Lohmiller clay loam because more moisture is available and the surface layer is not hard and crusted. On the unit as a whole, crops grow unevenly.

These soils are suited to most crops. Yields of some crops are below average and of others are about average. (Capability unit IIs–3, irrigated; IVs–5, nonirrigated; Clayey range site)

Lohmiller clay (Lh) (less than 1 percent slopes).—This soil is on level bottom land. It is similar to the clay loam described as representative of the Lohmiller series, but its surface layer is 12 to 18 inches of clay instead of clay loam. Included in some places are areas of silty clay. A few salty, seeped spots less than 1 acre in size are also included. In the irrigated valleys the water table is within 3 feet of the surface during part of the cropping season, but it is below 5 feet in nonirrigated areas.

This soil is used mainly for irrigated crops, but it is also well suited to nonirrigated crops. Yields of most crops are above average. Plowing and working this soil are hard. (Capability unit IIs–2, irrigated; IIIe–4, nonirrigated; Clayey range site)

Lohmiller clay, high (Lm) (less than 1 percent slopes).—This soil is on level fans and low terraces. It is similar to Lohmiller clay but is higher and better drained. Also, the water table is seldom within 5 feet of the surface for long periods. Included in some mapped areas are a few spots of Hysham clay less than one-tenth acre in size.

This soil produces average or above average yields of both irrigated and nonirrigated crops. It is hard to work and to plow. (Capability unit IIs–2, irrigated; IIIe–4, nonirrigated; Clayey range site)

Lohmiller-Hysham clays (Lo) (less than 1 percent slopes).—These soils are on level bottom land and low terraces. Of the mapped acreage, about 75 to 85 percent is Lohmiller clay and about 15 to 25 percent is Hysham clay. These soils are similar to Lohmiller-Hysham clay loams, but their surface layer is clay instead of clay loam. The clay extends to a depth of 10 to 14 inches.

These soils are used mainly for grazing, but they are also suitable as cropland. Yields of some crops are average and of others are below average. (Capability unit IIs–3, irrigated; IVs–5, nonirrigated; Clayey range site)

Lohmiller clay, wet (Ln) (less than 1 percent slopes).—This soil is on level bottom land and low terraces just below the Hysham Bench. Included in areas mapped are small areas that have a clay loam surface layer. Also included are marshy areas and areas of open water in shallow drainageways 50 to 100 feet wide. The water table is at or near the surface during most of the year and is highest during the irrigation season. In areas up to 5 acres or more in size, the water is at the surface most of the year. This excess water is the result of seepage from the main irrigation canal and of using too much irrigation water for many years.

This soil consists of clay, 18 to 26 inches thick, that is underlain by loam, silt loam, and fine sandy loam. Because the soil has been wet for a long period, it is mottled and, in the wettest places, is slightly grayer than normal. After this soil is drained, salinity is evident.

In its present condition, this soil is not suitable for cultivation; it is used entirely for grazing. If it were drained and irrigated, yields of most crops would be about average. (Capability unit IVw–1, irrigated; VIw–1, nonirrigated; Subirrigated range site)

Marias Series

The Marias series consists of deep, well-drained clays that are saline-alkali in many places. When these soils dry after rains, they shrink and form deep, wide cracks. After they are again wetted, they swell and the cracks close. Because the soil material moves as the cracks open and close, the faces along the cracks are polished and grooved below a depth of 10 to 12 inches. Some of the granules from the surface layer fall into the cracks.

In areas that are not saline-alkali, the surface layer is grayish-brown, granular clay and the subsoil is lighter colored, moderately alkaline clay. White spots of lime occur below a depth of 10 to 14 inches, and accumulated gypsum occurs below 40 inches. In the saline-alkali areas, a grayish, massive crust, ¼ to ½ inch thick, covers the entire surface and seals it when these soils dry after rains. The subsoil in the saline-alkali areas is strongly alkaline or

very strongly alkaline, grayish-brown to olive-gray, blocky clay in which salts and gypsum have accumulated at a depth below 20 inches.

Except through the cracks, all Marias soils take in water slowly or very slowly, but they hold a large amount that is available to plants during the middle and latter part of the growing season. The Marias soils that are not saline-alkali have high natural fertility and an average content of organic matter. Natural fertility is low in the saline-alkali Marias soils.

Marias soils are lighter colored in the surface layer and upper subsoil than the Promise soils and have a lower content of organic matter. They are not so clayey or dense as the Bowdoin soils, and they are deeper to platy shale than the Pierre soils. The saline-alkali Marias soils occur with the saline Hoven soils and with the saline-alkali Pierre soils Their surface is not glazed and barren or nearly barren like that of the saline Hoven soils, and their subsoil is not so dense and strongly alkaline.

Marias and Promise clays (Mf) (4 to 8 percent slopes).—These soils are on rolling, high uplands mainly in the southern part of the county. Included in some areas are slopes of 8 to 10 percent, and in other areas slopes are less than 4 percent. Marias clay or Promise clay occurs separately in some areas. These soils make up about 90 percent of the mapped acreage. Midway clay loam, Lismas clay, or Pierre clay makes up about 10 percent and are on some of the knobs and narrow, sharp ridges.

Marias clay is similar to Promise clay but has a slightly lighter colored surface layer and upper subsoil and is lower in organic-matter content. Also, organic matter does not extend so deeply in the Marias soils.

These soils are well suited to nonirrigated crops and produce average or above average yields. They are susceptible to blowing because the surface layer is granular. Washing is likely because slopes are not gentle. (Capability unit IIIe–5, nonirrigated; Clayey range site)

Marias clay, saline-alkali, 0 to 1 percent slopes (Ma).—This soil is on level fans and terraces north and south of the Yellowstone River. In most areas it has a profile like the one described for the Marias series. Of the acreage mapped as this soil, about 5 percent is generally Hoven clay, saline, in scattered spots. South of the river, particularly on Hysham Bench, this soil is not so crusty as it is north of the river and small scattered spots of Hoven clay, saline, are not included in the mapped areas. Compared with Marias clay, fans, saline-alkali, this soil is more nearly level.

This soil is suitable for only limited use as irrigated cropland, and it is not well suited as nonirrigated cropland. It produces below average yields of most irrigated crops and low yields of native forage. (Capability unit IVs–2, irrigated; VIs–4, nonirrigated; Dense Clay range site)

Marias clay, saline-alkali, 1 to 10 percent slopes (Mb).—This soil is on undulating to rolling uplands north of the Yellowstone River. Slopes of 2 to 6 percent are dominant. This soil has a profile similar to the one described for the Marias series, but in some places it is underlain by shale within 42 inches of the surface.

Of the acreage mapped as this soil, Pierre clay and Pierre clay, saline-alkali, make up 10 to 15 percent. They occur, in areas 2 to 15 acres in size, in the slightly convex areas and on the slopes along the shallower drainageways. Lismas clay, saline-alkali, and Hoven clay, saline, make up 5 to 10 percent of the mapped acreage. Lismas clay, saline-alkali, is in areas ¼ acre to 2 acres in size on small ridges, knolls, and crests and on slopes along the deeper drainageways. Hoven soils are the small barren spots, or slick spots, scattered throughout the mapped areas.

This soil is used only for grazing, which is its best use. It produces only fair stands of native grasses. (Capability unit VIs–4, nonirrigated; Dense Clay range site)

Marias clay, fans, saline-alkali (Mc) (1 to 8 percent slopes).—This soil is on fans, mostly north of the Yellowstone River. It has a profile like the one described for the saline-alkali soils of the Marias series. Small barren spots of Hoven clay, saline, make up about 5 percent or less of each mapped area.

This soil is used only for grazing, which is its best use. Even under good management, stands of native grasses are only fair. (Capability unit VIs–2, irrigated; VIs–4, nonirrigated; Dense Clay range site)

Marias-Hoven clays, saline (Md) (0 to 6 percent slopes).—These soils are on undulating uplands and on fans, mostly north of the Yellowstone River. Marias clay, saline-alkali, makes up about 65 to 80 percent of the mapped acreage; Hoven clay, saline, about 15 to 30 percent; and all other soils, about 5 percent. The Marias clay, saline-alkali, is crusty, but it supports vegetation. The Hoven clay, saline, is scattered throughout the mapped areas in the barren spots 5 to 10 or more feet wide and as much as one-eighth acre in size. Pierre clay, saline-alkali, or Lismas clay, saline-alkali, occurs in the uplands on the slightly higher knobs and along drainageways. In narrow valleys along the small streams are areas of Bowdoin, Havre, Hysham, Lohmiller, and Sage soils.

The Marias clay, saline-alkali, has a profile like the one described for saline-alkali soils in the Marias series. The Hoven clay, saline, has a profile like the one described for the saline soils in the Hoven series.

This mapping unit is used only for grazing, which is its best use. Yields of forage are low, but in suitable places yields can be increased by waterspreading. Reseeding improves the cover of depleted range. (Capability unit VIs–2, irrigated; VIs–4, nonirrigated; Panspots range site)

Marias-Pierre clays, saline-alkali (Me) (4 to 10 percent slopes).—These soils are on rolling uplands north of the Yellowstone River. About 50 to 60 percent of the mapped acreage is Marias clay, saline-alkali; about 30 to 40 percent is Pierre clay, saline-alkali; and about 10 to 15 percent is Lismas clay, saline-alkali, and Hoven clay, saline. The Marias clay, saline-alkali, is in the more gently rolling areas that have slopes of less than 6 percent, and the Pierre clay, saline-alkali, is on the more strongly rolling areas that have slopes of 6 to 15 percent. The Hoven clay, saline, is scattered throughout the mapped areas in small barren spots. Lismas clay, saline-alkali, occurs on sharp narrow ridges, crests, and knolls and on the steeper slopes along the deeper drainageways.

The Marias clay, saline-alkali, has a profile like the one described for the saline-alkali soils of the Marias series. The profile of the Pierre clay, saline-alkali, is like the one described for the saline-alkali soils of the Pierre series.

These soils are used only for grazing and are suitable only for that use. If range management is good, yields of

native grasses are fair. (Capability unit VIs–4, nonirrigated; Dense Clay range site)

McKenzie Series

Only the saline phase of the McKenzie series occurs in this county. These soils are deep, strongly alkaline and very strongly alkaline clays that are barren or nearly barren. The strong or very strong alkalinity extends from the surface through the profile. The surface layer of these soils is ⅛ to ½ inch of light-gray loam. It is underlain by strongly alkaline, compact, structureless clay that is spotted with gypsum at a depth of 4 to 8 inches and extends down to a depth of about 30 or 40 inches. McKenzie soils take in water very slowly but have a high water-holding capacity. Runoff is very high. Natural fertility is very low.

McKenzie soils, saline, are more barren and have a denser, more compact subsoil than the Marias and Pierre soils, saline-alkali. They are dry and more barren than the Hoven soils in the undrained basins. McKenzie soils are dry and do not have a salt crust on the surface, whereas the Sage soils are wet, have a high water table most of the year, and have a thin crust of salt on their surface.

McKenzie soils, saline, occur only with the Hoven soils, saline, and are similar to those soils.

McRae Series

The McRae series consists of deep, well-drained soils that have a loam surface layer and subsoil. The surface layer, 2 to 4 inches thick, is grayish brown. The subsoil is browner in the upper 6 to 8 inches than it is in the lower part. These soils are generally noncalcareous to a depth of 6 to 10 inches, but in some places they are calcareous at a depth of 3 or 4 inches. Lime has accumulated in white spots or seams from a depth of 8 to 10 inches to 24 to 30 inches. These soils take in water readily and have a high water-holding capacity. Natural fertility is high, and the organic-matter content is slightly below average.

The McRae soils occur with the Bainville, Fort Collins, and Havre soils. The subsoil of the McRae soils is brownish and generally noncalcareous, but that of the Bainville soils is yellowish and strongly calcareous. In a few places contrasting shale underlies the McRae soils, but Bainville soils developed from shale, which is near the surface. The subsoil of McRae soils does not contain so much clay as that of the Fort Collins soils. McRae soils have a noncalcareous subsoil that is browner than that of the Havre soils. Havre soils are light-colored stratified loams.

McRae loam (Mk) (8 to 16 percent slopes).—This soil is on strongly sloping fans and foot slopes in narrow valleys of the uplands. Strips 50 to 100 feet wide, that have slopes of as much as 20 percent are included in mapped areas at the upper end of fans, just below the steep uplands. Also included, along the narrow deeply cut waterways, are areas of Havre and Lohmiller soils that make up less than 5 percent of the mapped areas. The included soils total 10 to 15 percent of the mapped acreage. In most places this soil has the profile described for the McRae series, but in some places the entire profile is calcareous. On some slopes shale or sandstone underlies this soil at a depth of less than 5 feet.

This soil is used as nonirrigated cropland and for grazing. It is not well suited for continuous cultivation, because the risk of erosion is severe. Grazing is the best use, but rotations can be used that consist of hay or pasture and an occasional crop of small grain. (Capability unit IVe–3, nonirrigated; Silty range site)

McRae-Bainville loams, 8 to 20 percent slopes (Ml).—These soils are on steep foot slopes of narrow valleys that are below very steep rough broken land. Of the acreage mapped as these soils, McRae loam makes up about 60 to 70 percent; Bainville loam, about 20 to 30 percent; and Havre, Lohmiller, and Cherry soils, about 10 percent. Bainville loam is on the higher lying ridges and knobs. McRae loam lies between these ridges on the smoother fans and in narrow swales and valleys. Havre and Lohmiller soils are on the steep side slopes of the deeply cut streamways and on valley bottoms that are less than 100 feet wide. Cherry clay loam is on some of the fans in areas up to 5 acres in size.

These soils are used as nonirrigated cropland and for grazing. They are not well suited to cultivation. They are best used for hay and for grazing. (McRae soil: capability unit IVe–3, nonirrigated; Bainville soil: capability unit VIe–3, nonirrigated; Silty range site)

McRae-Bainville loams, 20 to 35 percent slopes (Mm).—These soils are on the steepest fans and foot slopes in narrow valleys of the steep and rough, broken uplands. These fans are deeply cut by small drainageways that have steep, nearly barren sides with slopes of 50 to 70 percent or more. In places shale or sandstone crops out on the steep sides. About 40 to 60 percent of the mapped acreage is McRae loam; about 30 to 40 percent is Bainville loam; and about 10 to 20 percent is Cherry clay loam, Havre loam, Lohmiller clay loam, Midway clay loam, or other soils.

These soils are used only for grazing and are best suited to that use. Under favorable range management, yields of native grasses are good. Depleted plant cover can be improved or restored by reseeding. (McRae soil: capability unit VIe–3, nonirrigated; Silty range site; Bainville soil: capability unit VIe–4, nonirrigated; Thin Silty range site)

McRae and Havre loams, 0 to 1 percent slopes (Mn).—These soils are on nearly level terraces and fans, mainly those under irrigation. McRae loam and Havre loam occur together or separately in the same field. In some irrigated areas, deep tilling and land leveling have changed the appearance of McRae loam so much that it resembles Havre loam. The McRae soils and the Havre soils are like the soils described for their respective series.

These soils are well suited as irrigated or nonirrigated cropland. They are only slightly susceptible to washing or blowing. Yields of crops are above average if the management of soil and water is good. (Capability unit I–1, irrigated; IIIc–1, nonirrigated; Silty range site)

McRae and Havre loams, 1 to 4 percent slopes (Mo).—These soils are on gently sloping fans below the uplands and at the mouth of some small streams. Below irrigation canals, slopes are mainly 1 to 2 percent. Slopes of 2 to 4 percent make up about 30 to 40 percent of the mapped acreage.

These soils are well suited as irrigated or nonirrigated cropland. Yields are average or above average for all crops. Areas with slopes of more than 2 percent are sus-

ceptible to erosion and are not well suited to row crops. (Capability unit IIe–1, irrigated; IIIc–1, nonirrigated; Silty range site)

McRae and Havre loams, 4 to 8 percent slopes (Mp).—These soils are on the steeper fans just below the uplands. Where the fans merge with the uplands, narrow bands that have slopes of as much as 10 percent are included. Areas of Havre soils, 25 to 100 feet wide, occur on the bottom land along small streams in the narrow valleys of the uplands. These areas make up less than 10 percent of the mapped acreage.

These soils are limited in their use as irrigated cropland, but they are well suited as nonirrigated cropland. Yields are average or above average. Water erosion is likely. (Capability unit IVe–1, irrigated; IIIe–2, nonirrigated; Silty range site)

Midway Series

The Midway series consists of shallow, light-colored, calcareous soils that formed in place from weakly consolidated shale. These soils generally have a surface layer of light yellowish-brown, granular clay loam 2 to 4 inches thick. The olive clay loam subsoil is underlain by soft clay loam shale at an average depth of about 26 inches. The depth to shale ranges from 5 to 30 inches. These soils take in water slowly and store moderate amounts. Natural fertility is below average, and the organic-matter content is low.

The Midway soils occur with the Bainville, Lismas, and the Renohill soils. They have more clay in their subsoil than the Bainville soils but less than the Lismas soils. The upper subsoil of Midway soils is not brown and noncalcareous, as it is in the Renohill soils.

Midway clay loam, 8 to 15 percent slopes (Mr).—This soil is on strongly rolling uplands throughout the county. In depth it ranges from about 10 inches at the top of ridges to as much as 30 inches at the lower parts of slopes.

Included with this soil are other soils that make up 10 to 20 percent of the mapped acreage. Bainville loam and Flasher fine sandy loam are on some of the ridges, crests, and knobs. Cherry clay loam, Havre loam, Lohmiller clay loam, and McRae loam are on the small fans and in the narrow valleys of streams. Winnett loam or clay loam or Renohill clay loam occurs in areas only a few acres in size.

This soil is used for grazing and is best suited to that use. It produces good yields if management is good. (Capability unit VIe–3, nonirrigated; Clayey range site)

Midway clay loam, 15 to 35 percent slopes (Ms).—This soil is on hilly uplands north and south of the Yellowstone River. It is most extensive in the Hysham Hills and to the south of them. From the narrow, rounded ridges and divides, the landscape breaks sharply and slopes into the narrow valleys of streams. This soil ranges from about 5 inches in depth on the steeper slopes to about 20 inches on the more gently sloping ones. Shale or sandstone crops out on top of the divides and on many of the more exposed south- and west-facing slopes. Some areas 2 or 3 acres in size are barren or nearly barren. Included on some of the south-facing slopes are areas having slopes of 60 percent or more.

About 15 to 20 percent of the mapped acreage is Bainville loam or silt loam, and about 15 to 20 percent consists of other soils. Cherry clay loam, McRae loam, and Nunn clay loam are in areas up to 10 acres in size on small fans that have slopes of 3 to 15 percent. Havre loam and Lohmiller clay loam are in the valleys less than 200 feet wide. Lismas clay, Renohill clay loam, and Tullock fine sandy loam occur on uplands in areas less than 5 acres in size. Scattered on the top of ridges are areas of Hilly gravelly land less than 3 acres in size.

This soil is used only for grazing. It produces an average amount of native forage if management is good. (Capability unit VIe–4, nonirrigated; Thin Clayey range site)

Midway-Bainville complex (Mt) (30 to 65 percent slopes).—This complex is in the southern part of the county on hilly, strongly dissected uplands. It is at the upper end of drainage systems. Much of it is covered by open or dense stands of pines and an understory of grasses. The slopes are generally 30 to 65 percent, but a few small areas are included that have slopes of less than 30 percent or of more than 65 percent. The crests of ridges and divides are narrow, even knifelike, in many places. They are generally almost barren. The soils are normally very shallow on these ridges, or shale and sandstone crop out. Barren areas up to 3 acres in size are almost vertical on south- and west-facing slopes. Many small streams have cut deeply into the underlying shale and sandstone to form valleys generally less than 200 feet wide. The depth and texture of the soils in this complex vary greatly within short distances.

Midway clay loam makes up about 40 to 60 percent of this complex, and Bainville loam and silt loam amount to about 30 to 40 percent. Other soils are included that make up 10 to 20 percent of the mapped acreage. Cherry clay loam, Havre loam, and McRae loam are in valleys and on fans. Travessilla soils, Tullock fine sandy loam, and Hilly gravelly land are on uplands.

The soils in this complex are used for grazing. If management is good, yields of native forage are moderate. (Capability unit VIIe–1, nonirrigated; Midway soil: Thin Clayey range site; Bainville soil: Thin Silty range site)

Midway-Nihill gravelly loams (Mu) (25 to 50 percent slopes).—These soils are on hilly uplands and steep, eroded edges of benches. Small included areas have slopes of more than 50 percent or of less than 25 percent.

Midway clay loam, gravelly clay loam, and gravelly loam make up about 60 to 70 percent of the mapped acreage, and Nihill gravelly loam and very gravelly loam amount to about 20 to 30 percent. The Nihill soils are on the upper fourth of the slopes of the benches and on the crests and knolls in the hilly areas. The Midway soils are on the slopes below the Nihill soils. The Midway soils are gravelly on the lower parts of slopes where gravelly loam has moved down from the upper part and has been deposited on the weathered clay loam shale in a layer 4 to 10 inches thick. On the steepest slopes, and on some of the south- and west-facing slopes, these soils are very shallow and nearly barren, or shale and sandstone crop out. These areas are less than 1 acre in size.

These soils are used only for grazing. They produce a fair amount of native forage if range management is good. (Capability unit VIIe–1, nonirrigated; Midway soil: Thin Clayey range site; Nihill soil: Thin Silty range site)

Midway-Shale outcrop complex (Mv) (30 to 70 percent slopes).—This complex occurs throughout the county on very steep, rough, broken uplands (fig. 9). It is at the upper end of drainage systems and on the very steep side walls along many of the larger stream valleys. Included in the mapped acreage are small areas with nearly vertical barren slopes that are inaccessible to livestock. Also included are a few small benches, fans, and foot slopes that have slopes of 10 to 30 percent. The soils in this complex are extremely variable in texture and depth.

Midway clay loam, Bainville silt loam, and other soils that support vegetation make up 60 to 80 percent of the mapped acreage. The rest consists of barren or nearly barren areas of very shallow soils and outcrops of shale or sandstone. In 60 percent of the acreage, on the south- and west-facing slopes, are barren or nearly barren areas up to 10 acres in size.

The soils in this complex are used only for grazing. They produce a small amount of native forage if range management is good. (Capability unit VIIe–2, nonirrigated; Thin Breaks range site)

Nihill Series

The Nihill series consists of deep, light-colored, calcareous very gravelly loams. These soils have a light brownish-gray gravelly loam surface layer, 2 to 4 inches thick, and a light olive-brown very gravelly loam subsoil. Below a depth of about 6 inches, lime crusts are on the pebbles. The subsoil is about 50 to 70 percent gravel by volume. In some places the subsoil is looser and coarser textured below a depth of 30 to 40 inches than it is above, and shale may occur. These soils take in water readily, but their water-holding capacity is limited by the high percentage of gravel. Natural fertility is low, and the content of organic matter is below average.

The Nihill soils occur with the Bainville and Midway soils but are deeper than those soils and have a higher percentage of gravel. They are deeper and not so coarse textured as Hilly gravelly land. In Nihill soils the upper subsoil is not brown clay loam, as it is in the Beaverton soils.

Nihill gravelly loam (Na) (20 to 40 percent slopes).—This soil is on the steep eroded edges of the higher terraces. It is the soil described for the Nihill series.

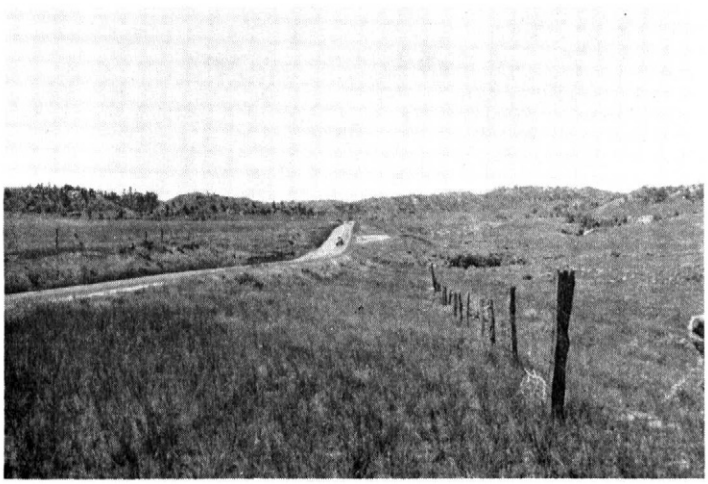

Figure 9.—**Midway-Shale outcrop complex in the background; McRae and Havre loams on the sloping fans in the foreground.**

The lower slopes in the narrow stream valleys are less than 20 percent. Slopes of more than 40 percent occur along the large streams in areas less than 30 acres in size. Some of the crests or ridges between the drainageways are smooth and wide and have slopes of 1 to 5 percent in areas less than 1 acre in size. Edgar loam or Hesper loam is on many of these crests. On some of the steeper slopes, generally the south- and west-facing ones, there are small outcrops of shale or areas of Lismas clay, Midway clay loam, or Bainville loam in areas less than 1 acre in size. In places on the steeper slopes, shale underlies these soils within 20 inches of the surface. The soils included with Nihill gravelly loam make up 10 to 15 percent of the mapped acreage.

This soil is used only for grazing, which is its best use. If management is good, yields of native forage are high. Reseeding improves or restores the depleted plant cover. (Capability unit VIe–4, nonirrigated; Thin Silty range site)

Nunn Series

The Nunn series consists of deep, well-drained soils that formed from clay loam material. Generally the Nunn soils have a grayish-brown, granular clay loam surface layer. The upper subsoil is noncalcareous, brown, prismatic light clay, and the lower subsoil is lighter colored, calcareous clay loam. White spots of lime occur between a depth of 10 to 14 inches and about 30 inches. In some places the upper subsoil is yellowish or olive-brown heavy clay loam. Below a depth of 40 inches the underlying material is loam or sandy loam in places. These soils take in water readily and have high water-holding capacity. Natural fertility is high, and the content of organic matter is average.

The Nunn soils have a browner upper subsoil than the Cherry soils and more distinct spots of lime. They are more clayey throughout than the Fort Collins soils but are not so clayey as the Bew soils.

Nunn clay loam, 0 to 1 percent slopes (Nn).—This soil is on level or nearly level terraces. It is more nearly level than Nunn clay loam, 1 to 3 percent slopes.

This soil is used entirely as irrigated cropland and is well suited to that use. The hazard of erosion is slight. If practices of soil and water management are good, yields of all crops are above average. (Capability unit I–1, irrigated)

Nunn clay loam, 1 to 3 percent slopes (No).—This soil occurs throughout the county on gently sloping fans and terraces. It is the soil described for the Nunn series.

Other included soils in areas less than 2 acres in size make up about 5 percent of the mapped acreage. Small areas of Nunn gravelly clay loam are on the fans on the Hysham Bench. In the stream valleys outside the valley of the Yellowstone River, small areas of Arvada loam, Beckton clay loam, Cherry clay loam, or Nunn clay are included.

In this soil, lime is at a depth of less than 10 inches where leveling and deep plowing have mixed the brown upper subsoil into the plow layer. In these places this soil is calcareous in the surface layer or just below it.

This soil is used mainly as irrigated and nonirrigated cropland, but the areas still in native grass are grazed. It is well suited for continuous cultivation but there are some risks of wind and water erosion. Crop yields are average and above average. Under irrigation, slopes of more than 2 percent are not well suited to row crops. (Capability unit IIe–1, irrigated; IIIc–1, nonirrigated; Clayey range site)

Nunn clay loam, 3 to 8 percent slopes (Nu).—This soil occurs throughout the county on the sloping fans just below the shale uplands. It has a profile like the soil described for the Nunn series. Slopes are as much as 10 percent in a narrow band near the upper end of the fans where they merge with the uplands.

Other soils make up about 10 percent of the mapped acreage. Below the gravel terraces, Nunn gravelly clay loam occurs in areas up to 2 acres in size. Arvada clay loam, Beckton clay loam, or Nunn clay are in areas of 1 acre or less. Of these included soils, any one or two of them may occur in a mapped area, but all of them do not.

This soil is used as irrigated and nonirrigated cropland and for grazing. It is well suited for cultivation, but there are risks of wind and water erosion. In irrigated areas this soil is used mainly for hay or pasture. It produces average or above average yields. (Capability unit IVe–1, irrigated; IIIe–2, nonirrigated; Clayey range site)

Nunn clay, 0 to 1 percent slopes (Nc).—This soil is on level terraces. It occurs only on the Hysham Bench southeast of the town of Hysham. This soil has a clay surface layer and is slightly more clayey in the upper subsoil than Nunn clay loam, 0 to 1 percent slopes, and, therefore, takes in water more slowly. It blows more easily because its surface layer is granular.

This soil is used entirely as irrigated cropland. It is hard to plow and work. Yields of all adapted crops are average or above average. (Capability unit IIs–2, irrigated)

Nunn clay, 1 to 3 percent slopes (Nd).—This soil is on gently sloping fans. Included in the areas mapped are areas of Nunn gravelly clay less than 1 acre in size.

This soil is used mainly for irrigated crops, but small areas are in nonirrigated crops or are grazed. It is well suited for cultivation, but there are risks of wind and water erosion. Yields of adapted crops are average or above average in irrigated and nonirrigated areas. (Capability unit IIIe–1, irrigated; IIIe–4, nonirrigated; Clayey range site)

Nunn clay, 3 to 8 percent slopes (Nm).—This soil is on sloping fans just below the uplands. It is similar to the soil described for the Nunn series except that its profile is more clayey in the surface layer and upper subsoil. Of the mapped acreage, other soils make up about 5 percent.

This soil is used as irrigated and nonirrigated cropland and for grazing. It is well suited to continuous nonirrigated crops, but irrigated areas are best suited to hay and pasture. Wind and water erosion are likely. Yields of adapted crops are average or above average. (Capability unit IVe–2, irrigated; IIIe–5, nonirrigated; Clayey range site)

Nunn-Beckton complex, 0 to 1 percent slopes (Nx).—This complex is on level terraces on the Hysham Bench southwest of the town of Hysham. Nunn clay and clay loam make up about 70 to 80 percent of the mapped acreage, and Beckton clay loam amounts to about 20 to 30 percent. Of some local areas up to 5 acres in size, Beckton clay loam makes up as much as 50 percent. It is scattered throughout the mapped areas as light-gray spots of varied size and shape. These spots reduce the growth of some crops. In this complex the Nunn soils have slightly more clay than the soil described for the Nunn series.

The soils in this complex are used only as irrigated cropland. They are well suited for that use. Yields of most crops are average or above average. (Capability unit IIs–2, irrigated)

Pierre Series

The Pierre series consists of light-colored, calcareous clays formed from underlying shale. The Pierre soils are saline-alkali in many places and are underlain by shale at a depth of 16 to 40 inches. When Pierre soils dry after rains, they shrink and form deep, wide cracks. After they are again wetted, they swell and the cracks close. Because the soil material moves as the cracks open and close, the faces along the cracks are polished and grooved below a depth of 10 inches. Some of the granules from the surface layer fall into the cracks.

In areas that are not saline-alkali, the surface layer is olive-gray, granular clay, 2 to 4 inches thick, and the subsoil is blocky, moderately alkaline clay underlain by shale at a depth of about 26 inches. A few spots of lime occur at a depth below 8 to 12 inches in some places. In saline-alkali areas, a light brownish-gray clay crust, ¼ to 1 inch thick, covers the entire surface and seals it when it dries after rains. The surface layer is strongly alkaline. The upper subsoil in the saline-alkali areas is strongly alkaline, grayish-brown, blocky clay. The lower subsoil is structureless and more compact than the upper subsoil. It has white spots and streaks of gypsum and other salts. Many large crystals of gypsum occur in the upper part of the shale.

Except through the cracks, all Pierre soils take in water slowly or very slowly. Pierre soils that are not saline-alkali have high water-holding capacity and are high in natural fertility, but contain less than the average amount of organic matter. They are hard to work and plow. In the saline-alkali areas of Pierre soils, natural fertility and the content of organic matter are low. Runoff is rapid.

The Pierre soils occur with the Lismas and Marias soils. They are deeper to shale than the Lismas soils but are not so deep as the Marias soils.

Pierre clay (Pa) (5 to 10 percent slopes).—This soil is on rolling shale uplands, mainly south of the Yellowstone River. It has a profile like the one described for the nonsaline areas of Pierre soils. In some mapped areas, slopes are as much as 12 percent.

About 10 to 15 percent of the mapped acreage consists of soils other than Pierre clay, which is on side slopes. Lismas clay is on the narrow top of crests or knolls in areas less than 1 acre in size. Marias clay or Marias clay, saline-alkali, occurs on the small fans or the lower parts of the longer slopes in areas less than 1 acre in size.

This soil is used mainly for grazing, but a few small areas are or have been cultivated. Nonirrigated areas can be cultivated occasionally, but risks of wind and water erosion are likely. Range is the best use. Yields of crops are about average, and yields of native grasses are high. (Capability unit IVe–7, nonirrigated; Clayey range site)

Pierre-Lismas clays (Pc) (10 to 25 percent slopes).—These soils are on strongly rolling shale uplands south of the Yellowstone River. A few areas are included that have slopes of less than 10 percent and more than 25 percent. Pierre clay is on the mid and lower parts of the slopes and makes up about 60 to 70 percent of the mapped acreage. Lismas clay is on the narrow ridges, crests, and knobs and makes up about 20 to 30 percent. It is in areas less than 30 acres in size. Other soils make up about 10 percent of the mapped acreage and are in areas of less than 5 acres. They include Marias clay, Midway clay loam, and Marias clay, saline-alkali.

Pierre clay and Lismas clay have been described for their respective series. Pierre clay ranges from about 16 inches to shale on the upper slopes to about 30 inches or more on the lower part. Lismas clay is as shallow as 6 to 8 inches to shale on top of the sharper ridges.

These soils are used only for grazing and are best suited for that use. They produce high yields of native forage. Depleted range can be improved by reseeding. (Pierre soil: capability unit VIe–3, nonirrigated; Clayey range site; Lismas soil: capability unit VIIs–1, nonirrigated; Shallow Clay range site)

Pierre-Lismas clays, saline-alkali (Pk) (10 to 25 percent slopes).—These soils are on rolling shale uplands north of the Yellowstone River. In small areas along some of the deeper streams, slopes are more than 25 percent. Pierre clay, saline-alkali, makes up about 60 to 70 percent of the mapped acreage; Lismas clay, saline-alkali, about 20 to 30 percent; and other soils, about 10 percent. Pierre clay, saline-alkali, is on side slopes below Lismas clay on the crests and ridges. Hoven clay, saline, and Marias clay, saline-alkali, in areas of less than 5 acres, are on some of the fans, in swales, or on the lower parts of the longer slopes. Shale crops out, in areas less than one-tenth acre in size, in some of the more deeply dissected areas. Pierre clay, saline-alkali, has a profile like the one described for the saline-alkali soils in the Pierre series.

In this complex the depth to shale is more than 30 inches in only a few places. The Lismas clay has a thin, crusty surface layer and is strongly alkaline.

These soils are used only for grazing and are best suited to that use. Yields of native grasses are low. Depleted plant cover can be improved or restored by reseeding. (Pierre soil: capability unit VIs–4, nonirrigated; Dense Clay range site; Lismas clay: capability unit VIIs–1, nonirrigated; Shallow Clay range site)

Promise Series

The Promise series consists of deep, dark-colored, calcareous clays. These soils have a dark grayish-brown, granular clay surface layer and an olive-gray, blocky subsoil. The upper 14 to 20 inches of the subsoil is darker than the lower part. A few white spots of lime are between depths of 10 and about 25 inches. When these soils dry after rains, they shrink and crack. The cracks are deep and wide, but they close when the soils swell after they are again wetted. Because the soil material moves as the cracks open and close, the faces along the cracks are polished and grooved below a depth of about 10 inches. In places some of the granules from the surface layer fall into these cracks. These soils take in water slowly. They have high water-holding capacity; but they release moisture slowly for the use of crops. Natural fertility is high, and the content of organic matter is above average. These soils are hard to plow and to work. They blow easily because the surface layer is fine textured and granular.

In this county Promise soils are mapped only with Marias soils in an undifferentiated soil group. Promise soils have a darker colored surface layer and upper subsoil than Marias soils.

Renohill Series

The Renohill series consists of moderately deep clay loams that formed from underlying shale. These soils have a grayish-brown, granular clay loam surface layer 3 or 4 inches thick. It is underlain by 4 to 6 inches of light olive-brown, prismatic, noncalcareous heavy clay loam or light clay. From a depth of 6 to 10 inches to shale at about 28 inches, the subsoil is lighter colored, calcareous clay loam spotted with white lime. The depth to the shale ranges from 26 to 40 inches. These soils take in water readily but have limited water-holding capacity because they are shallow to shale. Natural fertility is high, and the content of organic matter is average.

The Renohill soils are brownish and noncalcareous between depths of about 3 and 10 inches and are spotted with lime below, whereas the Midway soils are calcareous from the surface to the underlying shale and are olive colored in the upper part of the subsoil. Renohill soils are more clayey throughout than the Cushman soils but are not so clayey as the Pierre soils.

Renohill clay loam (Rn) (4 to 8 percent slopes).—This soil is on undulating uplands on smooth mid and lower slopes below crests. It is the soil described for the Renohill series. In small included areas slopes are less than 4 percent or more than 8 percent. Also included are other soils that make up 10 to 15 percent of the mapped acreage. Midway clay loam or Bainville loam is on some of the crests, ridges, and knobs in areas less than 2 acres in size. Nunn clay loam, Winnett loam, or Arvada loam is on small fans or in swales.

This soil is used mainly for grazing, but small areas are used for nonirrigated crops. It is well suited for continuous cultivation, but there are risks of wind and water erosion. Yields of nonirrigated crops are average or above average. (Capability unit IIIe–2, nonirrigated; Clayey range site)

Riverwash

Riverwash (Rw) occurs only on the flood plains of the Yellowstone River. It consists of barren bars of sand and gravel on the islands in the flood channels and adjacent to the main channels. These bars are above water most of the year, but they are unstable because the sand and gravel is shifted at times by floodwater. Willows grow in the more stable areas.

Riverwash is not used for farming, but it is good as a source of gravel and sand. (Capability unit VIIIs–1)

Sage Series

The Sage series consists mainly of deep, wet, strongly saline clays, but less saline silty clays also occur. In the clays a thin crust of salt covers a layer of light brownish-

gray, granular clay 15 to 20 inches thick. This layer has many specks and streaks of salt and gypsum. The subsoil, below a depth of 15 to 20 inches, is massive or structureless and has only a few specks of salt. In most places loam or clay loam materials underlie these soils below a depth of 40 to 50 inches. The water table is generally within 3 feet of the surface during most of the year. These soils take in water readily and have high water-holding capacity. Natural fertility is very low because these soils are highly saline and highly alkaline.

The Sage soils are more clayey throughout than the Laurel soils. They are wetter and more saline than the saline Hoven soils.

Sage clay (Sa) (less than 1 percent slopes).—This soil is on level bottom land and low terraces. It has the profile described for the Sage series. The wetness and the high water table are the results of seepage. Included in the mapped acreage is Sage silty clay or Marias clay, saline-alkali, in a few small areas of less than 1 acre. These areas make up less than 5 percent of the mapped acreage.

This soil is used only for low-yielding pasture. At present, it is not suitable for cultivated crops. If this soil is drained, reclaimed, and irrigated, it can be used for pasture and hay. Yields of all crops are low. (Capability unit IVw–1, irrigated; VIw–2, nonirrigated; Saline Subirrigated range site)

Sage silty clay (Sc) (less than 3 percent slopes).—This soil is on level terraces and gently sloping fans. Sage clay, in puffed spots, makes up about 5 percent of the mapped acreage.

Sage silty clay lacks the wetness and the salt crusts of the soil described for the Sage series. Its surface layer is light-gray loam 1 inch to 2 inches thick. It is underlain by 3 to 5 inches of strongly alkaline, brown, blocky clay. Below a depth of 4 to 7 inches and extending to 20 or 30 inches, the subsoil is strongly saline, light yellowish-brown clay containing many white specks and streaks of salts and gypsum. The lower subsoil is loam to clay loam. Although the water table of this soil is not so high as it is in Sage clay, there is enough moisture to support a good stand of native grasses.

This soil is used mostly for nonirrigated pasture, but some irrigated areas are used for hay, pasture, and other crops. It is not suitable as nonirrigated cropland, but it can be improved with reclamation and used as irrigated cropland. This soil produces low yields of most crops. (Capability unit IVs–1, irrigated; VIw–2, nonirrigated; Saline Subirrigated range site)

Shale Outcrop

Shale outcrop (Sh) consists of barren or nearly barren areas of shale that occur throughout the county. Less than 10 percent of the surface supports vegetation. In the southern part of the county, this land type is soft silty or clay loam shale on the very steep headwalls at the upper end of the drainageways. North of the river, it is made up of heavy clay shale that has bentonite layers in many places. Shale outcrop is of no value for grazing. (Capability unit VIIIs–1, nonirrigated)

Shonkin Series

The Shonkin series consists of deep, light-colored soils that formed in clayey material deposited in undrained basins and depressions. These soils have a surface layer of light-gray or light brownish-gray loam 6 to 9 inches thick. It is underlain by 3 to 5 inches of grayish, platy to blocky silty clay loam. The upper subsoil extends to a depth of 20 to 30 inches and is brown, blocky clay. The lower subsoil is lighter colored, calcareous clay loam or clay that is spotted with white lime at a depth of 36 inches. In many places on terraces, these soils are underlain by gravel within 5 feet of the surface. During most years, water ponds on these soils for short periods. Water infiltrates slowly, but the water-holding capacity is high. Natural fertility is high, but the content of organic matter is low.

In Shonkin soils the surface layer is grayish and is thicker than that in the Hoven soils, and the subsoil is brownish and less compact. Shonkin soils have a thicker surface layer than Gilt Edge soils and a blocky rather than a columnar upper subsoil.

Shonkin loam (Sk) (less than 1 percent slopes).—This soil is in the flat basins in the uplands and on the high terraces throughout the county. Because these basins do not have outlets, water ponds on the surface for short periods after heavy rains or snow melt during most years. In some years, this ponding damages crops. This soil is generally like the one described for the Shonkin series, but where it occurs with the Fattig soils, it is darker than the soil described. Hoven clay and other soils, in areas about 1 acre in size, make up about 10 percent of the mapped acreage.

Shonkin loam is used for grazing and for nonirrigated crops. It is well suited for cultivation. Except in years when it is flooded for long periods, yields of crops are above average. (Capability unit IIIc–1, nonirrigated; Overflow range site)

Terry Series

The Terry series consists of moderately deep, sandy soils that formed from underlying sandstone. The soils generally have a grayish-brown fine sandy loam surface layer 4 to 6 inches thick. It is underlain by an upper subsoil consisting of noncalcareous, brown, prismatic light sandy clay loam 6 to 10 inches thick. The lower subsoil is light-colored, calcareous fine sandy loam that is spotted with white lime at a depth of 12 to 14 inches. Sandstone or sandy shale underlies this soil at a depth of 22 to 32 inches. The brown upper subsoil ranges from heavy fine sandy loam to sandy clay loam. These soils take in water readily and have good water-holding capacity. Natural fertility is high, and the content of organic matter is average. These soils are subject to wind erosion.

The Terry soils have less clay in their upper subsoil than the Treasure soils and are shallower to bedrock. They have a noncalcareous, brown sandy clay loam upper subsoil, whereas the Tullock soils are calcareous throughout and are sandier in the subsoil. Terry soils have a higher proportion of sand than the Cushman soils.

Terry-Tullock fine sandy loams (Tf) (4 to 8 percent slopes).—These soils are on undulating uplands in the northern part of the county. Included in the mapped acreage are small areas having slopes of less than 4 percent

or more than 8 percent. Of the mapped acreage, Terry fine sandy loam makes up 60 to 70 percent; Tullock fine sandy loam, 20 to 30 percent; and other soils, 10 to 15 percent. Terry fine sandy loam is on the mid and lower parts of the side slopes below Tullock fine sandy loam on crests and rounded ridgetops. Tullock fine sandy loam is in areas up to 3 acres in size. Briggsdale loam or Treasure fine sandy loam is on small fans or in swales, in areas less than 3 acres in size. Bainville loam or Travessilla loam is on the top of some of the ridges or knobs in areas of less than 2 acres. Terry fine sandy loam and Tullock fine sandy loam are like the soils described for this respective series.

These soils are used mainly for grazing, but some areas are used for nonirrigated crops. They are well suited for continuous cultivation, but there are risks of wind and water erosion. In most years yields of crops are about average. (Capability unit IIIe–6, nonirrigated; Sandy range site)

Terry-Treasure fine sandy loams (Tm) (2 to 8 percent slopes).—These soils are mainly in the northern part of the county. Terry fine sandy loam is on the rolling uplands that have slopes of 4 to 8 percent. It makes up about 60 to 70 percent of the mapped acreage. Treasure fine sandy loam has slopes of 2 to 5 percent and is in swales, at heads of drainageways, and on fans and the lower parts of the longer slopes. It is in areas up to 5 acres or more in size and makes up about 25 to 35 percent of the mapped acreage. Tullock fine sandy loam, Travessilla fine sandy loam, or other soils are on the top of ridges or crests in areas less than 1 acre in size. They make up about 5 percent of the mapped acreage. Terry fine sandy loam has slightly more clay in the upper subsoil and is deeper to sandstone than the soil described for the Terry series. Treasure fine sandy loam is like the soil described for the Treasure series except that, in many places, it is underlain by sandstone or shale within 5 feet of the surface.

These soils are used mostly for grazing. Some areas have been farmed or are now used as nonirrigated cropland. These soils are well suited for continuous cultivation, but there are some risks of wind and water erosion. Yields of nonirrigated crops are average or above average. (Capability unit IIIe–6, nonirrigated; Sandy range site)

Terry-Winnett complex (Tn) (4 to 8 percent slopes).—This complex is on the undulating uplands in the northern part of the county. It is about 60 to 70 percent Terry fine sandy loam, about 20 to 30 percent Winnett fine sandy loam, and about 10 percent other soils. Terry fine sandy loam has more clay in the upper subsoil than the soil described for the Terry series. Winnett fine sandy loam has more sand throughout than the soil described for the Winnett series. Its upper subsoil consists of 5 to 7 inches of light brownish-gray fine sandy clay, and its lower subsoil is sandy loam or light sandy clay loam. Among the other soils in this complex are Tullock fine sandy loam and Bainville loam on the top of some ridges. These soils are in areas less than 2 acres in size. Also included are small pits that are barren and saline. They make up less than 1 percent of the total mapped acreage, but as much as 5 percent of some local areas.

This soil is used mainly for grazing, which is its best use. It is suited to nonirrigated crops, planted occasionally, but it is subject to wind and water erosion. This complex produces below average yields in most years because it includes such a high percentage of Winnett soils. (Capability unit IVe–5, nonirrigated; Sandy range site)

Travessilla Series

The Travessilla series consists of shallow, light-colored, calcareous soils over hard sandstone. These soils have a surface layer of grayish-brown loam or fine sandy loam 2 to 4 inches thick. Their subsoil of light yellowish-brown, structureless loam or fine sandy loam is underlain by the hard sandstone at a depth of 5 to 14 inches. These soils take in water readily but have very low water-holding capacity. Natural fertility is high, but the content of organic matter is below average.

The Travessilla soils are 5 to 14 inches deep to hard sandstone, whereas the Tullock soils are 10 to 40 inches to soft sandstone. Travessilla soils do not have the reddish colors of the Wibaux soil, nor the brown, noncalcareous subsoil of the Cushman soils, which are deeper and are underlain by shale.

Travessilla-Tullock fine sandy loams (Tp) (15 to 40 percent slopes).—These soils are on hilly to broken uplands. In the areas of Travessilla soils slopes are as much as 50 percent, but these areas make up only a small percentage of the mapped acreage. Travessilla fine sandy loam makes up about 40 to 50 percent of the mapped acreage; Tullock fine sandy loam, about 30 to 40 percent; other soils, about 10 to 15 percent; and Rock outcrop, about 5 percent. The Travessilla soils are on the ridges and on slopes of 10 to 50 percent. The Tullock soils have slopes of 10 to 20 percent. They are between the sandstone outcrops and on the longer slopes below the ridges of Travessilla soils. Sandstone crops out on the top of ridges and crests in the more rolling areas, and it forms ledges in the steeper areas. Included on some of the fans, in areas of less than 5 acres, are Glendive fine sandy loam or Treasure fine sandy loam. Also included are Bainville loam or Midway clay loam on isolated knobs or ridges in areas up to 5 acres in size.

These soils are used only for grazing, which is their best use. Yields of native grasses are high on the Tullock soils but low on the Travessilla soils. On the Tullock soils depleted plant cover can be restored by reseeding. (Travessilla soils: capability unit VIs–3, nonirrigated; Shallow Limy range site; Tullock soil: capability unit VIe–4, nonirrigated; Thin Sandy range site)

Travessilla-Rock outcrop complex (Tr) (30 to 70 percent slopes).—This complex is on uplands in areas that are very steep or rough and broken. Included are areas that have slopes of 70 to 80 percent. The soils in this complex make up 65 to 75 percent of the mapped acreage, and ledges and outcrops of sandstone and shale make up the rest. The soils include Travessilla loam and sandy loam, Bainville loam, and Tullock fine sandy loam and loamy fine sand.

The soils in this complex are suitable only for producing native forage, but much of the acreage is inaccessible for grazing. Yields of native forage are low. (Capability unit VIIs–3, nonirrigated; Very Shallow range site)

Treasure Series

The Treasure series consists of deep, well-drained loamy soils that formed in sandy loam material. These soils have a grayish-brown, fine sandy loam surface layer 5 to 7 inches

thick. Their upper subsoil is yellowish-brown, noncalcareous, prismatic heavy sandy clay loam or light sandy clay 10 to 15 inches thick. The lower subsoil is olive-gray, calcareous fine sandy loam that is spotted with white lime at a depth beginning 16 to 20 inches below the surface. These soils take in water readily and have high water-holding capacity. Natural fertility is high, and the content of organic matter is average. Wind erosion is a hazard.

The Treasure soils and the Glendive soils formed from the same kind of materials, but Treasure soils have more clay in their upper subsoil. They have more clay in their upper subsoil than the Terry soils and are not underlain by sandstone. Sand is more plentiful throughout Treasure soils than throughout the Briggsdale.

Treasure fine sandy loam, 2 to 4 percent slopes (Ts).—This soil is on fans between gravel terraces and within the rolling uplands. In most places it has the profile described for the Treasure series, but between the gravel terraces a few pebbles are on the surface and in the subsoil. Included in about 10 percent of the mapped acreage are Glendive fine sandy loam, Briggsdale loam, or other soils.

This soil is used for nonirrigated crops and for grazing. Some areas that were farmed have been seeded to tame grasses or have reverted to native grasses. This soil is well suited for cultivation, but wind erosion is likely because the surface layer is sandy. Yields of crops are average or above average. (Capability unit IIIe–6, nonirrigated; Sandy range site)

Treasure fine sandy loam, 4 to 8 percent slopes (Tu).—This soil is on the sloping fans below the uplands; it is also on fans between the higher terraces. Its profile is like the one described for the Treasure series. Slopes between 4 and 8 percent are dominant, but areas are included that have slopes of as much as 12 percent. These areas occur as narrow bands just below the steeper uplands. Also included, in areas less than 3 acres in size, are Briggsdale loam, Glendive loamy fine sand or fine sandy loam, and other soils. These areas make up 10 to 15 percent of the mapped acreage. In places on the foot slopes shale or other bedrock is at a depth of less than 5 feet.

This soil is used mostly for grazing and nonirrigated crops. Many areas that were farmed have been seeded to tame grasses or have reverted to native grasses. This soil is well suited for cultivation, but wind and water erosion are likely. Yields of crops are average or above average. (Capability unit IIIe–6, nonirrigated; Sandy range site)

Tullock Series

The Tullock series consists of moderately deep, light-colored, calcareous sandy soils that formed from the underlying soft sandstone. These soils have a light brownish-gray fine sandy loam surface layer 2 to 4 inches thick. Their yellowish subsoil—strongly calcareous, structureless fine sandy loam or loamy fine sand—is normally underlain by the soft sandstone at a depth of about 26 inches. The depth to the sandstone ranges from 10 to 40 inches. In places hard sandstone underlies these soils within 30 inches of the surface. These soils take in water rapidly but have low water-holding capacity. Natural fertility is moderate, and the content of organic matter is low. If plant cover is removed, these soils blow readily.

The Tullock soils have a lighter colored surface layer than the Flasher soils and a sandier subsoil than the Bainville soils. They are deeper to the sandstone than the Travessilla soils. The Tullock soils do not have an upper subsoil of brown sandy clay loam like that in the Terry soils.

Tullock fine sandy loam, 4 to 20 percent slopes (Tv).—This soil is on the rolling sandy uplands north and south of Yellowstone River. Slopes of 4 to 12 percent are dominant, but below the sandstone ledges slopes are as much as 20 percent. In some places this soil is cut by deep drainageways. About 10 percent of the mapped acreage is Tullock loamy fine sand, and about 15 percent is Bainville loam, Terry fine sandy loam, Glendive fine sandy loam, and other soils. These included soils occur in areas less than 5 acres in size.

This soil is used mainly for grazing, but a few small areas are farmed along with larger areas of other soils. Many areas have been farmed but were later seeded to tame grasses or have reverted to native grasses. This soil is not well suited to continuous nonirrigated crops. It blows easily where it is cultivated. Yields of most crops are below average, but yields of native grasses are high. This soil can be used for hay or pasture. (Capability unit VIe–3, nonirrigated; Sandy range site)

Wanetta Series

Soils of the Wanetta series formed from loam material that overlies loose sand and gravel. These soils have a grayish-brown loam surface layer 4 to 6 inches thick. Their upper subsoil is 6 to 10 inches of brown, noncalcareous, prismatic clay loam. It is underlain by a lighter colored lower subsoil of calcareous loam that has many white spots of lime at a depth of 12 to 16 inches. The loose sand and gravel are at a depth ranging from 22 to 42 inches (fig. 10). A few pebbles are on the surface and throughout these soils. In places the upper subsoil is not so brown nor so clayey as that described. These soils take in water readily but they have low to moderate water-holding capacity and are droughty because they are shallow to the gravel. Natural fertility is high and the content of organic matter is average.

The Wanetta soils are as much as 42 inches deep to the loose sand and gravel, whereas the Beaverton soils are less than 20 inches, and the Fort Collins are not underlain by sand and gravel.

Wanetta loam, 1 to 4 percent slopes (Wb).—This soil is on the nearly level to gently sloping high terraces. It is similar to the soil described for the series but has less clay in the upper subsoil. It is somewhat similar to Wanetta loam, deep, 2 to 4 percent slopes, but is underlain by loose sand and gravel at a depth of 22 to 32 inches rather than 32 to 42 inches. Totaling less than 10 percent of the mapped acreage are areas of Wanetta loam, deep, Beaverton gravelly loam, and other soils.

This soil is used mainly as nonirrigated cropland and for grazing. Some areas have been farmed but have reverted to tame grasses. Although it is shallow to gravel and low in water-holding capacity, this soil is suited to cultivation. In most years it produces lower yields of crops than the deeper Wanetta loams. (Capability unit IIIe–3, nonirrigated; Silty range site)

Wanetta loam, 4 to 8 percent slopes (Wc).—This soil is of limited extent. It is in sloping areas of high terraces between areas of Wanetta loam, 1 to 4 percent slopes, and

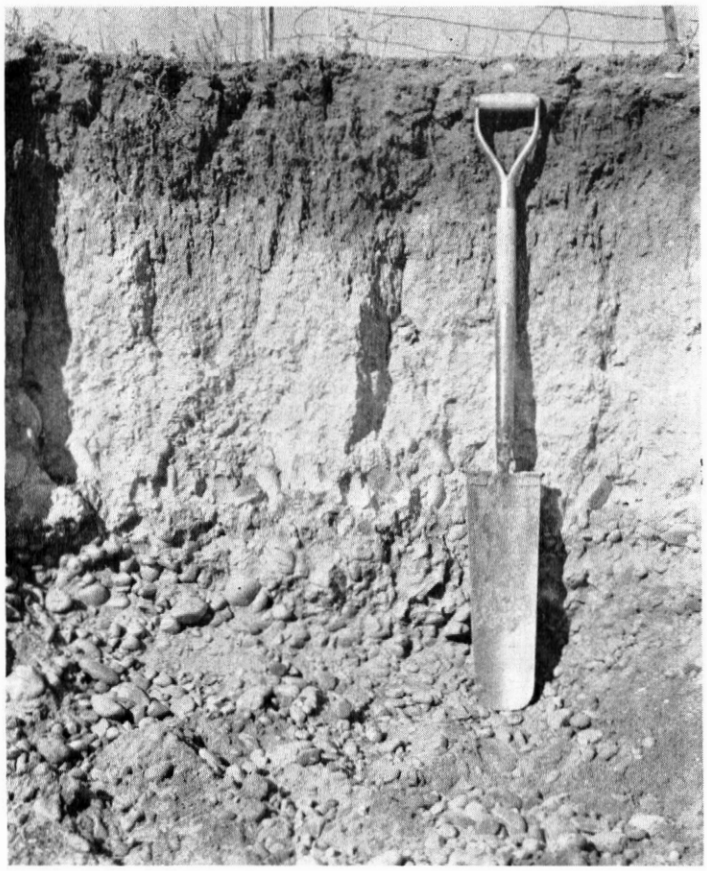

Figure 10.—**A Wanetta loam showing loose gravel at a depth of 30 inches and lime just above the gravel.**

the steeper edges of Hilly gravelly land on the slopes below. Included in the mapped acreage are a few small areas that have slopes of more than 8 percent. Also included are areas of Beaverton gravelly loam and other soils that make up less than 15 percent of the mapped acreage.

This soil is used mainly for grazing. A few areas have been used as nonirrigated cropland, but they were later seeded to tame grasses or have reverted to native grasses. This soil is suited to nonirrigated crops, but it is somewhat droughty because it is shallow to loose gravel. In most years yields are below average. (Capability unit IIIe–3, nonirrigated; Silty range site)

Wanetta loam, deep, 0 to 2 percent slopes (Wd).—This soil is on nearly level terraces. It is the soil described for the Wanetta series. Included in the mapped acreage are areas of Wanetta soil that have a sandy clay loam surface layer. Also included are areas of other soils that total less than 5 percent of the mapped acreage. Beaverton gravelly loam is on top of knobs in areas of less than one-half acre, and Shonkin loam is in undrained basins in areas of less than 1 acre.

This soil is used mainly as nonirrigated cropland, but some areas are grazed. A few fields have been seeded to tame grasses. This soil is well suited for cultivation and produces average to above average yields in most years. There is some risk of wind erosion. (Capability unit IIIc–1, nonirrigated; Silty range site)

Wanetta loam, deep, 2 to 4 percent slopes (Wm).—This soil is on the gently sloping to gently undulating high terraces. It has a profile similar to the one described for the Wanetta series. Of the acreage mapped as this soil, about 10 percent is Beaverton gravelly loam and other soils.

This soil is used mainly as nonirrigated cropland. Some areas are still in native range or have been seeded to tame grasses. This soil is suited for cultivation, but there is some risk of erosion. Yields are about average or above average. (Capability unit IIIc–1, nonirrigated; Silty range site)

Wanetta loam, deep, 4 to 8 percent slopes (Wn).—This soil is on the more sloping parts of the high benches and along the bench edges. It is limited in extent. Its profile is similar to the one described for the series but has slightly less clay in the upper subsoil. About 15 to 20 percent of the acreage mapped is other soils such as Beaverton gravelly loam and a sandier soil on some of the tops of the crests and knobs.

This soil is used mainly as nonirrigated cropland, but some areas are still in native range or are seeded to tame grasses. It is suited for cultivation and produces about average yields. In cultivated areas both wind and water erosion are likely. (Capability unit IIIe–2, nonirrigated; Silty range site)

Wibaux Series

The Wibaux series consists of the shallow and very shallow, reddish soils that formed in place from red beds of baked shale or clinkers. These soils have a surface layer of stony or shaly loam 2 or 3 inches thick that is only slightly darker than the stony or shaly loam subsoil. The hard, reddish bedrock is at a depth of 5 to 15 inches. The upper part of this rock is fractured, and the fragments are crusted with lime. These soils take in water readily but have very low water-holding capacity. Natural fertility is high. The Wibaux soils are redder than the Travessilla soils.

Wibaux-Rock outcrop complex (Wr) (30 to 70 percent slopes).—This complex is in the very steep, broken areas in the southwestern part of the county. About 60 to 70 percent of the complex is Wibaux stony and shaly loam, about 25 to 35 percent is Rock outcrop, and about 5 percent consists of soils on colluvial slopes below the rock ledges. The Wibaux soil has the profile described for the Wibaux series.

This mapping unit is used only for grazing, but some small areas are steep and inaccessible to livestock. Only a small amount of native forage is produced. (Capability unit VIIs–3, nonirrigated; Very Shallow range site)

Winnett Series

The Winnett series consists of light-colored soils that formed from underlying shale and have a claypan. In most places these soils have a surface layer of light brownish-gray loam 6 inches thick. It is abruptly underlain by a strongly alkaline upper subsoil that consists of dark grayish-brown, columnar clay 10 inches thick. A lighter colored lower subsoil of clay loam is calcareous and spotted white with salts and gypsum. Depth to the underlying shale is generally about 30 inches.

The surface layer ranges from 2 to 7 inches in thickness. In places the upper subsoil is not so dense as normal and has blocky rather than columnar structure. Also, the lower subsoil is spotted with lime, in places, rather than with salts and gypsum. The depth to shale ranges from 22 to 40 inches.

These soils take in water slowly but have good water-holding capacity. They are low in natural fertility and contain only a small amount of organic matter.

The Winnett soils occur with the Cushman, Fattig, and Renohill soils and have a more clayey, a more compact, and a more strongly alkaline subsoil. Winnett soils have a more strongly alkaline subsoil than Gilt Edge soils and are underlain by shale instead of coarse-textured material. They are not so saline as Arvada soils.

Winnett complex (Wt) (2 to 8 percent slopes).—This complex is on undulating to rolling uplands. About 70 to 80 percent of the complex is Winnett loam and clay loam, about 20 to 25 percent is other soils, and about 5 percent is barren or nearly barren saline pits. In most places Winnett soils are between the pits in vegetated areas of varied size and shape. Cushman loam, Renohill clay loam, or other soils occur in areas up to 10 acres in size. Also in this complex is a soil having a grayish surface layer and a blocky clay subsoil. Winnett loam has a profile like the one described for the Winnett series except that in much of the mapped acreage, the surface layer is only about 2 inches thick.

This complex is used mainly for grazing, which is its best use. A few small areas have been farmed and abandoned, and a few still are farmed. Yields are generally low. If management is good, yields of native forage are favorable. Depleted rangeland or abandoned cropland can be improved by seeding. (Capability unit VIs–4, nonirrigated; Panspots range site)

Winnett-Fattig complex (Wx) (2 to 6 percent slopes).—This complex is on the undulating uplands in the northwestern part of the county. About 40 to 60 percent of the complex is Winnett soil that has a loam, clay loam, or sandy loam surface layer, about 25 to 35 percent is Fattig loam, about 5 to 10 percent is other soils, and about 10 to 15 percent is barren pits. The Fattig, Winnett, and other soils are in the vegetated areas between small, barren areas. The Winnett soils in this complex have a profile similar to the one described for the Winnett series except that the texture of the surface layer varies and the surface layer and upper subsoil are darker colored.

This mapping unit is used only for grazing, which is its best use. It produces moderate yields of native forage if management is good. Depleted range can be improved by reseeding. (Capability unit VIs–4, nonirrigated; Panspots range site)

Use and Management of Soils

The soils of Treasure County are used mainly for pasture and range and for irrigated and nonirrigated crops. This section explains how the soils may be managed for these main purposes, and also for windbreaks and for building highways, farm ponds, and other engineering structures. It also gives the predicted yields of principal irrigated and nonirrigated crops. The method of presenting information is that of describing general practices suitable for all the soils, then grouping the soils that require similar management, describing the group, and suggesting suitable practices of management.

Management of Irrigated Cropland

The main objectives in the use of irrigated soils in Treasure County are (1) maintaining and increasing fertility; (2) using irrigation water effectively; (3) reducing soil erosion; and (4) effectively managing saline and alkali soils.

Maintaining fertility

In this county most of the soils used for irrigated crops have moderate or high natural fertility, but their plant nutrients and organic matter are gradually depleted if the soils are continuously cropped for long periods without good management. If continuous cropping under poor management continues long enough, yields may fall so low that the farmer does not make a profit.

But most of the soils in the county respond well to good management within a short period. This management provides a cropping system that includes a legume much of the time, the application of mineral fertilizer and barnyard manure, and the use of a green-manure crop. The mineral fertilizer supplies plant nutrients that the crops need, and the barnyard manure and the green manure supply organic matter that improves the soils.

The mineral fertilizer supplies nutrients that last for the year of application and, particularly the phosphatic fertilizer, has a residual carryover for future years. Most of the nitrogen fertilizer, however, is used up during the year of application. The kinds and amounts of fertilizer should be applied as indicated by soil tests and according to the needs of the crop. The farmer must decide the kinds and amounts of fertilizer to use. He is guided by the level of yields he wishes and by the amount of money he wants to invest in commercial fertilizer.

Proper use of irrigation water

If irrigation water is to be used efficiently, it must be applied by good methods in a system of irrigation that is suited to the soils and to the crop. Skilled preparation of land is needed to achieve good control of water. If a field has not been prepared properly, some parts of it receive too little water and other parts receive too much. If too much water is used in irrigation, some is lost in surface runoff and some leaches soluble plant nutrients out of the reach of roots. Leaching can be wasteful of plant nutrients, particularly of nitrogen, because a large amount of that nutrient is in soluble form.

Applying too much water also may raise the water table in an area and cause the area to be highly saline. In many places in the county, the soils have already been made saline in this way. If the water table in an area is continually raised by irrigation, the area may become so saline that it has to be abandoned as cropland unless costly practices are used to reclaim it.

Irrigation systems should be designed to fit the needs of the soil and of the crop to be grown. Applying water at an appropriate rate is important. Because the basic intake rate of soils may vary within a single field, the water should be applied at the rate that is most effective for most of the field. In many places the length of runs is deter-

mined by a difference in soil that causes a sharp change in the basic intake rate. A difference in slope also may call for installing a different kind of irrigation system or for adjusting the length of runs and rate of application.

In fields having a slope of 2 percent or less the down-slope-furrow method can be used if row crops are grown, and the border-dike method can be used for hay, small grain, and pasture. The border-dike method can be used for irrigating hay, small grain, and pasture on some soils that have slopes of as much as 4 percent. If row crops are grown on slopes of more than 2 percent, contour furrowing is the best method of irrigation. Generally, row crops should not be grown on slopes of more than 4 percent. The contour-ditch method can be used for irrigating hay, small grain, and pasture on all soils having a slope of more than 1 percent, but this method is most effective in the more sloping areas where the border method cannot be used. A sprinkler system can be used effectively on most soils that have slopes of as much as 15 percent.

Reducing soil erosion and soil deterioration

Losses through soil erosion cannot be stopped completely, but they can be kept low enough so that good yields are maintained. Under irrigation the amount of soil lost through washing is proportional to the slope, or fall, of the land. The steeper the land, the greater the risk of erosion. Much of the eroded material is not moved off the field but is moved only from the higher end to the lower. As this process goes on, the material deeper in the soil profile is slowly exposed. Because in most soils this material is less suitable for plants than the surface soil, yields are lower or the cost of production is increased.

As the soil moves off the top, material within the soil also moves. The more soluble plant nutrients are dissolved and leached deep into the soil below the root zone. These materials are eventually lost as water percolates downward and carries them into streams through subsurface drainage.

These losses of soil and nutrients can be reduced by using good practices of soil and water management. One good practice is using the soils for the purpose for which they are best suited. Other good practices are growing the best adapted crops in a good cropping system and using fertilizer and appropriate methods of irrigation.

Management and use of saline and alkali soils

In this county the productivity of many acres of irrigated land has been lowered by salinity and alkalinity that are the result of seepage from irrigation canals and of the overuse or unwise use of irrigation water. Some soils in the county, however, were saline and alkaline before irrigation was started. In these areas a rise in the level of ground water has increased salinity or alkalinity. Soils affected by salts require special remedial measures and management practices.

The two kinds of soils affected by salts in Treasure County are (1) those that contain excessive amounts of soluble salts, such as the Laurel, and (2) those that contain an abundance of adsorbed sodium, such as the Arvada and Hysham. Soils affected mainly by large quantities of soluble salts are called saline soils, and those affected by sodium are called sodic, or alkali, soils.

Saline soils can be reclaimed more easily than sodic soils. Where adequate drains can be installed, the concentrations of salts can be reduced by heavy irrigation. The irrigation water helps to leach the salts from the root zone. Sodic soils generally are more slowly permeable than saline soils and do not permit water to move downward so rapidly. In some places an amendment, such as gypsum, may be needed to improve chemical and physical properties of sodic soils before further reclamation is undertaken. Because applying chemical amendments is generally expensive, the soils should be tested to determine whether these amendments are needed.

In many places completely reclaiming saline or sodic soils is not practical, because of the high cost of amendments, the difficulty in providing and maintaining adequate drainage, or the slow permeability of the soils. Soils that cannot be reclaimed completely can be cropped if suitable cropping systems and management practices are used.

The management practices suitable for saline and alkali soils include (1) the selection of crops or crop varieties that produce satisfactory yields under moderately saline conditions; (2) the use of land preparation and tillage methods that aid in the control or the removal of salts and alkali; (3) the use of special planting procedures that minimize the concentrations of salts around the seed; (4) the use of irrigation methods that maintain a relatively high content of moisture in the root zone during the growing season and, at the same time, allow for periodic leaching of the soil; (5) the maintenance of water-conveyance and drainage systems; and (6) the use of special treatments, such as addition of chemical amendments, where needed, heavy applications of organic matter, and the growing of sod crops to improve soil structure.

Where salinity or alkalinity cannot be entirely eliminated, crops can be selected that produce satisfactory yields under the existing conditions. In selecting crops for these kinds of soils, particular attention should be given to the salt tolerance of the crop during the germination period. Poor yields often result from failure to establish a good stand. Some crops that are salt tolerant during later stages of growth are quite sensitive to salinity during germination. Among the crops highly tolerant of salts are barley, sugarbeets, and western wheatgrass. Crops having low tolerance for salts include beans and white Dutch, alsike, red, and Ladino clovers.

Salinity and alkalinity are generally controlled more easily in sandy soils than in clayey ones because sandy soils are generally more permeable and are less likely to deteriorate physically. Loamy and clayey soils, however, have greater water-holding capacity than sandy soils and ordinarily present no great problem of salinity control if they have good structure and are underlain by permeable materials that facilitate the removal of drainage water. Both prevention of salt accumulations and reclamation are most difficult in clayey soils in which slowly permeable materials extend to a considerable depth. Nothing can be done to correct these conditions in the dryland areas where no irrigation water is available for leaching.

Land Capability Classification

The capability classification is a grouping of soils that shows, in a general way, how suitable the soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated 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 a close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth of 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 country, indicates 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 or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it are subject to little or no erosion but have other limitations that restrict their use largely to pasture, range, woodland, or wildlife.

Within the subclasses are the capability units, which are groups of soils 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 identified by numbers assigned locally, for example, IIe–1 or IIIe–1.

Soils are classified in capability classes, subclasses, and units in accordance with the degree and kind of their permanent limitations; but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil; and without consideration of possible but unlikely major reclamation projects.

In this subsection soils are grouped in irrigated and nonirrigated capability units. The word "irrigated" in the name of the capability units that are generally irrigated, or that are suitable for irrigation, designates the irrigated capability units and the word "nonirrigated" designates the capability units that are not generally irrigated.

Capability Groups of Irrigated Soils

All the soils in classes I and II in Treasure County, and some of the soils in classes III, IV, and VI have been placed in irrigated capability units. None of the soils in the county are in class V. The irrigated capability units in this county are listed by class and subclass as follows.

Class I. Soils that have few limitations that restrict their use.

Capability unit I–1, irrigated.—Deep, well-drained loams or clay loams that have a moderately permeable loam or clay loam subsoil; on bottom lands and terraces that have slopes of not more than 1 percent.

Class II. Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe. Soils subject to moderate erosion if they are not protected.

Capability unit IIe–1, irrigated.—Deep, well-drained loams or clay loams on fans and terraces that have slopes ranging mainly from 1 to 2 percent.

Subclass IIs. Soils that have moderate limitations of moisture capacity or tilth.

Capability unit IIs–1, irrigated.—Deep, well-drained soils that occur on bottom lands and fans and have a sandy subsoil or, at a depth of 24 to 30 inches, loose sand and gravel.

Capability Unit IIs–2, irrigated.—Deep, well-drained soils that have a granular clay surface layer and a sandy loam to clay subsoil; on bottom lands, fans, and terraces that have slopes of not more than 1 percent.

Capability unit IIs–3, irrigated.—Deep, well-drained, moderately saline or alkaline loams, clay loams, and clays that have a loam or clay loam subsoil; on bottom lands, terraces, and fans that have slopes of not more than 1 percent.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

Capability unit IIIe–1, irrigated.—Deep, well-drained soils that have a granular clay surface layer and a clay or clay loam subsoil; on fans that have slopes of 1 to 3 percent.

Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.

Capability unit IIIs–1, irrigated.—Deep, well-drained loamy fine sands on bottom lands and fans that have slopes of less than 2 percent.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.

Capability unit IVe–1, irrigated.—Deep soils that have a loam or clay loam surface layer and a loam to clay subsoil; on fans that have slopes of 4 to 8 percent.

Capability unit IVe–2, irrigated.—Deep soils that have a granular clay surface layer and a clay loam or clay subsoil; on fans that have slopes of 3 to 8 percent.

Subclass IVw. Soils that have very severe limitations for cultivation because of excess water.

Capability unit IVw–1, irrigated.—Deep, wet, saline, loamy soils and clays that have a high water table and are on slopes of less than 4 percent.

Subclass IVs. Soils that have very severe limitations of stoniness, low moisture capacity, or other soil features.

Capability unit IVs–1, irrigated.—Deep, strongly saline and strongly alkaline soils that have a loam or silty clay surface layer and subsoil; on level bottom lands and terraces that have slopes of not more than 3 percent.

Capability unit IVs–2, irrigated.—Deep, well-drained, strongly alkaline clays that have a crusty surface and a clay subsoil; on terraces that have slopes of not more than 1 percent.

Capability unit IVs–3, irrigated.—Deep, heavy clays on bottom lands and terraces that have slopes of not more than 1 percent.

Capability unit IVs–4, irrigated.—Shallow fine sandy loams underlain by loose sand and gravel at a depth of 14 to 22 inches; on bottom lands and low terraces that have slopes of less than 1 percent.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.

Capability unit VIe–1, irrigated.—Deep loams and clay loams on the bench edges that have slopes of 8 to 15 percent.

Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, stones, or other features.

Capability unit VIs–1, irrigated.—Very shallow loams to sandy loams that are underlain by sand or gravel at a depth of 8 to 14 inches; on bottom lands that have slopes of less than 1 percent.

Capability unit VIs–2, irrigated.—Deep, well-drained, strongly saline or strongly alkaline soils on terraces and fans that have slopes ranging from 0 to 8 percent.

Management of irrigated capability units

In a capability unit, the soils have about the same limitations to use, produce about the same yields of crops, and require about the same kind of management. In the following pages, the management of the soil in each irrigated capability unit in the county is discussed. For additional information about irrigated crops, refer to the subsection "Management of Irrigated Cropland." In that subsection the management of saline and alkali soils is discussed generally.

CAPABILITY UNIT I–1, IRRIGATED

This capability unit consists of deep, well-drained soils that have a loam or clay loam surface layer and a moderately permeable loam or clay loam subsoil. These soils are on bottom lands and terraces that have slopes of not more than 1 percent. They are—

Cherry clay loam, 0 to 1 percent slopes.
Cherry clay loam, shallow, 0 to 1 percent slopes.
Fort Collins loam, 0 to 1 percent slopes.
Fort Collins loam, sandy substratum, 0 to 1 percent slopes.
Havre clay loam.
Havre clay loam, high.
Havre loam.
Havre loam, high.
Havre and Glendive soils (Havre soil only).
Lohmiller clay loam.
Lohmiller clay loam, fans, 0 to 1 percent slopes.
Lohmiller clay loam, high.
McRae and Havre loams, 0 to 1 percent slopes.
Nunn clay loam, 0 to 1 percent slopes.

These are the most productive irrigated soils in the county. They are fertile and easily tilled. They take in water readily and have high water-holding capacity. Erosion is a problem only if irrigation water is not handled properly, or if these soils are left unprotected during winter.

Favorable yields of all crops in the county can be produced on these soils. The principal crops are sugarbeets, corn for silage, dry beans, wheat, barley, oats, alfalfa, and grass and legume crops. Potatoes and truck crops can also be grown on these soils.

In a good crop sequence, a legume is kept in the cropping system at least one-third of the time, but it should not be grown for more than 5 successive years, nor should row crops be grown for more than 3 successive years.

Favorable yields are obtained by using green manure or barnyard manure and commercial fertilizer for all crops. Barnyard manure can be applied for each crop of sugarbeets if enough is available; otherwise, it can be reduced to one heavy application during the extent of the rotation. Nitrogen and phosphate fertilizers are added to fields of sugarbeets or corn. Phosphate, applied to alfalfa at least once during a complete rotation, increases the growth of crops and the quality of hay.

All methods of irrigation can be used on these soils. The border method distributes water best on soils in hay, small grain, or pasture. If irrigations are light and frequent, and runs are short, crops respond well, but care should be taken to prevent overirrigation. Some of the soils in this capability unit are rough and require leveling before they can be properly irrigated. Heavy grading does not permanently damage these soils.

CAPABILITY UNIT IIe–1, IRRIGATED

This capability unit consists of deep, well-drained soils that have a loam or clay loam surface layer and subsoil. These soils are on terraces and fans that have slopes ranging mainly from 1 to 2 percent. They are—

Cherry clay loam, 1 to 3 percent slopes.
Fort Collins loam, 1 to 4 percent slopes.
Fort Collins loam, sandy substratum, 1 to 3 percent slopes.
Lohmiller clay loam, 1 to 3 percent slopes.
McRae and Havre loams, 1 to 4 percent slopes.
Nunn clay loam, 1 to 3 percent slopes.

These soils are productive under irrigation. They are easily tilled. They take in water readily and have high water-holding capacity. Because of the slope, irrigation water should be handled carefully to avoid washing.

Favorable yields of all crops in the county can be produced on these soils. The principal crops are sugarbeets, corn for silage, dry beans, wheat, barley, oats, alfalfa, and grass-and-legume mixtures. Potatoes and truck crops also can be grown.

A good cropping system provides that alfalfa or another legume is kept on these soils at least half of the time and that a row crop is not grown for more than 2 years in succession. Alfalfa should not be left on these soils for more than 5 years. Row crops are not well suited on slopes of more than 2 percent.

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Favorable yields of crops can be obtained by adding green manure or barnyard manure and commercial fertilizer. If enough barnyard manure is available, it can be used on each crop of sugarbeets; otherwise, only one heavy addition should be applied during the extent of the rotation. Both nitrogen and phosphate fertilizers are added for sugarbeets and corn. The quality of alfalfa hay can be improved if phosphate is applied at least once during the rotation period.

If irrigation water is applied from small heads, and runs are short, excessive washing is prevented. All common methods of irrigation can be used, but water is best distributed by the border method on fields of hay or small grain, or on pasture. Overirrigation and excessive leaching of soil nutrients can be prevented by applying water frequently in light irrigations. Land leveling does not permanently damage these soils.

CAPABILITY UNIT IIs-1, IRRIGATED

This capability unit consists of deep, well-drained soils that occur on bottom lands and fans and have a sandy subsoil or, at a depth of 24 to 30 inches, loose sand and gravel. Slopes are less than 1 percent. The soils are—

Glendive clay loam.
Glendive fine sandy loam.
Glendive loam.
Havre loam, moderately deep.
Havre and Glendive soils (Glendive soil only).

These soils produce good yields of all crops grown in the county. They are fertile, are easily tilled, and take in water readily. Their water-holding capacity is reduced by the sandy subsoil or the gravel near the surface.

Glendive fine sandy loam blows easily if it is left bare during winter or for long periods at other times, but the other soils are not susceptible to erosion.

Under irrigation, these soils produce average or above average yields of crops. The principal crops are sugarbeets, corn for silage, dry beans, wheat, barley, oats, alfalfa, and grass-and-legume mixtures. Potatoes and truck crops can also be grown on these soils.

A satisfactory cropping system is one that keeps hay or pasture, including legumes, on these soils at least half of the time and a row crop for not more than 3 successive years. Leaving alfalfa on these soils for more than 5 successive years is not advisable.

Favorable yields are obtained by adding green manure or barnyard manure and nitrogen and phosphate fertilizers. If enough barnyard manure is available, it can be used on each crop of sugarbeets; otherwise, only one heavy application should be applied during the extent of the rotation. Nitrogen and phosphate fertilizers are added for sugarbeets or corn. The quality of alfalfa hay can be improved if phosphate is applied at least once during the rotation period. These soils are leached more readily and more deeply than soils having a loamy or clayey subsoil and, therefore, require slightly larger additions of fertilizer.

All methods of irrigation can be used on these soils, but to prevent overirrigation and excessive leaching of plant nutrients, short runs and small heads of water are best. Land leveling does not permanently damage these soils if cuts into the sandy subsoil or the underlying sand and gravel are avoided.

CAPABILITY UNIT IIs-2, IRRIGATED

This capability unit consists of deep, well-drained soils that have a granular clay surface layer and a sandy loam to clay subsoil. These soils are on bottom lands, fans, and terraces that have slopes of not more than 1 percent. They are—

Cherry clay, 0 to 1 percent slopes.
Cherry clay, moderately deep, 0 to 1 percent slopes.
Glendive clay.
Havre clay.
Lohmiller clay.
Lohmiller clay, high.
Nunn clay, 0 to 1 percent slopes.
Nunn-Beckton complex, 0 to 1 percent slopes.

These soils produce favorable yields of most crops. They take in water slowly but have high water-holding capacity. Plowing, working, and obtaining a good seedbed are difficult. Plowing at the wrong time leaves large, hard clods that are difficult to break down with tillage implements. These soils blow early in spring or in winter if they are left bare, but water erosion is not a problem.

Average and above average yields of adapted crops can be produced on these soils if soil and water are managed well. The principal crops are sugarbeets, corn for silage, dry beans, wheat, barley, oats, alfalfa, and grass-and-legume mixtures. Potatoes are not suited to these soils.

In a good crop sequence, a legume is kept in the cropping system at least half of the time, but it should not be grown for more than 5 successive years, nor should row crops be grown for more than 2 successive years.

If possible, these soils should be plowed in the fall because the freezing and thawing during winter help to break the hard clods into granules. This breaking makes a good seedbed easier to obtain. Tilth is maintained or improved by turning under a green-manure crop or by adding a large amount of barnyard manure. Additions of these manures and of commercial fertilizer maintain or increase yields. Barnyard manure is most beneficial to sugarbeets, corn, or beans. Yields and the quality of alfalfa hay are improved by adding a phosphate fertilizer.

These soils should not be left bare for long periods if the surface is loose. If plowing is in fall, a rough surface should be left during winter to reduce the risk of blowing.

All methods of irrigation can be used on these soils, but in some places leveling is needed so that irrigation water is distributed more efficiently. This leveling does not permanently damage these soils.

CAPABILITY UNIT IIs-3, IRRIGATED

This capability unit consists of deep, well-drained loams, clay loams, and clays that have small spots that are hard or crusty because salts or alkali is present. These soils have a loam or clay loam subsoil. They are on bottom lands, terraces, and fans that have slopes of not more than 1 percent. The soils are—

Cherry-Laurel clay loams.
Havre clay, saline.
Havre clay loam, saline.
Havre loam, saline.
Havre-Hysham loams.
Lohmiller-Hysham clays.
Lohmiller-Hysham clay loams.

These soils are saline or alkaline enough for yields of all crops to be reduced. The more strongly affected spots crust and seal after a rain or an irrigation. If this crust-

ing occurs soon after seeding, germination of seeds and emergence of seedlings are retarded or prevented. Plants that do survive are generally stunted, and growth is uneven in the fields. Although these spots improve slightly over the years if management is good, the effects of high alkalinity are always evident.

If these soils are irrigated, yields of some crops are average and of others are below average. The principal crops are sugarbeets, wheat, barley, oats, corn for silage, alfalfa, and pasture. Dry beans, potatoes, and truck crops are not suited to these soils. Sugarbeets do well, but yields of corn are very low.

In a good cropping system pasture or hay is kept on these soils for at least half of the time. Alfalfa should be left on fields only as long as yields are favorable. Row crops should not be grown for more than 2 successive years.

Favorable yields can be obtained on these soils by adding green manure, barnyard manure, crop residue, and commercial fertilizer. The hard alkali spots require the largest additions. These additions help to improve tilth, to increase water intake, and to reduce crusting. The yields of all crops are increased by additions of commercial fertilizer. By keeping the upper few inches of soil moist, germination of seeds and the early growth of seedlings are encouraged.

All methods of irrigation can be used on these soils, but border dikes are best for small grain, hay, or pasture. Heavy irrigations help to leach salts downward to a place where they are less harmful. These soils should be leveled, where needed, before they are irrigated, so that the water is distributed evenly. Deep leveling that exposes the highly saline subsoil should be avoided. Drainage may be needed in some places.

CAPABILITY UNIT IIIe-1, IRRIGATED

This capability unit consists of deep, well-drained soils that have a granular clay surface layer and a clay or clay loam subsoil. These soils are on fans that have slopes of 1 to 3 percent. They are—

Cherry clay, 1 to 3 percent slopes.
Cherry clay, moderately deep, 1 to 3 percent slopes.
Nunn clay, 1 to 3 percent slopes.

These soils produce high yields if they are irrigated. They take in water slowly but have high water-holding capacity. Plowing, working, and obtaining a good seedbed are difficult. Plowing at the wrong time of the year leaves large, hard clods that are difficult to break with tillage implements. Some blowing occurs if these soils are left bare early in spring or in winter. If irrigation water is not managed well, washing also occurs.

If the management of soil and water is good, yields of adapted crops are average or above average. The crops best suited are small grain, alfalfa, and pasture. Sugarbeets, corn for silage, and dry beans can be grown, but they require especially careful irrigation.

In a good cropping system, alfalfa, hay or a pasture mixture is kept on those soils at least three-fourths of the time and row crops are grown for not more than 2 successive years.

If possible, these soils should be plowed in the fall because the freezing and thawing during winter help to break the hard clods into granules and to improve the seedbed that is prepared in spring. Soil tilth is maintained or improved by turning under large amounts of green manure or barnyard manure. If these manures and a commercial fertilizer are added, yields are kept at a high level. Row crops benefit most from additions of green manure and barnyard manure. Phosphate fertilizer, applied to alfalfa, increases yields and improves the quality of the hay.

To prevent excessive washing, more careful control of irrigation water is needed on these soils than on more nearly level soils. Short runs and small heads of water are best. All methods of irrigation can be used, but the border method distributes water more evenly on hay, small grain, and pasture. Land leveling is needed to improve the distribution of water, and it does not permanently damage these soils.

CAPABILITY UNIT IIIs-1, IRRIGATED

The only soil in this capability unit is Glendive loamy fine sand. It is deep and well drained and occurs on bottom lands and fans that have slopes of less than 2 percent.

Because this soil is low in natural fertility, maintaining satisfactory crop yields is difficult. The soil takes in water very rapidly, but it is droughty because it can store only small amounts of moisture. Also difficult is the control of wind erosion, because the sandy soil blows easily if it is left bare for any length of time.

This soil can be used for most irrigated crops. It is best used for hay and pasture, but corn for silage, dry beans, and small grain are also suitable.

A satisfactory cropping system is one that keeps hay or pasture on this soil for more than 3 years and a row crop for 1 year. It is not advisable to keep alfalfa or other legumes on this soil for more than 5 successive years.

Favorable yields of all crops can be maintained only through the use of green manure or barnyard manure and commercial fertilizer. Larger amounts of commercial fertilizer are needed on this soil than on the more loamy or clayey soils to maintain an average level of productivity because the more soluble plant nutrients are leached from these soils more rapidly under irrigation.

A crop or crop residue on this soil most of the time reduces soil blowing. At times emergency tillage may be needed to control blowing.

Careful control of irrigation water is important. Only enough water to maintain an adequate moisture supply should be applied. Overirrigation excessively leaches the more soluble plant nutrients. Light irrigations applied in short runs are most satisfactory as a means of reducing the loss of fertility and avoiding the washing that otherwise takes place in the more sloping areas. Leveling or land conditioning may be needed in many areas before they can be used for irrigation or to improve application of water. Extremely deep cuts expose fine sands in places and should be avoided.

CAPABILITY UNIT IVe-1, IRRIGATED

This capability unit consists of deep soils that have a loam or clay loam surface layer and a loam to clay subsoil. These soils are on fans. They are—

Fort Collins loam, 4 to 8 percent slopes.
McRae and Havre loams, 4 to 8 percent slopes.
Nunn clay loam, 3 to 8 percent slopes.

These soils are high in natural fertility, and they contain an average or below average amount of organic matter. They take in water readily and have high water-

holding capacity. Because slopes are strong, the risk of water erosion is high where these soils are irrigated. Wind erosion is not a major problem.

The important irrigated crops are small grain, alfalfa, and pasture. Most of the acreage is in hay or pasture and produces high yields. Row crops are not well suited.

These soils are best suited to small grain, hay, and pasture. In a rotation period, these soils should be kept in hay or pasture at least three-fourths of the time and small grain should not be grown for more than 2 years in succession. It is not advisable to leave alfalfa or another legume on these soils for more than 6 years.

Commercial fertilizer, applied to alfalfa at least once or twice during a complete rotation, increases the growth of the crops. Pasture should be fertilized more often than alfalfa.

Because these soils are sloping or strongly sloping, irrigation water should be carefully controlled to prevent excessive washing. By mixing grasses with alfalfa, water erosion is reduced.

Irrigating by contour ditches provides the best control of water on these soils. The ditches should be spaced closely enough to permit the runs to be short. Efficient application of water from small heads, and at a suitable rate, helps control loss of soil through washing. Leveling and smoothing may be needed in some areas to improve distribution of water. Deep cuts made in leveling do not permanently damage these soils.

CAPABILITY UNIT IVe-2, IRRIGATED

This capability unit consists of deep soils that have a granular clay surface layer and a clay loam or clay subsoil. These soils are on fans. They are—

Cherry clay, 3 to 8 percent slopes.
Cherry clay, moderately deep, 3 to 8 percent slopes.
Nunn clay, 3 to 8 percent slopes.

These soils have high natural fertility and contain an average amount of organic matter. They take in water slowly but have high water-holding capacity. When these soils dry, large cracks form. Plowing and working are hard, and the strong slopes increase the hazard of water erosion. Because the surface layer is fine and granular, these soils blow easily unless they are protected by some kind of cover.

The main irrigated crops are hay, pasture, and small grain. Yields of these crops are high.

A suitable cropping system provides that hay or pasture is kept on these soils at least three-fourths of the time and that small grain is not grown for more than 2 years in succession. Alfalfa or other legumes should not be kept growing for more than 5 or 6 years.

Obtaining a good seedbed is difficult if these soils are plowed and worked at the wrong time. Fall plowing is a good practice because freezing and thawing during winter help to break the clods into granules. Favorable yields can be obtained by using commerical fertilizer on hay at least once or twice during the rotation period. On pasture fertilizer should be added more often.

On these sloping and strongly sloping soils, irrigation water should be carefully controlled to prevent excessive washing. To prevent blowing, some kind of protection is needed when these soils are not in crops. By mixing grasses with alfalfa, water erosion is reduced.

Irrigating by contour ditches provides the best control of water on these soils. The ditches should be spaced closely enough to permit the runs to be short. Efficient application of water from short heads, at a suitable rate, helps control loss of soil through washing. Leveling and smoothing may be needed to improve distribution of water. Deep cuts made in leveling do not permanently damage these soils.

CAPABILITY UNIT IVw-1, IRRIGATED

This capability unit consists of deep, wet, saline, loamy soils and clays. These soils are on bottom lands and low terraces and fans that have slopes of less than 4 percent. The water table is high, or there are seeps. The soils are—

Laurel clay loam.
Laurel loam.
Lohmiller clay, wet.
Sage clay.

All these soils except Lohmiller clay, wet, are strongly saline and alkaline and contain large amounts of toxic salts. White salt crusts the surface in spots or in large areas. Water-tolerant plants grow on Lohmiller clay, wet, but the other soils have little or no vegetation. All the soils have a water table at or near the surface most of the year. They take in water slowly.

Unless they are reclaimed, these soils are not suitable for cultivation. They can be partly reclaimed and used for limited cropping or for special crops. They respond very slowly to reclamation. Ten years or more must pass before crops other than pasture can be grown economically. Complete reclamation is not possible or necessary on these soils.

These soils produce low yields of the few crops that can be grown on them. They are hard to manage because they puddle, and hard crusts form on the surface when they dry. This crusting prevents most seedlings from emerging, unless special practices of soil and irrigation management are used. Cultivating the soils for many years reduces puddling and crusting only slightly. The soils in some areas may be benefited if gypsum or other amendments are added.

To improve these soils, first install deep drains, either open or tile, so that the water table is lowered. The drains should be deep enough to keep the level of ground water below a depth of 5 feet. After the upper part of the soil dries out, and heavy equipment can be used, the surface should be smoothed or leveled, where needed, so that irrigation water can be distributed uniformly.

During reclamation, only plants that tolerate much salinity and alkalinity should be grown, and these should be grown in long-term pasture. Tall wheatgrass, western wheatgrass, meadow fescue, and similar plants do well. Most legumes do not tolerate high salinity very well, but alfalfa, sweetclover, and others grow after they are established. Some of the small grains can be grown for hay. All plants are hard to start, and many of them will not last long. Yields of all crops will be very low for many years. After 10 years or more, sugarbeets, corn for silage, and small grain for grain or hay can be grown in the cropping system, but yields of some of these may be uneconomical. Pasture and hay are the best crops through the years.

Removing the high concentrations of salt in the upper part of the soils by leaching is necessary before crops can

be seeded. The hard crusts that form on the surface when these soils dry can be reduced by applying much barnyard manure and by plowing under large amounts of crop residue or green manure. The use of commercial fertilizer improves yields, and gypsum and other amendments may be of value in some areas during and after reclamation.

The most satisfactory way to apply irrigation water to hay and pasture is by the border method because this method controls and distributes the water best. If level borders are used in the more nearly level areas, salts are leached and the control of water is good. To leach the salts, more water should be applied than is needed by crops. By irrigating the soils often enough, they are kept from drying out. Water is particularly needed in the surface layer during germination and the seedling stage of growth.

CAPABILITY UNIT IVs-1, IRRIGATED

This capability unit consists of deep, well drained and moderately well drained soils that have a loam or silty clay surface layer and subsoil. These soils are strongly saline and strongly alkaline. They occur on bottom lands and low terraces that have slopes of not more than 3 percent. The soils are—

Arvada loam, 0 to 3 percent slopes.
Hysham-Havre loams.
Sage silty clay.

These soils are so saline and alkaline that they are not suitable for most cultivated crops. In most places the water table is more than 5 feet below the surface most of the year, but in some places it is raised by seepage, and salts crust the soil surface.

These soils produce low yields of the few crops that can be grown. Only plants that tolerate large amounts of salts and alkali should be grown. These soils respond very slowly to reclamation. At least 10 years must pass before crops other than pasture can be grown economically.

These soils take in water very slowly. Cultivated areas are hard to manage because they puddle when they are wet, and when they dry a hard crust forms on the surface. This crusting prevents the seedlings from emerging, unless special practices of soil and irrigation management are used. Even under special management, these soils improve only slightly during a period of many years. Complete reclamation is not feasible.

Before reclamation can be started on these soils, drainage is needed in places to keep the water table as low as possible. The method of reclamation and the time needed depend on local conditions.

During reclamation, only plants that tolerate much salinity and alkalinity should be grown, and these should be grown only in long-term rotations consisting mostly of pasture. Tall wheatgrass, western wheatgrass, meadow fescue, Canada wildrye, and similar grasses do well. Most legumes do not tolerate high salinity, but alfalfa, sweetclover, and other selected legumes grow if they get started. Some of the small grains can be grown for hay. All plants are hard to establish, and many of them do not last long. Yields of all crops are very low for many years. After these soils are managed for 10 years or more, sugarbeets, corn for silage, and small grain for grain or hay can be included in the rotation, but growing some of these crops may not be economical. Pasture and hay are the best crops through the years.

In places salts must be removed from the upper part of the soils before the soils can be seeded. Salinity is decreased and the soils are made easier to work by applying much barnyard manure and by plowing under large amounts of crop residue or green manure. The use of commercial fertilizer increases yields. During and after reclamation, gypsum or similar amendments may be of value in some areas.

The most satisfactory way to apply irrigation water to hay and pasture is by the border method, because this method controls and distributes the water best. If level borders are used in the more nearly level areas, there is some leaching and the control of water is maximum. To leach the salts, more water is applied than the crop needs. By irrigating the soils often enough, they are kept from drying out. Water is particularly needed in the surface layer during germination and the seedling stage of growth.

CAPABILITY UNIT IVs-2, IRRIGATED

Marias clay, saline-alkali, 0 to 1 percent slopes, is the only soil in this capability unit. This is a deep, well-drained soil that has a crusty surface and a strongly alkaline clay subsoil. It is on level terraces.

This soil is so alkaline that only a few kinds of irrigated crops can be grown, and the yields of these are low. Irrigated areas are hard to plow and to work. When this soil dries after a rain or an irrigation, its surface is thinly crusted. This crust makes it difficult for plants to emerge after their seeds sprout. In addition to the crust, wide cracks form when this soil dries. Except in these cracks, this soil takes in water slowly. Water-holding capacity, however, is very high. Natural fertility is about moderate.

This soil produces low yields of most crops. It is used mainly for sugarbeets, corn, small grain, alfalfa, and pasture. The best use is hay and pasture.

In the most suitable cropping system, hay or pasture is kept on this soil at least four-fifths of the time and a small grain, sugarbeets, or corn for silage is grown for not more than 2 years. Sugarbeets may be unprofitable, for they have low yields and are difficult to harvest.

Favorable yields of most crops can be obtained if barnyard manure and commercial fertilizer are added. During a rotation period, commercial fertilizer should be applied to alfalfa once or twice and to pasture more often. Fall plowing is a good practice.

All methods of irrigation can be used on this soil, but water is distributed best by the border or level-border method. Frequent, heavy irrigations help to keep this soil from drying and cracking. Water distribution is more uniform if the surface is smoothed. If deep cuts are made during land leveling, the subsoil is exposed but the soil is not permanently damaged.

CAPABILITY UNIT IVs-3, IRRIGATED

The only soil in this capability unit is Bowdoin clay. This deep, well-drained heavy clay occurs on level bottom lands and on low terraces that have slopes of not more than 1 percent.

This soil has high natural fertility but is very hard to plow because its content of clay is high. As the soil dries, wide cracks form. Except in these cracks, water is taken into this soil very slowly. Water-holding capacity is very

high. Blowing is likely if this soil is left bare during winter.

The principal irrigated crops, and the crops most suitable, are alfalfa, small grain, pasture, and native hay. Row crops are not well suited, but sugarbeets or corn for silage can be grown. Sugarbeets may be unprofitable because they produce low yields and are difficult to harvest.

In a good cropping system, hay or pasture is grown at least four-fifths of the time in a long-term rotation. A small grain can be grown for 2 or 3 years in succession while meadow or pasture is being reestablished. Alfalfa should not be left on this soil for more than 5 or 6 years.

Plowing in the fall is best because freezing and thawing during winter break the large, hard clods so that in spring a good seedbed is easier to obtain. Favorable yields of all crops are obtained by applying commercial fertilizer. During a rotation period, fertilizer should be applied to alfalfa once or twice, and to pasture or native hay more often.

All methods of irrigation can be used on this soil. To keep the soil from drying and cracking, the irrigations should be frequent and light. Distribution of water is improved by land leveling or smoothing. Deep cuts made during leveling do not permanently damage this soil.

CAPABILITY UNIT IVs-4, IRRIGATED

Glendive fine sandy loam, shallow, is the only soil in this capability unit. This soil occurs on level bottom lands and on low terraces that have slopes of less than 1 percent. Loose sand and gravel underlie this shallow soil at a depth of 14 to 22 inches.

This soil has low natural fertility. It takes in water readily. Because it is shallow to gravel, this soil has very low water-holding capacity and is droughty.

Yields of all irrigated crops are low. The most suitable crops are small grain, hay, and pasture.

In the most suitable cropping system, hay or pasture is kept on this soil for at least three-fourths of the time and a small grain is grown for 2 or 3 years. Corn for silage can also be used, but not for more than 1 year.

Because this soil loses large amounts of soluble plant nutrients, additions of commercial fertilizer and barnyard manure are needed if yields are to be maintained or increased. Large additions are needed if yields are to be profitable.

All systems of irrigation can be used on this soil, but the irrigation runs should be short. If irrigation water is applied frequently from small heads and applications are light, excessive leaching is prevented. Because this soil is shallow to gravel, special care is needed in leveling. Deep cuts expose the loose gravel and permanently damage this soil as well.

CAPABILITY UNIT VIe-1, IRRIGATED

Havre and Lohmiller soils, 8 to 15 percent slopes, are the only soils in this capability unit. These moderately steep soils are deep, calcareous loams and clay loams. They occur on the edges of benches.

These soils take in water readily and store large amounts in their subsoil. Because slopes are steep, the hazard of erosion is high in irrigated areas. Washing is severe unless these soils are adequately protected at all times. Under irrigation, these soils are best suited to long-term rotations in which hay or pasture is grown most of the time. A small grain can be grown for 1 or 2 years while the pasture is being reestablished. Commercial fertilizer helps maintain yields.

Irrigation water must be controlled carefully to prevent excessive washing. The water is best controlled by irrigating on the contour or by sprinklers.

CAPABILITY UNIT VIs-1, IRRIGATED

Banks soils are the only soil in this capability unit. These very shallow soils are underlain by loose gravel or sand at a depth of 8 to 14 inches. They are on bottom lands that have slopes of less than 1 percent.

These soils are too shallow and too droughty for cultivated crops. Water-holding capacity and natural fertility are very low. Irrigated hay or pasture can be grown, but the plants should be drought resistant. Leveling for improving the application of water should be kept at a minimum so that the loose gravel is not exposed.

CAPABILITY UNIT VIs-2, IRRIGATED

This capability unit consists of deep, well-drained, strongly alkaline or strongly saline soils on terraces and fans. Slopes range from 0 to 8 percent. The soils are—

Arvada-Laurel complex.
Marias clay, fans, saline-alkali.
Marias-Hoven clays, saline.

These soils are too strongly saline or too strongly alkaline for cultivation, but they can be used for irrigated hay or pasture. Yields of forage are low. The plants should be tolerant of salts and alkali.

Leveling for improving the application of water should be kept to a minimum. The irrigation method that requires the least amount of land preparation or conditioning should be used. Contour irrigation can be installed with little land conditioning.

Predicted Yields of Irrigated Crops

The predicted average yields of the principal irrigated crops are given in table 2 for each soil in the county on which irrigated crops can be satisfactorily grown. These yield predictions are given for two levels of management. They allow the farmer to estimate the average long-term productivity he may expect from his fields. The farmer can use these predictions in calculating the return he may expect if he changes his system of farming. This expected return can then be compared with an estimate of the cost of the changed system.

Only soils suitable for irrigated crops are listed in table 2, but all such soils are listed, whether they are presently used for irrigated crops or not. The predicted yields are based on information obtained from field observations and interviews with farmers and on information obtained from other agricultural workers who know about yields. Actual crop records of a few soils were used as a basis for comparison with other soils, after the other soils were arranged from the most productive to the least productive by comparing their characteristics.

In table 2 predicted yields under average management are given in columns A, and those under the highest pre-

TABLE 2.—*Predicted average yields per acre of the principal irrigated crops*

[Yields in columns A are those obtained under average management; those in columns B are yields to be expected under the highest prevailing management. Dashes indicate that the soil is not suitable for the crop]

Soil	Sugar-beets		Dry beans		Corn for silage [1]		Barley		Oats		Wheat		Alfalfa		Irrigated pasture	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Cwt.*	*Cwt.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Animal units per acre* [2]	*Animal units per acre* [2]
Arvada loam, 0 to 3 percent slopes	6	12	----	----	----	----	15	25	16	30	10	20	1.0	2.5	0.5	1.0
Bowdoin clay	8	14	----	----	----	----	20	35	25	40	15	25	1.5	4.0	1.0	2.0
Cherry clay, 0 to 1 percent slopes	14	20	18	25	16	24	50	75	60	95	40	50	4.0	6.0	1.8	3.0
Cherry clay, 1 to 3 percent slopes	14	20	18	25	16	24	50	75	60	95	40	50	4.0	6.0	1.8	3.0
Cherry clay, 3 to 8 percent slopes	----	----	----	----	----	----	40	60	50	80	30	40	3.0	5.0	1.5	2.8
Cherry clay, moderately deep, 0 to 1 percent slopes	14	20	18	25	16	24	50	75	60	95	40	50	4.0	6.0	1.8	3.0
Cherry clay, moderately deep, 1 to 3 percent slopes	14	20	18	25	16	24	50	75	60	95	40	50	4.0	6.0	1.8	3.0
Cherry clay, moderately deep, 3 to 8 percent slopes	----	----	----	----	----	----	40	60	50	80	30	40	3.0	5.0	1.5	2.8
Cherry clay loam, 0 to 1 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Cherry clay loam, 1 to 3 percent slopes	15	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Cherry clay loam, shallow, 0 to 1 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Cherry-Laurel clay loams	11	17	----	----	14	20	45	70	50	80	35	45	3.0	5.0	1.2	2.0
Fort Collins loam, 0 to 1 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Fort Collins loam, 1 to 4 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Fort Collins loam, sandy substratum, 0 to 1 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Fort Collins loam, sandy substratum, 1 to 3 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Glendive clay	16	22	18	25	14	22	50	75	55	90	40	50	4.0	6.0	1.0	2.5
Glendive clay loam	16	22	20	28	14	22	50	75	55	90	45	55	4.0	6.0	1.0	2.5
Glendive fine sandy loam	12	20	17	25	14	22	50	75	75	90	45	65	4.0	6.0	1.0	2.5
Glendive fine sandy loam, shallow	5	7	----	----	6	9	16	20	20	25	12	15	1.0	1.5	.5	1.5
Glendive loam	16	22	20	28	14	22	50	75	55	90	45	55	4.0	6.0	1.0	2.5
Glendive loamy fine sand	10	16	15	22	10	18	30	45	35	50	25	35	1.5	4.0	.8	2.0
Havre clay	16	22	18	25	18	26	50	75	60	95	45	55	4.5	6.5	1.8	3.0
Havre clay, saline	10	18	----	----	8	18	30	50	40	65	20	30	2.5	3.5	1.0	2.5
Havre clay loam	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Havre clay loam, high	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Havre clay loam, saline	10	18	----	----	8	18	30	45	40	65	20	30	2.5	3.5	1.0	2.5
Havre loam	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Havre loam, high	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Havre loam, moderately deep	13	18	16	23	16	24	45	65	55	85	35	45	3.0	4.5	1.5	2.8
Havre loam, saline	11	18	----	----	8	18	30	50	40	65	20	30	2.5	3.5	1.0	2.5
Havre and Glendive soils	16	22	18	24	16	24	50	75	58	93	43	53	4.3	6.3	1.4	2.8
Havre and Lohmiller soils, 8 to 15 percent slopes	----	----	----	----	----	----	20	35	40	65	15	25	2.5	4.5	.8	2.0
Havre-Hysham loams	10	15	----	----	6	12	30	50	40	75	25	35	2.0	4.0	1.2	2.0
Hysham-Havre loams	8	13	----	----	4	8	20	35	25	40	15	25	1.5	3.0	.6	1.5
Laurel clay loam	6	12	----	----	----	----	15	25	16	30	10	20	1.0	2.5	.4	1.0
Laurel loam	8	14	----	----	----	----	20	35	25	40	15	25	1.5	3.0	.4	1.0
Lohmiller clay	14	20	18	25	16	24	50	75	60	95	40	50	4.0	6.0	1.8	3.0
Lohmiller clay, high	14	20	18	25	16	24	50	75	60	95	40	50	4.0	6.0	1.8	3.0
Lohmiller clay loam	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Lohmiller clay loam, 1 to 3 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Lohmiller clay loam, fans, 0 to 1 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Lohmiller clay loam, high	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Lohmiller-Hysham clays	10	15	----	----	6	12	30	45	40	65	20	35	2.0	4.0	1.2	2.0
Lohmiller-Hysham clay loams	10	15	----	----	6	12	30	45	40	65	20	35	2.0	4.0	1.2	2.0
Marias clay, saline-alkali, 0 to 1 percent slopes	8	16	----	----	6	14	25	40	30	50	20	30	2.0	4.5	.8	2.0
McRae and Havre loams, 0 to 1 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
McRae and Havre loams, 1 to 4 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
McRae and Havre loams, 4 to 8 percent slopes	----	----	----	----	----	----	45	65	55	85	35	45	3.5	5.5	1.8	3.0
Nunn clay, 0 to 1 percent slopes	14	20	18	25	16	24	50	75	60	95	40	50	4.0	6.0	1.8	3.0
Nunn clay, 1 to 3 percent slopes	14	20	18	25	16	24	50	75	60	95	40	50	3.5	5.5	1.8	3.0

See footnotes at end of table.

TABLE 2.—*Predicted average yields per acre of the principal irrigated crops*—Continued

Soil	Sugarbeets		Dry beans		Corn for silage [1]		Barley		Oats		Wheat		Alfalfa		Irrigated pasture	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Tons	*Tons*	*Cwt.*	*Cwt.*	*Tons*	*Tons*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Animal units per acre* [2]	*Animal units per acre* [2]
Nunn clay, 3 to 8 percent slopes	----	----	----	----	----	----	40	60	50	80	30	40	3.0	5.0	1.5	2.8
Nunn clay loam, 0 to 1 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.5	1.8	3.0
Nunn clay loam, 1 to 3 percent slopes	16	22	20	28	18	26	55	80	65	100	45	55	4.5	6.0	1.8	3.0
Nunn clay loam, 3 to 8 percent slopes	----	----	----	----	----	----	45	65	55	85	35	45	3.5	5.5	1.5	2.8
Nunn-Beckton complex, 0 to 1 percent slopes	14	20	18	25	16	24	45	70	55	90	35	45	4.0	6.0	1.8	3.0
Sage clay	----	----	----	----	----	----	15	25	16	30	10	20	1.0	2.5	.4	1.0
Sage silty clay	----	----	----	----	----	----	15	25	16	30	10	20	1.0	2.5	.4	1.0

[1] Yields of corn vary considerably, depending on the variety used and the time needed for the corn to mature. Late maturing varieties normally produce higher yields than early maturing varieties, provided an early frost does not stop growth. Also, the time needed for maturing largely determines the amount of moisture in the silage, which may range from 65 to 85 percent when the silage is cut. The estimated yields of corn are averages of all varieties of corn commonly used.

[2] The number of animals, such as a cow, that can be grazed on 1 acre throughout the grazing season without damage to the pasture.

vailing management are given in columns B. Under average management barnyard manure is applied on sugarbeets once during the rotation period, and nitrogen and phosphate fertilizers are applied each year. No commercial fertilizer is used on beans, corn, or alfalfa.

Under the highest prevailing management, at least 5 tons of barnyard manure per acre is applied to sugarbeets each year or every other year, and nitrogen and phosphate fertilizers are applied each year. Commercial fertilizer is applied to beans and corn and to alfalfa at least once during a period of 3 years, or is applied twice if these crops are grown for 5 years. Because it is likely that improved crop varieties will be introduced, that more fertilizer will be used, and that farming methods generally will be improved, yields higher than those listed in columns B are possible.

Management of Nonirrigated Cropland

The management of nonirrigated cropland is not so complex as that of irrigated cropland. Because annual precipitation is low in most of Treasure County, conserving moisture is the main objective of dryfarming. Regardless of the kind of soil, variations in tillage practices are slight. Generally a year of small grain is alternated with a year of summer fallow. Corn grown for silage is substituted for summer fallow in some years. For successful crop production, the timeliness of tillage and seeding is important.

Conserving moisture and maintaining fertility

During the fallow year, the main goals are controlling weeds, storing moisture, and controlling erosion, particularly wind erosion. To achieve these goals, many types of implements are used, but those of the blade type and rod weeders are generally best because they leave more crop residue on the surface.

Most of the soils suitable for dryfarming have a moderate to high level of natural fertility. If moisture is adequate, these soils produce good yields. Bainville loams, for example, have lower water-holding capacity than Hesper loams and are not so productive. The fertility of all soils is highest immediately after they are plowed out of sod. Although the total amount of natural nutrients available to plants decreases with years of farming, crop yields today may be higher than those obtained earlier because improved crop varieties are used and methods of farming have improved.

Fertilizing dryland crops has not been so profitable in Treasure County as it has in other parts of Montana. The farmer can determine the economic feasibility of fertilizing by leaving part of each field unfertilized as a check against the fertilized part. Response to fertilizer has been poor, probably because annual rainfall is low.

Burning stubble is not commonly practiced in the county. This burning may temporarily bring a slight increase in yield, but continuous burning reduces the organic matter in the soil and thus leads to poorer tilth and lower yields. It also leaves the soil poorly protected from erosion by wind and water.

Controlling erosion

The dryfarmed soils in the county are subject to wind or water erosion in varying degrees. Basic in controlling erosion are maintaining good soil structure, protecting the surface with stubble mulch, planting steep, erodible slopes to permanent vegetation, and keeping a good stand of grass in pastures.

The larger fields are stripcropped for protection against erosion, particularly wind erosion. Some fields, however, are too small or too irregularly shaped to be stripcropped. Whether stripcropped or not, all cultivated areas are benefited by stubble-much tillage. Crop residue on the surface helps prevent erosion, and on Flasher fine sandy loam and other sandy soils, this protection is essential.

Some of the more sloping areas are suitable for contour farming. In many places soils not suitable for cultivation, or soils suitable for only occasional cultivation, often occur with soils that are more suitable. The use of these areas depends on their size, shape, and kind of soil that is dominant. The more extensive areas of steep, thin, or sandy soils should be kept in permanent grass. Cropping systems

that keep some kind of cover on the soil at all times help to retard erosion.

Grassed waterways should be established where water concentrates in cultivated fields. They are beneficial even in areas where contour cultivation is not practical.

Capability Groups of Nonirrigated Soils

In this subsection all the soils suitable for nonirrigated crops in the county are placed in capability units, and the management of these units is discussed. The following list shows the capability classes, subclasses, and capability units in the county.

Class III. Soils that have severe limitations that reduce the choice of plants, or require special conservation practices, or both.

- Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.
  - Capability unit IIIe–2, nonirrigated.—Deep and moderately deep soils that have a loam or clay loam surface layer and a loam to clay subsoil; mostly on slopes of 4 to 8 percent.
  - Capability unit IIIe–3, nonirrigated.—Moderately deep soils that have a loam surface layer and a loam or clay loam subsoil and are underlain by loose sand and gravel at a depth of 22 to 32 inches; on slopes of not more than 8 percent.
  - Capability unit IIIe–4, nonirrigated.—Deep, well-drained clays or clay loams that have a granular surface layer; on slopes of not more than 3 percent.
  - Capability unit IIIe–5, nonirrigated.—Deep, well-drained clays that have a granular surface layer; on slopes of 3 to 8 percent.
  - Capability unit IIIe–6, nonirrigated.—Deep and moderately deep fine sandy loams that have a sandy loam or clay loam subsoil; on slopes of 2 to 8 percent.
- Subclass IIIs. Soils that have severe limitations of moisture capacity or tilth.
  - Capability Unit IIIs–2, nonirrigated.—Deep, well-drained soils that have a clay loam surface layer and a dense clay subsoil; on slopes of less than 4 percent.
- Subclass IIIc. Soils that have severe climatic limitations.
  - Capability unit IIIc–1, nonirrigated.—Deep and moderately deep, nearly level and gently sloping soils that have a loam or clay loam surface layer and a loamy or clayey subsoil.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

- Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.
  - Capability unit IVe–3, nonirrigated.—Deep and moderately deep loams and clay loams that have a loam to clay subsoil; on slopes of 8 to 20 percent.
  - Capability unit IVe–4, nonirrigated.—Deep and moderately deep, loose fine sandy loams; on slopes of 0 to 20 percent.
  - Capability unit IVe–5, nonirrigated.—Deep and moderately deep fine sandy loams, loams, and clay loams that have a clay loam to clay subsoil and spots where there is a claypan; on slopes of 2 to 8 percent.
  - Capability unit IVe–6, nonirrigated.—Moderately deep and shallow loams underlain by sandstone or shale at a depth of 12 to 22 inches; on slopes of 2 to 8 percent.
  - Capability unit IVe–7, nonirrigated.—Moderately deep soils that have a granular clay surface layer and a clay subsoil that is underlain by shale at a depth of 20 to 40 inches; on slopes of 5 to 10 percent.
- Subclass IVs. Soils that have very severe limitations of stoniness, low moisture capacity, or other soil features.
  - Capability unit IVs–5, nonirrigated.—Deep, well-drained loams, clay loams, and clays that are saline or alkaline enough to reduce yields of crops; on slopes of less than 1 percent.

Class V. Soils not likely to erode that have other limitations, impractical to remove without major reclamation, that limit their use largely to pasture or range, woodland, or wildlife food and cover. (None in Treasure County.)

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

- Subclass VIe. Soils severely limited, chiefly by risk of erosion if protective cover is not maintained.
  - Capability unit VIe–2, nonirrigated.—Deep, loose, sandy soils on slopes of less than 2 percent to 20 percent.
  - Capability unit VIe–3, nonirrigated.—Deep and moderately deep sandy loams, loams, clay loams, and clays; on slopes that are generally steep but that range from 0 to 35 percent.
  - Capability unit VIe–4, nonirrigated.—Moderately deep and shallow fine sandy loams, loams, and clay loams; on slopes of 15 to 40 percent.
- Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation.
  - Capability unit VIw–1, nonirrigated.—Deep, wet clays that have a water table at or near the surface during most of the year; on bottom lands with slopes of less than 1 percent.
  - Capability unit VIw–2, nonirrigated.—Deep, wet, strongly saline loams, clay loams, silty clays, and clays; on slopes of less than 4 percent.
  - Capability unit VIw–3, nonirrigated.—Deep clays in flat undrained basins that are ponded periodically for varying periods during most years.
- Subclass VIs. Soils generally unsuitable for cultivation and limited for other uses by their moisture capacity, stones, or other features.
  - Capability unit VIs–3, nonirrigated.—Shallow soils that are less than 20 inches deep over loose sand and gravel, hard sandstone, or shale; on slopes of 1 to 40 percent.

Capability unit VIs-4, nonirrigated.—Deep, strongly alkaline clays that have a crusty surface and loams and clay loams in which many spots of barren clay occur; on slopes of 0 to 35 percent.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe. Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained.

Capability unit VIIe-1, nonirrigated.—Soils of varying texture and depth that are in steep and rough, broken areas; on slopes of 25 to 65 percent.

Capability unit VIIe-2, nonirrigated.—Hilly, steep, and rough broken shale land; on slopes of 30 to 70 percent.

Subclass VIIs. Soils very severely limited by moisture capacity, stones, or other soil features.

Capability unit VIIs-1, nonirrigated.—Shallow clays underlain by shale at a depth of 8 to 20 inches; on hilly uplands that have slopes of 10 to 40 percent.

Capability unit VIIs-2, nonirrigated.—Very gravelly soils underlain by loose sand and gravel; on eroded edges of benches where slopes range from 10 to 40 percent.

Capability unit VIIs-3, nonirrigated.—Shallow and very shallow loams and sandy loams that are underlain by loose gravel, shale, or sandstone at a depth of 5 and 10 inches; on hilly to rough, broken land that has slopes of 30 to 70 percent.

Capability unit VIIs-4, nonirrigated.—Nearly barren, strongly saline or strongly alkaline clays; on slopes of 0 to 4 percent.

Capability unit VIIs-5, nonirrigated.—Very shallow clays and considerable outcrops of barren shale; on slopes of 20 to 50 percent.

Class VIII. Soils and landforms that, without major reclamation, have limitations that preclude their use for commercial production of plants and restrict their use of recreation, wildlife, water supply, or esthetic purposes.

Subclass VIIIs. Rock or soil materials that have little potential for production of vegetation.

Capability unit VIIIs-1, nonirrigated.—Riverwash and shale outcrop.

Management of nonirrigated capability units

In this subsection, the soils in the county that are used for nonirrigated crops or for grazing have been placed in nonirrigated capability units and the use and management of those units are discussed. Because the soils in capability units of class VI, VII, and VIII are not suitable for crops but may be suitable as range, the range site into which the soils have been placed is also given so that the reader can readily turn to the range sites to learn about the use of the soils for range.

CAPABILITY UNIT IIIe-2, NONIRRIGATED

This capability unit consists of deep and moderately deep loams and clay loams that have a loam to clay subsoil. These soils are on sloping fans, terraces, and uplands. Slopes generally range from 4 to 8 percent. The soils are—

Briggsdale loam, 4 to 8 percent slopes.
Cushman loam, 4 to 8 percent slopes.
Cushman-Bainville loams, 4 to 8 percent slopes.
Edgar loam, 1 to 8 percent slopes.
Fort Collins loam, 4 to 8 percent slopes.
Hesper loam, 4 to 8 percent slopes.
McRae and Havre loams, 4 to 8 percent slopes.
Nunn clay loam, 3 to 8 percent slopes.
Renohill clay loam.
Wanetta loam, deep, 4 to 8 percent slopes.

These soils have high natural fertility and contain an average amount of organic matter. They are easily tilled. They take in water readily and hold an adequate supply of moisture. Because these soils are sloping, some water is lost in runoff during heavy rains or when snow melts. This runoff causes some rilling and, on fans immediately below steep uplands, severe erosion. Wind erosion is also a problem on these soils.

These soils are some of the more productive nonirrigated soils in the county. In most years when rainfall is higher than normal, they produce average and above average yields. The crops grown are winter wheat, spring wheat, barley, oats, and corn for silage. Alfalfa is grown for seed.

A suitable cropping system is small grain alternated with summer fallow. Corn is substituted for fallow in some years.

Wind stripcropping is generally used to lessen wind erosion, but stubble mulching is also needed to provide additional protection. If stripcropping is not used, a stubble mulch is essential for reducing soil blowing. Contour stripcropping can be used on some of the longer and smoother slopes. Emergency tillage may be needed in some years to prevent excessive blowing. Grassed waterways prevent gullying.

CAPABILITY UNIT IIIe-3, NONIRRIGATED

This capability unit is made up of moderately deep loams that have a loam or clay loam subsoil. These soils are underlain by loose sand and gravel at a depth of 22 to 32 inches. They are on terraces that have slopes of 1 to 8 percent. The soils are—

Wanetta loam, 1 to 4 percent slopes.
Wanetta loam, 4 to 8 percent slopes.

These soils have high natural fertility and contain an average amount of organic matter. They take in water readily but have limited water-holding capacity because gravel is near the surface. These soils are somewhat droughty in most years. Runoff is not much of a problem, except during heavy rains or when the snow on frozen soils melts. Blowing is the most serious problem of management.

These soils produce moderate yields of all nonirrigated crops, but in most years yields are lower than those on deeper soils. The principal crops are winter wheat, spring wheat, barley, oats, and corn for silage.

Generally a small grain is alternated with summer fallow in the cropping system.

To control wind erosion, wind stripcropping is generally used where fields are large enough. Stubble mulching provides additional protection. If wind stripcropping is not used, stubble mulch is needed to protect the soils against

wind erosion. These soils should not be left bare for long periods.

CAPABILITY UNIT IIIe-4, NONIRRIGATED

This capability unit consists of deep, well-drained soils that have a granular clay or clay loam surface layer and a clay subsoil. These soils are on gently sloping fans. They are—

Bew clay loam.
Cherry clay, 1 to 3 percent slopes.
Cherry clay, moderately deep, 1 to 3 percent slopes.
Havre clay.
Lohmiller clay.
Lohmiller clay, high.
Nunn clay, 1 to 3 percent slopes.

These soils have high natural fertility and contain an average amount of organic matter. They take in water slowly but store an adequate supply of moisture in their subsoil. This moisture is released slowly to plants throughout the growing season. Runoff causes some rilling. These soils are hard to plow and to work, and plowing at the wrong time forms large hard clods that do not break down easily.

Wind erosion is a problem in areas of these soils that are granular on the surface. The soils blow easily if they are not protected.

These soils produce all kinds of nonirrigated crops that are grown in the county. In most years yields are average, and in years of higher than normal rainfall, yields are above average. The crops grown are winter wheat, spring wheat, barley, oats, and corn for silage. Alfalfa is grown for seed production.

Small grain alternated with summer fallow is the usual cropping system, but corn grown for silage is substituted for summer fallow in some years.

Wind stripcropping is generally practiced, but stubble mulching is also needed to reduce soil blowing. These soils should not be left bare for long periods because they blow easily where the surface is granular. To prevent excessive blowing, emergency tillage may be needed in some years.

CAPABILITY UNIT IIIe-5, NONIRRIGATED

This capability unit consists of deep, well-drained soils that occur on sloping fans and uplands and have a clay surface layer and a clay subsoil. The surface layer is granular. The soils are—

Cherry clay, 3 to 8 percent slopes.
Cherry clay, moderately deep, 3 to 8 percent slopes.
Marias and Promise clays.
Nunn clay, 3 to 8 percent slopes.

These soils have high natural fertility and contain an average amount of organic matter. Although they take in water slowly, they store in their subsoil an adequate supply that is released slowly for use by plants throughout the growing season. In places runoff causes some rilling. When these soils dry, they form deep cracks. They are hard to plow and to work.

Wind erosion is the most serious erosion problem on these soils, particularly in places where the surface is granular. Blowing is likely in unprotected areas.

These soils produce average or above average yields of the nonirrigated crops grown in the county. The crops grown are winter wheat, spring wheat, barley, oats, and corn for silage. Alfalfa is grown for seed production.

The normal cropping system is small grain alternated with summer fallow. Corn grown for silage is substituted for summer fallow some years.

Wind stripcropping is generally used to control erosion, but stubble-mulch tillage may also be needed to reduce soil blowing. These soils are particularly susceptible to blowing during winter and early spring when the surface is granular. They should not be left bare for long periods. Emergency tillage may be needed at times to reduce blowing. Grassed waterways prevent gullying.

CAPABILITY UNIT IIIe-6, NONIRRIGATED

This capability unit consists of deep and moderately deep fine sandy loams that have a sandy loam or clay loam subsoil. These soils are on sloping fans and uplands. They are—

Cushman-Terry fine sandy loams, 2 to 8 percent slopes.
Terry-Tullock fine sandy loams.
Terry-Treasure fine sandy loams.
Treasure fine sandy loam, 2 to 4 percent slopes.
Treasure fine sandy loam, 4 to 8 percent slopes.

These soils have high natural fertility and contain an average amount of organic matter. They take in water readily and generally hold an ample supply of moisture in their subsoil. Because this moisture is released for plant use in these soils more rapidly than in the more clayey soils, crop yields are often lower, particularly in dry years.

Water erosion is not a serious problem except when rains are heavy or when the snow melts. Because the surface layer is sandy, these soils blow very easily.

The normal cropping system is small grain alternated with summer fallow.

Stripcropping is generally used to control erosion, but the strips are generally narrower than those on the soils in capability unit IIIe-6. Stubble mulch is also used to reduce soil blowing. Because these soils blow readily, they need some kind of protective cover at all times. At times emergency tillage may be needed to reduce wind erosion. Contour stripcropping and grassed waterways provide additional protection.

CAPABILITY UNIT IIIs-2, NONIRRIGATED

Gilt Edge clay loam is the only soil in this capability unit. It is deep and well drained and has a dense clay subsoil. It occurs on high terraces that have slopes of less than 4 percent.

This soil has moderate natural fertility but contains a less than average amount of organic matter. It takes in water readily at the surface, but its subsoil absorbs the water slowly. It has high water-holding capacity, but moisture is released very slowly by the subsoil for use by plants.

Wind erosion is a more serious problem on this soil than water erosion. Water erosion is not serious except during heavy rains or during the spring thaw.

This soil is suitable for small grain or corn for silage if these are alternated with summer fallow. Yields are about average in years of more favorable rainfall but are below average during normal years.

Wind stripcropping is generally used, and stubble-mulch tillage also helps to reduce erosion losses. Emergency tillage may be needed in the drier years to reduce soil losses by blowing.

CAPABILITY UNIT IIIc-1, NONIRRIGATED

This capability unit consists of deep and moderately deep, nearly level and gently sloping soils that have a loam or clay loam surface layer and a loamy or clayey subsoil. The soils are—

Briggsdale loam, 2 to 4 percent slopes.
Cherry clay loam, 1 to 3 percent slopes.
Cushman loam, 2 to 4 percent slopes.
Fattig loam.
Fort Collins loam, 0 to 1 percent slopes.
Fort Collins loam, 1 to 4 percent slopes.
Havre loam.
Havre loam, high.
Havre clay loam.
Havre clay loam, high.
Havre and Glendive soils (Havre soil only).
Hesper loam, 1 to 4 percent slopes.
Lohmiller clay loam.
Lohmiller clay loam, 1 to 3 percent slopes.
Lohmiller clay loam, high.
Lohmiller clay loam, fans, 0 to 1 percent slopes.
McRae and Havre loams, 0 to 1 percent slopes.
McRae and Havre loams, 1 to 4 percent slopes.
Nunn clay loam, 1 to 3 percent slopes.
Shonkin loam.
Wanetta loam, deep, 0 to 2 percent slopes.
Wanetta loam, deep, 2 to 4 percent slopes.

These soils have high natural fertility and high moisture-holding capacity. They take in water readily and hold a good supply for the use of crops. In unprotected areas, wind erosion may damage these soils.

The crops grown include wheat, barley, oats, and corn for silage. Some alfalfa is grown for seed.

The normal cropping system is small grain followed by a stubble-mulch fallow. Corn for silage may be substituted for fallow in some years.

Dry weather causes the main problems of management. Wind stripcropping and stubble mulching protect these soils against wind erosion. In dry years emergency tillage may be required to control soil drifting. Trees or shrubs may be grown successfully in windbreaks on these soils.

CAPABILITY UNIT IVe-3, NONIRRIGATED

This capability unit consists of deep and moderately deep loams and clay loams that occur on fans and uplands that have slopes of 8 to 20 percent. The soils are—

Cushman loam, 8 to 15 percent slopes.
Cushman-Bainville loams, 8 to 15 percent slopes.
Cushman-Tullock complex, 8 to 15 percent slopes.
Edgar loam, 8 to 15 percent slopes.
Havre and Lohmiller soils, 8 to 15 percent slopes.
McRae loam.
McRae-Bainville loams, 8 to 20 percent slopes (McRae soil only).

These soils have moderately high natural fertility and contain an average or below average amount of organic matter. They take in water readily and hold a moderate to large amount of it. Because slopes are steep, runoff is rapid and loss of soil by washing is likely.

These soils are best used for grazing, but they can be seeded to hay or used for pasture crops for short periods. In most years yields are average or below average.

The best cropping system is one in which these soils are kept in hay or pasture for long periods and are used for small grain alternated with fallow only before reestablishment of the hay or pasture stands. The cropping sequence should be such that these soils are kept in some kind of permanent cover for at least 60 percent of the time. Small grain and summer fallow should not be used for more than 6 years in succession.

In cultivated areas, some kind of cover, either a crop or crop residue, should be kept on these soils at all times to reduce the hazard of erosion. Stubble-mulch tillage together with stripcropping or contour stripcropping normally gives adequate protection. Grassed waterways may also be needed to prevent gullying in the small waterways. On the steep fans below the uplands, diversion terraces may help to protect these soils from runoff from the uplands.

CAPABILITY UNIT IVe-4, NONIRRIGATED

This capability unit consists of deep and moderately deep, loose fine sandy loams. These soils are on bottom lands and fans with slopes of less than 2 percent and on rolling uplands with slopes of 4 to 20 percent. The soils are—

Flasher fine sandy loam, 4 to 20 percent slopes.
Glendive fine sandy loam.
Glendive fine sandy loam, fans.
Havre and Glendive soils (Glendive soil only).

These soils have moderately high natural fertility and contain an average or below average amount of organic matter. They take in water rapidly and have low water-holding capacity. They blow easily because they are sandy. Water erosion is not a problem.

These soils are best used for grazing or for a few kinds of crops. They can be cultivated for short periods if intensive practices are used to prevent excessive loss through wind erosion. Yields of most crops are below average except in years when rainfall is favorable.

The best cropping system is hay or pasture grown for a long time, and small grain and summer fallow used only between the last use and the reestablishment of stands. The crop sequence should be one that keeps some kind of cover on these soils at least three-fourths of the time. Cultivation to small grain, including the summer fallow, should not exceed more than 4 successive years.

If these soils are cultivated, practices should be applied that keep some kind of cover, either a crop or crop residue, on the surface at all times so that soil losses by blowing are reduced. Stubble-mulch tillage is essential in the years when there is enough stubble. Where stripcropping is possible, it gives added control, but narrower strips are needed on these soils than on the loams or clay loams.

CAPABILITY UNIT IVe-5, NONIRRIGATED

This capability unit consists of deep and moderately deep fine sandy loams, loams, and clay loams that have a clay loam to clay subsoil and spots where there is a claypan. In places the claypan is exposed at the surface. These soils are on fans and uplands that have slopes of 2 to 8 percent. They are—

Cushman-Winnett complex.
Terry-Winnett complex.

Most areas of these soils are used for grazing, which is their best use. These soils are suitable for limited use for nonirrigated crops. The principal crops grown are winter wheat and barley. These soils produce average yields in years when rainfall is higher than normal but below average yields when rainfall is normal. Because of the

claypan, the growth of crops is uneven. Except where there is a claypan, these soils take in water readily. They hold an adequate supply of moisture. Soil losses by blowing are a problem in most years.

In the normal cropping system small grain is followed by summer fallow. In the best system, hay or pasture is grown most of the time and small grain and summer fallow are not used for more than 4 years in succession.

In cultivated areas, wind stripcropping or contour stripcropping should be used wherever possible. Stubble mulching provides additional protection against soil losses in the years when there is enough stubble. These soils should not be left bare for long periods. Grassed waterways prevent gullying in the small waterways.

CAPABILITY UNIT IVe-6, NONIRRIGATED

This capability unit consists of moderately deep and shallow, loamy soils that are underlain by sandstone or shale at a depth of 12 to 22 inches. These soils are on undulating to rolling uplands that have slopes of 2 to 8 percent. They are—

Cushman-Travessilla loams, 2 to 8 percent slopes.
Fattig-Travessilla complex.

These soils are used only for grazing, which is their best use. They are suitable for limited use as nonirrigated cropland. Crop yields are below average in most years. Natural fertility is high, but water-holding capacity is low or very low. Both wind and water erosion are likely.

Small grain, alternated with summer fallow, can be grown, but the best cropping system provides hay or pasture most of the time and small grain and summer fallow for not more than 4 years in succession.

Where possible, wind stripcropping or contour stripcropping should be used to control erosion during the years of cultivation. In those years, if there is enough stubble, these soils also should be stubble mulched.

CAPABILITY UNIT IVe-7, NONIRRIGATED

Pierre clay is the only soil in this capability unit. It is moderately deep and occurs on rolling shale uplands that have slopes of 5 to 10 percent. This soil has a granular clay surface layer and a clay subsoil. Shale occurs at a depth of 20 to 40 inches.

This soil is used mainly for grazing, which is its best use. A few areas have been farmed, and a few are farmed today. Yields are about average in most years and are above average in years of favorable rainfall. This soil takes in water slowly but holds adequate amounts of it. Natural fertility is high, but the content of organic matter is below average. Plowing and working are difficult.

Because the surface layer is granular, wind erosion is a serious problem. The main crops are winter wheat, barley, and oats. Alfalfa is grown for seed and hay.

The normal cropping system is small grain alternated with summer fallow. In cultivated areas wind stripcropping or contour stripcropping should be used if possible. A stubble mulch provides additional protection against soil losses if there is enough stubble. This soil should not be left bare for long periods.

CAPABILITY UNIT IVs-5, NONIRRIGATED

This capability unit consists of deep, well-drained loams, clay loams, and clays that are saline or alkaline. These soils are on level bottom lands and terraces that have slopes of less than 1 percent. They are—

Cherry-Laurel clay loams.
Havre clay loam, saline.
Havre loam, saline.
Havre clay, saline.
Havre-Hysham loams.
Lohmiller-Hysham clays.
Lohmiller-Hysham clay loams.

Most of these soils are used for grazing, which is their best use. Some areas are used as cropland or as hayland that is flooded. Use for nonirrigated crops is limited by salts or alkali. Even in favorable years, crop yields are below average. Yields are increased by flood irrigation.

The cropping system should provide that these soils are kept in pasture or hay most of the time and that small grain is grown only in the more favorable years.

Where possible, wind stripcropping should be used on these soils. In the years that enough straw is produced, a stubble mulch should also be used for protection against the wind.

CAPABILITY UNIT VIe-2, NONIRRIGATED

This capability unit consists of deep, loose loamy fine sands and fine sands on level bottom lands and rolling uplands. Slopes range from less than 2 percent to 20 percent. The soils are—

Dwyer fine sand.
Flasher loamy fine sand.
Glendive loamy fine sand.

These soils are too sandy and droughty for cultivation. They blow easily in cultivated areas and in areas where the plant cover is disturbed. The soils in this capability unit are also in the Sands range site.

CAPABILITY UNIT VIe-3, NONIRRIGATED

This capability unit is made up of deep and moderately deep sandy loams, loams, clay loams, and clays that occur on rolling uplands and steep fans. Slopes are generally steep but range from 0 to 35 percent. The soils are—

Arvada loam, 0 to 3 percent slopes.
Arvada complex.
Bainville loam, 8 to 15 percent slopes.
Bainville-Midway complex, 8 to 15 percent slopes.
Bowdoin clay.
Havre and Lohmiller soils.
Havre and Lohmiller soils, saline.
Hysham-Havre loams.
McRae-Bainville loams, 8 to 20 percent slopes (Bainville soil only).
McRae-Bainville loams, 20 to 35 percent slopes (McRae soil only).
Midway clay loam, 8 to 15 percent slopes.
Pierre-Lismas clays (Pierre soil only).
Tullock fine sandy loam, 4 to 20 percent slopes.

These soils are too steep, too likely to erode, or too shallow for cultivation. They are best suited to native grasses and produce moderate yields of forage if range management is good. Hay or pasture crops can also be grown.

Waterspreading on suitable sites increases forage yields. Depleted plant cover can be improved or restored by reseeding. Areas of these soils that overflow regularly or that are used for waterspreading produce vegetation like that on the Overflow range site. The soils in this capability unit are also in the Sandy, the Silty, or the Clayey range site.

CAPABILITY UNIT VIe-4, NONIRRIGATED

This capability unit is made up of moderately deep and shallow fine sandy loams, loams, and clay loams on hilly and very steep uplands. These soils are—

Bainville loam, 15 to 35 percent slopes.
Bainville-Midway complex, 15 to 35 percent slopes.
Bainville-Tullock complex.
Flasher fine sandy loam, 20 to 35 percent slopes.
Havre and Lohmiller soils, 15 to 35 percent slopes.
Lismas-Midway complex.
McRae-Bainville loams, 20 to 35 percent slopes (Bainville soil only).
Midway clay loam, 15 to 35 percent slopes.
Nihill gravelly loam.
Travessilla-Tullock fine sandy loams (Tullock soil only).

These soils are too steep for cultivation, and they erode easily if they are not managed well. They produce good yields of native grasses if grazing is regulated. The soils in this capability unit are also in the Thin Sandy, the Thin Silty, or the Thin Clayey range site.

CAPABILITY UNIT VIw-1, NONIRRIGATED

Lohmiller clay, wet, is the only soil in this capability unit. This deep soil occurs on level bottom lands and, in most areas, has a water table within 3 feet of the surface during the growing season. Because of seepage from irrigation, the water table is at the surface in some areas part of the year.

This soil is too wet for cultivation and is best used for grazing. It produces much forage, but special management is required to keep livestock from trampling the plant cover. Depleted or destroyed plant cover can be improved or restored by reseeding. The soil in this capability unit is also in the Subirrigated range site.

CAPABILITY UNIT VIw-2, NONIRRIGATED

This capability unit is made up of deep, strongly saline loams, clay loams, silty clays, and clays that have a high water table. These soils occur on bottom lands, on terraces, and in undrained basins. Slopes are less than 4 percent. The soils are—

Laurel clay loam.
Laurel loam.
Sage clay.
Sage silty clay.

These soils are too wet or too saline or alkaline for nonirrigated crops, but they produce high yields of native grasses if range management is good. The soils in this capability unit are also in the Saline Subirrigated range site.

CAPABILITY UNIT VIw-3, NONIRRIGATED

Only Hoven clay is in this capability unit. This deep clay is in the flat undrained basins and depressions that are ponded periodically during most years.

This soil is best suited for grazing; it is too wet and too clayey for cultivation. It produces much native forage, but regulated grazing is required to prevent trampling. The soil in this capability unit is also in the Overflow range site.

CAPABILITY UNIT VIs-3, NONIRRIGATED

This capability unit is made up of shallow soils less than 20 inches deep over loose sand and gravel, hard sandstone, or shale. These soils are nearly level to rolling. They are—

Banks soils.
Beaverton gravelly loam.
Glendive and Banks soils.
Travessilla-Tullock fine sandy loams (Travessilla soil only).

These soils are too shallow and droughty for cultivation. They are best suited for grazing. They produce an average amount of native forage if they are managed well. Depleted plant cover can be improved or restored by reseeding. The soils in this capability unit are also in the Sandy, the Shallow to Gravel, or the Shallow Limy range site.

CAPABILITY UNIT VIs-4, NONIRRIGATED

This capability unit consists of deep, strongly alkaline clays that have a crusty surface and of loams and clay loams in which there are many spots of barren clay. These soils are nearly level to rolling. Slopes range from 0 to 35 percent. The soils are—

Arvada-Laurel complex.
Gilt Edge-Arvada complex.
Lismas-Pierre clays, saline-alkali (Pierre soil only).
Marias clay, saline-alkali, 0 to 1 percent slopes.
Marias clay, saline-alkali, 1 to 10 percent slopes.
Marias clay, fans, saline-alkali.
Marias-Hoven clays, saline.
Marias-Pierre clays, saline-alkali.
Pierre-Lismas clays, saline-alkali (Pierre soil only).
Winnett complex.
Winnett-Fattig complex.

These soils are too strongly alkaline and too low in fertility to be used for nonirrigated crops. They are best suited for grazing. Under good management, these soils produce good yields of native forage. Depleted plant cover can be improved or restored by reseeding. In suitable areas, forage can be increased by waterspreading. The soils in this capability unit are also in the Panspots or the Dense Clay range site.

CAPABILITY UNIT VIIe-1, NONIRRIGATED

This capability unit consists of thin, calcareous loams and clays in steep and rough, broken areas. Slopes range from 25 to 65 percent. The soils are—

Midway-Bainville complex.
Midway-Nihill gravelly loams.

These soils are subject to severe erosion if there is not enough plant cover for protection. Intensive range management is needed if a fair amount of forage is to be produced. The soils in this capability unit are also in the Thin Silty or the Thin Clayey range site.

CAPABILITY UNIT VIIe-2, NONIRRIGATED

This capability unit consists of soils of varying depth and texture in hilly, steep, and rough, broken areas. Slopes range from 30 to 70 percent. The soils are—

Bainville-Shale outcrop complex.
Midway-Shale outcrop complex.

These soils are too dense and too strongly alkaline for is depleted. Intensive range management is needed if a fair amount of forage is to be produced. The soils in this capability unit are also in the Thin Breaks range site.

CAPABILITY UNIT VIIs-1, NONIRRIGATED

This capability unit consists of shallow clays that have a granular or crusty surface layer and are underlain by shale at a depth of 8 to 20 inches. These soils occur on

hilly uplands that have slopes of 10 to 40 percent. The soils are—

Lismas clay.
Lismas-Pierre clays, saline-alkali (Lismas soil only).
Pierre-Lismas clays (Lismas soil only).
Pierre-Lismas clays, saline-alkali (Lismas soil only).

These soils are too shallow and too steep for cultivation. They are best suited for grazing. Even if managed properly, they produce only a small amount of forage. Reseeding to restore depleted plant cover is practical only on the less steep slopes. The soils in this capability unit are also in the Shallow Clay range site.

CAPABILITY UNIT VIIs-2, NONIRRIGATED

Only Hilly gravelly land is in this capability unit. It consists of shallow and very shallow, very gravelly soils over loose sand and gravel. This hilly to steep land is on eroded edges of benches where slopes range from 10 to 40 percent.

This land is too droughty and too steep for cultivation. It is best suited for grazing. Even under good range management, only a small amount of forage is produced in most years. It is not practical to reseed areas where plant cover is depleted.

Hilly gravelly land is also in the Gravel range site.

CAPABILITY UNIT VIIs-3, NONIRRIGATED

This unit consists of the shallow and very shallow loams and sandy loams that are underlain by loose gravel, shale, or sandstone. These soils occur in hilly to rough, broken areas where slopes range from 30 to 70 percent. The soils are—

Travessilla-Rock outcrop complex.
Wibaux-Rock outcrop complex.

These soils are too steep and too shallow for cultivation. Even under good management, they produce only a little native forage. The soils in this capability unit are also in the Very Shallow range site.

CAPABILITY UNIT VIIs-4, NONIRRIGATED

Only Hoven and McKenzie soils are in this capability unit. These soils are nearly barren, strongly saline or strongly alkaline clays and have slopes ranging from 0 to 4 percent.

These soils are too dense and too strongly alkaline for cultivation. Even under good range management, they produce only a little native forage in suitable areas, but waterspreading increases the yields. The soils in this capability unit are also in the Saline Upland range site.

CAPABILITY UNIT VIIs-5, NONIRRIGATED

In this capability unit are steep and rough, broken areas where soils are very shallow and barren outcrops of shale are considerable. Slopes range from 20 to 50 percent. In this unit are—

Badlands.
Lismas-Shale outcrop complex.

These soils are too steep and too shallow for cultivation, and they produce only a small amount of native forage. The soils in this capability unit are also in the Badlands or the Shale range site.

CAPABILITY UNIT VIIIs-1, NONIRRIGATED

This capability unit consists of barren areas of sand and gravel along river channels and of barren shale outcrops on uplands. The unit is made up of—

Riverwash.
Shale outcrop.

These land types produce little or no usable forage. Their primary use is for sand or gravel that might be useful.

Predicted Yields of Nonirrigated Crops

In table 3 are three sets of predicted yields of the principal nonirrigated crops grown in the county under the management generally practiced. The yields in columns A are for years when the rainfall is less than normal, and those in columns B are for years when the rainfall is more than normal. The yields in columns C are average annual yields for a 20-year period.

Yields are given for different conditions of rainfall, rather than for different levels of management, because the most important single factor that affects the growth of nonirrigated crops is the total amount of moisture that is available during the growing season. This moisture depends mostly on the amount that falls from April through June, but the precipitation that falls during the fallow period is also important because it adds to the supply in the subsoil and is used by crops during the following year. Also beneficial are rains in fall because they supply moisture that helps germination of seeds and the growth of seedlings.

In the management generally used on nonirrigated soils, small grain is alternated with summer fallow. To control weeds, subsoil tillage implements are used four to six times during the fallow period. Some farmers also spray with chemicals for weed control. Generally, commercial fertilizer is not added. Probably the most important factor in this management is the timeliness of the tillage operations, but also important are the type of tillage implements and the effectiveness of the weed control.

In addition to the amount and distribution of rainfall, temperature affects the growth of nonirrigated crops. Cool temperatures during the growing season are favorable to the growth of small grain. Even if moisture is favorable, yields may be reduced considerably by hot dry winds or long periods of hot weather in May through July. Research has shown that an average of 5 or 6 inches of available water, either precipitation or water stored in the soil, is needed to produce a minimum yield of 1 or 2 bushels per acre. If 10 or 11 inches of water is available during the growing season, yields are increased to about 15 bushels per acre. Each additional inch of water above 11 inches during the growing season increases yields 4 to 5 bushels per acre.

On the Edgar, McRae, and similar loamy soils, yields are influenced about equally by seasonal precipitation and by the moisture stored during the fallow period. The moisture stored during summer fallow in the Bew, Marias, Nunn, Promise, and other of the more clayey soils is about 25 percent more effective than that stored in the more loamy soils during the fallow period. The moisture is more effective in the clayey soils, not because those soils have a larger capacity for holding water, but because the

TABLE 3.—*Predicted average acre yields of principal nonirrigated crops*

[Yields in columns A are for years when rainfall is less than normal; yields in columns B are for years when rainfall is more than normal; yields in columns C are the average annual yields of a 20-year period]

Soil	Winter wheat			Spring wheat			Barley			Oats		
	A	B	C	A	B	C	A	B	C	A	B	C
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Arvada complex	8	30	13	6	22	11	9	27	13	10	33	16
Bew clay loam	11	36	18	10	36	16	14	45	20	16	50	24
Briggsdale loam, 2 to 4 percent slopes	11	36	18	10	36	16	14	45	20	16	50	24
Briggsdale loam, 4 to 8 percent slopes	11	36	18	10	36	16	14	45	20	16	50	24
Cherry clay, 1 to 3 percent slopes	11	36	18	10	36	16	14	45	20	16	50	24
Cherry clay, 3 to 8 percent slopes	11	36	18	10	36	16	14	45	20	16	50	24
Cherry clay, moderately deep, 1 to 3 percent slopes	11	36	18	10	36	16	14	45	20	16	50	24
Cherry clay, moderately deep, 3 to 8 percent slopes	11	36	18	10	36	16	14	45	20	16	50	24
Cherry clay loam, 1 to 3 percent slopes	11	36	18	10	36	16	14	45	20	16	50	24
Cushman loam, 2 to 4 percent slopes	10	34	16	9	32	14	13	40	17	15	48	21
Cushman loam, 4 to 8 percent slopes	10	34	16	9	32	14	13	40	17	15	48	21
Cushman loam, 8 to 15 percent slopes	9	28	13	8	24	12	10	29	15	12	36	18
Cushman-Bainville loams, 4 to 8 percent slopes	9	30	14	8	27	12	11	35	15	13	41	18
Cushman-Bainville loams, 8 to 15 percent slopes	8	24	12	7	21	11	10	26	13	12	33	16
Cushman-Terry fine sandy loams, 2 to 8 percent slopes	10	32	16	9	29	14	13	36	17	15	43	21
Cushman-Tullock complex, 8 to 15 percent slopes	8	24	12	8	21	11	10	26	14	12	27	16
Cushman-Travessilla loams, 2 to 8 percent slopes	7	24	12	6	21	11	9	26	13	10	32	16
Cushman-Winnett complex	7	24	12	6	22	11	9	27	13	10	33	16
Edgar loam, 1 to 8 percent slopes	11	38	17	9	33	15	14	40	18	16	48	22
Edgar loam, 8 to 15 percent slopes	9	32	14	8	27	12	11	35	15	13	40	18
Fattig loam	10	32	16	10	32	14	13	36	17	15	48	21
Fattig-Travessilla complex	7	24	12	6	21	11	9	26	13	10	33	16
Flasher fine sandy loam, 4 to 20 percent slopes	8	24	11	6	21	11	9	26	13	10	33	16
Fort Collins loam, 0 to 1 percent slopes	11	36	17	9	34	15	13	43	19	16	50	23
Fort Collins loam, 1 to 4 percent slopes	11	36	17	9	34	15	13	43	19	16	50	23
Fort Collins loam, 4 to 8 percent slopes	11	36	17	9	34	15	13	43	19	16	50	23
Gilt Edge clay loam	9	32	15	8	29	13	10	36	16	12	44	18
Glendive fine sandy loam	8	22	11	6	20	10	8	25	12	9	30	15
Glendive fine sandy loam, fans	8	28	12	6	25	11	10	31	14	12	38	16
Havre clay	9	32	14	8	29	12	11	37	15	14	44	18
Havre clay loam	10	34	15	9	31	13	12	39	16	15	46	20
Havre clay loam, high	10	34	15	9	31	13	12	39	16	15	46	20
Havre clay loam, saline	6	20	10	5	18	9	6	23	11	8	27	14
Havre loam	10	34	15	9	31	13	12	39	16	15	46	20
Havre loam, high	10	34	15	9	31	13	12	39	16	15	46	20
Havre loam, saline	5	22	10	4	20	9	6	23	11	8	30	14
Havre-Hysham loams	5	20	10	4	20	9	6	23	11	8	30	14
Hesper loam, 1 to 4 percent slopes	12	42	20	10	36	18	15	45	22	18	52	27
Hesper loam, 4 to 8 percent slopes	12	42	20	10	36	18	15	45	22	18	52	27
Lohmiller clay loam	10	36	16	9	32	14	13	40	18	15	48	22
Lohmiller clay loam, 1 to 3 percent slopes	10	36	16	9	32	14	13	40	18	15	48	22
Lohmiller clay loam, fans, 0 to 1 percent slopes	10	36	16	9	32	14	13	40	18	15	48	22
Lohmiller clay loam, high	10	36	16	9	32	14	13	40	18	15	48	22
Lohmiller clay	11	36	18	10	36	16	14	45	20	16	50	24
Lohmiller clay, high	11	36	18	10	36	16	14	45	20	16	50	24
Lohmiller-Hysham clays	5	20	10	5	18	9	6	23	11	8	30	14
Lohmiller-Hysham clay loams	5	20	10	5	18	9	6	23	11	8	30	14
Marias and Promise clays	12	42	20	9	36	18	15	45	25	18	52	27
McRae loam	11	32	14	8	27	12	11	35	15	14	42	18
McRae-Bainville loams, 8 to 20 percent slopes	9	28	13	7	25	11	10	30	13	12	37	16
McRae and Havre loams, 0 to 1 percent slopes	11	34	16	8	31	13	12	39	16	15	46	20
McRae and Havre loams, 1 to 4 percent slopes	11	34	16	8	31	13	12	39	16	15	46	20
McRae and Havre loams, 4 to 8 percent slopes	11	34	16	8	31	13	12	39	16	15	46	20
Nunn clay loam, 0 to 1 percent slopes	14	50	24	12	45	22	18	56	30	21	60	30
Nunn clay loam, 1 to 3 percent slopes	11	40	18	9	36	16	14	45	20	16	50	24
Nunn clay loam, 3 to 8 percent slopes	11	40	18	9	36	16	14	45	20	16	50	24
Nunn clay, 1 to 3 percent slopes	10	34	15	9	29	14	13	36	17	15	48	22
Nunn clay, 3 to 8 percent slopes	7	32	15	7	29	12	11	36	15	13	41	15
Renohill clay loam	10	34	15	9	29	14	13	36	17	15	48	22
Shonkin loam	14	50	24	12	45	22	18	56	30	21	60	30
Terry-Tullock fine sandy loams	7	32	15	7	29	12	11	36	15	13	41	18
Terry-Treasure fine sandy loams	10	34	16	8	31	14	13	38	17	14	46	20

TABLE 3.—*Predicted average acre yields of principal nonirrigated crops*—Continued

Soil	Winter wheat			Spring wheat			Barley			Oats		
	A	B	C	A	B	C	A	B	C	A	B	C
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Terry-Winnett complex	8	24	12	6	22	11	9	27	13	10	33	16
Treasure fine sandy loam, 2 to 4 percent slopes	11	35	17	9	32	15	14	40	18	16	48	22
Treasure fine sandy loam, 4 to 8 percent slopes	11	35	17	9	32	15	14	40	18	16	48	22
Tullock fine sandy loam, 4 to 20 percent slopes	8	22	11	7	20	10	9	25	13	10	30	15
Wanetta loam, 1 to 4 percent slopes	9	30	14	7	25	13	11	31	16	13	38	19
Wanetta loam, 4 to 8 percent slopes	9	30	14	7	25	13	11	31	16	13	38	19
Wanetta loam, deep, 0 to 2 percent slopes	11	36	16	9	32	14	14	40	18	16	48	21
Wanetta loam, deep, 2 to 4 percent slopes	11	36	16	9	32	14	14	40	18	16	48	21
Wanetta loam, deep, 4 to 8 percent slopes	11	36	16	9	32	14	14	40	18	16	48	21

moisture is held more tightly in the clayey soils and early growth is slowed. Consequently, more moisture is available to crops later in the growing season when a shortage of moisture is more critical.

In table 3, only those soils suitable for some kind of nonirrigated crop are listed. The yields in colums A, those predicted for years of less favorable weather, exclude the years of crop failure. In years of less favorable weather, which is about 3 years out of 20, yields of winter wheat are less than 10 bushels on most soils and are less than 6 bushels on many others. Yields of 6 bushels or less are considered as failures. In the more favorable years, yields of winter wheat exceed 40 bushels per acre on the better soils. Average and above average yields can be expected about 60 percent of the time, and below average yields can be expected about 40 percent of the time.

Range Management [1]

In this subsection the principles of range management are discussed, and the soils of the county are placed in range sites. These sites and their vegetation are described. Also, yields of forage are estimated for each range site.

In Treasure County 90 percent of the total acreage is grazed. The areas grazed occur throughout the county, except in the valleys of the Yellowstone and the Bighorn Rivers and of some of their larger tributaries. Much of the land that is grazed is too steep or is otherwise unsuitable for cultivated crops.

Livestock provides the largest income in the county. Most of the livestock are cattle, but a few bands of sheep are grazed on ranges in the northern part of the county. The success of the livestock enterprise depends on the way ranchers and farmers manage their range and feed their cattle.

Management principles and practices

If the range is kept in good or excellent condition and is improved where it is depleted, large amounts of forage are produced and soil, water, and plants are conserved. The growth of grass and of other forage plants depends on the development of the roots, stalk, leaves, and flower. Also important are food storage in roots, seed production, and forage regrowth. To permit these natural processes of growth, grazing must be regulated.

If grazing is not carefully regulated, livestock select and eliminate the most palatable plants. Less desirable, or second-choice, plants increase, and if heavy grazing continues, those plants are thinned out or eliminated and undesirable weeds, or invaders, take their place.

Research and experience of ranchers have shown that damage to desirable plants is lessened and the range is improved if not more than half the grass that grows in a year is removed by grazing. Then—

(1) The better grasses maintain or improve their vigor and thus crowd out weeds or prevent them from invading.
(2) Plants store food that is used in quick and vigorous growth after droughts and in spring.
(3) Roots increase in number and in length so that they reach additional moisture and plant nutrients.
(4) Plants, particularly grass, protect the soil from wind and water erosion.
(5) Plants serve as a mulch that allows a rapid intake of water.
(6) Snow is held by plants where it falls, and it later melts and supplies water that soaks into the soil and is available for use.
(7) The feed reserve for dry years is increased, and a forced sale of livestock caused by lack of feed may be prevented.

To insure that not more than half of the yearly volume of grass is grazed, the stocking rate is adjusted from season to season according to forage production. The management should provide reserve pastures or other feed during droughts, or when forage production is low for other reasons. Thus, grazing should be no more than moderate at any time. In addition, it is often desirable to keep stocker steers or other livestock ready for sale so that the rancher can balance the number of his livestock with the forage available and not be forced to sell his breeding animals.

Two practices that are essential for maintaining or improving the condition of range, regardless of the other

[1] By STERLE E. DALE, range conservationist, Soil Conservation Service.

practices used, are proper range use and deferred grazing. In *proper range use* grazing is at a rate that maintains the vigor of plants, a reserve of forage, and adequate cover for protection. In *deferred grazing* the range is rested for a definite period during the growing season so that the vigor of forage is increased and desirable plants reproduce naturally. Also, deferred grazing builds up a reserve of forage for later use.

Other practices that improve the condition of the range are seeding, distributing watering places, fencing, salting, and controlling brush.

Seeding.—Native or improved grasses can be established on range suited to them by seeding or reseeding. The climate and the soils should be suitable for supporting, with no care other than management of grazing, the kinds of plants seeded. Suitable grasses are those dominant in the climax vegetation and other plants suited to the soils. If native grass is seeded, the seed should be produced no farther away than 150 miles to the south, 200 miles to the north, or 200 miles to the east or west.

Watering places.—If possible, watering places should be distributed through the range so that all parts of the range are grazed uniformly and the animals do not have to go far for water. Wells, springs, and seeps furnish most of the water for livestock in the county. The nature of each range determines the kind of watering place most practical and its location.

Fencing.—Fences are constructed so that grazing can be managed more easily. By cross fencing large areas, better distribution of grazing can be obtained. Pastures may need to be separated according to seasonal use, because of the limited time that water is available. If a particular range site is large enough, it may be fenced because then it can be more easily managed.

Salting.—Salt is necessary to supplement range forage. Salting at different places improves the distribution of grazing.

Controlling brush.—Chemical control of undesirable brush, generally big sagebrush, may be necessary in some areas so that the forage is improved and livestock can be handled more easily.

Feed and forage program

A feed and forage program should be provided if the production of forage is to be high, the range conserved, and animals kept in good condition throughout the year. This program should provide range forage, harvested roughage, and supplemental concentrates. During emergencies, the rancher can feed his livestock on reserved roughage, and he can use the supplemental concentrates whenever they are needed. The use of roughage and deferred grazing of native pasture conserve plant cover. Reserves of feed are kept in winter for meeting the normal requirement of the animals. Feed shortages can be avoided by reserving the surplus produced in years of high yields.

Range sites and condition classes

Different kinds of range produce different kinds and amounts of original vegetation. For good range management, an operator should know the different kinds of range in his holdings and the plants that will grow on each site. Then management can be used that favors growth of the best forage plants on each kind of range. Managing range can be approached by grouping soils in range sites.

A *range site* is a combination of soil, climate, and vegetation. It is best explained as a kind of rangeland that differs from another kind of rangeland in its ability to produce a different kind or amount of the original, or climax, vegetation. Climax vegetation is the combination of range plants that originally grew on a given soil. The most productive combination of range plants on the site is generally the climax vegetation.

Range condition is the term used to relate the current condition of the range to the potential of which the site is capable. It is expressed as the percentage of climax, or original, vegetation that is present on the site. Following are the different classes of range condition and the percentage of the climax vegetation present in each:

Condition class	*Percentage of the climax vegetation on the site*
Excellent	76 to 100
Good	51 to 75
Fair	26 to 50
Poor	0 to 25

Range sites in Treasure County

In this subsection, most of the soils in the county are placed in range sites and each range site is described. Described also is the dominant vegetation on the range sites when they are in excellent condition. Soils that are used only as irrigated cropland and that have not been placed in range sites are—

Cherry clay, 0 to 1 percent slopes.
Cherry clay, moderately deep, 0 to 1 percent slopes.
Cherry clay loam, 0 to 1 percent slopes.
Cherry clay loam, shallow, 0 to 1 percent slopes.
Fort Collins loam, sandy substratum, 0 to 1 percent slopes.
Fort Collins loam, sandy substratum, 1 to 3 percent slopes.
Glendive clay.
Glendive clay loam.
Glendive fine sandy loam, shallow.
Havre loam, moderately deep.
Nunn clay, 0 to 1 percent slopes.
Nunn clay loam, 0 to 1 percent slopes.
Nunn-Beckton complex, 0 to 1 percent slopes.

In the descriptions that follow, the native plants are discussed in terms of decreasers, increasers, and invaders. Decreasers and increasers are climax plants. Decreasers are the most heavily grazed and consequently are the first to be injured by overgrazing. Increasers withstand grazing better than decreasers and are less palatable to the livestock; they increase when the range is grazed, and they replace the decreasers. Invaders are weeds or other undesirable plants that become established after the climax vegetation has been reduced by grazing.

SUBIRRIGATED RANGE SITE

The only soil in the Subirrigated range site is Lohmiller clay, wet. This soil is on slopes of less than 1 percent. The water table is within 3 feet of the surface during most of the growing season and, at times, is at the surface in some places.

The original plant community included the decreasers basin wild-rye, Canada wild-rye, wetland sedges, and switchgrass. Western wheatgrass and snowberry were among the increasers. Long, continuous overuse has virtually eliminated the decreasers, and their place has largely been taken by mat muhly, Baltic rush, various

sedges, and other increasers. Invaders commonly include Kentucky bluegrass, dandelion, Canada thistle, and foxtail barley.

SALINE SUBIRRIGATED RANGE SITE

The Saline Subirrigated range site consists of deep, strongly saline loam, clay loam, silty clay, and clay on nearly level bottom lands and fans. These soils are subirrigated most of the year by a high water table. Because of this high water table, salts have accumulated on the surface in places. The soils are—

Laurel clay loam.
Laurel loam.
Sage clay.
Sage silty clay.

The original plant community included the decreasers alkali sacaton, alkaligrass, alkali bluegrass, western wheatgrass, and sedges. Inland saltgrass, mat muhly, and greasewood were among the increasers. If this range site is overused, foxtail barley and smartweed invade. The aftermath of an irrigated crop on this range site has been grazed frequently during the nonirrigation season.

OVERFLOW RANGE SITE

In the Overflow range site are a clay and a loam in flat undrained basins and depressions. These soils are ponded at times because they receive additional moisture in the form of runoff from the adjacent areas. Areas of other soils on which waterspreading is practiced are also included in this site. The soils are—

Hoven clay.
Shonkin loam.

The original plant community included green needlegrass, slender wheatgrass, Canada wild-rye, and other decreasers, which made up as much as 40 percent of the total annual growth. Western wheatgrass is the principal increaser. If the range is overused, the invaders include cheatgrass, Kentucky bluegrass, foxtail barley, and needleleaf sedge.

Vegetation stays green longer on this site than on others and attracts livestock so well that the distribution of animals is a problem. If areas of this site are fenced where it is feasible to do so, grazing and the season of use can be controlled.

SANDS RANGE SITE

The Sands range site consists of a loose fine sand and loamy fine sands on nearly level to rolling areas. Slopes range from 2 to 20 percent. The soils are—

Dwyer fine sand.
Flasher loamy fine sand.
Glendive loamy fine sand.

The original plant community included sand bluestem, prairie sandreed, little bluestem, Indian ricegrass, and other decreasers. Needle-and-thread, western wheatgrass, and threadleaf sedge were among the increasers. If the condition of this range site declines, cheatgrass, green sagewort, Japanese chess, six-weeks fescue, and other plants invade. This site is likely to be damaged by trampling and by wind erosion if it is grazed too closely.

SANDY RANGE SITE

The Sandy range site consists of fine sandy loams that have a fine sandy loam or sandy clay loam subsoil. It is scattered throughout the county in nearly level to rolling areas. The soils are—

Cushman-Terry fine sandy loams, 2 to 8 percent slopes.
Cushman-Tullock complex, 8 to 15 percent slopes (Tullock soil only).
Flasher fine sandy loam, 4 to 20 percent slopes.
Glendive fine sandy loam.
Glendive fine sandy loam, fans.
Glendive and Banks soils (Glendive soil only).
Havre and Glendive soils (Glendive soil only).
Terry-Treasure fine sandy loams.
Terry-Tullock fine sandy loams.
Terry-Winnett complex.
Treasure fine sandy loam, 2 to 4 percent slopes.
Treasure fine sandy loam, 4 to 8 percent slopes.
Tullock fine sandy loam, 4 to 20 percent slopes.

The original plant community included the decreasers sand bluestem, little bluestem, prairie sandreed, and Indian ricegrass. Needle-and-thread, western wheatgrass, sand dropseed, and blue grama were among the increasers. Long, continuous overuse has frequently eliminated the decreasers and increasers and their place has been taken by invaders such as cheatgrass, Japanese chess, six-weeks fescue, curlycup gumweed, and broom snakeweed.

SILTY RANGE SITE

The Silty range site consists of deep and moderately deep, well-drained soils that have 2 inches or more of loam or silt loam over a loam, clay loam, or clay subsoil. These soils are extensive and occur throughout the county in level to rolling areas. The soils are—

Arvada loam, 0 to 3 percent slopes.
Arvada complex.
Bainville loam, 8 to 15 percent slopes.
Bainville-Midway complex, 8 to 15 percent slopes (Bainville soil only).
Briggsdale loam, 2 to 4 percent slopes.
Briggsdale loam, 4 to 8 percent slopes.
Cushman loam, 2 to 4 percent slopes.
Cushman loam, 4 to 8 percent slopes.
Cushman loam, 8 to 15 percent slopes.
Cushman-Bainville loams, 4 to 8 percent slopes.
Cushman-Bainville loams, 8 to 15 percent slopes.
Cushman-Tullock complex, 8 to 15 percent slopes (Cushman soil only).
Cushman-Travessilla loams, 2 to 8 percent slopes (Cushman soil only).
Cushman-Winnett complex.
Edgar loam, 1 to 8 percent slopes.
Edgar loam, 8 to 15 percent slopes.
Fattig loam.
Fattig-Travessilla complex (Fattig soil only).
Fort Collins loam, 0 to 1 percent slopes.
Fort Collins loam, 1 to 4 percent slopes.
Fort Collins loam, 4 to 8 percent slopes.
Gilt Edge clay loam.
Glendive loam.
Havre loam.
Havre loam, high.
Havre loam, saline.
Havre and Glendive soils (Havre soil only).
Havre and Lohmiller soils (Havre soil only).
Havre and Lohmiller soils, 8 to 15 percent slopes (Havre soil only).
Havre and Lohmiller soils, saline (Havre soil only).
Havre-Hysham loams.
Hesper loam, 1 to 4 percent slopes.
Hesper loam, 4 to 8 percent slopes.
Hysham-Havre loams.
McRae loam.
McRae-Bainville loams, 8 to 20 percent slopes.
McRae-Bainville loams, 20 to 35 percent slopes (McRae soil only).

McRae and Havre loams, 0 to 1 percent slopes.
McRae and Havre loams, 1 to 4 percent slopes.
McRae and Havre loams, 4 to 8 percent slopes.
Wanetta loam, 1 to 4 percent slopes.
Wanetta loam, 4 to 8 percent slopes.
Wanetta loam, deep, 0 to 2 percent slopes.
Wanetta loam, deep, 2 to 4 percent slopes.
Wanetta loam, deep, 4 to 8 percent slopes.

The original plant community included green needlegrass, western wheatgrass, Montana wheatgrass, bluebunch wheatgrass, thickspike wheatgrass, little bluestem, and other decreasers. Decreasers now make up approximately 50 percent of the vegetation. Needle-and-thread, blue grama, threadleaf sedge, Sandberg bluegrass, and big sagebrush were among the increasers. When the condition of the range deteriorates, decreasers and increasers are replaced by invaders that include cheatgrass, Japanese chess, six-weeks fescue, curlycup gumweed, broom snakeweed, tumblegrass, foxtail barley, and various noxious plants.

This range site is one of the largest in the county, and it supports more upland grazing than most other sites. Because slopes are gentle and the forage is palatable, this range site is favored by livestock, and those parts that are within easy reach of water have been overgrazed. Where these soils are flooded or where waterspreading is used, plants grow that are similar to those on the Overflow range site.

CLAYEY RANGE SITE

The Clayey range site consists of deep and moderately deep, well-drained clay loams, silty clay loams, and granular clays that have a loam, clay loam, or clay subsoil. These soils are level to rolling. They are—

Bainville-Midway complex, 8 to 15 percent slopes (Midway soil only).
Bew clay loam.
Bowdoin clay.
Cherry clay, 1 to 3 percent slopes.
Cherry clay, 3 to 8 percent slopes.
Cherry clay, moderately deep, 1 to 3 percent slopes.
Cherry clay, moderately deep, 3 to 8 percent slopes.
Cherry clay loam, 1 to 3 percent slopes.
Cherry-Laurel clay loams.
Havre clay loam.
Havre clay loam, high.
Havre clay loam, saline.
Havre clay.
Havre clay, saline.
Havre and Lohmiller soils (Lohmiller soil only).
Havre and Lohmiller soils, 8 to 15 percent slopes (Lohmiller soil only).
Havre and Lohmiller soils, saline (Lohmiller soil only).
Lohmiller clay loam, high.
Lohmiller clay loam.
Lohmiller clay loam, fans, 0 to 1 percent slopes.
Lohmiller clay loam, 1 to 3 percent slopes.
Lohmiller-Hysham clay loams.
Lohmiller clay, high.
Lohmiller clay.
Lohmiller-Hysham clays.
Marias and Promise clays.
Midway clay loam, 8 to 15 percent slopes.
Nunn clay loam, 1 to 3 percent slopes.
Nunn clay loam, 3 to 8 percent slopes.
Nunn clay, 1 to 3 percent slopes.
Nunn clay, 3 to 8 percent slopes.
Pierre clay.
Pierre-Lismas clays (Pierre soil only).
Renohill clay loam.

The original plant community included the decreasers western wheatgrass, thickspike wheatgrass, green needlegrass, bluebunch wheatgrass, and various forbs. Among the increasers were blue grama, Sandberg bluegrass, sedges, big sagebrush, greasewood, plains reedgrass, and plains muhly. When the range deteriorates, plants that invade include curlycup gumweed, broom snakeweed, tumblegrass, foxtail barley, and cheatgrass. Where these soils are flooded or where waterspreading is used, plants grow that are similar to those on the Overflow range site.

THIN SANDY RANGE SITE

The Thin Sandy range site consists of deep and moderately deep, calcareous, sandy loam soils that have a very thin surface layer. These soils are in hilly areas in which the hills have smooth side slopes. Slopes range from 15 to 40 percent. The soils are—

Bainville-Tullock complex (Tullock soil only).
Flasher fine sandy loam, 20 to 35 percent slopes.
Travessilla-Tullock fine sandy loams (Tullock soil only).

Prominent among the decreasers in the original vegetation were sand bluestem, little bluestem, Indian ricegrass, prairie sandreed, and side-oats grama. The increasers included needle-and-thread, sand dropseed, blue grama, and prairie junegrass. In areas that have a long history of overuse, the invaders include cheatgrass, six-weeks fescue, Kentucky bluegrass, dandelion, western ragweed, false buffalograss, and various broad-leaved annuals.

THIN SILTY RANGE SITE

The Thin Silty range site consists of deep and moderately deep, calcareous loams and silt loams that have a very thin surface layer. These soils are in steep and hilly areas that have smooth slopes. The soils are—

Bainville loam, 15 to 35 percent slopes.
Bainville-Tullock complex (Bainville soil only).
Bainville-Midway complex, 15 to 35 percent slopes (Bainville soil only).
Havre and Lohmiller soils, 15 to 35 percent slopes (Havre soil only).
McRae-Bainville loams, 20 to 35 percent slopes (Bainville soil only).
Midway-Bainville complex (Bainville soil only).
Midway-Nihill gravelly loams (Nihill soil only).
Nihill gravelly loam.

The original plant community included the decreasers bluebunch wheatgrass, western wheatgrass, little bluestem, side-oats grama, and various forbs. Decreasers made up 40 to 50 percent of the original plant community. Among the increasers were blue grama, plains muhly, threadleaf sedge, snowberry, plains reedgrass, and various forbs. The invaders now on this range site include cheatgrass, salsify, Japanese chess, and broom snakeweed.

THIN CLAYEY RANGE SITE

The Thin Clayey range site consists of deep and moderately deep, calcareous clay loams that have a very thin surface layer. The soils are in steep or hilly areas that have smooth slopes. The soils are—

Bainville-Midway complex, 15 to 35 percent slopes (Midway soil only).
Havre and Lohmiller soils, 15 to 35 percent slopes (Lohmiller soil only).
Lismas-Midway complex.
Midway clay loam, 15 to 35 percent slopes.
Midway-Bainville complex (Midway soil only).
Midway-Nihill gravelly loams (Midway soil only).

The original plant community included the decreasers western wheatgrass, bluebunch wheatgrass, green needle-

grass, and various forbs, such as silver leaf scurfpea, purple prairieclover, American vetch, and slimflower scurfpea. The increasers included blue grama, prairie junegrass, Sandberg bluegrass, threadleaf sedge, big sagebrush, and various forbs. After long, continuous overuse, decreasers and increasers are replaced by invaders that include cheatgrass, Japanese chess, six-weeks fescue, broom snakeweed, and various broad-leaved annuals.

SHALLOW CLAY RANGE SITE

The Shallow Clay range site consists of shallow clays in which the granular or crusty surface layer is underlain by shale at a depth of 6 to 16 inches. These soils are on rolling to hilly shale uplands. Slopes range from 10 to 40 percent. The soils are—

Lismas clay.
Lismas-Pierre clays, saline-alkali (Lismas soil only).
Pierre-Lismas clays (Lismas soil only).
Pierre-Lismas clays, saline-alkali (Lismas soil only).

The original plant community included the decreasers bluebunch wheatgrass, prairie sandreed, western wheatgrass, Montana wheatgrass, green needlegrass, and winterfat. Decreasers made up 60 to 80 percent of the original vegetation. Among the increasers were plains reedgrass, prairie junegrass, blue grama, Sandberg bluegrass, squirreltail, and Gardner saltbush. In deteriorated areas, the invaders include curlycup gumweed, broom snakeweed, foxtail barley, annual bromes, and broad-leaved annuals.

SHALLOW TO GRAVEL RANGE SITE

The Shallow to Gravel range site consists of loamy soils in which the development of roots is limited by sand and gravel at a depth of 10 to 20 inches. The soils are nearly level to gently sloping. They are—

Banks soils.
Beaverton gravelly loam.
Glendive and Banks soils (Banks soil only).

The original plant community included the decreasers bluebunch wheatgrass, western wheatgrass, needle-and-thread, and thickspike wheatgrass. Among the increasers now present are sand dropseed, blue grama, plains muhly, threadleaf sedge, and various forbs. Invaders include cheatgrass, Japanese chess, six-weeks fescue, red three-awn, and broad-leaved annuals.

In areas of Banks soils that are flooded, plants grow that are similar to those of the Overflow range site. Subirrigated areas of the Banks and Glendive soils have vegetation similar to that of the Subirrigated range site.

SHALLOW LIMY RANGE SITE

The Shallow Limy range site consists of calcareous loams or sandy loams in which the growth of roots is restricted by hard sandstone within 16 inches of the surface. These soils are on rolling to hilly uplands that have slopes ranging from 0 to 40 percent. The soils are—

Cushman-Travessilla loams, 2 to 8 percent slopes (Travessilla soil only).
Fattig-Travessilla complex (Travessilla soil only).
Travessilla-Tullock fine sandy loams (Travessilla soil only).

The original vegetation on this range included the decreasers bluebunch wheatgrass, needle-and-thread, western wheatgrass, little bluestem, winterfat, and various forbs, such as American vetch. The principal increasers are blue grama, sand dropseed, plains muhly, threadleaf sedge, and prairie junegrass. The invaders now on deteriorated range include cheatgrass, red three-awn, broom snakeweed, and curlycup gumweed.

PANSPOTS RANGE SITE

The Panspots range site consists of deep and moderately deep soils with a claypan. Hard clay or other compact material is at or near the surface in shallow depressions. The depressions occupy about 20 to 50 percent of the range site. These soils are nearly level to rolling. Slopes range from 0 to 8 percent. The soils are—

Arvada-Laurel complex.
Gilt Edge-Arvada complex.
Marias-Hoven clays, saline.
Winnett complex.
Winnett-Fattig complex.

The original vegetation included the decreasers western wheatgrass, green needlegrass, needle-and-thread, Indian ricegrass, and winterfat. Among the increasers were blue grama, prairie junegrass, plains reedgrass, squirreltail, big sagebrush, greasewood, pricklypear cactus, and Gardner saltbush. Invaders that now grow include Kentucky bluegrass, curlycup gumweed, broom snakeweed, tumblegrass, foxtail barley, cheatgrass, and six-weeks fescue.

DENSE CLAY RANGE SITE

The Dense Clay range site consists of well-drained clays that have a crusty surface layer over a strongly alkaline subsoil. The subsoil takes in water slowly and is extremely hard when dry and very sticky when wet. These soils are nearly level to rolling and occur mainly north of the Yellowstone River. Slopes range from 0 to 35 percent. The soils are—

Lismas-Pierre clays, saline-alkali (Pierre soil only).
Marias clay, fans, saline-alkali.
Marias clay, saline-alkali, 0 to 1 percent slopes.
Marias clay, saline-alkali, 1 to 10 percent slopes.
Marias-Pierre clays, saline-alkali.
Pierre-Lismas clays, saline-alkali (Pierre soil only).

Western wheatgrass was the main decreaser in the original vegetation. The increasers included Sandberg bluegrass, squirreltail, needleleaf sedge, pricklypear cactus, big sagebrush, and greasewood. Where present, invaders include pepperweed, annual sunflower, curlycup gumweed, and cheatgrass.

THIN BREAKS RANGE SITE

The Thin Breaks range site consists of soils that formed from different kinds of geologic material and vary in depth. Because rock crops out at different levels, slopes are steep and irregular and topography is rough and broken. Slopes range from 30 to 70 percent. Trees may grow locally above the outcrops. The soils are—

Bainville-Shale outcrop complex.
Midway-Shale outcrop complex.

Decreasers made up 60 to 80 percent of the original plant community. The decreasers included prairie sandreed, bluebunch wheatgrass, western wheatgrass, Indian ricegrass, green needlegrass, little bluestem, side-oats grama, needle-and-thread, yucca, and winterfat. Among the increasers were prairie junegrass, blue grama, plains muhly, silver sagebrush, and threadleaf sedge. At present, the invaders include curlycup gumweed, broom snakeweed, tumblegrass, foxtail barley, sandwort, and annual bromes.

GRAVEL RANGE SITE

Only Hilly gravelly land is on the Gravel range site. This land type is made up mostly of gravel and small stones that reduce the moisture-holding capacity and affect the kinds and amounts of native plants that grow. This land occurs on edges of eroded terraces and is hilly and steep. Slopes range from 10 to 40 percent.

Decreasers made up 30 to 50 percent of the original plant community. Among the decreasers were bluebunch wheatgrass, needle-and-thread, sand dropseed, Indian ricegrass, and forb decreasers. Most of the other original vegetation consisted of increasers that included prairie junegrass, plains reedgrass, blue grama, threadleaf sedge, squirreltail, and fringed sagewort. At present, after a long period of overuse, invaders are prevalent and include cheatgrass, six-weeks fescue, broom snakeweed, and tumblegrass.

VERY SHALLOW RANGE SITE

The Very Shallow range site consists of steep and hilly soils that in most places are less than 10 inches deep over hard bedrock. Outcrops of bedrock are common. Tall grasses, shrubs, and stunted trees mark deep pockets of soils that have formed in the cracks of the bedrock. Slopes range from 30 to 70 percent. This range site occupies a relatively small acreage in the county. The soils are—

Travessilla-Rock outcrop complex.
Wibaux-Rock outcrop complex.

The original plant community included the decreasers western wheatgrass, needle-and-thread, sand dropseed, prairie junegrass, bluebunch wheatgrass, and little bluestem. Among the increasers were blue grama, Sandberg bluegrass, forbs, and woody plants such as skunkbush sumac. Invaders present today may include cheatgrass, Japanese chess, broad-leaved annuals, and red three-awn.

SALINE UPLAND RANGE SITE

Only Hoven and McKenzie soils are in the Saline Upland range site. These soils are well-drained, strongly alkaline, compact clays that have accumulated salts near the surface. They occur on fans and terraces with slopes of 0 to 4 percent. Much of the range site is barren, but salt- and alkali-tolerant plants grow in some places.

Decreasers that were in the original vegetation included alkali sacaton, western wheatgrass, plains reedgrass, squirreltail, and inland saltgrass. Among the increasers were Gardner saltbush, greasewood, and pricklypear cactus. Invaders that grow in many places today include curlycup gumweed, broom snakeweed, and foxtail barley.

SHALE RANGE SITE

The Shale range site consists of only Lismas-Shale outcrop complex. It is on steep uplands where shale crops out in many places or clay is underlain by shale at a depth of less than 10 inches. Slopes range from 20 to 50 percent. This range site is not extensive in the county.

The original vegetation included the decreasers western wheatgrass, prairie junegrass, plains muhly, blue grama, bluebunch wheatgrass, and Montana wheatgrass. Among the increasers were forbs, greasewood, and broad-leaved, salt-tolerant plants. Invaders that occur in places are cheatgrass, rabbitbrush, and annual broad-leaved saltbushes.

BADLANDS RANGE SITE

Badlands is the only mapping unit in the Badlands range site. It consists mainly of barren or nearly barren shale intermingled with narrow grazeable areas that are broken by drainageways. The drainageways are dry most of the year. Because the topography is very steep, rough, and broken, many areas are inaccessible to livestock.

This range site is of little importance because it covers only small areas. The original plant community contained the decreasers bluebunch wheatgrass, green needlegrass, western wheatgrass, needle-and-thread, sand dropseed, prairie junegrass, plains reedgrass, blue grama, and inland saltgrass. Among the increasers were greasewood and various forbs. Invaders sometimes present include cheatgrass, six-weeks fescue, red three-awn, broom snakeweed, and broad-leaved annuals.

Estimated yields

Yields on a range site vary according to the amount and distribution of rainfall each year. They are also affected by the degree of grazing in past years. In addition, yields are reduced by trampling and by rodents and insects.

Following is the estimated annual total top growth of forage for each range site, assuming it has received average rain throughout the year and is in excellent condition.

Range site:	*Air-dry weight (lb. per acre)*
Subirrigated	3,700–4,300
Saline Subirrigated	2,600–3,200
Overflow	2,200–2,700
Sands	1,700–2,200
Sandy	1,300–1,800
Silty	1,200–1,700
Clayey	1,000–1,500
Thin Sandy	900–1,400
Thin Silty	800–1,300
Thin Clayey	800–1,300
Shallow Clay	700–1,200
Shallow to Gravel	700–1,200
Shallow Limy	600–1,100
Panspots	700–1,200
Dense Clay	600–1,100
Thin Breaks	600–1,100
Gravel	300–800
Very Shallow	300–800
Saline Upland	200–700
Shale	100–600
Badlands	100–600

Windbreaks and Native Woodlands [2]

In this subsection the management of windbreaks is discussed, and the soils of the county are placed in windbreak suitability groups. Also discussed is the management of native woodland.

Tree windbreaks

Some of the farmhouses and ranchhouses in Treasure County are protected by natural woodland. Random plantings of a few scattered trees are common around buildings, but only a few windbreaks have been planted to provide maximum protection and beauty.

Tree windbreaks help to reduce the velocity of wind on farms and ranches. Their main purpose is to protect farmsteads against the wind and blowing soil and snow, but

[2] LEWIS S. MATTHEWS, woodland conservationist, Soil Conservation Service, assisted in writing this subsection.

some of them also serve as snow fences along roads. Windbreaks also provide shelter for livestock and are a source of food and cover for birds and other wildlife. A good windbreak adds considerably to the attractiveness and comfort of homesteads and other buildings. It should be wide enough and long enough to give maximum protection.

Considered in locating windbreaks are (1) the direction of the prevailing winds during periods when winds are strongest and (2) the direction of the slope on which the trees are to be planted. To be most effective, windbreaks should be approximately at right angles to the direction of the prevailing wind. They should be planted on two or more sides of the farm buildings. In areas where slopes are not more than 4 percent, the trees of a windbreak may be planted downslope in straight lines. In steeper areas, the trees should be planted on the contour or as nearly on the contour as possible, provided that the contour lines are generally at right angles to the direction of the prevailing wind.

Because all kinds of trees do not grow satisfactorily on all kinds of soils, the planting stock should be selected carefully so that the species best adapted to the soils and the site are used. This selection insures that survival and rate of growth will be high, and that the trees will reach their maximum height in the shortest span of years.

Because rainfall is low in the county, the establishment of trees is difficult except in the irrigated areas. The trees planted in the nonirrigated areas require special practices of moisture conservation. Land preparation before planting and good care after planting are important to the successful establishment of a windbreak. In this county both native and introduced trees and shrubs are used in windbreak plantings. The native trees and shrubs include American elm, green ash, boxelder, cottonwood, willow, buffaloberry, chokecherry, and wild plum. The introduced trees and shrubs include Siberian elm, caragana, honeysuckle, lilac, white willow, and golden willow. In addition to the native ponderosa pine and Rocky Mountain juniper, Colorado spruce is one of the better evergreens for farmstead plantings. All of these species can be planted on the better soils, but willow and cottonwood do best where the supply of water is good. The most hardy trees are caragana, Russian-olive, Siberian elm, green ash, ponderosa pine, and Rocky Mountain juniper. Skunkbush sumac, buffaloberry, Russian-olive, cottonwood, golden willow, white willow, Siberian elm, and Rocky Mountain juniper tolerate slight to moderate salinity or alkalinity. Of these, Russian-olive and buffaloberry are the most tolerant.

Windbreak suitability groups

The soils of Treasure County have been placed in eight windbreak suitability groups according to their suitability for trees and shrubs adapted to windbreaks. About the same kinds of trees have similar rates of growth on the soils in each group. In the following pages each group is described and trees and shrubs suitable for planting are named.

WINDBREAK SUITABILITY GROUP 1

This group consists of deep, well-drained soils that have a loamy, clayey, or sandy surface layer and a loamy or sandy subsoil within a depth of 24 inches. These soils are calcareous at the surface, or they are noncalcareous from the surface to a depth of 8 to 16 inches, and have a zone of accumulated lime within a depth of 20 inches. The soils in this group have slopes of less than 8 percent. The soils are—

Briggsdale loam, 2 to 4 percent slopes.
Briggsdale loam, 4 to 8 percent slopes.
Cherry clay loam, shallow, 0 to 1 percent slopes.
Cherry clay, moderately deep, 0 to 1 percent slopes.
Cherry clay, moderately deep, 1 to 3 percent slopes.
Cherry clay, moderately deep, 3 to 8 percent slopes.
Dwyer fine sand.
Edgar loam, 1 to 8 percent slopes.
Fort Collins loam, 0 to 1 percent slopes.
Fort Collins loam, 1 to 4 percent slopes.
Fort Collins loam, 4 to 8 percent slopes.
Fort Collins loam, sandy substratum, 0 to 1 percent slopes.
Fort Collins loam, sandy substratum, 1 to 3 percent slopes.
Glendive clay.
Glendive clay loam.
Glendive fine sandy loam.
Glendive fine sandy loam, fans.
Glendive loam.
Glendive loamy fine sand.
Glendive and Banks soils (Glendive soil only).
Havre clay.
Havre clay loam.
Havre clay loam, high.
Havre loam.
Havre loam, high.
Havre and Glendive soils.
Havre and Lohmiller soils.
Havre-Hysham loams (Havre soil only).
Hesper loam, 1 to 4 percent slopes.
Hesper loam, 4 to 8 percent slopes.
Hysham-Havre loams (Havre soil only).
Lohmiller clay loam, fans, 0 to 1 percent slopes.
Lohmiller clay loam, 1 to 3 percent slopes.
Lohmiller-Hysham clays (Lohmiller soil only).
Lohmiller-Hysham clay loams (Lohmiller soil only).
McRae and Havre loams, 0 to 1 percent slopes.
McRae and Havre loams, 1 to 4 percent slopes.
McRae and Havre loams, 4 to 8 percent slopes.
Terry-Treasure fine sandy loams (Treasure soil only).
Treasure fine sandy loam, 2 to 4 percent slopes.
Treasure fine sandy loam, 4 to 8 percent slopes.

These soils are the most suitable in the county for planting trees in windbreaks. Most of the suitable trees attain their maximum height on these soils sooner than they do on any other soils in the county. Without irrigation, cottonwood and willow are not suited to these soils.

WINDBREAK SUITABILITY GROUP 2

This group consists of deep, well-drained clay loams and clays. These soils are calcareous at the surface or are noncalcareous from the surface to a depth of 15 inches. In most places a zone of accumulated lime is at a depth of less than 20 inches. Most of the soils in this group have slopes of less than 8 percent. The soils are—

Cherry clay, 0 to 1 percent slopes.
Cherry clay, 1 to 3 percent slopes.
Cherry clay, 3 to 8 percent slopes.
Cherry clay loam, 0 to 1 percent slopes.
Cherry clay loam, 1 to 3 percent slopes.
Cherry-Laurel clay loams (Cherry soil only).
Lohmiller clay.
Lohmiller clay, high.
Lohmiller clay loam.
Lohmiller clay loam, high.
Nunn clay, 0 to 1 percent slopes.
Nunn clay, 1 to 3 percent slopes.
Nunn clay, 3 to 8 percent slopes.
Nunn clay loam, 0 to 1 percent slopes.
Nunn clay loam, 1 to 3 percent slopes.
Nunn clay loam, 3 to 8 percent slopes.
Nunn-Beckton complex, 0 to 1 percent slopes.

These soils are slightly less favorable for planting trees in windbreaks than the soils in group 1, and the rate growth of trees is somewhat slower. Irrigation is needed for most kinds of trees, but some grow without irrigation.

WINDBREAK SUITABILITY GROUP 3

This group consists of well-drained, loamy and sandy soils that have loose gravel or bedrock at a depth of 20 to 36 inches. Most of the soils in this group have slopes of less than 15 percent. The soils are—

Cushman loam, 2 to 4 percent slopes.
Cushman loam, 4 to 8 percent slopes.
Cushman loam, 8 to 15 percent slopes.
Cushman-Bainville loams, 4 to 8 percent slopes (Cushman soil only).
Cushman-Bainville loams, 8 to 15 percent slopes (Cushman soil only).
Cushman-Terry fine sandy loams, 2 to 8 percent slopes.
Cushman-Tullock complex, 8 to 15 percent slopes.
Cushman-Winnett complex (Cushman soil only).
Edgar loam, 8 to 15 percent slopes.
Fattig loam.
Fattig-Travessilla complex (Fattig soil only).
Flasher fine sandy loam, 4 to 20 percent slopes.
Flasher loamy fine sand.
Havre loam, moderately deep.
Havre and Lohmiller soils, 8 to 15 percent slopes.
McRae loam.
McRae-Bainville loams, 8 to 20 percent slopes (McRae soil only).
Renohill clay loam.
Terry-Tullock fine sandy loams.
Terry-Treasure fine sandy loams (Terry soil only).
Terry-Winnett complex (Terry soil only).
Tullock fine sandy loam, 4 to 20 percent slopes.
Wanetta loam, 1 to 4 percent slopes.
Wanetta loam, 4 to 8 percent slopes.
Wanetta loam, deep, 0 to 2 percent slopes.
Wanetta loam, deep, 2 to 4 percent slopes.
Wanetta loam, deep, 4 to 8 percent slopes.
Winnett-Fattig complex (Fattig soil only).

The soils of this group are more droughty than the soils of group 1, and trees grow more slowly than on groups 1 and 2. Most kinds of trees can be grown with irrigation. The trees best suited to nonirrigated areas are caragana, sand cherry, Nanking cherry, Russian-olive, Siberian elm, ponderosa pine, and Rocky Mountain juniper.

WINDBREAK SUITABILITY GROUP 4

This group consists of deep, moderately saline loams and clay loams. The soils are—

Cherry-Laurel clay loams (Laurel soil only).
Havre clay, saline.
Havre clay loam, saline.
Havre loam, saline.
Havre and Lohmiller soils, saline.

These soils are suited to fewer species than the soils in groups 1, 2, or 3. Skunkbush sumac, buffaloberry, Russian-olive, Rocky Mountain juniper, and other hardy species can be grown without irrigation. In irrigated areas white willow, golden willow, and cottonwood are suited.

WINDBREAK SUITABILITY GROUP 5

This group consists of soils that are ponded intermittently and of soils that are wet all the time. The soils are—

Hoven clay.
Lohmiller clay, wet.
Shonkin loam.

These soils are well suited to many kinds of trees, but water-tolerant ones grow best. The kind of trees planted depends on the condition of the site.

WINDBREAK SUITABILITY GROUP 6

This group consists of deep and moderately deep, well-drained, clayey and loamy soils. The moderately deep soils have shale at a depth of 20 to 40 inches. Most of the soils in this group have slopes of less than 15 percent. The soils are—

Bew clay loam.
Bowdoin clay.
Gilt Edge clay loam.
Gilt Edge-Arvada complex (Gilt Edge soil only).
Marias and Promise clays.
Pierre clay.
Pierre-Lismas clays (Pierre soil only).

These soils are not so well suited to trees for windbreaks as are the more loamy soils. The rate of growth is slow. The trees should be planted far apart. Hardy trees, such as caragana, Russian-olive, Siberian elm, ponderosa pine, and Rocky Mountain juniper, are best suited, but in irrigated areas a wider variety can be planted.

WINDBREAK SUITABILITY GROUP 7

This group consists of shallow and moderately deep, loamy soils that have loose gravel, shale, or sandstone at a depth of less than 20 inches. The soils in this group have slopes of less than 15 percent. They are—

Bainville loam, 8 to 15 percent slopes.
Bainville-Midway complex, 8 to 15 percent slopes.
Banks soils.
Beaverton gravelly loam.
Cushman-Bainville loams, 4 to 8 percent slopes (Bainville soil only).
Cushman-Bainville loams, 8 to 15 percent slopes (Bainville soil only).
Cushman-Travessilla loams, 2 to 8 percent slopes.
Fattig-Travessilla complex (Travessilla soil only).
Glendive fine sandy loam, shallow.
Glendive and Banks soils (Banks soil only).
McRae-Bainville loams, 8 to 20 percent slopes (Bainville soil only).
Midway clay loam, 8 to 15 percent slopes.

These soils are poorly suited to trees planted in windbreaks, and only caragana, Russian-olive, Rocky Mountain juniper, and other hardy trees should be planted. The trees grow slowly and take more time on these soils than on better soils to attain their maximum height. In irrigated areas, however, a wider variety of trees can be planted and the rate of growth is faster. Trees should be planted far apart.

WINDBREAK SUITABILITY GROUP 8

This group consists of soils and land types that are not suitable for planting trees in windbreaks. It also includes all soils on slopes of more than 15 percent. The soils and land types are—

Arvada loam, 0 to 3 percent slopes.
Arvada complex.
Arvada-Laurel complex.
Badlands.
Bainville loam, 15 to 35 percent slopes.
Bainville-Midway complex, 15 to 35 percent slopes.
Bainville-Tullock complex.
Bainville-Shale outcrop complex.
Cushman-Winnett complex (Winnett soil only).
Flasher fine sandy loam, 20 to 35 percent slopes.

Gilt Edge-Arvada complex (Arvada soil only).
Havre-Hysham loams (Hysham soil only).
Havre and Lohmiller soils, 15 to 35 percent slopes.
Hilly gravelly land.
Hoven and McKenzie soils.
Hysham-Havre loams (Hysham soil only).
Laurel clay loam.
Laurel loam.
Lismas clay.
Lismas-Pierre clays, saline-alkali.
Lismas-Midway complex.
Lismas-Shale outcrop complex.
Lohmiller-Hysham clays (Hysham soil only).
Lohmiller-Hysham clay loams (Hysham soil only).
Marias clay, saline-alkali, 0 to 1 percent slopes.
Marias clay, saline-alkali, 1 to 10 percent slopes.
Marias clay, fans, saline-alkali.
Marias-Hoven clays, saline.
Marias-Pierre clays, saline-alkali.
McRae-Bainville loams, 20 to 35 percent slopes.
Midway clay loam, 15 to 35 percent slopes.
Midway-Bainville complex.
Midway-Nihill gravelly loams.
Midway-Shale outcrop complex.
Nihill gravelly loam.
Pierre-Lismas clays (Lismas soil only).
Pierre-Lismas clays, saline-alkali.
Riverwash.
Sage clay.
Sage silty clay.
Shale outcrop.
Terry-Winnett complex (Winnett soil only).
Travessilla-Rock outcrop complex.
Travessilla-Tullock fine sandy loams.
Wibaux-Rock outcrop complex.
Winnett complex.
Winnett-Fattig complex (Winnett soil only).

Native woodland

Stands of pine, juniper, and cottonwood originally grew in this area and were a source of fuel and building material for the early settlers. Many of the old buildings that were built on homesteads are still standing, and some of them are still in use. Posts of juniper and pine that were set in some of the first fences are still serviceable. Today, however, woodland is of minor importance in the county.

Through the years, sawmill operations have been on a small scale. Both pine and cottonwood were cut for timber, but the last sawmill closed in 1955. The pine produces usable timber in the common grades, but the stands now are scattered and produce so little timber that operating a commercial sawmill is not economical. Cottonwood is used locally as rough lumber for buildings and bridges, but its use is limited. Most of the juniper of fencepost size has been cut. Fenceposts can be cut from the denser stands of pine or cottonwood. The pine makes durable fenceposts if it is treated with a preservative.

Pine trees grow too slowly to justify thinning, pruning, and other operations to improve the stands. On some of the better sites, scattered pine trees have attained a diameter of 18 inches and have provided two or three sawlogs 16 feet long. These mature trees, however, are 150 to 200 years old. The count of the annual rings on the larger trees indicates that 30 to 40 years are required to add the last 2 inches of growth to the diameter of the trees.

The native woodland in the county is most important for providing shelter for livestock and protection to watersheds. The cottonwoods and other hardwoods in the valleys help in protecting streambanks against water erosion.

796-973—67——5

Engineering Properties and Uses of the Soils [3]

This subsection (1) lists the engineering uses that can be made of the information in this report; (2) briefly explains the two systems of classification generally used by engineers; (3) lists the properties of each soil that are important in engineering; (4) interprets those properties; and (5) lists the test data obtained when selected soils were tested to determine their engineering properties.

The engineer is primarily interested in how the soil functions as a construction material. He is, therefore, concerned with those properties of the soil that determine its suitability as a building material and that limit its use in construction. In selecting the soil material used in construction, the stability needed for the proposed structure is considered. The physical properties of soil material that is used for structural purposes are determined by well-established laboratory methods and field tests. The methods for interpreting the test results vary considerably, according to the purpose for which the material is to be used. Many soil properties affect the construction, operation, and maintenance of roads, airports, pipelines, and building foundations; of facilities for water storage and erosion control; and of systems for irrigation, drainage, or sewage disposal. The soil properties most important to the engineer are permeability to water, shear strength, compaction characteristics, soil drainage, shrink-swell potential, grain-size distribution, plasticity, depth, and reaction. Also important are depth to the water table and to bedrock, water-holding capacity, and topography.

With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depth of the layers here reported. But even in those situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected. The information in this report can be used to—

1. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.
2. Make preliminary evaluations of soil and ground conditions that will aid in selecting the location of highways, airports, pipelines, and cables and in planning detailed investigations at the selected locations.
3. Locate probable sources of sand, gravel, and rock that may be used in construction.
4. Aid in selecting and planning industrial, business, residential, and recreational sites.
5. Correlate performance of engineering structures with soil mapping units to develop information for planning that will be useful in designing and maintaining structures.

[3] EUGENE H. SPERRY, State conservation engineer, Soil Conservation Service, helped prepare this subsection.

6. Determine the suitability of soil mapping units to withstand cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published reports and aerial photographs to make maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates for construction pertinent to a particular area.

Some terms used by soil scientists may not be familiar to the engineer, and other terms may have a special meaning in soil science. These terms are defined in the Glossary.

Engineering classification systems

Two systems are commonly used by engineers for classifying soils according to their relative suitability for use in road construction. One of these systems was developed by the American Association of State Highway Officials and is commonly called the AASHO system (*1*).[4] The other was adopted by the Corps of Engineers, United States Army, and is known as the Unified system (*13*).

The AASHO system classifies soils on the basis of their field performance in road construction. In this system all soils are grouped into seven major groups on the basis of their bearing strength or bearing capacity. The groups range from A–1, the best, which consists of gravelly soils having a high bearing capacity, to A–7, the poorest, which consists of clayey soils having a low bearing strength when wet. Some of these groups are subdivided into subgroups. In each group or subgroup the relative engineering value of the soil material is indicated by a group index. Group indexes range from 0 for the best materials to 20 for the poorest. The group index is shown in parentheses following the symbol of the soil group (see table 6).

The Unified system is based on the identification of soils according to their texture, plasticity, and liquid limit. The soils are placed into groups according to their performance as engineering construction material. Three important properties form the basis of the soil identification: (1) Percentages of the gravel, the sand, and the fine fractions that pass the No. 200 sieve; (2) shape of the grain-size distribution curve; and (3) plasticity and compressibility characteristics. The four fractions recognized are cobbles, gravel, sand, and fines (silt or clay). In the Unified system the soils are divided into three main divisions: (1) Coarse-grained soils, (2) fine-grained soils, and (3) highly organic soils. The highly organic soils do not occur in this county. The fifteen basic groups in the system range from GW and GP, which are clean gravel with few or no fines, through ML and CL to CH. Soils in the CH group are inorganic clays (fat clays) in which 30 percent of the material passes the No. 200 sieve. Soils that

[4] Italic numbers in parentheses refer to Literature Cited, p. 173.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Ar	Arvada loam, 0 to 3 percent slopes.	On well-drained fans and terraces; water table below 15 feet in nonirrigated areas, but in irrigated areas is within 5 feet of the surface. About 2 to 6 inches of grayish loam underlain by 6 to 10 inches of strongly alkaline silty clay or heavy silty clay loam that is underlain, in turn, by strongly saline and alkali silty clay loam at a depth of 12 to 16 inches; silty clay loam grades into stratified loam to clay loam below 40 inches.	0–4	Loam	ML	A–4
			4–12	Light silty clay or heavy silty clay loam.	CL or CH	A–7
			12–40	Silty clay loam	CL or CH	A–7
			40–60	Stratified loam to clay loam.	ML or CL	A–6
Av	Arvada complex (1 to 6 percent slopes).	On level to sloping, well-drained fans and terraces; water table is at a great depth. About 70 to 80 percent of this complex consists of 6 to 10 inches of grayish-colored loam or clay loam underlain by 8 to 12 inches of blocky light clay loam that is underlain, in turn, by 6 to 8 inches of calcareous light clay or clay loam to loam or light clay at a depth beginning at 20 to 24 inches and extending to 60 inches. See Arvada loam, 0 to 3 percent slopes (Ar) for properties of the other 20 to 30 percent of this complex.	0–6	Loam or clay loam	ML or CL	A–4 or A–6
			6–15	Light clay or light silty clay.	CL	A–6 or A–7
			15–22	Silty clay loam or clay loam.	CL or ML	A–6 or A–7
			22–45	Silty clay loam or clay loam.	CL	A–6 or A–7
			45–60	Stratified loam, fine sandy loam, and silt loam.	ML	A–4

are on the borderline between two classifications have a joint classification, for example, ML–CL.

In both of these systems of classification, the fine fractions of the soil are separated into groups by use of sieves having openings of different size. The No. 4 sieve takes out particles larger than approximately ¼ inch. The No. 10 sieve takes out particles ranging in size from 2 millimeters to approximately ¼ inch, and the No. 200 sieve takes out particles larger than 0.074 millimeter. In both the AASHO and Unified systems, the weight of the fines passing through the No. 200 sieve in proportion to the total weight of the soil is the most important single factor in determining into which subgroup a soil is placed.

The textural classification used by the United States Department of Agriculture (USDA) is based on the relative percentages of sand, silt, and clay, by weight. Bearing strength, plasticity, and liquid limits are not considered. The sand, silt, and clay particles each have a defined range in size, generally expressed in millimeters. The particles of sand size are subdivided into five subclasses according to size in millimeters as follows: Very coarse sand, 2 to 1; coarse sand, 1 to 0.5; medium sand, 0.5 to 0.25; fine sand, 0.25 to 0.1; and very fine sand, 0.1 to 0.05. All particles coarser than 2 millimeters but not larger than 3 inches in diameter are pebbles; a mass of pebbles is called gravel. Cobbles are more than 3 inches in diameter, but not more than 10 inches.

Engineering description of the soils

Table 4 gives an engineering description of the soils in Treasure County and an estimate of physical properties important in engineering. The soils and their sites are described from an engineering viewpoint. The soil material in the horizons of a profile typical of the soil or soil group listed is classified in the USDA, Unified, and AASHO systems. Percentages of material passing the No. 4, No. 10, and No. 200 sieves are also given for each horizon.

Permeability, or the rate water moves through a horizon, is given in inches per hour. This is the permeability of a soil in place, as measured by the Uhland method. The available water capacity is listed in inches per inch of soil. For example, table 4 shows that 1 inch of Arvada loam, 0 to 3 percent slopes, can hold 0.17 inch of water. Therefore, the 4-inch surface layer of Arvada loam, 0 to 3 percent slopes, can hold 0.68 inch of water.

Broad ratings are given in table 4 for salinity, corrosivity, dispersion, and shrink-swell potential. A dispersed soil normally has low permeability, tends to have high bulk density, and forms lumps on drying. The shrink-swell potential is an estimate of how much a soil shrinks and swells under extremes of dryness and wetness. A knowledge of this potential is important in planning the use of a soil for building roads or other engineering structures.

their estimated physical properties

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	75–90	0. 2– 0. 8	0. 17	8. 2	None	Low	Low	Low	Low.
100	100	90–95	<0. 2	0. 20	9. 0+	Slight	High	Moderate	High	High.
100	100	90–95	<0. 2	0. 19	9. 0+	Very severe.	Very high	High	High	High.
100	100	75–90	<0. 2	0. 17	9. 0+	Severe	Very high	High	High	Low.
100	100	80–90	0. 2– 0. 8	0. 17	7. 2	None	Low	Low	None	Low.
100	100	85–90	0. 8– 2. 0	0. 20	7. 4	None	Moderate	Low	None	Moderate.
100	100	85–90	0. 2– 0. 8	0. 17	8. 4	None	Moderate	Low	None	Moderate.
100	100	85–90	0. 2– 0. 8	0. 17	8. 4	None	Moderate	Low	None	Moderate.
100	100	85–90	0. 2– 0. 8	0. 17	8. 6	Slight	Moderate	Moderate	Low	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Ax	Arvada-Laurel complex (1 to 8 percent slopes).	On nearly level to sloping, well-drained terraces and fans; water table is seasonally within 5 feet of the surface only under main irrigation canal. About 75 to 80 percent of this complex is Arvada loam and clay loam, and about 20 to 25 percent is Laurel clay loam. Laurel clay loam has ½ to 1 inch of light-gray loam underlain by 3 to 6 inches of blocky silty clay or silty clay loam; from 6 to 8 inches down to about 12 to 16 inches is strongly alkaline, granular silty clay loam or silty clay that is streaked and specked with gypsum and other soluble salts and is underlain by 14 to 24 inches of strongly alkaline silty clay loam or clay loam containing an abundance of gypsum and other soluble salts; stratified loam and sandy loam 30 to 40 inches below the surface. For properties of the Laurel soil, see Laurel clay loam (La); properties given here are for the Arvada soils.	0–4	Loam or clay loam.	ML	A-4
			4–12	Light silty clay or heavy silty clay loam.	CL or CH	A-7
			12–40	Silty clay loam	CL or CH	A-7
			40–60	Stratified loam to clay loam.	ML or CL	A-4 or A-6
Ba	Badlands	Rough, broken, deeply dissected areas of nearly barren shale in which soil occurs in narrow valleys; more than 85 percent of the surface is barren.				
Bb	Bainville loam, 8 to 15 percent slopes.	On rolling shale uplands; shale is closer to surface on narrow ridges, crests, and knolls than it is in swales and on smaller fans. About 10 to 24 inches of strongly calcareous loam or silt loam underlain by 6 to 8 inches of strongly calcareous shaly loam or silt loam that, in turn, is underlain by calcareous soft loam or silt loam shale at a depth of 12 to 48 inches.	0–22	Loam or silt loams	ML	A-4
			22–26	Shaly loam or silt loam.	ML	A-4
			26–60	Weakly consolidated shale.	ML or CL	A-4 or A-6
Bc	Bainville loam, 15 to 35 percent slopes.	On hilly uplands throughout the county. About 10 inches of loam underlain by 5 inches of silt loam that is underlain, in turn, by silty shale at a depth of less than 20 inches. Shale is within depth of 10 inches on the narrow ridges and crests.	0–10	Loam	ML	A-4
			10–15	Silt loam and shale fragments.	ML	A-4
			15–60	Silty shale	ML or CL	A-4 or A-6
Bf	Bainville-Tullock complex (15 to 35 percent slopes).	On hilly uplands, mainly south of the Yellowstone River. Bainville loam makes up about 60 to 70 percent of this complex, Tullock fine sandy loam about 20 to 25 percent, and other soils in valleys and on fans about 5 to 10 percent. Tullock soil occurs mainly on top of knolls, crests, and ridges. For properties of the Tullock soil, see Tullock fine sandy loam, 4 to 20 percent slopes (Tv); properties given here are for the Bainville soil.	0–10	Silt loam	CL	A-6 or A-7
			10–15	Silt loam and shale fragments.	ML	A-4
			15–60	Silty shale	ML or CL	A-4 or A-6

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	75–90	0. 2– 0. 8	0. 17	8. 2	None	Low	Low	Low	Low.
100	100	90–95	<0. 2	0. 20	9. 0+	Slight	High	Moderate	High	High.
100	100	90–95	<0. 2	0. 19	9. 0+	Very severe	Very high	High	High	High.
100	100	75–90	<0. 2	0. 17	9. 0+	Severe	Very high	High	High	Low.
100	100	85–95	0. 2–0. 8	0. 17	8. 4	None	Low	Low	Low	Low.
80–90	75–85	65–75	0. 2–0. 8	0. 17	8. 4	None	Low	Low	Low	Low.
70–90	70–80	60–70	<0. 2	0. 17	8. 4–8. 7	None to slight.	Moderate	Moderate	Moderate	Low.
100	100	85–95	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	Low	Low.
80–90	75–85	65–75	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	Low	Low.
70–90	70–80	60–70	<0. 2	0. 17	8. 6–9. 0	Slight to moderate.	Moderate	Moderate	Moderate	Moderate.
100	100	85–95	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	Low	Moderate.
80–90	75–85	65–75	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	Low	Low.
70–90	70–80	60–70	<0. 2	0. 17	8. 6–9. 0	Slight to moderate.	Moderate	Moderate	Moderate	Moderate.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Bm	Bainville-Midway complex, 8 to 15 percent slopes.	On strongly rolling uplands. Bainville soil makes up about 50 to 60 percent of this complex, Midway clay loam about 50 to 60 percent, and other soils in valleys, on fans, and on slopes about 10 to 15 percent. For properties of the Midway soil, see Midway clay loam, 8 to 15 percent slopes (Mr); properties given here are for the Bainville soil.	0–22	Loam or silt loam	ML	A–4
			22–26	Shaly loam or silt loam.	ML	A–4
			26–60	Weakly consolidated shale.	ML or CL	A–4 or A–6
Bn	Bainville-Midway complex, 15 to 35 percent slopes.	On hilly uplands throughout the county. Bainville soil makes up about 30 to 50 percent of this complex, Midway soil about 30 to 50 percent, and other soils in narrow valleys and on fans about 20 to 30 percent. For properties of the Midway soil, see Midway clay loam, 8 to 15 percent slopes (Mr); properties given here are for the Bainville soil.	0–22	Loam or silt loam	ML	A–4
			22–26	Shaly loam or silt loam.	ML	A–4
			26–60	Weakly consolidated shale.	ML or CL	A–4 or A–6
Bo	Bainville-Shale outcrop complex (30 to 70 percent slopes).	Very steep, rough, broken, dissected areas at the upper part of the drainage systems. Bainville soil makes up about 50 to 60 percent of this complex, barren or nearly barren outcrops of shale about 20 to 30 percent, and other soils the rest. For properties of outcrops, see Shale outcrop (Sh); properties given here are for the Bainville soil.	0–10	Silt loam	CL	A–6 or A–7
			10–15	Silt loam and shale fragments.	ML	A–4
			15–60	Silty shale	ML or CL	A–4 or A–6
Bs	Banks soils (less than 1 percent slopes).	On flood plains along the Bighorn and Yellowstone Rivers, mainly in the wooded areas; subject to overflow only during extremely high runoff in spring or during ice jams; water table is within 5 feet of the surface during part of year. About 4 inches of loam or very sandy loam underlain by loamy fine sand or fine sand that is underlain, in turn, by well-graded sand and gravel or sand.	0–4	Loam or very sandy loam.	ML	A–4
			4–12	Loamy fine sand or fine sand.	SM	A–2
			12–60	Well-graded sand and gravel or sand.	GW or SW	A–1
Bt	Beaverton gravelly loam (1 to 3 percent slopes).	On well-drained high terraces; ground water is not a problem. About 2 to 4 inches of gravelly loam underlain by 5 to 8 inches of blocky gravelly clay loam that is underlain, in turn, by 3 to 5 inches of gravelly loam, and that by 3 to 6 inches of very gravelly sandy loam; loose, well-graded sand and gravel are at a depth of 14 to 18 inches.	0–2	Gravelly loam	GM	A–4
			2–7	Gravelly clay loam.	GC	A–6
			7–12	Gravelly loam	GM	A–2
			12–16	Very gravelly sandy loam.	GM	A–1
			16–60	Well-graded sand and gravel.	SW or GW	A–1
Bu	Bew clay loam (1 to 3 percent slopes).	On well-drained terraces north of the Yellowstone River; ground water is not a problem. About 4 to 6 inches of loam or clay loam underlain by 3 to 4 feet of clay that is blocky and noncalcareous in upper 8 to 10 inches and is calcareous and spotted with lime from about 14 to 40 inches or more; below a depth of 42 to 50 inches, there are stratified loam to clay loam, stratified loamy fine sand, and sandy loam, gravelly loam, or loose sand and gravel.	0–5	Clay loam	CL	A–6
			5–44	Clay	CL or CH	A–7
			44–60	Clay loam or stratified material.	CL or ML	A–6 or A–7

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	85–95	0.2– 0.8	0.17	8.4	None	Low	Low	Low	Low.
80–90	75–85	65–75	0.2– 0.8	0.17	8.4	None	Low	Low	Low	Low.
70–90	70–80	60–70	<0.2	0.17	8.4–8.7	None to slight.	Moderate	Moderate	Moderate	Low.
100	100	85–95	0.2– 0.8	0.17	8.4	None	Low	Low	Low	Low.
80–90	75–85	65–75	0.2– 0.8	0.17	8.4	None	Low	Low	Low	Low.
70–90	70–85	60–70	<0.2	0.17	8.4–8.7	None to slight.	Moderate	Moderate	Moderate	Low.
100	100	85–95	0.2– 0.8	0.17	8.4	None	Low	Low	Low	Moderate.
80–90	75–85	65–75	0.2– 0.8	0.17	8.4	None	Low	Low	Low	Low.
70–90	70–80	60–70	<0.2	0.17	8.6–9.0	Slight to moderate.	Moderate	Moderate	Moderate	Moderate.
100	100	75–85	2.0– 5.0	0.17	8.4	None	Very low	Low	None	Low.
100	100	25–30	5.0–10.0	0.03	8.4	None	Very low	Low	None	Low.
50–70	50–60	<5	>10.0	0.01	8.4	None	Very low	Low	None	Low.
60–70	50–60	35–40	0.8– 2.0	0.12	6.5	None	Low	Low	None	Low.
60–70	50–60	35–40	0.8– 2.0	0.12	7.2	None	Low	Low	None	Low.
50–60	35–40	20–25	0.2– 0.8	0.12	8.4	None	Low	Low	None	Low.
40–50	30–35	10–15	5.0–10.0	0.05	8.4	None	Very low	Low	None	Low.
40–50	20–30	<5	>10.0	0.01	8.5	None	Very low	Low	None	Low.
100	100	90–95	0.8– 2.0	0.17	7.4	None	Moderate	Low	None	Moderate.
100	100	94–98	0.2– 0.8	0.20	8.0	None	Moderate	Low	None	High.
100	100	85–95	<0.2	0.18	8.4	Slight	Moderate to high.	Moderate	None	Moderate to high.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Bw	Bowdoin clay (less than 1 percent slopes).	On well-drained terraces and high bottom lands; except near irrigation canals, ground water is below 10 feet at all times; periodic overflow from drains is common in some places. About 30 to 50 inches of clay underlain by strata ranging from very fine sandy loam to silty clay loam.	0–42 42–60	Clay Stratified clay loam and loam.	CH CL or ML	A–7 A–6 or A–4
Bx By	Briggsdale loam, 2 to 4 percent slopes. Briggsdale loam, 4 to 8 percent slopes.	On well-drained fans and in swales of the uplands; ground water is not a problem. About 3 to 5 inches of loam underlain by 8 to 12 inches of blocky heavy clay loam or light clay that is underlain, in turn, by 3 to 5 inches of calcareous clay loam, light clay loam, or loam below a depth of 16 to 20 inches; spotted with white lime in upper 20 to 30 inches; in places soft loam, silt loam, or clay loam shale underlies these soils at a depth of 40 to 60 inches or more.	0–4 4–14 14–18 18–60	Loam Blocky heavy clay loam or light clay. Clay loam Loam	ML CL ML or CL ML	A–4 A–6 or A–7 A–4 or A–6 A–6
Ca Cb Cc	Cherry clay, 0 to 1 percent slopes. Cherry clay, 1 to 3 percent slopes. Cherry clay, 3 to 8 percent slopes.	On well-drained fans and terraces; ground water is not a problem except in irrigated areas, where it is within 5 feet of the surface during some part of the irrigation season. About 4 to 8 inches of granular clay underlain by 4 to 6 inches of blocky clay that is underlain, in turn, by 30 to 40 inches of calcareous clay loam or silty clay loam having a few seams or spots of lime in upper part; stratified loam below 40 to 50 inches.	0–50 50–60	Clay, silty clay, and silty clay loam. Stratified loam, silt loam, and very fine sandy loam.	CL ML	A–6 or A–7 A–4
Cd Cf Cg Ch Ck	Cherry clay, moderately deep, 0 to 1 percent slopes. Cherry clay, moderately deep, 1 to 3 percent slopes. Cherry clay, moderately deep, 3 to 8 percent slopes. Cherry clay loam, 0 to 1 percent slopes. Cherry clay loam, 1 to 3 percent slopes.	On well-drained fans and terraces; ground water is not a problem except in irrigated areas, where it is within 5 feet of the surface for very short periods during the irrigation season. About 4 to 8 inches of granular clay or clay loam underlain by 22 to 30 inches of light clay or clay loam that is underlain, in turn, by stratified sediments below a depth of 24 to 40 inches.	0–26 26–60	Light clay or clay loam. Stratified loam, silt loam, and very fine sandy loam.	CL ML	A–6 or A–7 A–4
Cm	Cherry clay loam, shallow, 0 to 1 percent slopes.	On well-drained terraces; ground water is not a problem, except during the irrigation season, where it is within 5 feet of the surface for very short periods. About 8 to 14 inches of clay loam underlain by stratified loam, very fine sandy loam, and silt loam; in a few places a stratum of fine sandy loam occurs below a depth of 50 inches.	0–10 10–60	Clay loam Stratified sediments of loam, very fine sandy loam, and silt loam.	CL ML	A–6 A–4

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	96–98	<0. 2	0. 25	8. 4	None	High	Low	None	High.
100	100	90–95	0. 2– 0. 8	0. 17	8. 8	Slight to moderate.	High	Moderate	Slight	Moderate to low.
100	100	85–90	0. 8– 2. 0	0. 17	7. 2	None	Low	Low	None	Low.
100	100	90–95	0. 8– 2. 0	0. 19	8. 0	None	ow	Low	None	Moderate.
100	100	85–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
100	100	80–90	0. 2– 0. 8	0. 17	8. 4	None	Low to moderate.	Low	None	Low.
100	100	90–95	0. 2– 0. 8	0. 19	8. 4	None	Moderate	Low	None	Moderate.
100	100	80–90	0. 2– 0. 8	0. 17	8. 6	Slight	Moderate	Moderate	None	Low.
100	100	94–98	0. 2– 0. 8	0. 19	8. 4	None	Moderate	Low	None	Moderate.
100	100	85–95	0. 2– 0. 8	0. 17	8. 4–8. 7	Slight	Low	Low	None	Low.
100	100	94–98	0. 2– 0. 8	0. 19	8. 4	None	Low	Low	None	Moderate.
100	100	80–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.

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TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Cn	Cherry-Laurel clay loams (less than 1 percent slopes).	On well-drained fans and terraces; ground water is not a problem, except in irrigated areas, where it may be within 5 feet of the surface for short periods during the irrigation season. Cherry soil makes up 75 to 85 percent of the complex and Laurel soil 15 to 25 percent. Laurel soil is hard and crusty and has saline spots. For other properties of the Laurel soil, see Arvada-Laurel complex (Ax); properties given here are for the Cherry soil.	0–22	Clay loam or silty clay loam.	CL	A-6
			22–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A-4
Cp	Cushman loam, 2 to 4 percent slopes.	On undulating to rolling uplands; soils developed in place from underlying soft shale. About 4 to 8 inches of loam underlain by 4 to 8 inches of blocky clay loam that is underlain, in turn, by calcareous loam at a depth of 10 to 14 inches; the calcareous loam is spotted with lime in the upper part; soft shale occurs at a depth of 24 to 34 inches.	0–4	Loam	ML	A-4
Cr	Cushman loam, 4 to 8 percent slopes.		4–8	Loam	ML	A-4 or A-6
Cs	Cushman loam, 8 to 15 percent slopes.		8–28	Light clay loam	ML or CL	A-4 or A-6
			28–60	Interbedded soft loamy shale.	ML or CL	A-4 or A-6
Ct	Cushman-Bainville loams, 4 to 8 percent slopes.	On rolling uplands. Cushman soil makes up about 65 to 75 percent of the complex, and Bainville soil about 15 to 25 percent. The Bainville soil is mainly on the top of ridges, crests, and knolls and generally is less than 20 inches deep to shale. For properties of the Bainville soil see Bainville loam, 8 to 15 percent slopes (Bb); properties given here are for the Cushman soil.	0–4	Loam	ML	A-4
			4–8	Loam	ML	A-4 or A-6
			8–28	Light clay loam	ML or CL	A-4 or A-6
			28–60	Interbedded soft loamy shale.	ML or CL	A-4 or A-6
Cu	Cushman-Bainville loams, 8 to 15 percent slopes.	On strongly rolling uplands. Cushman loam makes up about 50 to 60 percent of this complex, Bainville soil about 20 to 30 percent, and other soils about 10 percent. The Bainville soil is on the top of crests, ridges, and knolls, and in most places is less than 20 inches deep over shale. For properties of the Bainville soil, see Bainville loam, 8 to 15 percent slopes (Bb); properties given here are for the Cushman soil.	0–4	Loam	ML	A-4
			4–8	Loam	ML	A-4 or A-6
			8–28	Light clay loam	ML or CL	A-4 or A-6
			28–60	Interbedded soft loamy shale.	ML or CL	A-4 or A-6
Cv	Cushman-Terry fine sandy loams, 2 to 8 percent slopes.	On undulating shale uplands. Cushman soil makes up about 60 to 70 percent of this complex, Terry soil about 20 to 30 percent, and other soils about 10 percent. For properties of the Terry soil, see Terry-Treasure fine sandy loams (Tm); properties given here are for the Cushman soil.	0–6	Fine sandy loam	SM	A-4
			6–14	Silty clay loam	CL or CH	A-7
			14–36	Silt loam	CL	A-6 or A-7
			36–60	Silty shale	ML or CL	A-4 or A-6
Cw	Cushman-Tullock complex, 8 to 15 percent slopes.	On strongly rolling uplands. Cushman loam makes up about 60 to 70 percent of this complex, Tullock fine sandy loam about 15 to 25 percent, and other soils about 10 percent. Cushman loam is on the smooth side slopes below the crests and ridges of Tullock fine sandy loam. For properties of the Tullock soil, see Tullock fine sandy loam, 4 to 20 percent slopes (Tv); properties given here are for the Cushman soils.	0–4	Loam	ML	A-4
			4–8	Loam	ML	A-4 or A-6
			8–28	Light clay loam	ML or CL	A-4 or A-6
			28–60	Interbedded soft loamy shale.	ML or CL	A-4 or A-6

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	90–95	<0. 2	0. 19	8. 9–9. 4	Slight	High	High	High	Moderate.
100	100	80–90	<0. 2	0. 18	8. 9–9. 4	Moderate	High	High	High	Low.
100	100	80–90	0. 8– 2. 0	0. 17	7. 0	None	Low	Low	None	Low.
100	100	80–90	0. 8– 2. 0	0. 17	7. 4	None	Low	Low	None	Low.
100	100	80–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
70–90	70–80	60–70	0. 8– 2. 0	0. 19	8. 5–8. 7	None to slight.	Moderate	Moderate	None	Low.
100	100	80–90	0. 8– 2. 0	0. 17	7. 0	None	Low	Low	None	Low.
100	100	80–90	0. 8– 2. 0	0. 17	7. 4	None	Low	Low	None	Low.
100	100	80–90	0. 8– 2. 0	0. 17	8. 4	None	Low	Low	None	Low.
70–90	70–80	60–70	<0. 2	0. 17–0. 19	8. 5–8. 7	None to slight.	Moderate	Moderate	None	Low to moderate.
100	100	80–90	0. 8– 2. 0	0. 17	7. 0	None	Low	Low	None	Low.
100	100	80–90	0. 8– 2. 0	0. 17	7. 4	None	Low	Low	None	Low.
100	100	80–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
70–90	70–80	60–70	<0. 2	0. 17–0. 19	8. 5–8. 7	None to slight.	Moderate	Moderate	None	Low to moderate.
100	100	40–45	2. 0– 5. 0	0. 15	7. 8	None	Very low	Low	None	Low.
100	100	85–90	0. 8– 2. 0	0. 19	8. 2	None	Low	Low	None	High.
100	100	85–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Moderate.
70–90	70–80	60–70	<0. 2	0. 17	8. 6–8. 8	None to slight.	Moderate	Moderate	Low to moderate.	Low to moderate.
100	100	80–90	0. 8– 2. 0	0. 17	7. 0	None	Low	Low	None	Low.
100	100	80–90	0. 8– 2. 0	0. 17	7. 4	None	Low	Low	None	Low.
100	100	80–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
70–90	70–80	60–70	<0. 2	0. 17–0. 19	8. 5–8. 7	None to slight.	Moderate	Moderate	None	Low to moderate.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Cx	Cushman-Travessilla loams, 2 to 8 percent slopes.	On undulating uplands. Cushman loam makes up about 65 to 75 percent of this complex, Travessilla loam about 20 to 30 percent, and other soils about 5 percent. The sandstone underlies the Cushman soil at a depth of 14 to 22 inches and the Travessilla soil at 8 to 14 inches. For properties of the Travessilla soil, see Travessilla-Tullock fine sandy loams (Tp); properties given here are for the Cushman soil.	0–10	Loam	ML	A–4
			10–22	Loam	ML	A–4
			22+	Hard sandstone		
Cy	Cushman-Winnett complex (2 to 8 percent slopes).	On undulating to rolling shale uplands. Cushman loam makes up about 60 to 70 percent of this complex, Winnett loam and clay loam about 15 to 30 percent, and other soils about 10 percent. Winnett soil is scattered throughout in slightly depressional areas, some of which are barren. For properties of the Winnett soil, see Winnett complex (Wt); properties given here are for the Cushman soil.	0–4	Loam	ML	A–4
			4–8	Loam	ML	A–4 or A–6
			8–28	Light clay loam	ML or CL	A–4 or A–6
			28–60	Interbedded soft loamy shale.	ML or CL	A–4 or A–6
Dw	Dwyer fine sand (5 to 15 percent slopes).	On high benches and in dunelike areas. About 5 feet or more of fine sand; in places on the high benches, a few pebbles are on the surface and throughout the profile; good drainage; ground water is not a problem.	0–60	Fine sand	SM	A–2
Ed	Edgar loam, 1 to 8 percent slopes.	On rolling to strongly rolling, well-drained high terraces. About 3 to 5 inches of loam underlain by 4 to 6 inches of noncalcareous, prismatic loam that is underlain, at a depth of 12 to 14 inches, by calcareous loam with common to many white spots of lime; strongly calcareous clay loam and a few pebbles at a depth of 26 to 40 inches; gravelly loam or gravelly clay loam is below 36 to 40 inches in places; the steeper slopes of some convex ridges have a scattering of gravel on the surface; gravel and sand occur below a depth of 5 feet in the more nearly level areas.	0–10	Loam	ML	A–4
Eg	Edgar loam, 8 to 15 percent slopes.		10–34	Calcareous loam	ML	A–4
			34–60	Strongly calcareous light clay loam.	ML or CL	A–4
Fa	Fattig loam (2 to 6 percent slopes).	On undulating shale uplands. About 3 to 5 inches of nearly black loam underlain by dark-colored, blocky heavy clay loam or light clay that is underlain, in turn, by weakly consolidated shale at a depth of 30 to 42 inches.	0–4	Loam	ML or CL	A–7
			4–24	Heavy clay loam to light clay.	OL or CL	A–6 or A–7
			24–34	Heavy clay loam	CL	A–6
			34–60	Loamy to silty clay loam soft shale.	ML or CL	A–4, A–6, or A–7.
Fc	Fattig-Travessilla complex (4 to 8 percent slopes).	On undulating shale uplands. Fattig loam makes up about 60 to 70 percent of this complex, Travessilla loam about 20 to 30 percent, and other soils about 10 to 15 percent. Fattig loam is generally on the smooth side slopes, and Travessilla loam is on the ridges and flat tops. In places sandstone underlies the Fattig soil within a depth of 26 to 32 inches. The Travessilla soil is underlain by hard sandstone at a depth of 8 to 16 inches. For properties of Travessilla soil, see Travessilla-Tullock fine sandy loams (Tp); properties given here are for Fattig soil.	0–4	Loam	OL	A–7
			4–24	Heavy clay loam to light clay.	CL or CH	A–7
			24–34	Heavy clay loam	CL	A–6
			34–60	Loamy to silty clay loam soft shale.	ML or CL	A–4, A–6, or A–7.

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	80–90	0.8– 2.0	0.17	7.4	None	Low	Low	None	Low.
100	100	80–90	0.2– 0.8	0.17	8.4	None	Low	Low	None	Low.
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100	100	80–90	0.8– 2.0	0.17	7.0	None	Low	Low	None	Low.
100	100	80–90	0.8– 2.0	0.17	7.4	None	Low	Low	None	Low.
100	100	80–90	0.2– 0.8	0.17	8.4	None	Low	Low	None	Low.
70–90	70–90	60–70	<0.2	0.17–0.19	8.5–8.7	None to slight.	Moderate	Moderate	None	Low to moderate.
100	100	15–20	5.0–10.0	0.06	8.2	None	Very low	Low	None	Low.
100	100	75–85	0.8– 2.0	0.17	7.6	None	Low	Low	None	Low.
100	100	75–85	0.2– 0.8	0.17	8.4	None	Low	Low	None	Low.
95	95	75–85	0.2– 0.8	0.17	8.4	None	Low	Low	None	Low.
100	100	70–80	2.0– 5.0	0.19	6.5	None	Low	Low	None	Low.
100	100	80–90	0.8– 2.0	0.20	6.8	None	Moderate	Low	None	Moderate.
100	100	80–90	0.2– 0.8	0.19	7.2	None	Moderate	Low	None	Moderate.
70–90	70–80	60–70	<0.2	0.20	8.7	Slight	High	Moderate	Moderate	Moderate.
100	100	70–80	2.0– 5.0	0.19	6.5	None	Low	Low	None	Low.
100	100	80–90	0.8– 2.0	0.20	6.8	None	Moderate	Low	None	Moderate.
100	100	80–90	0.2– 0.8	0.19	7.2	None	Moderate	Low	None	Moderate.
70–90	70–80	60–70	<0.2	0.20	8.7	Slight	High	Moderate	Moderate	Moderate.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Ff	Flasher fine sandy loam, 4 to 20 percent slopes.	On rolling to hilly sandy uplands in southern part of county. About 8 to 12 inches of fine sandy loam or loamy fine sand underlain by 14 to 30 inches of strongly calcareous loamy fine sand or fine sand that is underlain, in turn, by beds of weakly consolidated, strongly calcareous sandstone at a depth of 22 to 42 inches.	0–8	Fine sandy loam	SM	A–2
			6–28	Loamy fine sand	SM	A–1 or A–2
Fh	Flasher fine sandy loam, 20 to 35 percent slopes.		28–60	Weakly consolidated sandstone of fine sand or loamy fine sand.	SM	A–1 or A–2
Fm	Flasher loamy fine sand (6 to 20 percent slopes).	On rolling to hilly sandy uplands in southern part of county. About 8 to 12 inches of fine sandy loam or loamy fine sand underlain by 14 to 30 inches of strongly calcareous loamy fine sand or fine sand that is underlain, in turn, by beds of strongly calcareous sandstone at a depth of 22 to 42 inches.	0–30	Loamy fine sand	SM	A–1 or A–2
			30–60	Weakly consolidated sandstone.	SM	A–1 or A–2
Fn	Fort Collins loam, 0 to 1 percent slopes.	On well-drained fans and terraces; ground water is not a problem, except in irrigated areas, where for short periods ground water is within 5 feet of the surface. About 3 to 5 inches of loam underlain by 7 to 10 inches of prismatic clay loam or silty clay loam. Below a depth of 12 to 14 inches down to 60 inches, the material is stratified, calcareous loam spotted with white lime in the upper 10 to 16 inches. On Hysham Bench and in other places, the material below 20 to 26 inches is silty clay, silty clay loam, or stratified material.	0–5	Loam	ML	A–4
			5–14	Clay loam	CL or ML	A–4 or A–6
Fo	Fort Collins loam, 1 to 4 percent slopes.		14–60	Loam	ML	A–4
Fr	Fort Collins loam, 4 to 8 percent slopes.					
Fs	Fort Collins loam, sandy substratum, 0 to 1 percent slopes.	On well-drained fans and terraces; ground water is not a problem, except in irrigated areas, where for short periods ground water is within 5 feet of the surface. About 3 to 5 inches of loam underlain by 7 to 10 inches of prismatic clay loam or silty clay loam. Below a depth of 12 to 14 inches down to 60 inches, the material is stratified, calcareous loam spotted with white lime in the upper 10 to 16 inches. On Hysham Bench and in other places, the material below 20 to 26 inches is silty clay, silty clay loam, or stratified sandy material.	0–8	Loam	ML	A–4
			8–14	Clay loam	CL	A–4 or A–6
			14–22	Loam	ML	A–4
Ft	Fort Collins loam, sandy substratum, 1 to 3 percent slopes.		22–60	Stratified fine sandy loam and loamy fine sand.	ML	A–4
Ga	Gilt Edge clay loam, (1 to 3 percent slopes).	On undulating, well-drained high terraces; ground water is not a problem. About 2 to 6 inches of gray loam underlain by 8 to 12 inches of columnar and blocky clay. From a depth of 12 to 16 inches down to about 60 inches, the material is clay spotted with white lime in the upper part. Gravelly loam occurs from 40 to 48 inches down to about 5 feet and is underlain by loose, well-graded sand and gravel or by loam to clay loam containing accumulated gypsum and other salts.	0–5	Loam	ML	A–4
			5–14	Clay	CH	A–7
			14–40	Clay	CL	A–7
			40–60+	Variable		

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	25–35	>5.0	0.15	8.2	None	Very low	Low	None	Low.
100	100	15–25	>5.0	0.07	8.4	None	Very low	Low	None	Low.
100	100	15–25	<0.2	0.05	8.5	None	Very low	Low	None	Low.
100	100	15–25	>5.0	0.07	8.2	None	Very low	Low	None	Low.
100	100	15–25	<0.2	0.05	8.5	None	Very low	Low	None	Low.
100	100	80–90	0.2– 0.8	0.17	7.0	None	Low	Low	None	Low
100	100	80–90	0.8– 2.0	0.18	7.6	None	Low	Low	None	Moderate.
100	100	80–90	0.2– 0.8	0.17	8.4	None	Low	Low	None	Low.
100	100	80–90	0.8– 2.0	0.17	7.5	None	Low	Low	None	Low.
100	100	80–90	0.8– 2.0	0.18	8.0	None	Low	Low	None	Moderate.
100	100	80–90	0.2– 0.8	0.17	8.4	None	Low	Low	None	Low.
100	100	50–60	2.0– 5.0	0.14	8.4	None	Very low	Low	None	Low.
100	100	75–85	0.2 – 0.8	0.17	6.5	None	Low	Low	Low	Low.
100	100	92–96	0.05– 0.2	0.21	8.0	None	High	Moderate	Low	High.
100	100	92–96	0.05– 0.2	0.20	8.6	Slight	High	Moderate	Moderate	High.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Gb	Gilt Edge-Arvada complex.	On nearly level to gently undulating, well-drained high terraces. About 50 to 60 percent of this complex is Gilt Edge soil, about 30 to 40 percent is Arvada clay, and about 10 percent other soils. Properties given here are for Gilt Edge soil.	0–5	Loam	ML	A-4
			5–14	Clay	CH	A-7
			14–40	Clay	CL	A-7
			40–60+	Variable		
		The Arvada soil is in barren or nearly barren areas. It has a thin surface layer of ½ inch to 2 inches of gray loam, an upper subsoil of 6 to 10 inches of columnar or blocky clay, and a lower subsoil of clay spotted with lime in the upper part and containing accumulated gypsum in the lower part; in places clay shale, gravelly loam, or stratified material occurs below 50 inches.	0–12	Clay	CH or CL	A-7
			12–60	Clay	CL or CH	A-7
Gc	Glendive clay (less than 1 percent slopes).	On level bottom lands and low terraces; during irrigation season, ground water fluctuates between a depth of less than 5 feet and more than 10 feet. About 8 to 14 inches of clay, clay loam, loam, or fine sandy loam underlain by 20 to 30 inches of fine sandy loam; below a depth of 32 to 40 inches the material is loamy fine sand and fine sand containing strata of fine sand or very fine sandy loam. On flood plains well-graded sand and gravel underlie these soils at a depth of 40 to 60 inches.	0–10	Clay or clay loam	CL	A-6 or A-7
Gg	Glendive clay loam (less than 1 percent slopes).		10–32	Stratified fine sandy loam and loamy fine sand.	SM	A-2
			32–60	Loamy fine sand and fine sand.	SM	A-2
Gh	Glendive fine sandy loam (less than 1 percent slopes).	On level to sloping bottom lands, fans, and low terraces; during irrigation season, ground water fluctuates between a depth of less than 5 feet and more than 10 feet. About 32 inches of fine sandy loam underlain by 28 inches of fine sandy loam and loamy fine sand. On flood plains well-graded sand and gravel underlie these soils at a depth of 60 inches.	0–32	Fine sandy loam	SM	A-4
Gm	Glendive fine sandy loam, fans (2 to 8 percent slopes).		32–60	Fine sandy loam and loamy fine sand.	SM	A-2
Go	Glendive loam (less than 1 percent slopes).	On level bottom lands; during irrigation season, ground water fluctuates between a depth of less than 5 feet and more than 10 feet. About 12 inches of loam underlain by about 22 inches of fine sandy loam that is underlain, in turn, by about 26 inches of fine sandy loam and loamy fine sand; well-graded sand and gravel at a depth of about 60 inches.	0–12	Loam	ML	A-4
			12–34	Fine sandy loam	SM	A-4
			34–60	Fine sandy loam and loamy fine sand.	SM	A-2
Gn	Glendive fine sandy loam, shallow (less than 1 percent slopes).	On level bottom lands and low terraces; ground water is within 5 feet of the surface at times during each year; most areas are too high for overflow. About 14 to 22 inches of fine sandy loam or light loam underlain by well-graded sand and gravel.	0–18	Fine sandy loam	SM	A-4
			18–60	Well-graded sand and gravel.	SW	A-1

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	75–85	0.2 – 0.8	0.17	6.5	None	Low	Low	Low	Low.
100	100	92–96	0.05– 0.2	0.21	8.0	None	High	Moderate	Low	High.
100	100	92–96	0.05– 0.2	0.20	8.6	Slight	High	Moderate	Moderate	High.
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100	100	92–96	0.05– 0.2	0.21	8.4	None	High	Moderate	None	High.
100	100	92–96	0.05– 0.2	0.20	8.8	Moderate	High	Moderate	None	High.
100	100	80–90	0.2– 0.80	0.20	8.4	None	Low	Low	None	Low.
100	100	35–45	2.0– 5.0	0.13	8.4	None	Very low	Low	None	Low.
100	100	15–25	2.0– 5.0	0.07	8.4	None	Very low	Low	None	Low.
100	100	40–50	0.8– 2.0	0.15	8.4	None	Very low	Low	None	Low.
100	100	25–35	2.0– 5.0	0.07	8.4	None	Very low	Low	None	Low.
100	100	75–85	0.8– 2.0	0.17	8.4	None	Very low	Low	None	Low.
100	100	35–45	2.0– 5.0	0.15	8.4	None	Very low	Low	None	Low.
100	100	25–35	2.0– 5.0	0.07	8.4	None	Very low	Low	None	Low.
100	100	40–50	2.0– 5.0	0.15	8.4	None	Very low	Low	None	Low.
60–70	50–60	<5	>10.0	0.02	8.4	None	Very low	Low	None	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Gs	Glendive loamy fine sand (less than 2 percent slopes).	On level or nearly level bottom lands and fans; ground water is within 6 feet of the surface at times during each year; areas close to main channels overflow occasionally during ice jams or when streams are extremely high. About 30 to 40 inches of loamy fine sand underlain by fine sand; in places well-graded sand or sand and gravel occur at a depth of less than 40 inches; sand or sand and gravel are within 10 feet of the surface in all parts of the flood plain.	0–32	Loamy fine sand	SM	A–2
			32–60	Stratified fine sand or fine sand and loamy fine sand.	SM	A–1
Gv	Glendive and Banks soils (less than 1 percent slopes).	In brushy areas, some of which are flooded during ice jams or in spring when runoff is great. Glendive soil makes up about 60 to 70 percent of the mapping unit, Banks soil about 15 to 25 percent, and Havre soil about 10 percent. Glendive soil varies greatly in texture and thickness of layers. Properties given here are for the Banks soil.	0–4	Loam or very sandy loam.	ML	A–4
			4–12	Loamy fine sand or fine sand.	SM	A–2
			12–60	Well-graded sand or gravel and sand.	GW or SW	A–1
Ha	Havre clay (less than 1 percent slopes).	On level bottom lands and low terraces; ground water is within 5 feet or less during the irrigation season and in places is within 3 feet for short periods. About 8 to 12 inches of clay, clay loam, silt loam, or loam underlain by stratified loam, silt loam, or very fine sandy loam containing a few thin clay loam or fine sandy loam layers less than 3 inches thick; below 40 to 50 inches, the material is generally stratified loam, sandy loam, and loamy fine sand or is loamy fine sand. In places loose, well-graded to poorly graded sand or well-graded sand and gravel underlie these soils at a depth of 40 to 60 inches; this material is generally within 10 feet of the surface on the lower flood plains.	0–10	Clay or clay loam	CL	A–6 or A–7
Hc	Havre clay loam (less than 1 percent slopes).		10–50	Stratified loam or silt loam.	ML	A–4
			50–60	Fine sandy loam and loamy fine sand.	SM	A–4
Hb	Havre clay, saline (less than 1 percent slopes).	On level bottom lands; ground water is within 3 feet of the surface at times during the irrigation season. Except that they are saline enough to damage crops, these soils are like Havre clay and Havre clay loam.	0–10	Clay or clay loam	CL	A–6 or A–7
			10–42	Loam or silt loam	ML	A–4
Hf	Havre clay loam, saline (less than 1 percent slopes).		42–60	Fine sandy loam and loamy fine sand.	SM	A–4
Hg	Havre loam (less than 1 percent slopes).	On level bottom lands and low terraces. About 45 inches of loam and silt loam underlain by strata of loam to very fine sand.	0–45	Loam and silt loam.	ML	A–4
			45–60	Strata of loam to very fine sand.	ML or SM	A–4
Hm	Havre loam, saline (less than 1 percent slopes).	On level bottom lands. Except that it is moderately saline, and loam or silt loam does not extend so deeply, this soil is like Havre loam on bottom lands.	0–10	Loam or silt loam	ML	A–4
			10–26	Loam or silt loam	ML	A–4
			26–60	Stratified fine sandy loam or loam and silt loam.	ML or SM	A–4
Hd	Havre clay loam, high (less than 1 percent slopes).	On well-drained terraces; ground water is not a problem, except during the irrigation season, when it is within 5 feet of the surface for very short periods. About 8 to 14 inches of clay loam underlain by stratified loam, very fine sandy loam, and silt loam; in a few places a stratum of fine sandy loam occurs below a depth of 50 inches.	0–10	Clay loam	CL	A–6
			10–60	Stratified sediments of loam, very fine sandy loam, and silt loam.	ML	A–4

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	25–35	2.0– 5.0	0.10	8.4	None	Very low	Low	None	Low.
100	100	15–25	5.0–10.0	0.07	8.4	None	Very low	Low	None	Low.
100	100	75–85	2.0– 5.0	0.17	8.4	None	Very low	Low	None	Low.
100	100	23–30	5.0–10.0	0.03	8.4	None	Very low	Low	None	Low.
50–70	50–60	<5	>10.0	0.01	8.4	None	Very low	Low	None	Low.
100	100	90–95	0.2– 0.8	0.18	8.4	None	Moderate	Low	None	Moderate.
100	100	80–90	0.2– 0.8	0.17	8.4	None	Moderate	Low	None	Low.
100	100	35–45	2.0– 5.0	0.09	8.4	Moderate	Moderate	Moderate	None	Low.
100	100	90–95	0.2– 0.8	0.18	8.8	Moderate	High	Moderate	Moderate	Moderate.
100	100	80–90	0.2– 0.8	0.17	9.0	Moderate	High	Moderate	Moderate	Moderate.
100	100	35–45	2.0– 5.0	0.09	9.0	Slight	High	Moderate	Moderate	Low.
100	100	80–90	0.2– 0.8	0.17	8.4	None to slight.	Low to moderate.	Low	Low	Low.
100	100	60–80	2.0– 5.0	0.15	8.6	Slight to moderate.	Moderate to high.	Moderate	Low	Low.
100	100	75–90	0.2– 0.8	0.17	8.4	Moderate	High	Moderate	Moderate	Low.
100	100	75–90	0.2– 0.8	0.17	8.6	Moderate	High	Moderate	Moderate	Low.
100	100	50–90	0.2– 2.0	0.17	8.6	Slight	Moderate	Moderate	Moderate	Low.
100	100	94–98	0.2– 0.8	0.19	8.4	None	Low	Low	None	Moderate.
100	100	80–90	0.2– 0.8	0.17	8.4	None	Low	Low	None	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Hh	Havre loam, high (less than 1 percent slopes).	On well-drained terraces and fans; ground water is below a depth of 15 feet, except in irrigated areas, where it may be within 5 feet for short periods during the irrigation season. About 20 to 30 inches of loam or silt loam underlain by thinly stratified loam, silt loam, and very fine sandy loam. In places the material below 50 inches is loamy fine sand or fine sandy loam.	0–40	Loam or silt loam	ML	A–4
			40–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
Hl	Havre loam, moderately deep (less than 1 percent slopes).	On level bottom lands and low terraces; ground water is within 4 feet of the surface during irrigation season. About 22 to 30 inches of loam underlain by well-graded sand or by sand and gravel containing some fines.	0–26	Loam	ML	A–4
			26–60	Well-graded sand or sand and gravel.	SW	A–1
Hn	Havre and Glendive soils (less than 1 percent slopes).	In brushy areas along the Bighorn and Yellowstone River flood plains; most areas are too high for flooding except when there are ice jams; ground water is within 5 feet of the surface at times in summer. Havre soil makes up about 60 to 70 percent of the mapping unit, Glendive soil about 20 to 35 percent, and Banks and other soils about 5 to 10 percent. These soils vary so much in texture and in thickness of layers that their properties cannot be accurately given.				
Ho	Havre and Lohmiller soils (less than 1 percent slopes).	In narrow valleys along streams that drain the uplands; areas generally dissected by one or more deep channels; most of the flood plains are flooded only during the extremely high runoff in spring or during flash floods caused by cloudbursts. These soils vary so much in texture and in thickness of layers that their properties cannot be accurately given.				
Hp	Havre and Lohmiller soils, 8 to 15 percent slopes.	Steep, eroded edges of fans and terraces; areas of these soils may consist entirely of Havre soil or of Lohmiller soil, or of both. Texture and thickness of layers of Havre soils are so variable that properties cannot be accurately given; properties given here are for Lohmiller soil.	0–26	Light clay or clay loam.	CL	A–6 or A–7
Hr	Havre and Lohmiller soils, 15 to 35 percent slopes.		26–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
Hs	Havre and Lohmiller soils, saline (less than 1 percent slopes).	In narrow valleys along streams that drain the uplands. Except that they are saline, these soils are like Havre and Lohmiller soils (Ho). Like those soils, they vary so much in texture and in thickness of layers that their properties cannot be accurately given.				

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	75–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
100	100	70–90	0. 2– 0. 8	0. 17	8. 6–8. 8	None to slight.	Low	Low	None	Low.
100	90–100	75–85	0. 8– 2. 0	0. 17	8. 4	None	Low	Low	None	Low.
60–70	30–50	<5	>10. 0	0. 02	8. 4	None	Very low	Low	None	Low.
100	100	94–98	0. 2– 0. 8	0. 19	8. 4	None	Moderate	Low	None	Moderate.
100	100	85–95	0. 2– 0. 8	0. 17	8. 4–8. 7	Slight	Low	Low	None	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Ht	Havre-Hysham loams (less than 1 percent slopes).	On nearly level, well-drained fans and terraces; ground water is below 10 feet most of the year, but below the irrigation canal, ground water may be within 5 feet of the surface for short periods. Havre loam makes up about 60 to 80 percent of this complex and Hysham loam about 20 to 40 percent. For properties of the Hysham loam, see Hysham-Havre loams (Hz); properties given here are for the Havre soil.	0–10	Clay loam	CL	A–6
			10–60	Stratified sediments of loam, very fine sandy loam, and silt loam.	ML	A–4
Hu	Hesper loam, 1 to 4 percent slopes.	On well-drained high terraces. About 3 to 5 inches of loam underlain by 8 to 12 inches of prismatic-blocky silty clay loam that is underlain, in turn, by 25 inches of calcareous silt loam or poorly graded loam, spotted with white lime; below a depth of 40 inches, there is calcareous loam, silt loam, or very fine sandy loam; in places gravelly loam occurs at a depth of 40 to 60 inches; well-graded sand or sand and gravel occur within 10 feet of the surface.	0–5	Loam	ML	A–4
Hv	Hesper loam, 4 to 8 percent slopes.		5–15	Heavy silty clay loam.	CL	A–6 or A–7
			15–40	Silt loam or poorly graded loam.	ML	A–4
			40–60	Poorly graded loam or very fine sandy loam.	ML	A–4
Hw	Hilly gravelly land (10 to 40 percent slopes).	On dissected and even edges of high terraces. About 8 to 12 inches of very gravelly sandy loam underlain by well-graded sand or sand and gravel.	0–8	Very gravelly sandy loam.	GW–GM	A–1
			8–72	Well-graded sand or well-graded sand and gravel.	GW	A–1
Hx	Hoven clay (less than 1 percent slopes).	In flat, undrained basins and depressions that are subject to periodic flooding from local runoff; ponding may occur each year or only 2 or 3 years out of 10; water may remain on the surface until late in summer. About 1 inch to 3 inches of light-gray loam underlain by columnar or blocky heavy clay that becomes massive with increasing depth.	0–30	Clay	CH	A–7
			30–60	Clay	CH	A–7
Hy	Hoven and McKenzie soils (0 to 4 percent slopes).	On barren fans and terraces; ground water is not a problem. About ¼ to 1 inch of light-gray loam underlain by dense, massive or weak, blocky, strongly alkaline clay or silty clay; many accumulations of gypsum from about 4 to 8 inches down to 40 or more inches; below a depth of 40 inches, the material is strongly alkaline, stratified silty clay and silty clay loam that contain strata of silt loam and soluble salts and gypsum. Properties given here are for both Hoven and McKenzie soils.	0–45	Clay or silty clay	CH	A–7
			45–60	Stratified silty clay to silt loam.	CL	A–6 or A–7–6.

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	94–98	0. 2– 0. 8	0. 19	8. 4	None	Low	Low	None	Moderate.
100	100	80–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
100	100	80–90	0. 8– 2. 0	0. 17	6. 6	None	Low	Low	None	Low.
100	100	88–92	0. 8– 2. 0	0. 19	7. 5	None	Low	Low	None	Moderate.
100	100	88–92	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
100	100	80–90	0. 2– 0. 8	0. 17	8. 5	None	Low	Low	None	Low.
50–60	25–30	6–10	5. 0–10. 0	0. 05	8. 0	None	Very low	Low	None	Low.
30–40	25–35	<5	>10. 0	0. 02	8. 4	None	Very low	Low	None	Low.
100	100	95–100	<0. 10	0. 25	8. 0–8. 2	None	High	Moderate	Moderate	High.
100	100	95–100	<0. 05	0. 25	8. 6–8. 8	Moderate	Very high	Moderate	Moderate	High.
100	100	95–100	<0. 05	0. 20	8. 8–9. 2	Severe	Very high	High	High	High.
100	100	85–95	<0. 05	0. 18	9. 0–9. 5	Moderate	Very high	High	High	Moderate to high.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Hz	Hysham-Havre loams (less than 2 percent slopes).	On well-drained fans and terraces; except during short periods in irrigated areas, ground water is below a depth of 10 feet. Hysham loam makes up about 60 to 80 percent of this complex and Havre loam about 20 to 40 percent. Hysham loam has 2 to 4 inches of loam underlain by 6 to 10 inches of extremely hard, strongly alkaline, thick prismatic or blocky loam; below 8 to 10 inches are strongly alkaline, stratified loam and very fine sandy loam that have moderate amounts of soluble salts. Havre loam is slightly more saline in the lower part than Havre loam, high (Hh), but in other respects it has properties like those of that soil; properties given here are for the Hysham loam.	0–10	Loam	ML	A–4
			10–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
La	Laurel clay loam (less than 1 percent slopes).	In waterlogged and imperfectly drained areas of the bottom lands, low terraces, and fans; ground water is within 5 feet of the surface most of the year and within 3 feet for 2 or 3 months during the irrigation season. About 22 to 30 inches of strongly saline loam, clay loam, or silty clay loam underlain by stratified sediments ranging from fine sandy loam to silt loam; in places the material below 50 inches consists of fine sandy loam and loamy fine sand stratified with fines and lenses; a salt crust, 1/8 to 1/4 inch thick, covers all or part of the surface; abundant soluble salts and gypsum in upper 16 to 24 inches. In some places this soil lacks the high water table and the salts on the surface and has properties like those of Laurel clay loam as described for the Arvada-Laurel complex (Ax).	0–20	Clay loam or silty clay loam.	CL	A–6
			20–30	Clay loam or silty clay loam.	CL	A–6
			30–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
Lb	Laurel loam (less than 4 percent slopes).	In waterlogged and imperfectly drained areas of the bottom lands and fans; ground water is within 5 feet of the surface most of the year and within 3 feet for 2 or 3 months during the irrigation season. About 22 to 30 inches of strongly saline loam or silt loam underlain by stratified sediments ranging from fine sandy loam to silt loam; in places material below 50 inches consists of fine sandy loam and loamy fine sand stratified with fines and lenses; in some places a salt crust, ⅛ to ¼ inch thick, covers the surface; abundant soluble salts and gypsum in upper 16 to 24 inches. In some places this soil lacks the high water table and the salts on the surface and has properties like those of Laurel clay loam as described for the Arvada-Laurel complex (Ax).	0–22	Loam or silt loam	ML	A–4
			22–46	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
			46–60	Fine sandy loam and loamy fine sand.	ML	A–4
Lo	Lismas clay (15 to 40 percent slopes).	On strongly rolling to hilly uplands. About 2 or 3 inches of granular clay underlain by 8 to 12 inches of massive or weak, blocky clay that is underlain, in turn, by marine shale at a depth of 8 to 16 inches; shale is platy clay that has accumulations of gypsum in the upper part.	0–12	Clay	CL or CH	A–7
			12–18	Shaly clay	SC	A–7 or A–2
			18–60	Platy clay shale	CL or ML	A–7

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	80–90	<0. 2	0. 17	9. 0–9. 4	Slight	High	Moderate	High	Low.
100	100	75–90	<0. 2	0. 17	9. 0–9. 4	Moderate	High	Moderately high.	High	Low.
100	100	85–95	0. 8– 2. 0	0. 18	9. 0+	Very severe.	Very high	High	High	Moderate.
100	100	85–95	0. 2– 0. 8	0. 18	9. 0+	Severe	Very high	High	High	Moderate.
100	100	75–90	0. 2– 0. 8	0. 17	9. 0+	Moderate	High	Moderate	High	Low.
100	100	75–90	0. 8– 2. 0	0. 17	9. 0+	Very severe	Very high	High	High	Low.
100	100	75–90	0. 2– 0. 8	0. 17	9. 0+	Severe	Very high	High	High	Low.
100	100	60–75	0. 2– 0. 8	0. 16	9. 0+	Moderate	Very high	Moderate	High	Low.
100	100	94–98	<0. 2	0. 20	8. 2–8. 6	Slight	High	Low	Low	High.
80–90	60–80	30–50	<0. 2	0. 20	8. 4–8. 8	Moderate	High	Moderate	Low	High.
60–80	60–80	40–60	<0. 05	0. 25	8. 8–9. 0	Moderate	High	High	Moderate	High.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Ld	Lismas-Pierre clays, saline-alkali (15 to 35 percent slopes).	On hilly and dissected uplands north of the Yellowstone River. Lismas soil on ridges, crests, and more strongly dissected areas makes up about 50 to 60 percent of this complex; Pierre soil on the lower and smoother side slopes below the crests makes up about 30 to 40 percent; other soils in swales and on fans make up about 10 percent. Lismas clay is 8 to 16 inches deep over the platy clay shale and is strongly alkaline and saline. For properties of the Pierre soil, see Pierre-Lismas clays, saline-alkali (Pk); properties given here are for the Lismas soil.	0–12 12–18 18–60	Clay Shaly clay Platy clay shale	CL or CH CL or SC CL or SC	A–7 A–7 or A–2 A–7
Lf	Lismas-Midway complex (15 to 35 percent slopes).	On hilly uplands. Lismas clay makes up about 40 to 60 percent of this complex, Midway clay loam about 30 to 50 percent, and other soils about 10 percent. For properties of the Midway soil, see Midway clay loam, 15 to 35 percent slopes (Ms); properties given here are for the Lismas soil.	0–12 12–18 18–60	Clay Shaly clay Platy clay shale	CL or CH SC CL or ML	A–7 A–7 or A–2 A–7
Lg	Lismas-Shale outcrop complex (20 to 50 percent slopes).	On steep, rough, broken, and deeply dissected clay shale uplands. Lismas clay makes up about 60 to 70 percent of this complex, Shale outcrop 25 to 35 percent, and other soils about 5 percent. For properties of outcrop, see Shale outcrop (Sh); properties given here are for the Lismas soil.	0–12 12–18 18–60	Clay Shaly clay Platy clay shale	CL or CH CL or SC CL or SC	A–7 A–7 or A–2 A–7
Lh Lo	Lohmiller clay (less than 1 percent slopes). Lohmiller clay loam (less than 1 percent slopes).	On level bottom lands and low terraces; ground water normally within 5 feet of the surface at times during irrigation season but in places may be within 3 feet. About 12 to 16 inches of clay or clay loam underlain by 14 to 22 inches of clay loam or silty clay loam that has a few thin strata of loam or silt loam; below 30 to 40 inches are stratified loam, silt loam, and very fine sandy loam.	0–12 12–30 30–60	Clay or clay loam Clay loam or silty clay loam. Stratified loam, silt loam, and very fine sandy loam.	CL CL ML	A–6 or A–7 A–6 A–4
Lm Lr Ls Lt	Lohmiller clay, high (less than 1 percent slopes). Lohmiller clay loam, 1 to 3 percent slopes. Lohmiller clay loam, fans, 0 to 1 percent slopes. Lohmiller clay loam, high (less than 1 percent slopes).	On well-drained fans and terraces; ground water is not a problem, except in irrigated areas, where it is within 5 feet of the surface for very short periods during the irrigation season. About 4 to 8 inches of granular clay or clay loam underlain by 22 to 30 inches of clay or clay loam that is underlain, in turn, by stratified sediments below a depth of 24 to 40 inches.	0–26 26–60	Light clay or clay loam. Stratified loam, silt loam, and very fine sandy loam.	CL ML	A–6 or A–7 A–4
Ln	Lohmiller clay, wet.	In poorly drained and waterlogged areas at base of breaks on level bottom lands and low terraces; ground water within 2 feet of the surface all year; some open water in the shallow channels. About 18 to 26 inches of clay, silty clay, clay loam, or silty clay loam underlain by stratified loam, silt loam, and very fine sandy loam that are underlain, in turn, by coarser textured material at a depth of 40 to 60 inches; coarser textured material is well-graded sand and gravel in some places.	0–22 22–60	Clay, silty clay, clay loam, and silty clay loam. Stratified loam, silt loam, and very fine sandy loam.	CL ML	A–6 or A–7 A–4

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	94–98	<0. 2	0. 20	8. 2–8. 6	Slight	High	Low	Low	High.
80–90	60–80	30–50	<0. 2	0. 20	8. 4–8. 8	Moderate	High	Moderate	Low	High.
60–80	60–80	40–60	<0. 05	0. 25	8. 8–9. 0	Moderate	High	High	Moderate	High.
100	100	94–98	<0. 2	0. 20	8. 2–8. 6	Slight	High	Low	Low	High.
80–90	60–80	30–50	<0. 2	0. 20	8. 4–8. 8	Moderate	High	Moderate	Low	High.
60–80	60–80	40–60	<0. 05	0. 25	8. 8–9. 0	Moderate	High	High	Moderate	High
100	100	94–98	<0. 2	0. 20	8. 2–8. 6	Slight	High	Low	Low	High.
80–90	60–80	30–50	<0. 2	0. 20	8. 4–8. 8	Moderate	High	Moderate	Low	High.
60–80	60–80	40–60	<0. 05	0. 25	8. 8–9. 0	Moderate	High	High	Moderate	High.
100	100	85–95	0. 2– 0. 8	0. 17–0. 19	8. 4	None	Moderate	Low	None	Moderate.
100	100	85–95	0. 2– 0. 8	0. 17	8. 4	None	Moderate	Low	None	Moderate.
100	100	75–85	0. 2– 0. 8	0. 17	8. 6	Slight	Moderate	Moderate	Low	Low.
100	100	94–98	0. 2– 0. 8	0. 19	8. 4	None	Moderate	Low	None	Moderate.
100	100	85–95	0. 2– 0. 8	0. 17	8. 4–8. 7	Slight	Low	Low	None	Low.
100	100	85–95	0. 2– 0. 8	0. 17–0. 19	8. 4	Moderate	High	Moderate	Low	Moderate.
100	100	75–85	0. 2– 0. 8	0. 17	8. 7	Moderate	High	Moderate	Low	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Lu	Lohmiller-Hysham clays.	On well-drained fans and terraces; ground water is not a problem, except in irrigated areas, where it may be within 5 feet of the surface for short periods during the irrigation season; Lohmiller soil makes up 75 to 85 percent of this complex and Hysham soil 15 to 25 percent. For properties of the Lohmiller soil see Lohmiller clay (Lh); properties given here are for the Hysham soil.	0–14	Clay loam or clay	CL	A–6
Ly	Lohmiller-Hysham clay loams.		14–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
Ma	Marias clay, saline-alkali, 0 to 1 percent slopes.	On nearly level to sloping, well-drained fans and terraces and undulating to rolling uplands; ground water below a depth of 10 feet except in irrigated areas, where it is within 5 feet of the surface for short periods during the irrigation season. Continuous crust, less than ½ inch thick, is underlain by 20 to 26 inches of strongly alkaline, blocky clay or silty clay that is underlain, in turn, by strongly alkaline, massive or weak, blocky clay having common to many clusters and spots of gypsum; in places on the upland, these soils are underlain by platy clay shale at a depth of 4 to 5 feet.	0–8	Silty clay or clay	CL	A–7
			8–20	Silty clay or clay	CH	A–7
Mb	Marias clay, saline-alkali, 1 to 10 percent slopes.		20–60	Clay or silty clay	CH	A–7
Mc	Marias clay, fans, saline-alkali.					
Md	Marias-Hoven clays, saline (0 to 6 percent slopes).	On nearly level to sloping fans and terraces and undulating uplands; ground water is not a problem, for the water table is below a depth of 15 to 20 feet. Marias clay, saline-alkali, makes up about 65 to 80 percent of this complex, Hoven clay, saline, about 15 to 30 percent, and other soils about 5 percent. Hoven clay, saline, is in the barren or nearly barren areas. For properties of the Hoven soil, see Hoven and McKenzie soils (Hy); properties given here are for the Marias soil.	0–8	Silty clay or clay	CL	A–7
			8–20	Silty clay or clay	CH	A–7
			20–60	Clay or silty clay	CH	A–7
Me	Marias-Pierre clays, saline-alkali (4 to 10 percent slopes).	On rolling uplands. Marias clay, saline-alkali, makes up about 50 to 60 percent of this complex, Pierre clay, saline-alkali, about 30 to 40 percent, and other soils about 10 to 15 percent. Pierre clay is on ridges and more convex slopes and in the steeper more dissected areas. In places platy clay shale underlies the Marias soil at a depth of 40 to 60 inches. For properties of the Pierre soil, see Pierre-Lismas clays, saline-alkali (Pk); properties given here are for the Marias soil.	0–8	Silty clay or clay	CL	A–7
			8–20	Silty clay or clay	CH	A–7
			20–60	Clay or silty clay	CH	A–7
Mf	Marias and Promise clays (4 to 8 percent slopes).	On rolling uplands. Both of these soils have 3 to 4 inches of granular clay underlain by 18 to 20 inches of blocky clay or silty clay. From a depth of about 24 inches to 45 or 50 inches, the material is massive or weak, blocky clay spotted with white lime; below that depth to about 60 inches or more, there is clay loam or weakly consolidated clay shale, some of which is carbonaceous. Properties given are for both the Marias and the Promise soils.	0–4	Granular clay	CL	A–7
			4–45	Clay	CL or CH	A–7
			45–60	Clay loam or clay	CL or CH	A–7

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	90–95	>0. 20	0. 19	8. 9–9. 4	Slight	High	High	High	Moderate.
100	100	80–90	>0. 20	0. 18	8. 9–9. 4	Moderate to strong.	High	High	High	Low.
100	100	96–98	0. 05– 0. 2	0. 20	7. 8–8. 0	None	Moderate	Low	Low	High.
100	100	96–98	0. 05– 0. 2	0. 20	8. 8	Slight	High	Moderate	Moderate	High.
100	100	96–98	0. 05– 0. 2	0. 20	8. 1	Moderate	High	Moderate	Moderate	High.
100	100	96–98	0. 05– 0. 2	0. 20	7. 8–8. 0	None	Moderate	Low	Low	High.
100	100	96–98	0. 05– 0. 2	0. 20	8. 8	Slight	High	Moderate	Moderate	High.
100	100	96–98	0. 05– 0. 2	0. 20	8. 1	Moderate	High	Moderate	Moderate	High.
100	100	96–98	0. 05– 0. 2	0. 20	7. 8–8. 0	None	Moderate	Low	Low	High.
100	100	96–98	0. 05– 0. 2	0. 20	8. 8	Slight	High	Moderate	Moderate	High.
100	100	96–98	0. 05– 0. 2	0. 20	8. 1	Moderate	High	Moderate	Moderate	High.
100	100	85–95	0. 2 – 0. 8	0. 20	7. 5	None	High	Moderate	None	High.
100	100	85–95	0. 05– 0. 2	0. 20	8. 4	None	High	Moderate	None	High.
100	100	85–95	0. 05– 0. 2	0. 17–0. 20	8. 4	None to slight.	High	Moderate	None	High.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Mk	McRae loam (8 to 16 percent slopes).	On well-drained terraces and fans; ground water is below a depth of 15 feet, except in irrigated areas, where it may be within 5 feet for short periods during the irrigation season. Both McRae and Havre soils have 20 to 30 inches of loam or silt loam underlain by thinly stratified loam, silt loam, and very fine sandy loam. In places the material below 50 inches is loamy fine sand or fine sandy loam. On some of the steeper fans, the McRae soils are underlain by shale at a depth of 40 to 60 inches. Properties given here are for both the McRae and the Havre soils.	0–40	Loam or silt loam	ML	A–4
			40–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
Mn	McRae and Havre loams, 0 to 1 percent slopes.					
Mo	McRae and Havre loams, 1 to 4 percent slopes.					
Mp	McRae and Havre loams, 4 to 8 percent slopes.					
Ml	McRae-Bainville loams, 8 to 20 percent slopes.	On moderately steep fans that have ridges and knolls covered with soils weathered from shale. McRae loam on the fans and foot slopes makes up about 60 to 70 percent of this complex; Bainville loam on the convex ridges and knolls makes up about 20 to 30 percent; and other soils makes up about 10 percent. In places on steeper fans, the McRae soil is underlain by shale at a depth of less than 5 feet. Some deeply cut stream courses with steep sidewalls occur. For properties of the Bainville soil, see Bainville loam, 8 to 15 percent slopes (Bb); properties given here are for the McRae soil.	0–40	Loam or silt loam	ML	A–4
			40–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
Mm	McRae-Bainville loams, 20 to 35 percent slopes.	On steep fans and foot slopes in narrow valleys of the uplands. Common in this complex are deeply cut stream courses with almost vertical sidewalls. McRae loam makes up about 40 to 60 percent of this complex, Bainville loam about 30 to 40 percent, and other soils about 10 to 20 percent. On many of the steeper fans and foot slopes, loam or clay loam shale underlies the McRae soil at a depth of 3 to 5 feet. For properties of the Bainville soil, see Bainville loam, 15 to 35 percent slopes (Bc); properties given here are for the McRae soil.	0–40	Loam or silt loam	ML	A–4
			40–60	Stratified loam, silt loam, and very fine sandy loam.	ML	A–4
Mr	Midway clay loam, 8 to 15 percent slopes.	On rolling shale uplands; about 20 to 30 inches of calcareous clay loam or silty clay loam underlain by calcareous silty clay loam or light silty clay shale; shale is within a depth of 20 inches on narrow ridges, crests, and knolls. About 10 to 20 percent of Bainville soils and other soils are included in the mapping unit.	0–26	Clay loam or silty clay loam.	CL	A–6
			26–60	Silty clay loam shale.	CL or MH	A–6 or A–7
Ms	Midway clay loam, 15 to 35 percent slopes.	On hilly shale uplands; about 10 to 22 inches of calcareous clay loam or silty clay loam underlain by calcareous silty clay loam shale; shale is within a depth of 10 inches on the ridges, crests, and knolls; of the mapping unit, Midway soils make up about 60 to 70 percent, Bainville soils about 15 to 20 percent, and deep loams and clay loams on fans about 15 to 20 percent.	0–16	Clay loam or silty clay loam.	CL	A–6
			16–60	Silty clay loam shale.	CL or MH	A–6 or A–7

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	75–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
100	100	70–90	0. 2– 0. 8	0. 17	8. 6–8. 8	None to slight.	Low	Low	None	Low.
100	100	70–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
100	100	70–90	0. 2– 0. 8	0. 17	8. 6–8. 8	None to slight.	Low	Low	None	Low.
100	100	70–90	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
100	100	70–90	0. 2– 0. 8	0. 17	8. 6–8. 8	None to slight.	Low	Low	None	Low.
100	100	94–98	0. 20– 0. 80	0. 19	8. 4–8. 6	None to slight.	Moderate	Low	None	Moderate.
100	100	90–98	<0. 20	0. 20	8. 6–9. 0	Slight to moderate.	High	Moderate	Low to moderate.	Moderate to high.
100	100	94–98	0. 20– 0. 80	0. 19	8. 4–8. 6	None to slight.	Moderate	Low	None	Moderate.
100	100	90–98	<0. 20	0. 20	8. 6–9. 0	Slight to moderate.	High	Moderate	Low to moderate.	Moderate to high.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Mt	Midway-Bainville complex (30 to 65 percent slopes).	On hilly and rough, broken uplands, at upper part of drainage systems. Midway soil makes up about 40 to 60 percent of this complex, Bainville soil about 30 to 40 percent, and other soils about 10 to 20 percent. For properties of the Bainville soil, see Bainville loam, 15 to 35 percent slopes (Bc); for the Midway soil, see Midway clay loam, 15 to 35 percent slopes (Ms).				
Mu	Midway-Nihill gravelly loams (25 to 50 percent slopes).	On steep, eroded edges of high terraces. Midway gravelly clay loam on the lower part of slopes makes up about 60 to 70 percent of this complex, Nihill gravelly loam on the upper part of slopes makes up about 20 to 30 percent, and other soils about 10 percent. For properties of the Nihill soil, see Nihill gravelly loam (Na); for properties of Midway soil, see Midway clay loam, 15 to 35 percent slopes (Ms).				
Mv	Midway-Shale outcrop complex (30 to 70 percent slopes).	On very steep and rough, broken upland areas that border the streams and are at the upper part of drainage systems; commonly slopes are nearly vertical. Midway soil makes up about 60 to 80 percent of this complex, and barren or nearly barren Shale outcrop about 20 to 40 percent; outcrops are in areas of less than 1 acre to as much as 10 acres; the soil is more than 12 inches deep over the shale in only a few places. For properties of outcrop, see Shale outcrop (Sh); for properties of Midway soil, see Midway clay loam, 15 to 35 percent slopes (Ms).				
Na	Nihill gravelly loam (20 to 40 percent slopes).	On steep, eroded edges of high terraces. About 6 to 10 inches of gravelly loam underlain by 14 to 30 inches or more of very gravelly loam or sandy loam that is underlain, in turn, by well-graded sand and gravelly, platy clay shale, or by silt loam or by silty clay loam shale. Small areas of deeper soils are on some of the narrow crests.	0–8 8–40 40+	Gravelly loam Very gravelly loam. Variable	GM GM ----------	A-2 A-2 ----------
Nc Nd Nm Nn No Nu Nx	Nunn clay, 0 to 1 percent slopes. Nunn clay, 1 to 3 percent slopes. Nunn clay, 3 to 8 percent slopes. Nunn clay loam, 0 to 1 percent slopes. Nunn clay loam, 1 to 3 percent slopes. Nunn clay loam, 3 to 8 percent slopes. Nunn-Beckton complex, 0 to 1 percent slopes.	On well-drained fans and terraces; ground water is below 15 feet, except in irrigated areas, where it is within 5 feet of the surface for short periods. About 4 to 8 inches of granular clay loam or clay underlain by 8 to 12 inches of prismatic-blocky heavy clay loam, heavy silty clay loam, or light silty clay; at a depth of 6 to 20 inches down to 45 or 50 inches, the material is calcareous clay loam or silty clay loam, and below that depth, it is stratified poorly graded loam, silt loam, and very fine sandy loam. In some places a layer of silty clay, less than 12 inches thick, occurs below a depth of 20 inches. Properties given here are for both the Nunn and the Beckton soils.	0–6 6–15 15–50 50–65	Granular clay loam or clay. Light clay, light silty clay, heavy silty clay loam, or heavy clay loam. Clay loam or silty clay loam with thin layers of silty clay. Clay loam, silty clay loam, or stratified loam, silt loam, and very fine sandy loam.	CL or ML CL CL ML or CL	A-4 or A-6 A-6 or A-7 A-6 A-4 or A-6

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
50–60	32–45	20–30	0. 8– 2. 0	0. 10	8. 0	None	Low	Low	None	Low.
35–45	20–30	15–20	0. 8– 2. 0	0. 07	8. 4	None	Low	Low	None	Low.
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100	100	85–95	0. 2– 0. 8	0. 17	7. 5	None	Moderate	Low	None	Moderate
100	100	90–95	0. 8– 2. 0	0. 17–0. 18	8. 0	None	Moderate	Low	None	Moderate
100	100	90–95	0. 2– 0. 8	0. 17	8. 7–9. 1	None	Moderate	Low	None	Moderate
100	100	75–95	0. 2– 0. 8	0. 17	8. 7–9. 1	None to slight.	Moderate	Moderate	None	Low.

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TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Pa	Pierre clay (5 to 10 percent slopes).	On rolling uplands. About 2 to 4 inches of granular clay underlain by 16 to 28 inches of blocky to massive clay that is underlain, in turn, by 4 to 8 inches of shaly clay; platy clay shale of marine origin is at a depth of 16 to 40 inches; accumulated gypsum is common in weathered material of upper part of shale and just above it.	0–3	Granular clay	CL or ML	A–7
			3–18	Clay	CH or CL	A–7
			18–26	Clay with shale fragments.	CL or SC	A–2 or A–7
			26–60	Platy clay shale	ML or CL	A–7
Pc	Pierre-Lismas clays (10 to 25 percent slopes).	On strongly rolling to hilly uplands. Pierre clay on the mid and lower parts of slopes makes up about 60 to 70 percent of this complex; Lismas clay on the convex ridges and crests makes up about 20 to 30 percent, and other soils make up about 10 percent. Pierre clay is less than 30 inches deep to the shale and Lismas clay is less than 12 inches. For properties of the Lismas soil see Lismas clay (Lc); properties given here are for the Pierre soil.	0–3	Clay	CH or ML	A–7
			3–18	Clay	CH or CL	A–7
			18–26	Clay and shale fragments.	CH or SC	A–6 or A–7
			26–70	Platy clay shale	GC or CL	A–7
Pk	Pierre-Lismas clays, saline-alkali (10 to 25 percent slopes).	On strongly rolling to hilly uplands. On the surface of Pierre clay, saline-alkali, is a continuous crust that is less than 1 inch thick and is underlain by strongly alkaline, blocky clay that is underlain, in turn, by shaly clay containing gypsum; platy clay shale of marine origin occurs at a depth of 16 to 30 inches. Lismas clay is less than 16 inches to the shale. Pierre clay, saline-alkali, is on the mid and lower slopes and makes up about 60 to 70 percent of this complex; Lismas clay, saline-alkali, is on the convex ridges and in dissected areas and makes up 20 to 30 percent; and other soils make up about 10 percent. For properties of the Lismas soil, see Lismas clay (Lc); properties given here are for the Pierre soil.	0–7	Clay	CH	A–7
			7–20	Clay with gypsum	CH	A–7
			20–28	Shaly clay with gypsum.	CL or SC	A–7
			28–60	Saline platy clay shale.	CL or GC	A–7 or A–6
Rn	Renohill clay loam (4 to 8 percent slopes).	On rolling uplands. About 2 to 4 inches of granular clay loam underlain by 5 to 8 inches of prismatic heavy clay loam or light clay that is underlain, in turn, by calcareous clay loam or silty clay loam; clay shale occurs at a depth of 26 to 40 inches but is within a depth of 20 inches on many of the narrow ridges, crests, and knolls.	0–9	Clay loam or silty clay loam.	CL	A–6 or A–7
			9–30	Clay loam or silty clay loam.	CL	A–6 or A–7
			30–60	Clay loam soft shale.	CL	A–6 or A–7–6.
Rw	Riverwash.	Well-graded gravel and sand or well-graded sand in overflow channels of rivers; channels are likely to be flooded each year.	0–60	Well-graded sand with or without gravel or well-graded sand and gravel.	SW or GW	A–1–a
Sa	Sage clay (less than 1 percent slopes).	On level, waterlogged low terraces and bottom lands below irrigation canals; ground water is within 3 feet of the surface during the irrigation season, but it drops to below 5 feet in winter. About 20 to 26 inches of strongly saline clay that has many spots of salts and gypsum and is underlain by 20 to 30 inches of massive clay; below a depth of 40 to 50 inches are stratified loam, clay loam, and fine sandy loam.	0–26	Clay or silty clay	CH or CL	A–7
			26–50	Clay	CH or CL	A–7
			50–60	Stratified loam, very fine sandy loam, and silt loam.	ML	A–4

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	94–98	0. 05– 0. 2	0. 20	8. 4	None	High	Low	None	High.
100	100	94–98	0. 05– 0. 2	0. 20	8. 4	None	High	Low	None	High.
80–90	60–80	30–50	0. 2– 0. 8	0. 19	8. 7	Slight to moderate.	High	Moderate	Low	High.
60–80	60–80	40–60	<0. 2	0. 20	8. 6–9. 0	Moderate	High	Moderate	Moderate	High.
100	100	94–98	0. 05– 0. 2	0. 20	8. 4	Moderate	High	Low	None	High.
100	100	94–98	0. 05– 0. 2	0. 20	8. 4	None	High	Low	None	High.
80–90	60–80	30–50	0. 20– 0. 8	0. 19	8. 7	Slight to moderate.	High	Moderate	Low	High.
60–80	60–80	40–60	<0. 2	0. 20	8. 6–9. 0	Moderate	High	Moderate	Moderate	High.
100	100	94–98	<0. 2	0. 20	8. 7	Slight	High	Low	High	High.
100	100	94–98	<0. 2	0. 20	8. 8–9. 0	Slight	High	Moderate	Moderate	High.
100	60–80	40–60	<0. 2	0. 19	8. 5–8. 7	Moderate	High	Moderate	Moderate	High.
60–80	60–80	40–60	<0. 2	0. 20	8. 9–9. 2	Moderate	High to very high.	Moderate to high.	Moderate to high.	High.
100	100	90–96	0. 2– 0. 8	0. 17	7. 4	None	Moderate	Low	None	Moderate.
100	100	90–96	0. 2– 0. 8	0. 17	8. 4	None	Moderate	Low	None	Moderate.
80–90	80–90	60–80	<0. 2	0. 17	8. 8	Slight	High	Moderate	Slight	Moderate.
60–80	40–60	<5 >	10. 0	0. 02	----------	None	Very low	Low	None	Low.
100	100	85–95	0. 2– 0. 8	0. 19	8. 8–9. 2	Very severe.	Very high	High	High	High.
100	100	85–95	<0. 2	0. 19	8. 7–9. 0	Severe	Very high	High	High	High.
100	100	75–90	<0. 2	0. 17	8. 8–9. 2	Moderate	Very high	Moderate	High	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Sc	Sage silty clay (less than 3 percent slopes).	On well-drained fans and terraces; ground water is below a depth of 10 feet, except below irrigation canals where it is within 5 feet at times during the irrigation season. About 1 to 2 inches of light-gray loam underlain by 20 to 30 inches of strongly alkaline silty clay that has many spots and streaks of salts below a depth of 4 to 8 inches. Below that depth, the material is strongly alkaline, stratified loam, silt loam, and clay loam.	0–1	Loam	ML	A–4
			1–6	Silty clay	CL	A–7
			6–14	Silty clay	CL	A–7
			14–32	Silty clay loam	CL or CH	A–7
			32–60	Stratified loam, silt loam, and clay loam.	ML	A–4
Sh	Shale outcrop.	Rough, broken and very steep areas that are barren in 90 percent of the area.	0–60	Platy clay, silty clay loam, or silt loam shale.	CH, CL, or ML.	A–6 or A–7
Sk	Shonkin loam (less than 1 percent slopes).	In flat, undrained basins and depressions of the high terraces or uplands; subject to periodic ponding from local runoff for short periods early in spring. About 6 to 9 inches of light-gray loam or silt loam underlain by 3 to 5 inches of blocky silty clay loam or clay loam that is underlain, in turn, by 14 to 18 inches of blocky clay or silty clay. From a depth of 28 to 30 inches, and extending to 50 inches or more, the material is clay loam or light clay that overlies variable material on the gravel terraces; below a depth of 50 to 60 inches, the material is well-graded sand and gravel, or in some places on the uplands is clayey sediments or shale.	0–7	Loam or silt loam	ML	A–4
			7–12	Silty clay loam	CL or CH	A–7
			12–28	Clay or silty clay	CL	A–7
			28–50	Clay loam or light clay.	CL	A–6 or A–7
			50–60	Clay loam or stratified material.	CL or ML	A–4 or A–6
Tf	Terry-Tullock fine sandy loams (4 to 8 percent slopes).	On rolling uplands underlain by soft sandstone or sandy shale. Terry soil has 5 inches of fine sandy loam underlain by 14 to 16 inches of light sandy clay loam that is calcareous in the lower part. From 18 to 22 inches down to the sandstone, at a depth of 26 to 32 inches, the material is calcareous fine sandy loam. Terry fine sandy loam on the mid and lower slopes makes up 60 to 70 percent of this complex; Tullock fine sandy loam on the convex crests and ridges makes up about 20 to 30 percent; and other soils make up 10 to 15 percent. For properties of the Tullock soil, see Tullock fine sandy loam, 4 to 20 percent slopes (Tv); properties given here are for the Terry soil.	0–5	Fine sandy loam	SM	A–4
			5–20	Light sandy clay loam.	SC or ML	A–6
			20–28	Fine sandy loam	SM	A–4
			28–60	Weakly consolidated sandstone.	SM	A–2
Tm	Terry-Treasure fine sandy loams (2 to 8 percent slopes).	Undulating to rolling uplands. Terry fine sandy loam on the upland slopes makes up about 60 to 70 percent of this complex; Treasure fine sandy loam on fans and in swales makes up about 25 to 35 percent; and other soils make up about 5 percent. For properties of the Treasure soil, see Treasure fine sandy loam, 2 to 4 percent slopes (Ts); properties given here are for the Terry soil.	0–5	Fine sandy loam	SM	A–4
			5–20	Light sandy clay loam.	SC or ML	A–6
			20–28	Fine sandy loam	SM	A–4
			28–60	Weakly consolidated sandstone.	SM	A–2

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	75–85	0. 2– 0. 8	0. 17	8. 8	None	Moderate	Low	High	Low.
100	100	90–95	<0. 2	0. 19	9. 0–9. 2	Moderate	High	Moderate	High	High.
100	100	90–95	0. 2– 0. 8	0. 19	8. 8–9. 2	Severe	Very high	High	High	High.
100	100	90–95	<0. 2	0. 17	8. 7–9. 0	Very severe	Very high	High	High	High.
100	100	75–90	<0. 2	0. 17	8. 6–8. 9	Severe	Very high	High	High	Low.
60–90	60–90	40–80	<0. 2	0. 25–0. 17	8. 6–9. 4	Slight to severe.	Moderate to very high.	Moderate to high.	Moderate to high.	Low to high.
100	100	80–90	0. 2– 0. 8	0. 17	7. 9	None	Low	Low	Moderate	Low.
100	100	90–95	0. 8– 2. 0	0. 17	7. 5	None	Low	Low	None	High.
100	100	90–95	0. 2– 0. 8	0. 19	7. 9	None	Moderate	Low	None	Moderate.
100	100	90–95	0. 2– 0. 8	0. 19	8. 4	None	Moderate	Low	None	Moderate.
100	100	75–90	0. 2– 0. 8	0. 17	8. 4	None	Moderate	Low	None	Low.
100	100	40–45	2. 0– 5. 0	0. 15	7. 0	None	Low	Low	None	Low.
100	100	45–55	0. 8– 2. 0	0. 17	7. 8	None	Low	Low	None	Moderate.
100	100	40–45	0. 8– 2. 0	0. 15	8. 4	None	Low	Low	None	Low.
100	100	25–35	<0. 2	0. 10	8. 4	None	Moderate	Low	None	Low.
100	100	40–45	2. 0– 5. 0	0. 15	7. 0	None	Low	Low	None	Low.
100	100	45–55	0. 8– 2. 0	0. 17	7. 8	None	Low	Low	None	Moderate.
100	100	40–45	0. 8– 2. 0	0. 15	8. 4	None	Low	Low	None	Low.
100	100	25–35	<0. 2	0. 10	8. 4	None	Moderate	Low	None	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
			Inches			
Tn	Terry-Winnett complex (4 to 8 percent slopes).	On rolling uplands. Terry fine sandy loam makes up about 60 to 70 percent of this complex, Winnett fine sandy loam about 20 to 30 percent, and other soils about 10 percent. The Winnett soil is in the slight depressions and in blowout areas. The Winnett soil has a sandy clay loam subsoil that has slightly less clay than the subsoil of the Terry soil. For properties of the Winnett soil, see Winnett complex (Wt); properties given here are for the Terry soil.	0–6	Fine sandy loam	SM	A–4
			6–18	Heavy sandy clay loam or sandy clay.	CL	A–4 or A–6
			18–34	Light sandy clay loam or heavy fine sandy loam.	SC or ML	A–6
			34–60	Soft sandstone or sandy shale.	SM	A–2
Tp	Travessilla-Tullock fine sandy loams (15 to 40 percent slopes).	On hilly uplands. The Travessilla soil is fine sandy loam or loam underlain by hard sandstone at a depth of 8 to 14 inches. It is on the ridges and steeper slopes and makes up about 40 to 50 percent of this complex. Tullock fine sandy loam is on side slopes and makes up about 30 to 40 percent of this complex, and other soils make up about 10 to 15 percent. For properties of the Tullock soil, see Tullock fine sandy loam, 4 to 20 percent slopes (Tv): properties given here are for the Travessilla soil.	0–12	Loam or fine sandy loam.	ML or SM	A–4
			12+	Hard sandstone	----------	----------
Tr	Travessilla-Rock outcrop complex (30 to 70 percent slopes).	In very steep and rough broken areas. The soils are Travessilla, Bainville, and Tullock and make up about 65 to 70 percent of this complex. Sandstone crops out as ledges and bluffs. These and shale outcrops make up about 25 to 35 percent of this complex. Where soil occurs, it is 5 to 12 inches thick over the sandstone or shale. Properties given here are for the Travessilla soil.	0–12	Loam or fine sandy loam.	ML or SM	A–4
			12+	Hard sandstone	----------	----------
Ts	Treasure fine sandy loam, 2 to 4 percent slopes.	On well-drained fans; ground water is not a problem. About 5 to 7 inches of fine sandy loam underlain by 10 to 15 inches of prismatic heavy sandy clay loam or light sandy clay that is underlain, in turn, by 4 to 8 inches of calcareous light sandy clay loam to fine sandy loam having white spots of lime in the upper part; in places silt loam or loam occurs below 50 inches. On some of the fans, particularly where they merge with the uplands, shale occurs at a depth of 45 to 60 inches or more.	0–5	Fine sandy loam or sandy loam.	SM	A–4
Tu	Treasure fine sandy loam, 4 to 8 percent slopes.		5–18	Heavy sandy clay loam or light sandy clay.	CL or ML	A–6 or A–7
			18–24	Light sandy clay	SC or CL	A–6 or A–7
			24–60	Fine sandy loam	SM	A–4
Tv	Tullock fine sandy loam, 4 to 20 percent slopes.	On rolling uplands underlain by soft sandstone. About 6 to 10 inches of fine sandy loam underlain by 16 to 30 inches of strongly calcareous loamy fine sand that is underlain, in turn, by weakly consolidated, strongly calcareous sandstone at a depth of 22 to 40 inches and within a depth of 20 inches on some of the ridges and crests. Lime is the primary binding agent in the sandstone.	0–8	Fine sandy loam	SM	A–2
			8–28	Loamy fine sand	SM	A–1 or A–2
			28–60	Soft sandstone of loamy fine sand or fine sand.	SM	A–1 or A–2

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
100	100	40–50	0. 8– 2. 0	0. 15	6. 6	None	Low	Low	Low	Low.
100	100	65–75	<0. 2	0. 18	8. 8	None	Moderate	Moderate	Moderate	Moderate to high.
100	100	45–55	<0. 2	0. 17	9. 0	Moderate	High	Moderate	Moderate	Moderate.
100	100	25–35	<0. 2	0. 10	9. 0	Slight	Moderate	Moderate	Moderate	Low.
100	100	40–80	0. 8– 2. 0	0. 15	8. 2	None	Low	Low	None	Low.
100	100	40–80	0. 8– 2. 0	0. 15–0. 17	8. 2	None	Low	Low	None	Low.
100	100	40–45	2. 0– 5. 0	0. 15	6. 5	None	Low	Low	None	Low.
100	100	55–65	0. 8– 2. 0	0. 17	7. 4	None	Low	Low	None	Moderate.
100	100	45–55	0. 8– 2. 0	0. 17	8. 4	None	Low	Low	None	Moderate.
100	100	40–45	0. 8– 2. 0	0. 15	8. 4	None	Low	Low	None	Low.
100	100	20–35	>5. 0	0. 15	8. 4	None	Very low	Low	None	Low.
100	100	15–25	>5. 0	0. 07	8. 4	None	Very low	Low	None	Low.
100	100	15–25	<0. 2	0. 05	8. 4	None	Very low	Low	None	Low.

TABLE 4.—*Brief description of soils and*

Map symbol	Soil name	Description of soil and site	Depth from surface	Classification		
				USDA texture	Unified	AASHO
Wb	Wanetta loam, 1 to percent slopes.	On well-drained high terraces; ground water is not a problem. About 5 to 7 inches of loam underlain by 10 to 12 inches of prismatic light clay loam and heavy loam; below a depth of 15 to 18 inches the material is calcareous loam that is underlain by 4 to 8 inches of very gravelly loamy sand or sandy loam; sand and gravel are at a depth of 24 to 42 inches.	0–6	Loam	ML	A–4
Wc	Wanetta loam, 4 to 8 percent slopes.		6–18	Light clay loam and heavy loam.	ML or CL	A–4 or A–6
Wd	Wanetta loam, deep, 0 to 2 percent slopes.		18–32	Loam	ML	A–4
Wm	Wanetta loam, deep, 2 to 4 percent slopes.		32–40	Very gravelly loamy sand or sandy loam.	GM or SM.[1]	A–1 or A–2
Wn	Wanetta loam, deep, 4 to 8 percent slopes.		40–60	Well-graded sand and gravel.	SW	A–1
Wr	Wibaux-Rock outcrop complex (30 to 70 percent slopes).	Steep and rough, broken areas on scoria beds. About 5 to 15 inches of stony or slaty loam underlain by the shattered scoria, burned shale, or porcelanite bedrock.	0–8	Slaty or stony loam.	GM	A–2
			8+	Porcelanite beds		
Wt	Winnett complex (2 to 8 percent slopes).	On undulating to rolling shale uplands. About 2 to 7 inches of loam underlain by 8 to 12 inches of dense, columnar, strongly alkaline clay; from 12 to 16 inches down to the silty clay loam shale at 26 to 34 inches, the material is silty clay loam with nests of gypsum and other salts; gypsum has also accumulated in the upper part of the shale.	0–5	Loam or silt loam	ML	A–4
			5–14	Silty clay or clay	CL or CH	A–7
			14–30	Clay loam or silty clay loam.	CL	A–6 or A–7
			30–60	Silty clay loam soft shale.	CL	A–6 or A–7
Wx	Winnett-Fattig complex (2 to 6 percent slopes).	On undulating shale uplands. Winnett soil makes up about 55 to 70 percent of this complex, Fattig loam about 25 to 35 percent, and other soils about 5 to 10 percent. Many barren and nearly barren small pits or scab spots are scattered throughout. The dark-colored carbonaceous shale has affected the color and the content of organic carbon. For properties of the Fattig soil, see Fattig loam (Fa); properties given here are for the Winnett soil.	0–5	Loam or silt loam	ML	A–4
			5–14	Silty clay or clay	CL or CH	A–6 or A–7
			14–30	Clay loam or silty clay loam.	CL	A–6 or A–7
			30–60	Silty clay loam soft shale.	CL	A–6 or A–7

[1] Based on assumption that percentage given in the No. 4 sieve column belongs in the No. 10 sieve column.

Engineering interpretation of the soils

Evaluation of the soils for engineering use is given in table 5. The soils are rated according to their suitability as a source of construction material. Special features are pointed out that affect specified kinds of engineering structures and practices. The interpretations in table 5 are based on the estimates of soil properties given in table 4, on actual test data, and on the knowledge of specialists.

Engineering test data

In table 6 are the results from tests of soil samples from soils in Treasure and Yellowstone Counties, Mont. The tests were made according to standard procedures so that the soils could be evaluated for engineering purposes.

The result of a mechanical analysis, obtained by the combined sieve and hydrometer method, can be used to determine the relative proportions of different size particles that make up the soil sample. The clay content obtained by the hydrometer method, which is generally used by engineers, should not be used to determine soil textural classes.

In a moisture-density test, or compaction test, a sample of soil material is compacted several times with the same compactive effort, each time at a higher moisture content. The dry density (unit weight) of the soil material increases until the "optimum moisture content" is reached. After that, the dry density decreases with an increase in moisture content. The highest dry density obtained in the compaction tests is termed "maximum dry density." Moisture density data are important in earthwork because, as a rule, optimum stability is obtained if the soil is compacted to about maximum dry density when it is at approximately the optimum moisture content.

The values of the liquid limit and the plastic limit indicate the effect of water on the consistence of soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from a semisolid to a plastic state. As the moisture content is further increased, the material changes from a plastic to a liquid

their estimated physical properties—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction	Salinity	Corrosivity		Dispersion	Shrink-swell potential
No. 4	No. 10	No. 200					Untreated steel pipe	Concrete conduit		
			Inches per hour	*Inches per inch of soil*	*pH*					
95–100	95–100	75–85	0. 8– 2. 0	0. 17	7. 8	None	Low	Low	None	Low.
95–100	95–100	75–85	0. 8– 2. 0	0. 17	8. 0	None	Low	Low	None	Moderate.
95–100	95–100	75–85	0. 2– 0. 8	0. 17	8. 4	None	Low	Low	None	Low.
30–40	20–30	5–10	5. 0–10. 0	0. 06	8. 4	None	Very low	Low	None	Low.
60–70	30–50	<5	>10. 0	0. 02	8. 4	None	Very low	Low	None	Low.
25–35	20–30	15–25	2. 0–5. 0	0. 07	8. 2	None	Very low	Low	None	Low.
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100	100	80–90	0. 2– 0. 8	0. 17	6. 6	None	Low	Low	Low	Low.
100	100	90–95	<0. 2	0. 20	8. 8	None	Moderate	Low	High	High.
100	100	90–95	<0. 2	0. 19	9. 0	Moderate	High	Moderate	High	Moderate.
100	100	90–95	<0. 2	0. 18	9. 0	Slight to moderate.	High	Moderate	Moderate	Moderate.
100	100	80–90	0. 2–0. 8	0. 17	6. 6	None	Low	Low	Low	Low.
100	100	90–95	<0. 2	0. 20	8. 8	None	Moderate	Low	High	High.
100	100	90–95	<0. 2	0. 19	9. 0	Moderate	High	Moderate	High	Moderate.
100	100	90–95	<0. 2	0. 18	9. 0	Slight to moderate.	High	Moderate	Moderate	Moderate.

state. The plastic limit is the moisture content at which the material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The numerical difference between the liquid limit and the plastic limit is called the plasticity index. It indicates the range of moisture content within which soil material is in a plastic condition.

Formation and Classification of Soils

This section consists of four main parts. The first part discusses the factors of soil formation as they relate to the formation of soils in Treasure County. In the second part the soils of the county are placed in their respective soil orders and great soil groups, and these orders and groups are discussed. The third part describes each soil series, including a profile representative of the series. In the fourth part, a table lists the results of the mechanical and chemical analysis of 10 selected soil profiles.

796-973—67——8

Factors of Soil Formation

Five factors affect the development of genetic horizons in a soil profile. These factors are (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil-forming processes have taken place; (3) the plants and animals that live on and in the soil; (4) the relief, or lay of the land; and (5) the time the forces of soil development have acted on the parent material. Unless much time passes, none of the other factors have their full effect.

The factors of soil formation are so closely interrelated that few generalizations can be made about the effect of any one factor unless conditions are specified for the other four. Many of the physical and chemical processes responsible for the formation of a soil from parent material are unknown.

Parent material

The parent material of soils consists of the unconsolidated, only slightly altered regolith, or mantlerock, from

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Arvada (Ar, Ax).	Not suitable.	Poor	Poor	Poor; high dispersion; slow permeability in compacted fill; high erodibility.	High dispersion; highly erodible slopes; low stability; subject to piping; very slow permeability; high corrosivity.	No unfavorable features.	Low dry density; very unstable slopes; high erodibility; subject to piping; high volume change.
Arvada (Av)	Good	Not a source.	Not a source.	Fair to poor; medium plasticity; moderate to high dry density; low shear strength; moderate volume change.	Medium compressibility and expansion; high capillarity; moderate to high frost action; low to moderate corrosivity.	No unfavorable features.	Features fair; moderately high dry density; moderately high volume change; permeability slow in compacted embankment; fair to good compaction characteristics; low to moderate shear strength.
Bainville (Bb, Bm, Ct, Cu, Ml).	Fair	Not a source.	Not a source.	Poor; high percentage of silt, very fine sand, and lime; low dry density; very low shear strength.	Medium to high compressibility; highly erodible slopes; moderate frost action.	Variable; local site investigation needed to determine character of underlying shale.	Low dry density; moderate shear strength; high erodibility.
Bainville (Bc, Bf, Bn, Mm).	Fair	Not a source.	Not a source.	Poor; high percentage of silt, very fine sand, and lime; low dry density; very low shear strength.	Steep and hilly topography; shallow to shale.	Topography not suitable for sewage lagoons.	Low dry density; moderate shear strength; high erodibility.

engineering properties of soils

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Very slow permeability; high corrosivity for tile; unstable and highly erodible slopes in open ditches; high dispersion.	Very slow permeability; high dispersion; high alkalinity and salinity; uneven surface (microrelief).	Dispersed soils; highly alkaline subsoil; high salinity at shallow depth.	Unstable slopes; high erodibility.	High erodibility; strong alkalinity and salinity; vegetation very difficult to establish.	Very slow permeability; high dispersion; high or very high corrosivity; high shrink-swell potential.	High dispersion; high shrink-swell potential; low bearing capacity.	Unsuitable for most engineering uses.
Not applicable.	Not applicable.	Not applicable.	Moderate shear strength; moderate erodibility.	No unfavorable features.	Moderately slow permeability.	Low load-bearing capacity when wet; low shear strength; low compressibility.	Suitable for some engineering uses where material with low shear strength can be used; good stability when material is compacted and dry.
Not applicable.	Not applicable.	Not applicable.	Soft silty shale at 18 to 30 inches; high erodibility.	Low water-holding capacity; shallow to shale; high erodibility.	Moderately slow permeability; shallow to shale.	Moderately slow permeability; moderate frost action.	Suitable for engineering uses when material is dry or properly compacted; may lose stability if material is wet or subject to frost action; shale makes obtaining stability in deep cuts difficult.
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Moderately slow permeability; shallow to shale.	Moderately slow permeability; moderate frost action.	Suitable for engineering uses when material is dry or properly compacted; may lose stability if material is wet or subject to frost action; shale makes obtaining stability in deep cuts difficult.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons.	
						Reservoir area	Embankment
Bainville (Bo, Mt).	Poor	Not a source.	Not a source.	Poor; high percentage of silt, very fine sand, and lime; low dry density; very low shear strength.	Very steep and rough broken topography; very shallow to shale.	Topography not suitable for sewage lagoons.	Low dry density; moderate shear strength; high erodibility.
Banks (Bs, Gv).	Good to poor.	Good; well-graded sand below 8 to 14 inches.	Good; well-graded gravel below 8 to 14 inches.	Good; high dry density; good permeability.	No unfavorable features other than periodic overflow in places.	Substratum too porous; unsuitable for reservoirs.	Permeability rapid in compacted embankment.
Beaverton (Bt).	Fair	Good; well-graded sand and few to many pebbles; screening to remove pebbles needed.	Good; well-graded sand and gravel below 16 to 20 inches.	Good; high dry density; high shear strength; high compactibility.	No unfavorable features; high load-bearing capacity; no compressibility; good drainage.	Substratum too porous; unsuitable for farm ponds.	Permeability moderately high in compacted embankment.
Beckton (Nx).	Good	Not a source.	Not a source.	Fair to poor; medium plasticity; moderate dry density; low shear strength; fair compaction characteristics; slow permeability if fill is compacted; moderate volume change; fair workability.	Medium to high compressibility and expansion; high capillarity; moderate to high frost action; moderate corrosivity.	No unfavorable features.	Features fair; moderate dry density; fair compaction characteristics; permeability slow in compacted embankment; low to moderate shear strength; moderate volume change; low resistance to piping; fair workability.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Features not suitable; slopes too steep; slippage hazard.	Suitable for engineering uses when material is dry or properly compacted; may lose stability if material is wet or subject to frost action; shale makes obtaining stability in deep cuts difficult.
No unfavorable features.	Very low water-holding capacity.	Soils very shallow to sand and gravel.	Shallow to very porous substratum.	Very shallow to porous gravel; very low water-holding capacity.	No unfavorable features other than high water table at times.	No unfavorable features other than high ground water level.	Suitable for engineering uses needing material with rapid permeability; good stable material.
Not applicable.	Not applicable.	Not applicable.	Shallow to very porous substratum; very low water-holding capacity.	Very low water-holding capacity; shallow to loose gravel.	Features excellent; very rapid permeability in substratum; no ground water problem.	Features excellent; high load-bearing capacity; high shear strength; good drainage; very rapid permeability in substratum; little or no consolidation (settling) problem.	Suitable for engineering uses needing material with high shear strength and rapid permeability; very stable material.
Slow to moderately slow permeability; unstable slopes in open ditches.	No unfavorable features.	No unfavorable features.	Not applicable.	Not applicable.	Slow to moderately slow permeability; moderate shrink-swell potential.	Low load-bearing capacity; low shear strength; slow to moderately slow permeability; moderate to high frost action; moderate shrink-swell potential.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where nearly impervious.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Bew (Bu)	Fair to good.	Poor in most places.	Fair; well-graded sand and gravel below 6 feet.	Poor; low dry density; high volume change; poor workability.	High compressibility and expansion; high elasticity; high volume change; moderate frost action; slow permeability; moderate corrosivity for untreated steel pipe.	No unfavorable features other than gravel and sand at depth of less than 6 feet.	Low dry density; low sheer strength; high volume change; poor workability.
Bowdoin (Bw).	Not suitable; high clay content.	Not a source.	Not a source.	Poor; low dry density; high volume change; very slow permeability; high plasticity; poor workability.	High compressibility and expansion; high plasticity; high shrink-swell potential; moderate frost action; very slow permeability; high corrosivity.	No unfavorable features.	Low dry density; low shear strength; high volume change; poor workability.
Briggsdale (Bx, By).	Good	Not a source.	Not a source.	Fair to poor; medium plasticity; moderately high dry density; low shear strength; moderate volume change.	Moderate compressibility and expansion; high capillarity; moderate frost action; low to moderate corrosivity.	For sewage lagoons, moderate limitations caused by slope.	Features fair; moderately high dry density; moderately high volume change; permeability slow in compacted embankment; low to moderate shear strength.
Cherry (Ca, Cb, Cc, Ch, Ck).	Good	Not a source.	Not a source.	Fair to poor; medium plasticity; moderately high dry density; low shear strength.	Moderate compressibility and expansion; high capillarity; moderate to high frost action; some consolidation (settling) problem when wet; low to moderate corrosivity.	No unfavorable features.	Moderately high dry density; moderately high volume change; permeability slow in compacted embankment; low to moderate shear strength.
Cherry (Cd, Cf, Cg).	Good	Not a source.	Not a source.	Fair to poor; medium plasticity; moderately high dry density; low shear strength.	Moderate compressibility and expansion; high capillarity; moderate to high frost action; some consolidation (settling) problem when wet; low to moderate corrosivity.	Subsoil too porous below 26 inches.	Moderately high dry density; moderately high volume change; permeability slow in compacted embankment; low to moderate shear strength.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable	Not applicable.	Not applicable.	Low shear strength; high shrink-swell potential; poor workability.	No unfavorable features.	Slow permeability; high volume change.	Low load-bearing capacity; high shrink-swell potential; low shear strength; slow permeability; high corrosivity for untreated steel pipe.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where nearly impervious.
Very slow permeability.	Very slow permeability; poor workability.	Poor workability.	Low shear strength; high volume change; poor workability.	No unfavorable features.	Very slow permeability; high shrink-swell potential.	Low load-bearing capacity; high shrink-swell potential; low shear strength; very slow permeability.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.
Not applicable	Not applicable.	Not applicable.	Moderately high shear strength; moderate erodibility.	No unfavorable features.	Moderately slow permeability; some shrink-swell potential; high proportion of silt and very fine sand; moderate limitations of slope in sloping areas.	Low load-bearing capacity when wet; low shear strength; moderately slow permeability; some consolidation (settling) problem.	Suitable for some engineering uses where material with low shear strength can be used; material stable if compacted and dry.
Moderately slow to slow permeability; unstable slopes in open ditches; high content of silt and very fine sand below 40 to 50 inches reduces effectiveness of tile.	No unfavorable features other than moderate erosion problem on steep slopes.	No unfavorable features.	Moderately high shear strength; moderate volume change.	No unfavorable features.	Moderately slow permeability; moderate limitations of slope in sloping areas.	Low load-bearing capacity; low shear strength.	
Unstable side slopes in open ditches; high content of silt and fine sand below 26 inches reduces effectiveness of tile.	Slight consolidation (settling) problem when wet; moderate erosion problem on steep slopes.	No unfavorable features.	Moderate to low shear strength.	High erodibility below 26 inches.	Permeability moderately slow in upper part but increases in lower part; moderate limitations of slope in sloping areas.	Low load-bearing capacity when wet; some consolidation (settling) problem when wet; low shear strength.	

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Cherry (Cm)	Good	Not a source.	Not a source.	Fair to poor; low dry density; low shear strength.	Severe consolidation (settling) problem and low load-bearing capacity when wet; moderate to high frost action; low corrosivity; moderate to high capillarity.	Permeability too rapid below 10 to 14 inches; consolidation (settling) problem.	Low dry density; low shear strength; high erodibility.
Cushman (Cp, Cr, Cs, Ct, Cu, Cv, Cw).	Good	Not a source.	Not a source.	Fair to poor; less than 30 inches to shale; low dry density; low shear strength; high erodibility.	Medium to high compressibility; highly erodible slopes; moderate frost action; moderate corrosivity in lower part.	Variable; local investigation needed to determine character of underlying shale; for sewage lagoons, moderate or severe limitations caused by slope.	Low dry density; moderate shear strength; high erodibility.
Cushman (Cx).	Good	Not a source.	Not a source.	Good; sandstone layer increases dry density and shear strength.	Features fair to good, depending on continuity of sandstone layer.	Variable; local investigation needed to determine character of underlying shale; for sewage lagoons, severe limitations caused by slope.	Low dry density; moderate shear strength; high erodibility.
Dwyer (Dw)	Good	Good; poorly graded sand.	Not a source.	Good; may separate when wet; subject to wind erosion; unstable banks.	No unfavorable features.	Severe limitations; rapid permeability; high percolation rate.	Moderate to severe limitations; permeability rapid in compacted embankments; high shear strength; high erodibility.
Edgar (Ed, Eg).	Good	Fair; well-graded sand or sand and some gravel below 6 feet; screening to remove gravel needed.	Good; well-graded sand and gravel below 6 feet in places.	Fair; moderate dry density; moderate to high frost action; low shear strength; low volume change; good workability.	Medium compressibility and expansion; medium load-bearing capacity; some consolidation (settling) problem when wet; good drainage; no ground water.	Moderate permeability; substratum below 5 feet; highly variable; for sewage lagoons, slight to severe limitations caused by slope.	Moderately high dry density; low shrink-swell potential; low to moderate shear strength; good workability.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Unstable side slopes in open ditches; high content of silt and very fine sand reduces effectiveness of tile; severe consolidation; (settling) problem.	Severe consolidation (settling) problem when wet.	No unfavorable features.	Moderate to low shear strength; low density when compacted; high erodibility.	High erodibility below 26 inches.	Moderate to moderately slow permeability, some consolidation (settling) problem when wet.	Severe consolidation (settling) problem when wet; low load-bearing capacity when wet; low shear strength.	
Not applicable.	Not applicable.	Not applicable.	Soft silty shale at 24 to 32 inches; high erodibility.	Moderate water-holding capacity; high erodibility.	Moderately slow permeability; shallow depth to shale; moderate to severe limitations of slope.	Moderately slow to slow permeability; moderate frost action.	Satisfactory when dry or properly compacted; material may lose stability when wet or by frost action; presence of shale is a problem in deep cuts.
Not applicable.	Not applicable.	Not applicable.	Soft shale or hard sandstone at less than 24 inches; high erodibility.	Moderate water-holding capacity; high erodibility.	Shale and sandstone at less than 24 inches.	Moderately slow to slow permeability; moderate frost action.	Satisfactory when dry or properly compacted; material may lose stability when wet or by frost action; presence of shale is a problem in deep cuts.
Not applicable.	Not applicable.	Not applicable.	Unstable slopes; high erodibility.	Very low water-holding capacity; rapid permeability; high erodibility; low fertility.	Rapid permeability; some initial consolidation (settling) problem when wet.	Features excellent; high load-bearing capacity; high shear strength; rapid permeability; little or no consolidation (settling) problem when wet.	Ideal support when confined; good for subgrades or as a blanket.
Not applicable.	Not applicable.	Not applicable.	No unfavorable features.	No unfavorable features.	Moderately slow permeability; slight to severe limitations of slope.	Low shear strength; medium to high compressibility.	Suitable for many engineering uses requiring medium plasticity and moderate to low shear strength.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Fattig (Fa, Fc, Wx).	Good	Not a source.	Not a source.	Poor; high organic-matter content; low dry density; moderately high volume change.	Medium to high compressibility; moderate to high frost action; moderate corrosivity for untreated steel pipe; low load-bearing capacity.	Variable; local investigation needed to determine character of bedrock; for sewage lagoons, moderate or severe limitations caused by slope.	High organic-matter content; low dry density; low shear strength.
Flasher (Ff, Fh, Fm).	Fair to poor; subject to wind erosion.	Good; poorly graded sand and some fines; washing to remove fines needed.	Not a source.	Good; high density when fill is compacted; low volume change; high erodibility.	No compressibility; good drainage; rapid permeability; very low frost action; unstable slopes.	Features unfavorable; soils too porous; severe limitations caused by slope.	Permeability high in compacted embankment; high erodibility; high piping potential.
Fort Collins (Fn, Fo, Fr).	Good	Not a source.	Not a source.	Fair; moderate dry density; moderate to high frost action; low shear strength; moderate to low volume change; highly erodible and unstable slopes.	Medium compressibility and expansion; low load-bearing capacity; some consolidation (settling) problem; ground water saturated during irrigation season.	Moderate limitations; moderate permeability; some consolidation (settling) problem when wet; moderate limitations caused by slope.	Moderately high dry density; moderate to low volume change; medium to low shear strength; high erodibility; good workability.
Fort Collins (Fs, Ft).	Good	Poor; too many fines.	Not a source.	Fair; moderate dry density; moderate to high frost action; low shear strength; moderate to low volume change; highly erodible and unstable slopes.	Medium to high compressibility; moderate to high consolidation (settling) problem.	Limitations moderate to severe; moderately rapid permeability below 20 inches.	Moderately high dry density; moderate to low volume change; moderate to low shear strength; high erodibility; good workability.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable.	Not applicable.	Not applicable.	Soft shale and sandstone at 12 to 40 inches; unstable slopes; high erodibility.	Shale or bedrock at 12 to 40 inches; high erodibility.	Moderately slow to slow permeability; shale at variable depth; moderate to severe limitations of slope.	Moderately slow to slow permeability; moderate frost action; moderately high shrink-swell potential.	Suitable for some engineering uses when dry or properly compacted; material may lose stability when wet or by frost action; presence of shale is a problem in obtaining stability in deep cuts.
Not applicable.	Not applicable.	Not applicable.	Shale or soft sandstone within 40 inches; high erodibility.	Variable depth to bedrock; very low water-holding capacity; high erodibility.	Severe limitations of slope in steep areas.	Features excellent; high load-bearing capacity; high shear strength; rapid permeability; little or no consolidation (settling) problem.	Suitable for many engineering uses requiring high stability and high shear strength.
Moderate permeability; unstable side slopes in open ditches; high content of silt and very fine sand reduces effectiveness of tile.	No unfavorable features other than some consolidation (settling) problem when wet; high erodibility on steep slopes.	No unfavorable features.	Moderately to highly erodible, unstable slopes.	High erodibility.	Some consolidation (settling) problem; moderate slope limitations in sloping areas.	Low shear strength; medium to high compressibility; some consolidation (settling) problem; fair to poor load-bearing capacity; low to moderate shrink-swell potential.	Suitable for many engineering uses requiring medium plasticity and moderate to low shear strength.
Unstable and highly erodible side slopes.	High erodibility on steep slopes.	Cuts deeper than 20 inches may expose sandy substratum.	Moderately to highly erodible, unstable slopes.	High erodibility.	High erodibility in sloping areas.	Low shear strength; medium to high compressibility; some consolidation (settling) problem; fair to poor load-bearing capacity; low to moderate shrink-swell potential.	Suitable for many engineering uses requiring medium plasticity and moderate to low shear strength.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Gilt Edge (Ga, Gb).	Fair to poor.	Good to poor; depth to well-graded sand or sand and gravel; variable.	Good to poor, depending on depth to well-graded sand and gravel.	Poor; low dry density; high volume change.	High compressibility and expansion; high elasticity; low load-bearing capacity; high shrink-swell potential; moderate frost action; very slow permeability; high corrosivity for untreated steel pipe, moderate corrosivity to concrete.	No unfavorable features.	Moderate limitations; low dry density; low shear strength; high volume change; poor workability.
Glendive (Gc, Gg, Gh, Go, Gs, Gv).	Fair to good.	Good; well-graded sand if fines are washed out.	Good; well-graded sand and gravel at 3 to 10 feet.	Fair; fair stability; moderate permeability when fill is compacted; moderately high density when fill is compacted; high susceptibility to piping; good workability.	Very low compressibility; moderate frost action; high erodibility when exposed on banks; in places water table within 5 feet of surface during irrigation season.	Moderately rapid permeability; porous substratum below 4 feet; water table within 5 feet during irrigation season.	Fair stability; permeability moderate in compacted embankment; high susceptibility to erosion and piping.
Glendive, fans (Gm).	Good	Not a source.	Not a source.	Fair; fair stability; moderate permeability when fill is compacted; moderately high density when fill is compacted; high susceptibility to piping; good workability.	No unfavorable features.	Moderately rapid permeability; moderate limitations caused by slope.	Fair stability; permeability moderate in compacted embankment; high susceptibility to erosion and piping.
Glendive, shallow (Gn).	Good	Fair; well-graded sand; screening to remove gravel needed.	Good; well-graded sand and gravel below 14 to 22 inches.	Fair; fair stability; moderate permeability when fill is compacted; moderately high density when fill is compacted; high susceptibility to piping; good workability.	No unfavorable features other than water table within 3 feet in places during irrigation season.	Substratum too porous within 22 inches; high water table part of year.	Severe limitations; coarse material; rapid seepage rate; highly pervious; limited for fill material.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable.	Not applicable.	Not applicable.	Low shear strength; high volume change; poor workability.	No unfavorable features.	Severe limitations; very slow permeability.	Low load-bearing capacity; high shrink-swell potential; low shear strength; very slow permeability.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.
Unstable ditchbank material; high erodibility.	Low water-holding capacity; susceptibility to wind erosion; low fertility.	Deep cuts may expose infertile material.	Not applicable.	Not applicable.	No unfavorable features other than high water table at times.	Features excellent; good load-bearing capacity; high shear strength; rapid permeability; little or no consolidation (settling) problem; high water table at times.	Suitable for many engineering uses requiring high stability and high shear strength.
Not applicable.	Not applicable.	Not applicable.	Highly erodible, unstable slopes.	High erodibility; low water-holding capacity.	No unfavorable features other than high water table at times and moderate limitations of slope.	No unfavorable features.	Suitable for many engineering uses requiring high stability and high shear strength.
No unfavorable features.	Very rapid permeability; very low water-holding capacity.	Loose, coarse sand and gravel at 14 to 22 inches; avoid deep cuts.	Not applicable.	Not applicable.	No unfavorable features other than high water table at times.	No unfavorable features other than high water table at times.	Suitable for many engineering uses requiring high stability and high shear strength.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Havre (Ha, Hc, Hg, Hn, Ho).	Good	Fair to good; well-graded sand or sand and gravel within 10 feet; screening to remove gravel needed.	Fair to good; well-graded sand or sand and gravel generally within 10 feet but as shallow as 4 feet in places.	Fair; moderate dry density; moderate to high frost action; low shear strength; low volume change; good workability.	Medium compressibility and expansion; fair to poor load-bearing capacity; seasonally high water table within 3 feet; occasional overflow in places; moderate corrosivity for untreated steel pipe.	Moderate permeability; seasonally high water table within 5 feet or less; unstable for fill material.	Poor stability; poor compaction characteristics; permeability moderate in compacted embankment; moderate to low dry density; medium compressibility; high erodibility; subject to piping.
Havre, moderately deep (Hl).	Good	Fair; well-graded sand and gravel below 30 inches; screening to remove gravel needed.	Good; well-graded sand and gravel below 30 inches.	Fair; moderate dry density; moderate to high frost action; low shear strength; low volume change; good workability.	Medium compressibility and expansion; fair to poor load-bearing capacity; seasonally high water table within 3 feet; occasional overflow in places; moderate corrosivity for untreated steel pipe.	Features unfavorable; very porous substratum within 3 feet; seasonally high water table.	Poor stability; poor compaction characteristics; permeability moderate in compacted embankment; moderate to low dry density; medium compressibility; high erodibility; subject to piping.
Havre (mostly saline) (Hb, Hf, Hm, Hs, Ht, Hz).	Poor; moderate salinity.	Poor; well-graded sand or sand and gravel within 10 feet; screening to remove gravel needed.	Fair; well-graded sand and gravel within 4 feet in some places but within 15 feet in most places.	Fair; moderate dry density; moderate to high frost action; low shear strength; low volume change; good workability; moderate salinity; high erodibility.	Medium compressibility and expansion; fair to poor load-bearing capacity; seasonally high water table within 3 feet; occasional overflow in places; moderate to severe corrosivity.	Moderate permeability.	Poor stability; poor compaction characteristics; permeability moderate in compacted embankment; moderate to low dry density; medium compressibility; high erodibility; subject to piping.
Havre (steep) (Hp, Hr).	Good	Not a source.	Not a source.	Fair to poor; moderate dry density; moderate to high frost action; fair to poor compaction characteristics; poorly graded material.	Medium compressibility and expansion; fair to poor load-bearing capacity; high erodibility where deep cuts are needed; some consolidation (settling) problem; moderate to high frost action.	Slopes of more than 8 percent.	Poor stability; poor compaction characteristics; permeability moderate in compacted embankments; moderate to low dry density; high erodibility; subject to piping.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Moderate permeability; unstable ditchbank caused by high content of silt and very fine sand.	No unfavorable features.	No unfavorable features.	High erodibility; unstable embankments.	No unfavorable features other than high erodibility.	Moderate to moderately slow permeability; seasonally high water table within 3 feet in places.	Low shear strength; fair to poor load-bearing capacity; medium to high compressibility; seasonally high water table.	Suitable for many engineering uses requiring medium plasticity and moderate to low shear strength.
No unfavorable features.	No unfavorable features.	No unfavorable features other than loose sand and gravel at 22 to 36 inches.	Loose sand and gravel at 22 to 36 inches; availability of material limited.	No unfavorable features other than high erodibility.	No unfavorable features other than seasonally high water table.	No unfavorable features other than seasonally high water table.	Suitable for some engineering uses.
Moderate to moderately slow permeability; unstable ditchbanks; high erodibility; moderate to high corrosivity.	Moderate salinity.	No unfavorable features.	No unfavorable features.	High erodibility; vegetation difficult to establish.	Moderate to moderately slow permeability; seasonally high water table in some areas.	Moderate salinity; low shear strength; fair to poor load-bearing capacity; medium to high compressibility; moderate to severe corrosivity; seasonally high water table in places.	Suitable for some enginneering uses where moderate salinity can be tolerated; low shear strength.
Not applicable.	Steep slopes; high susceptibility to erosion; use best adapted irrigation system.	Not applicable.	Not applicable.	Not applicable.	Steepness.	Poor to fair load-bearing capacity; low shear strength; medium to high compressibility; moderate to high shrink-swell potential; some consolidation (settling) problem when wet.	Suitable for many engineering uses requiring medium plasticity and fair to poor shear strength; low load-bearing capacity; material poorly graded; high proportion of silt and very fine sand.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Havre, high (Hd, Hh, Mn, Mo, Mp).	Good	Not a source.	Not a source.	Fair to poor; moderate dry density; moderate to high frost action; fair to poor compaction characteristics; poorly graded material.	Medium compressibility and expansion; fair to poor load-bearing capacity; high erodibility where deep cuts are needed; some consolidation (settling) problem; moderate to high frost action.	Moderate permeability; unstable for fill material; compacted seal blanket may be needed.	Poor stability; poor compaction characteristics; permeability moderate in compacted embankments; moderate to low dry density; high erodibility; subject to piping.
Hesper (Hu, Hv).	Good	Not a source.	Fair; well-graded sand and gravel below 6 feet in places.	Fair to poor; moderate dry density; moderate to high frost action; fair to poor compaction characteristics; poorly graded material.	Medium compressibility and expansion; fair to poor load-bearing capacity; high erodibility where deep cuts are needed; some consolidation (settling) problem; moderate to high frost action.	Moderate permeability; unstable for fill material; compacted seal blankets may be needed.	Poor stability; poor compaction characteristics; permeability moderate in compacted embankments; moderate to low dry density; high erodibility; subject to piping.
Hilly gravelly land (Hw).	Not suitable.	Good; well-graded sand below 6 to 10 inches with or without a few pebbles; screening to remove gravel may be needed.	Good; well-graded sand and gravel below 6 to 10 inches.	Good; high stability; high permeability when fill is compacted.	No unfavorable features.	Features unfavorable; soil too porous.	Features unfavorable; soil not porous.
Hoven (Hx)	Not suitable; high clay content.	Not a source.	Not a source.	Poor; low dry density; high volume change; high plasticity; very slow permeability; poor workability; high plasticity.	High compressibility and expansion; high elasticity; high volume change; moderate frost action; very slow permeability; high corrosivity to untreated steel pipe; periodic flooding.	No unfavorable features.	Low dry density; permeability slow in compacted embankment; high shrink-swell potential; high compressibility.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Moderate permeability; unstable ditchbanks; high content of silt and very fine sand reduces efficiency of tile.	No unfavorable features other than some consolidation (settling) problem when wet.	No unfavorable features.	High erodibility; unstable embankments; high susceptibility to piping.	No unfavorable features other than high erodibility.	Moderate to moderately slow permeability; some consolidation (settling) problem when wet.	Low load-bearing capacity; low shear strength; medium to high compressibility; moderate to high frost action; some consolidation (settling) problem.	Suitable for many engineering uses requiring medium plasticity and fair to poor shear strength; low load-bearing capacity; material poorly graded; high proportion of silt and very fine sand.
Not applicable	Not applicable.	Not applicable.	No unfavorable features.	No unfavorable features other than high erodibility.	Moderate to moderately slow permeability; some consolidation (settling) problem when wet.	Low load-bearing capacity; low shear strength; medium to high compressibility; moderate to high frost action; some consolidation (settling) problem.	Suitable for many engineering uses requiring medium plasticity and fair to poor shear strength; low load-bearing capacity; material poorly graded; high proportion of silt and very fine sand.
Not applicable	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Features not suitable; too steep unless located on more level crests and ridges.	No unfavorable features; high load-bearing capacity; very rapid permeability.	Ideal support when confined; good for subgrades or as a blanket.
Not applicable	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Very slow permeability; occasional ponding on surface.	Features not suitable.	Unsuitable for most engineering uses; poor subgrade material; fair to good stability if material is properly compacted; satisfactory where impervious.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Hoven (saline) (Hy).	Not suitable.	Not a source.	Not a source.	Poor; high dispersion; very slow permeability when fill is compacted; very unstable slopes; high volume change.	High compressibility and expansion.	No unfavorable features.	Low dry density; material is impervious if compacted.
Hysham (Ht, Hz, Lu, Ly).	Not suitable.	Poor; well-graded sand and gravel below 15 feet.	Poor; well-graded sand and gravel below 15 feet.	Poor; high dispersion; very slow permeability when fill is compacted; low stability; high erodibility; high susceptibility to piping; high salinity.	Low load-bearing capacity; low shear strength; medium compressibility; moderate to high frost action; unstable slopes; high corrosivity.	No unfavorable features.	Low stability; low dry density; high erodibility; high dispersion; high susceptibility to piping; high to very high salinity; high corrosivity.
Laurel (Ax, Cn, La).	Not suitable.	Not a source.	Poor; on lower terraces, well-graded gravel and sand within 10 feet.	Poor; high dispersion; very slow permeability when fill is compacted; low stability; high erodibility; high susceptibility to piping; high salinity.	Low load-bearing capacity; low shear strength; medium compressibility; moderate to high frost action; unstable slopes; high corrosivity.	No unfavorable features.	Low stability; low dry density; high erodibility; high dispersion; high susceptibility to piping; high to very high salinity; high corrosivity.
Laurel (La, Lb).	Not suitable.	Poor; well-graded sand with gravel below 8 feet; screening to remove gravel needed.	Poor; well-graded sand and gravel below 8 feet.	Poor; very high salinity; high dispersion; very low compactibility.	High water table within 2 feet of surface most of year; low load-bearing capacity; low shear strength; high dispersion; unstable slopes; very high corrosivity.	High water table within 2 feet of surface most of year; very high salinity.	Low stability; low dry density; high erodibility; high dispersion; high susceptibility to piping; high to very high salinity; high corrosivity.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Very slow permeability; high dispersion; high shrink-swell potential; strong salinity and alkalinity; high to very high corrosivity.	Very slow permeability; high dispersion; high salinity and alkalinity; very poor workability.	Highly saline subsoil may be exposed by leveling; poor workability.	Unstable slopes; high volume change; very slow permeability; vegetation very difficult to establish; high dispersion.	High erodibility; strong salinity and alkalinity; very slow permeability; vegetation difficult to establish.	Very slow permeability; high dispersion; high shrink-swell potential; high corrosivity.	Low load-bearing capacity; high shrink-swell potential; low shear strength; very slow permeability; high corrosivity.	Not suitable for most engineering uses, because of high alkalinity.
Very slow permeability; high dispersion; high shrink-swell potential; strong salinity and alkalinity; high to very high corrosivity.	Very slow permeability; high dispersion; high salinity and alkalinity; very poor workability.	Highly saline subsoil may be exposed by leveling; poor workability.	Unstable slopes; high volume change; very slow permeability; vegetation very difficult to establish; high dispersion.	High erodibility; strong salinity and alkalinity; very slow permeability; vegetation difficult to establish.	Very slow permeability; high dispersion; high corrosivity.	Low load-bearing capacity; low shear strength; low to moderate shrink-swell potential; very slow permeability; high corrosivity.	Not suitable for most engineering uses, because of high alkalinity.
Very slow permeability; high dispersion; high shrink-swell potential; strong salinity and alkalinity; high to very high corrosivity.	Very slow permeability; high dispersion; high salinity and alkalinity; very poor workability.	Highly saline subsoil may be exposed by leveling; poor workability.	Unstable slopes; high volume change; very slow permeability; vegetation very difficult to establish; high dispersion.	High erodibility; strong salinity and alkalinity; very slow permeability; vegetation difficult to establish.	Very slow permeability; high dispersion; high corrosivity.	Low load-bearing capacity; low shear strength; low to moderate shrink-swell potential; very slow permeability; high corrosivity.	Not suitable for most engineering uses, because of high alkalinity.
High water table within 2 feet of surface most of year; very slow permeability; unstable slopes; high dispersion; very high corrosivity.	Very high salinity and alkalinity; very slow permeability; high dispersion; high water table.	High water table; high salinity.	Not applicable.	Not applicable.	High water table within 2 feet of surface most of year; slow permeability; high dispersion; very high corrosivity.	Shallow water table within 2 feet of surface most of year; low load-bearing capacity; slow permeability; very high corrosivity; low shear strength.	Not suitable for most engineering uses, because of high alkalinity.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Lismas (Lc, Ld, Lf, Lg, Pc, Pk).	Not suitable; high clay content; salinity.	Not a source.	Not a source.	Poor; low dry density; high volume change; high compressibility; poor workability.	High compressibility and expansion; high elasticity; high shrink-swell potential; very slow permeability; unstable slopes where deep cuts expose shale; poor workability; high corrosivity to untreated steel pipes.	No unfavorable features; condition of bedrock at site determine favorability.	Low dry density; low shear strength; high volume change; poor workability.
Lohmiller (Ho, Lh, Lo).	Good	Poor; well-graded sand with gravel below 10 feet; screening to remove gravel needed.	Fair; well-graded sand and gravel; below 10 feet in most places.	Fair to poor; moderately high dry density; low shear strength; medium plasticity; moderate volume change.	Medium compressibility and expansion; high frost action; high capillarity; moderate corrosivity; seasonal water table within 3 to 5 feet.	Seasonal water table within 3 to 5 feet; moderate permeability in lower substratum.	Medium compressibility; moderate dry density; permeability slow in compacted embankment; moderate shrink-swell potential.
Lohmiller, high (Hp, Hr, Lm, Lr, Ls, Lt, Lu, Ly).	Good	Poor; poorly graded sand with fines may occur below 5 feet; washing to remove gravel needed.	Not a source.	Fair to poor; moderately high dry density; low shear strength; medium plasticity; moderate volume change.	Medium compressibility and expansion; high frost action; high capillarity; moderate corrosivity.	Moderate permeability in substratum; compacted seal blanket may be needed.	Medium compressibility; moderate dry density; permeability slow in compacted embankment; moderate shrink-swell potential.
Lohmiller, wet (Ln).	Fair to good.	Poor; well-graded sand or sand and gravel may occur below 6 feet.	Fair; well-graded sand and gravel below 6 inches in places.	Fair to poor; moderately high dry density; low shear strength; medium plasticity; moderate volume change.	Water table at or near surface most of the year; high compressibility; high corrosivity.	Features unfavorable; water table too high.	Shallow depth to water table.
Marias, saline-alkali (Ma).	Not suitable; high alkalinity; soil crusty.	Not a source.	Not a source.	Poor; low dry density; high volume change; high plasticity; very slow permeability; poor workability; unstable slopes.	High compressibility and expansion; high elasticity; high shrink-swell potential; moderate frost action; very slow permeability; moderate to high corrosivity.	No unfavorable features.	Low dry density; poor compactibility; permeability very slow in compacted embankment.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable	Not applicable.	Not applicable.	Slopes too steep; soils too shallow to shale.	Not applicable.	Features not suitable; less than 20 inches to platy clay shale; very slow permeability; high shrink-swell potential; steep slopes.	Low load-bearing capacity; poor shear strength; high shrink-swell potential; very slow permeability; high compressibility.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.
Moderately slow to slow permeability; ditch-banks unstable.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Seasonally high water table within 3 to 5 feet; moderately slow permeability.	Seasonally high water table; low load-bearing capacity; slow to moderately slow permeability; moderate shrink-swell potential.	Suitable for some engineering uses allowing low shear strength; material stable if compacted and dry.
Moderately slow to slow permeability; ditch-banks unstable.	No unfavorable features.	No unfavorable features.	No unfavorable features.	No unfavorable features.	Moderately slow permeability.	Low load-bearing capacity; low shear strength; low to moderate shrink-swell potential.	Suitable for some engineering uses with low shear strength; material stable if compacted and dry.
Moderately slow to slow permeability; ditch-banks unstable.	Water table too near to surface; strong salinity; deep drains needed.	Water table too near to surface.	Not applicable.	Not applicable.	Features not suitable; water table too near to surface.	Features not suitable; water table too near to surface.	Suitable for some engineering uses with low shear strength; material stable if compacted and dry.
Very slow permeability; high dispersion.	Very slow permeability; poor workability.	Deep cuts expose saline substratum; poor workability.	Low shear strength; high dispersion; poor workability; low fertility.	Vegetation difficult to establish; saline substratum.	Very slow permeability; high dispersion; high shrink-swell potential; moderate to severe limitations of slope.	Low load-bearing potential; low shear strength; high shrink-swell potential; very slow permeability.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Marias, saline-alkali or saline (Mb, Mc, Md, Me).	Not suitable; high alkalinity; soil crusty.	Not a source.	Not a source.	Poor; low dry density; high volume change; high plasticity; very slow permeability; poor workability; unstable slopes.	High compressibility and expansion; high elasticity; high shrink-swell potential; moderate frost action; very slow permeability; moderate to high corrosivity.	No unfavorable features other than moderate limitations caused by slope.	Low dry density; poor compactibility; permeability very slow in compacted embankment.
Marias and Promise (Mf).	Fair; high clay content.	Not a source.	Not a source.	Poor; low dry density; high volume change; high plasticity; very slow permeability; poor workability; unstable slopes.	High compressibility and expansion; high elasticity; high shrink-swell potential; moderate frost action; very slow permeability; moderate to high corrosivity.	No unfavorable features other than moderate limitations caused by slope.	Low dry density; poor compactibility; permeability very slow in compacted embankment.
McRae (Mk, Ml, Mm).	Good	Not a source.	Not a source.	Fair to poor; moderate dry density; moderate to high frost action; fair to poor compaction characteristics; poorly graded materials.	Medium compressibility and expansion; fair to poor load-bearing capacity; high erodibility where deep cuts are needed; some consolidation (settling) problem when wet.	Moderate permeability; a compacted seal blanket may be needed.	Poor compaction characteristics; low stability; permeability moderate in compacted embankments; moderate to low dry density; medium compressibility; subject to piping.
McRae (Mn, Mo, Mp).	Good	Not a source.	Not a source.	Fair to poor; moderate dry density; moderate to high frost action; fair to poor compaction characteristics; poorly graded materials.	Medium compressibility and expansion; fair to poor load-bearing capacity; high erodibility where deep cuts are needed; some consolidation (settling) problem when wet.	Moderate permeability; a compacted seal blanket may be needed.	Poor compaction characteristics; low stability; permeability moderate in compacted embankments; moderate to low dry density; medium compressibility; subject to piping.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Vegetation difficult to establish; saline substratum.	Very slow permeability; high dispersion; high shrink-swell potential; moderate to severe limitations of slope.	Low load-bearing potential; low shear strength; high shrink-swell potential; very slow permeability.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.
Not applicable.	Not applicable.	Not applicable.	Rolling topography; high shrink-swell potential; poor workability.	Rapid runoff rate; very slow permeability.	Shale at depth of less than 32 inches; very slow permeability; high shrink-swell potential; moderate limitations of slope.	Low load-bearing potential; low shear strength; high shrink-swell potential; very slow permeability.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.
Not applicable.	Not applicable.	Not applicable.	Not applicable.	High erodibility.	Moderate permeability; severe limitations of slope.	Poor to fair load-bearing capacity; low shear strength; medium to high compressibility; moderate to high frost action; some consolidation (settling) problem when wet.	Suitable for many engineering uses; requiring medium plasticity and fair to poor shear strength and load-bearing capacity; material contains high proportion of silt and very fine sand.
Moderate to moderately slow permeability; unstable ditchbanks; high content of silt and very fine sand reduces efficiency of tile.	No unfavorable features other than some consolidation (settling) problem when wet.	No unfavorable features.	High erodibility; unstable embankments; high susceptibility to piping.	No unfavorable features other than high erodibility.	Moderate permeability; moderate limitations of slope.	Poor to fair load-bearing capacity; low shear strength; medium to high compressibility; moderate to high frost action; some consolidation (settling) problem when wet.	Suitable for many engineering uses; requiring medium plasticity and fair to poor shear strength and load-bearing capacity; material contains high proportion of silt and very fine sand.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Midway (Lf, Mr, Ms).	Fair; low fertility.	Not a source.	Not a source.	Fair to poor; medium plasticity; moderately high dry density; low shear strength; moderate volume change.	Medium compressibility; high capillarity; slow permeability; moderate frost action; unstable slopes when deep cuts expose shale.	Seepage may occur along some strata; severe limitations caused by slope; local site investigation needed; slopes too steep.	Medium compressibility; moderate dry density; permeability slow in compacted embankment; moderate volume change.
Midway (Mt, Mv).	Poor; low fertility.	Not a source.	Not a source.	Fair to poor; medium plasticity; moderately high dry density; low shear strength; moderate volume change.	Steep and rough broken topography; 8 to 12 inches to shale; unstable slopes when deep cuts expose shale; moderate frost action; moderate to high corrosivity.	Features unfavorable for sewage lagoons; slopes too steep; local site investigation needed to determine feasibility for use as reservoir areas.	Medium compressibility; moderate dry density; permeability slow in compacted embankment; moderate volume change.
Midway (Mu).	Poor; low fertility.	Fair; well-graded sand with gravel on ridges, crests, and upper parts of slopes with no overburden; screening to remove gravel needed.	Good; well-graded sand and gravel on ridges, crests, and upper parts of slopes with no overburden.	Fair to good; presence of gravel makes better fill, shale within 15 inches on lower parts of slopes.	Steep and rough broken topography; less than 15 inches to shale; unstable slopes when deep cuts expose shale; moderate frost action.	Features unfavorable for sewage lagoons; slopes too steep; local site investigation needed to determine feasibility for use as reservoir areas.	Medium compressibility; moderate dry density; permeability slow in compacted embankment; moderate volume change.
Nihill (Mu, Na).	Fair; soils gravelly; low fertility.	Poor-------	Poor to good; well-graded gravel.	Good; good workability; good compaction characteristics; high dry density; high shear strength; good for subgrade.	High load-bearing capacity; little or no compressibility; moderate permeability.	Moderately rapid permeability; slopes too steep for lagoons; local investigation of site needed for reservoir areas.	Permeability moderately high in compacted embankment; fair stability; low resistance to piping.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable	Not applicable.	Features unfavorable; soils too steep and too shallow to shale.	Features unfavorable; soils too steep and too shallow to shale.	High erodibility; shale at less than 20 inches.	Moderately slow to slow permeability; shale at depth of less than 20 inches; severe limitations of slope.	Medium load-bearing potential; low shear strength; medium to high compressibility; moderate to high frost action; moderate shrink-swell potential.	Suitable for some engineering uses; low shear strength; material stable if compacted.
Not applicable	Not applicable.	Features unfavorable; soils too steep and too shallow to shale.	Features unfavorable; soils too steep and too shallow to shale.	Not applicable; slopes too steep.	Features unfavorable; soils too steep and too shallow to shale.	Medium load-bearing potential; low shear strength; medium to high compressibility; moderate to high frost action; moderate shrink-swell potential.	Suitable for some engineering uses; low shear strength; material stable if compacted.
Not applicable	Not applicable.	Features unfavorable; soils too steep and too shallow to shale.	Features unfavorable; soils too steep and too shallow to shale.	Not applicable; slopes too steep.	Features not suitable unless sewage lagoons are located on crests and ridges that are not so steep and are gravelly.	Features not suitable unless site located on crests and ridges of Nihill soils.	Suitable for some engineering uses; low shear strength; material stable if compacted.
Not applicable	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Features not suitable; soils too steep.	Features good; high load-bearing capacity; high shear strength; moderate permeability; little or no consolidation (settling) problem.	Suitable for engineering uses needing material with high shear strength; good compaction characteristics; high stability when dry.

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TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Nunn (Nc, Nd, Nm, Nn, No, Nu, Nx).	Good	Not a source.	Not a source.	Fair to poor; medium plasticity; moderate dry density; low shear strength; fair compaction characteristics; slow permeability when fill is compacted; moderate volume change.	Medium to high compressibility and expansion; high capillarity; moderate to high frost action; low to moderate corrosivity.	No unfavorable features other than moderate limitations on slopes of more than 2 percent.	Fair stability; moderate dry density; fair compaction characteristics; permeability slow in compacted embankments; low shear strength; moderate volume change; low resistance to piping; fair workability.
Pierre (Ld, Me, Pa, Pc, Pk).	Poor to not suitable; high clay content; some soils strongly alkaline and crusty.	Not a source.	Not a source.	Poor; low dry density; high volume change; very slow permeability; high plasticity; poor workability.	High compressibility and expansion; high elasticity; moderate to high frost action; high shrink-swell potential; very slow permeability; low load-bearing capacity; shale below 20 to 40 inches; moderate to high corrosivity.	No unfavorable features; condition of bedrock at site determines favorability; for sewage lagoons, severe limitations caused by slope.	Low dry density; low shear strength; high volume change; permeability very slow in compacted embankments; poor compaction characteristics; poor workability.
Renohill (Rn).	Good	Not a source.	Not a source.	Fair to poor; medium plasticity; moderate to low dry density; low shear strength; low stability; high erodibility; moderate volume change; fair compaction characteristics.	Shale at 26 to 40 inches; medium to high compressibility; high capillarity; high frost action; limited for use as fill material.	Seepage along bedrock strata in some areas; local site investigation necessary; for sewage lagoons, severe limitations caused by slope.	Moderately high dry density; low shear strength; moderate volume change; fair to good stability; fair compaction characteristics; medium to high compressibility; permeability slow in compacted embankment; fair compaction characteristics.
Riverwash (Rw).	Not suitable.	Good; well-graded sand; screening to remove gravel needed.	Good; well-graded sand and gravel.	Good for subgrade.	Subject to annual overflow.	Not applicable	Not applicable

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Slow to moderately slow permeability; poor stability on ditchbanks.	No unfavorable features.	No unfavorable features.	Moderate shear strength; moderate erodibility; fair workability.	High erodibility.	Slow to moderately slow permeability; moderate shrink-swell potential; moderate limitations of slope in sloping areas.	Low load-bearing capacity; low shear strength; slow to moderately slow permeability; moderate to high frost action; moderate shrink-swell potential.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where nearly impervious.
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Features not suitable; shale at depth of 18 to 40 inches; very slow permeability.	Features not suitable; low load-bearing capacity; high shrink-swell potential; moderate to high frost action; low shear strength; very slow permeability.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.
Not applicable.	Not applicable.	Not applicable.	Shale at depth of 26 to 40 inches; rolling topography; high erodibility.	Shale at 26 to 40 inches; high erodibility; vegetation difficult to establish.	Shale at depth of 26 to 40 inches; slow to moderately slow permeability.	Low load-bearing capacity; low shear strength; slow permeability; moderate to high frost action; moderate shrink-swell potential; shale within 26 to 40 inches.	Unsuitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where impervious.
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Good source of well-graded material with very few fines.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Sage (Sa)	Not suitable; very strong salinity and alkalinity.	Poor; well-graded sand or sand with gravel below 10 feet in places.	Poor; well-graded sand and gravel below 10 feet in places.	Poor; very strong salinity; high dispersion; poor compaction characteristics; low dry density; low stability; high erodibility; high susceptibility to piping; high volume change; poor workability.	Water table within 5 feet all year and within 2 feet during some seasons; low stability; high compressibility; high consolidation (settling) problem; low shear strength; low load-bearing capacity; high to very high corrosivity.	Features unfavorable; high water table; low stability.	High compressibility; low shear strength; poor compaction characteristics; high dispersion; permeability very slow in compacted embankment; very poor workability; high susceptibility to piping.
Sage (Sc)	Not suitable; very strong salinity and alkalinity.	Poor; well-graded sand or sand with gravel below 10 feet in places.	Poor; well-graded sand and gravel below 10 feet in places.	Poor; very strong salinity; high dispersion; poor compaction characteristics; low dry density; low stability; high erodibility; high susceptibility to piping; high volume change; poor workability.	High compressibility; low stability; low load-bearing capacity; low shear strength; high shrink-swell capacity; very high corrosivity.	No unfavorable features.	High compressibility; low shear strength; poor compaction characteristics; high dispersion; permeability very slow in compacted embankment; very poor workability; high susceptibility to piping.
Shale outcrop (Sh).	Not suitable.	Not a source.	Not a source.	Poor; low dry density; high volume change; unstable slopes; low permeability when fill is compacted.	Very steep and rough broken topography; low availability of construction material.	No unfavorable features.	Features unfavorable.
Shonkin (Sk).	Good	Fair; well-graded sand with gravel below 5 feet on terraces; screening to remove gravel needed; not a source on uplands.	Fair; well-graded sand and gravel below 5 feet on terraces; not a source on up lands.	Fair to poor; low dry density; low permeability when fill is compacted; moderate to high volume change; poor compaction characteristics.	Ponding for short periods most years; high compressibility and expansion; high elasticity.	Overflow; best suited for dugouts.	Low dry density; low shear strength; high volume change; poor workability.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Very slow permeability; high dispersion; unstable ditchbanks; high erodibility; high to very high corrosivity.	Very strong salinity and alkalinity; very slow permeability; very poor workability; soil tends to crust.	Cuts expose strongly saline subsoil; poor workability; high dispersion.	Not applicable	Not applicable.	Features not suitable; high water table.	Features not suitable.	Unsuitable for all engineering uses.
Very slow permeability; high dispersion; unstable ditchbanks; high erodibility; high to very high corrosivity.	Very strong salinity and alkalinity; very slow permeability; very poor workability; soil tends to crust.	Cuts expose strongly saline subsoil; poor workability; high dispersion.	High dispersion; poor stability; high erodibility; very strong salinity and alkalinity; vegetation difficult to establish.	Strong salinity and alkalinity; high erodibility; vegetation difficult to establish.	Very slow permeability; high dispersion; high corrosivity.	Low load-bearing capacity; low stability; high compressibility; very slow permeability; strong salinity; high dispersion; high shrink-swell potential.	Unsuitable for all engineering uses.
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Features not suitable.	Features unfavorable.	Not suitable for most engineering uses.
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Features not suitable; subject to ponding.	Features not suitable; subject to ponding.	Not suitable for most engineering uses; poor subgrade material; material stable if properly compacted; satisfactory where nearly impervious.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Terry (Cv, Tf, Tm, Tn).	Good	Not a source.	Not a source.	Good; fair to good compaction characteristics; moderate to low permeability when fill is compacted; good workability; good for subgrade.	Favorable topography; slight compressibility; good for fill material; moderate frost action; weakly consolidated sandstone below 22 to 32 inches.	Features generally unfavorable because of bedrock; local site investigation needed; moderate limitations caused by slope.	Permeability moderate in compacted embankment; high piping potential; low shrink-swell potential; only slight compressibility.
Travessilla (Cx, Fc).	Fair to good.	Not a source.	Not a source.	Good; high shear strength; low compressibility; low shrink-swell potential; high load-bearing capacity; good workability; many flat stones.	Hard sandstone layer at depth of 8 to 14 inches; stones hinder hauling and grading; limited for fill material.	Features unfavorable; fractured bedrock causes seepage problem; for sewage lagoons, severe limitations caused by slope and depth.	Hard sandstone within 14 inches; good stability; soils too porous; permeability slow to moderate in compacted embankment; poor compaction characteristics.
Travessilla (Tp, Tr).	Fair to poor.	Not a source.	Not a source.	Good; high shear strength; low compressibility; low shrink-swell potential; high load-bearing capacity; good workability; many flat stones.	Steep and very steep topography with outcrops of sandstone.	Features unfavorable; steep and very steep topography.	Features unfavorable.
Treasure (Tm, Ts, Tu).	Good	Not a source.	Not a source.	Good; high dry density; high shear strength; low plasticity; low volume change; fair to good compaction characteristics; moderate to slow permeability when fill is compacted; good stability.	Low compressibility; low shrink-swell potential; low frost action; moderate permeability.	Moderate to moderately rapid permeability in lower subsoil; moderate limitations caused by slope.	High dry density; nearly impervious; moderate permeability in compacted embankment; slight compressibility.
Tullock (Cw, Tf, Tv).	Good	Not a source.	Not a source.	Good; high dry density; high shear strength; low plasticity; low volume change; fair to good compaction characteristics; moderate to slow permeability when fill is compacted; good stability.	Low compressibility; low shrink-swell potential; low frost action; moderate permeability.	Soft sandstone at 10 to 40 inches; upper part too porous; farm ponds need site investigation; for sewage lagoons, moderate or severe limitations caused by slope.	Fair stability; good compaction characteristics; permeability moderate in compacted embankment; high shear strength; low compressibility; very low volume change.

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable	Not applicable.	Not applicable.	Soft sandstone or shale between 22 and 32 inches; rolling topography.	Soft sandstone or shale between 22 and 32 inches; high erodibility.	Shale or soft sandstone within a depth of 32 inches; moderate limitations of slope.	Features excellent; high load-bearing capacity; high shear strength; moderate permeability; little or no compressibility; moderate frost action.	Suitable for many engineering uses requiring material of high stability, high shear strength, and low elasticity.
Not applicable	Not applicable.	Not applicable.	Shallow depth; hard rock at 8 to 14 inches.	Shallow to hard rock; very low water-holding capacity.	Hard sandstone layer at depth of 8 to 14 inches.	No unfavorable features; high load-bearing capacity; high shear strength; moderate to low frost action.	Suitable for engineering uses needing material with high shear strength and rapid permeability; material very stable.
Not applicable	Not applicable.	Not applicable.	Features unfavorable; soils too steep.	Features unfavorable.	Features unfavorable; too steep.	No unfavorable features; high load-bearing capacity; high shear strength; moderate to low frost action.	Suitable for engineering uses needing material with high shear strength and rapid permeability; material very stable.
Not applicable	Not applicable.	Not applicable.	Deep cuts expose more erodible material.	Erodibility	Slight to moderate limitations of slope.	No unfavorable features; high load-bearing capacity; high shear strength; moderate to low frost action.	Suitable for engineering uses needing material with high shear strength and rapid permeability; material very stable.
Not applicable	Not applicable.	Not applicable.	Deep cuts expose sandier materials; high erodibility; subject to wind erosion.	Sandy material; high erodibility; vegetation difficult to establish; low water-holding capacity.	Soft sandstone between 10 and 40 inches; moderately rapid to rapid permeability in material above sandstone; moderate to severe limitations of slope.	No unfavorable features; high load-bearing capacity; high shear strength; moderate to low frost action.	Suitable for engineering uses needing material with high shear strength and rapid permeability; material very stable.

TABLE 5.—*Interpretations of*

Soil series and map symbol	Suitability as source of—				Features affecting—		
	Topsoil	Sand	Gravel	Road fill	Highway location	Farm ponds or sewage lagoons	
						Reservoir area	Embankment
Wanetta (Wb, Wc, Wd, Wm, Wn).	Good	Fair; well-graded sand with gravel; screening to remove gravel needed; 22 to 42 inches of overburden.	Good; well-graded sand and gravel with very few fines between 22 and 42 inches.	Good; well-graded material available; good workability.	No unfavorable features.	Features unfavorable; substratum too porous below 22 to 42 inches.	Rapid permeability below 22 to 42 inches.
Wibaux (Wr).	Poor to not suitable.	Not a source.	Not a source.	Good; unaltered porcelanite; fused sandstone or scoria within 12 inches.	Very steep and rough broken topography; porcelanite or scoria beds within 12 inches.	Not applicable	Not applicable
Winnett (Cy, Tn, Wt, Wx).	Poor to not suitable.	Not a source.	Not a source.	Poor; high dispersion; poor compaction characteristics; very slow permeability when compacted; high volume change; poor workability; high susceptibility to piping; high erodibility.	Shale between 22 and 40 inches. limited for fill material; moderately high compressibility; high capillarity; very slow permeability; moderate to high frost action; moderate to high shrink-swell potential; unstable bank when deep cuts expose shale; moderate to high corrosivity.	No unfavorable features other than some seepage along bedrock; for sewage lagoons, moderate limitations caused by slope.	Poor stability; poor compaction characteristics; permeability very slow in compacted embankment; medium to high compressibility; high susceptibility to piping; high volume change; high erodibility.

which genetic soil horizons are believed to have been formed. Geologic bedrock is not parent material, but the mantle of residuum that weathered directly from the bedrock can be the source of parent material. The rate and degree that horizons develop depend largely on the mineralogical and lithological composition of the parent material. In most places the parent material determines the kind of soil profile that develops. Generally, soils formed in sandy material are sandy, and those formed in clay material are clayey. Parent material weathers in place from the underlying bedrock or is transported and redeposited by wind or water. In Treasure County the parent material of the soils are the result of three geologic processes: (1) transportation and redeposition by water; (2) transportation and redeposition by wind; and (3) weathering in place of the bedrock.

The material transported by water has been redeposited as alluvium on the fans, terraces, and flood plains within the valleys of the Bighorn and Yellowstone Rivers and their tributaries. In the larger valleys these deposits range from sand and gravel to clay. The range in texture of the deposits depends on the local geologic formations and is narrower in the valleys of Sarpy Creek, Tullock Creek, and similar small streams.

In most places the material on the flood plains is thinly stratified. Each stratum reflects the size of the drainage area and the volume and velocity of a single flood. Wanetta and similar soils occur on the high terraces of gravel

engineering properties of soils—Continued

Features affecting—Continued							Remarks
Agricultural drainage	Irrigation	Land leveling	Terraces and diversions	Waterways	Sewage disposal fields	Building sites	
Not applicable.	Not applicable.	Not applicable.	Porous gravelly substratum within 22 inches in places.	Low water-holding capacity where underlain by gravel within 24 inches; deep cuts expose porous sand and gravel.	No serious limitation; material above gravel is moderately permeable; moderate limitations of slope in sloping areas.	No unfavorable features.	Suitable for engineering uses needing material with high shear strength and rapid permeability; very stable material.
Not applicable.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	Features unfavorable.	Features not suitable.	Suitable for engineering uses needing material with high shear strength and rapid permeability; very stable material.
Not applicable.	Not applicable.	Not applicable.	Shale within 22 to 40 inches; cuts expose dense clay or saline subsoil; vegetation difficult to establish; high erodibility.	Deep cuts expose dense clay material; high erodibility; vegetation difficult to establish.	Very slow permeability; high dispersion; moderate to severe corrosivity; high shrink-swell potential; shale between 22 and 40 inches.	Very slow permeability; low load-bearing capacity; low shear strength; high dispersion; moderate to high shrink-swell potential; moderate to high frost action; moderate to high corrosivity.	Not suitable for most engineering uses.

that were laid down in the middle to late Pleistocene age, but Hesper soils probably are older than Wanetta soils. Hesper soils are on high terraces that were probably laid down early in the Pleistocene age or late in the Tertiary age. In more recent times, the gravel on the highest benches occupied by Hesper soils has been covered by eolian deposits of varying thickness. This wind-laid material also thinly mantles some of the upland slopes, but in many places on these slopes, the mantle is so thin that it has not affected the soil profile that developed from the underlying material.

Indications are that some eolian material also affected the development of the soils, such as those on Hysham Bench, on the lower fans and terraces. The main source of this material is nearby beds of soft silt and very fine sand that have been decomposed, weathered, or washed by water. The material has a high proportion of silt and very fine sandy loam. However, the distribution of particle size is not the same as that of true loess, and the eolian deposits are difficult to distinguish from the alluvium that was derived from the same source.

The bedrock in the county varies widely in lithologic composition. North of the Yellowstone River and east of Muggins Creek, there is an extensive area of marine shale that is gray and saline or alkaline. This shale weathers to sodium-saturated clay that is the parent material of the saline-alkali Marias and Pierre soils and the saline Hoven soils. South of the river the clay shale has

796-973—67——10

TABLE 6.—*Engineering test data for soil samples taken from*

Soil type and location	Parent material	BPR and Montana report No.[1]	Depth	Horizon
			Inches	
Cherry clay: ¼ mile south and 165 ft. east of center of sec. 2, T. 1 S., R. 25 E., Yellowstone County.	Moderately fine textured alluvium.	216691	0–6	Ap
		213521	6–14	B2
		213522	21–72	C
Marias clay, fans, saline-alkali: 720 ft. north and 20 ft. west of SE. corner of sec. 6, T. 7 N., R. 36 E., Treasure County.	Deep clay sediments.	S32671	0–4	A1
		S32672	11–19	C2
		S32673	46–60	C6
Marias clay, saline-alkali: 200 ft. north and 100 ft. west of SE. corner of NE¼ of sec. 31, T. 8 N., R. 35 E., Treasure County.	Deep clay sediments.	S32674	0–4	A1
		S32675	4–11	C1
		S32676	41–60	C5
Marias clay, saline-alkali: 1,380 ft. south and 340 ft. east of NW. corner of NE¼ of sec. 33, T. 8 N., R. 35 E., Treasure County.	Deep clay sediments.	S32677	0–9	A1
		S32678	9–18	C1
		S32679	26–30	C3
McRae loam: 340 ft. west and 120 ft. south of SE. corner of NE¼ of sec. 1, T. 4 N., R. 33 E., Yellowstone County.	Medium-textured, local alluvium on fans.	216695	0–6	Ap, B2
		213536	10–44	C1ca, C2ca
		213537	44–76	C
McRae loam: 1,350 ft. south and 330 ft. east of SW. corner of NW¼ of sec. 19, T. 4 N., R. 33 E., Yellowstone County.	Medium-textured, local alluvium on fans.	216696	0–5	Ap
		213534	9–34	C1ca, C2ca
		213535	34–76	C
Tullock fine sandy loam: 115 ft. north and 180 ft. east of SW corner of sec. 36, T. 2 N., R. 27 E., Yellowstone County.	Moderately sandy residuum.	216694	4–9	A1
		213530	9–30	C1, C2
		213531	30–44	CR

[1] Tests performed by Bureau of Public Roads (BPR) for Treasure County and by Montana State Highway Commission (MSHC) in cooperation with the U.S. Department of Commerce, Bureau of Public Roads, for Yellowstone County in accordance with standard procedures of the American Association of State Highway Officials (AASHO), except as stated in footnote 2. Sample numbers beginning with the letter "S" designate samples tested by BPR.

[2] Moisture-density tests by BPR, based on the "Moisture-Density Relations of Soils Using 5.5-lb. Rammer and 12-in. Drop, AASHO Designation T 99–57, Method A." Moisture-density tests by MSHC based on the "Suggested Method for Moisture-Density Relation of Soils Using Harvard Compaction Apparatus, ASTM Procedure for Testing Soils, April 1958" (*2*).

[3] Mechanical analyses according to the AASHO Designation: T 88–57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conserva-

low salinity and alkalinity and is the parent material of the Pierre soils that are not saline-alkali.

The most extensive areas of bedrock in the county are the areas of weakly consolidated sandstone and shale of late Cretaceous and early Tertiary age. This bedrock was derived primarily from fresh water or terrestrial deposits. The shale of silt loam and loam texture weathered to form the parent material from which the Bainville and Cushman soils developed. The soft sandstone weathered to form the parent material of the Flasher, Terry, and Tullock soils. The soft shale of clay loam texture weathered to form the parent material of the Midway and Renohill soils.

Climate

The present climate of Treasure County probably has existed for several thousand years. This climate is characterized by low annual rainfall, which has affected the formation of soils. Although the rainfall is low, most of it apparently has fallen, in long continuous gentle rains, when the soils were not frozen. Rains of this kind are more effective in moistening the soil than are torrential downpours.

As water from a gentle rain moves downward in the soil, it carries with it soluble materials that are the by-products of weathering and are a part of the parent material. The more soluble monovalent salts, such as sodium sulfate, are removed first. These are followed by gypsum, which is less soluble. Since lime is the least soluble, it is the last to be moved down and redeposited. As time passes, the monovalent salts and gypsum are leached to the greatest depth, normally 5 to 8 feet. The lime is redistributed in a horizon of accumulation, generally just below the B2 horizon. The depth of the maximum concentration of lime is a clue that indicates just how far the rainfall has penetrated. This redistribution of lime is characteristic of all the zonal soils in the county.

But the low rainfall and cold winters have caused the soils in Treasure County to develop slowly. The low rainfall has limited the depth that salts and carbonates are leached. The cold winters have greatly retarded the rate of chemical reaction and the decomposition of parent ma-

seven soil profiles in Treasure and Yellowstone Counties, Mont.

Moisture-density [2]		Mechanical analyses [3]									Liquid limit	Plasticity index	Classification	
		Percentage passing sieve—				Percentage smaller than—								
Maximum dry density	Optimum moisture	⅜ in.	No. 4 4.76 mm.	No. 10 2.0 mm.	No. 200 0.074 mm.	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.	0.001 mm.			AASHO [4]	Unified [5]
Lb. per cu. ft.	*Percent*													
104	20	------	------	100	81	78	63	44	27	------	34	13	A-6(9)	CL.
104	19	------	------	100	82	72	57	42	29	------	32	13	A-6(9)	CL.
108	19	------	------	100	80	73	60	45	35	------	35	17	A-6(11)	CL.
94	24	------	------	100	98	95	80	62	51	44	51	22	A-7-6(15)	MH-CH.
96	24	------	------	100	98	96	85	69	58	52	63	34	A-7-6(20)	CH.
104	22	------	------	100	99	95	76	59	49	54	62	37	A-7-6(20)	CH.
98	22	------	------	100	96	93	76	61	51	45	46	19	A-7-6(13)	CL.
96	24	------	------	100	96	92	80	64	56	49	58	31	A-7-6(20)	CH.
106	21	------	------	100	90	83	68	54	46	40	55	34	A-7-6(19)	CH.
93	27	------	------	100	96	94	84	69	59	50	60	30	A-7-5(20)	MH-CH.
95	26	------	------	100	92	------	------	------	------	------	66	36	A-7-5(20)	CH.
95	26	------	------	100	96	95	90	79	72	70	77	47	A-7-5(20)	CH.
110	15	------	------	100	68	54	34	16	8	------	23	5	A-4(7)	ML-CL.
114	13	------	------	100	61	48	29	20	12	------	21	3	A-4(5)	ML.
116	12	------	------	100	60	48	26	15	8	------	20	2	A-4(5)	ML.
106	16	------	------	100	72	50	34	13	8	------	24	3	A-4(7)	ML.
110	15	------	------	100	71	56	28	16	11	------	21	0	A-4(7)	ML.
113	14	------	------	100	77	64	39	21	11	------	23	4	A-4(8)	ML-CL.
107	16	------	------	100	35	30	21	10	8	------	25	0	A-2-4(0)	SM.
106	16	----	100	95	29	29	20	10	5	------	24	0	A-2-4(0)	SM.
103	18	100	90	85	26	22	14	9	4	------	[6] NP	[6] NP	A-2-4(0)	SM.

tion Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses data used in this table are not suitable for naming textural classes for soils.

[4] Based on AASHO Designation: M 145-49 (*1*).

[5] Based on the Unified Soil Classification System, Tech. Memo. No. 3-357, v. 1, Corps of Engineers (*13*). SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points of the A-line are to be given a borderline classification. Examples of borderline classifications obtained by this use are ML-CL and MH-CH.

[6] NP means nonplastic.

terial. They also have slowed biological activity and the growth of vegetation, which are active factors in soil development. As a result, nearly all the soils in Treasure County have lime within the profile and have an abundance of weatherable minerals. In contrast, the soils of regions of higher humidity and higher rainfall have more deeply leached soils than those in this county. In many places the soils formed where rainfall is higher do not have horizons of lime accumulation.

Living organisms

Trees, grasses, shrubs, and other herbaceous plants, as well as micro-organisms, earthworms, and various other forms of plant and animal life, live on and in the soils and influence the direction and the rate of soil development. The kinds of plants and animals that live in and on the soil are determined by factors of the local environment, mainly climate, parent material, relief, age of the soils, and associated organisms. Plants and animals largely determine the kinds and amounts of organic matter added to the soil and the way in which this material is incorporated with the mineral part of the soil. Organic matter is added to the soil as dead leaves, as roots, and as whole plants. Most of it is added to the surface horizon, where it is acted on by micro-organisms and other minute forms of life and by chemicals in the soils and in the plant remains. These change the raw materials to humus and other forms in the soil.

In Treasure County the original plant cover consisted of many kinds of mid and short grasses, but there were also scattered shrubs and trees in some places. These plants have had the principal living influence on the development of the soils. Through the centuries, grasses have contributed much organic matter to the soils when their many roots and tops decomposed. This organic matter has imparted to the upper horizons a moderately dark color that is particularly evident in the Hesper and other older soils that have a grayish-brown surface layer and a dark-colored upper subsoil. The Havre, Lohmiller, and other younger soils have not been in place long enough

for accumulation of much organic matter from the plants growing on them. As a result, these soils have a light-colored surface layer that contains little organic matter.

Time

Long periods of time are required for the formation of parent material and for the transformation of this parent material into a soil having genetically related horizons. Differences in the length of time that geologic materials have been in place are, therefore, commonly reflected in the distinctness of the horizons in the soil profile.

The time required for weathering of rock and for changes to take place in the parent material varies according to the mineralogy or lithology of the parent rock. As a consequence, a soil with well-expressed horizon characteristics may form from one kind of parent material, whereas these characteristics may be lacking or only weakly expressed in a soil formed from another kind of material.

The difference in the degree of expression of the B2 horizon in the Briggsdale, Fort Collins, and McRae soils indicates the effect of time on the development of these soils. All of these soils have formed from deep, transported, calcareous parent material of loam texture. The Briggsdale soils have a prismatic-blocky light clay B2 horizon that has thick films of clay on all ped faces. In contrast, the B2 horizon of the Fort Collins soils has a clay loam B2 horizon that has weaker prismatic structure and less distinct films of clay on the peds. The McRae soils have a loam B2 horizon that expresses only color and structure, but these soils can be differentiated from their parent material by the loss of lime. The amount of clay in the B2 horizon indicates that the Briggsdale soils have been in place for a longer period of time than either the Fort Collins or the McRae soils.

The Arvada and similar soils have developed a strong clayey B2 horizon in loamy parent material within a shorter period of time than have the Briggsdale soils. Presumably, the processes of soil formation have been accelerated by sodium, which acts as a catalyst in the deflocculation and subsequent translocation of the clay. Marias soils formed from clay material and are on old landscapes, but the weathering processes have not expressed themselves as fully as in the Bew soils, which have a strong B2 horizon that also formed from clay.

Relief

Relief modifies the development of soils by modifying the effect of climate and vegetation in relatively small areas. Relief affects exposure to sun and wind, moisture, soil temperature, the rate of erosion, and the kinds and amounts of plant and animal life on and in the soil. Certain features of relief, such as degree of slope, or shape of surface, together with soil permeability, control the movement of water on the surface and through the soil.

The relief of the county is perhaps easier understood if it is described in terms of landforms. Throughout the long periods of geologic time, the bedrock has been eroded. This erosion has formed a dissected landscape by cutting many deep, narrow valleys into what was once a nearly level plateau or plain. The sharpness or boldness of the topography is directly related to the resistance of the bedrock to geologic erosion. Steep slopes and narrow ridges between the drainageways have formed in areas of the less resistant bedrock, whereas topography is more subdued in areas where the bedrock is more resistant.

Where the slopes are steep or runoff is rapid, the soil material is removed by erosion almost as fast as it is formed. As a result the soils are shallow and do not have clearly expressed horizons. Bainville, Lismas, and Midway soils are of this kind.

Soil material is not moved so rapidly on the smoothly sloping or rolling uplands. It is undisturbed long enough to permit soils to form genetic horizons like those in the Cushman and Renohill soils.

Where water has deposited material that formed fans, terraces, or flood plains, the surface is smooth and plane. Less water runs off these areas than off steeper ones and moisture penetrates deeper into the soil and carries with it soluble salts and lime. The increase in moisture encourages more rapid growth of living organisms and acts as a catalyst for more intense weathering. The Briggsdale, Fort Collins, McRae, and Nunn soils are on fans, terraces, or flood plains.

Classification of Soils

From the broadest category to the narrowest, soils are ordinarily classified by order, great soil group, series, and phase. Series, type, and phase are defined in the section "How This Survey Was Made." The category of soil order consists of three classes—zonal, intrazonal, and azonal. Each of these orders has many great soil groups. In a great soil group are soils that have fundamental characteristics in common.

The zonal order consists of those great soil groups that have soils with well-defined characteristics that reflect the influence of the active factors of soil genesis. The active factors are climate and living organisms, chiefly vegetation (*10*). Brown soils are the only zonal soils in Treasure County.

The intrazonal order consists of those great soil groups with distinct, genetically related horizons that reflect the dominating influence of some local factor of topography or parent material over the influence of climate and living organisms. The intrazonal soils in the county are Grumusols, Solonchak soils, Solonetz soils, and Soloth soils.

The azonal soil order consists of soils lacking well-developed profile characteristics that reflect the influence of age. The parent material or the topography has prevented the development of normal soil profile characteristics. Azonal soils in Treasure County belong to the Alluvial, Lithosol, and Regosol great soil groups.

In the list that follows the soil series of Treasure County are placed in their respective soil orders and great soil groups.

Order and great soil group	*Series*
Zonal—	
Brown soils	Beaverton, Bew, Briggsdale, Cherry, Cushman, Edgar, Fattig, Fort Collins, Hesper, McRae, Nunn, Renohill, Terry, Treasure, Wanetta.

Intrazonal–	
Grumusols	Marias, Pierre, Promise.
Solonchak soils	Laurel, Sage.
Solonetz soils	Arvada, Beckton, Gilt Edge, Hoven, Hysham, McKenzie, Winnett.
Soloth soils	Shonkin.
Azonal–	
Alluvial soils	Banks, Bowdoin, Glendive, Havre, Lohmiller.
Lithosols	Bainville, Flasher, Lismas, Midway, Travessilla, Tullock, Wibaux.
Regosols	Dwyer, Nihill.

Brown soils

The Brown soils in this county are in the zonal order and have developed from parent material ranging from sandy loam to clay. Development has been in a semiarid climate for varying periods of time. For many years the native vegetation has been mid and short grasses. The soils most representative of this great soil group occur on the undulating to rolling uplands and on the level to sloping fans and terraces. In Brown soils the degree that horizons in different series are expressed varies considerably, both in the soils formed in the same and in different kinds of material.

The Brown soils of Treasure County have a grayish-brown A horizon; a B2 horizon that differs from the A in color, structure, or texture; and a weak to distinct horizon of accumulated lime that begins at a depth of 7 to 15 inches. When the upper part of the B2 horizon is dry, coats on peds are darker colored than the A horizon by a value of 0.5 to 1. When crushed and rubbed, these peds are lighter colored by a value of at least 1. The content of organic matter gradually decreases from the A1 horizon down through the profile; it normally is about 2.5 percent in the A1 horizon, about 1.5 in the upper part of the B2 horizon, and less than 0.5 percent in the Cca horizon.

The Briggsdale, Edgar, Fort Collins, McRae, and Wanetta soils are Brown soils that formed in calcareous loam. In these soils genetic horizons are expressed in varrying degrees. The Briggsdale soils intergrade toward Planosols.

The Edgar and McRae soils have a noncalcareous B2 horizon and a horizon of lime accumulation. The parent material of these soils has been changed to a minimum degree. The main change is the removal and redistribution of the lime from the upper 6 to 10 inches of the soil and the subsequent release of iron. This change has resulted in a stronger chroma and in a B horizon that is a color or structural horizon, or both. Edgar soils have a more distinct Cca horizon than McRae soils.

The Fort Collins and Wanetta soils have a loam A horizon; a brown, prismatic clay loam B2 horizon; and a distinct Cca horizon of segregated lime. The B2 horizon is a textural horizon and reflects a change in texture between the loam A horizon and the underlying loam parent material. The B2 horizon has one and one-fourth to one and one-half times as much clay as the A horizon.

The Briggsdale soils have a light brownish-gray loam A horizon that contains an abundance of bleached silt and sand grains and is underlain abruptly by a brown, prismatic-blocky heavy clay loam or light clay B2t horizon. Also present is a distinct horizon of lime segregated in loam. The bleached grains in the A horizon indicate that much organic matter and clay have been removed from the A horizon and redeposited in the B2 horizon. The B2 horizon of Briggsdale soils has at least twice as much clay as the overlying A horizon.

The degree that the B2 horizon developed in Brown soils formed in calcareous loam in Treasure County is minimal in Edgar and McRae soils, medial in Fort Collins and Wanetta soils, and maximal in Briggsdale soils.

Some soils that developed in deep clay loam material show horizon development similar to that of soils developed in calcareous loam. The Cherry soils show minimal development comparable to that of McRae soils, for Cherry soils have a noncalcareous or weakly calcareous, blocky B2 horizon, no more clay in the B horizon than in the A, and a weak horizon of lime accumulation. The Nunn soils have a B2t horizon with slightly more clay than its A horizon above and its C horizon below. The Nunn soils are comparable to the Fort Collins soils because both have medial development of the B2 horizon. In Treasure County, no soils developed in clay loam material have a maximal development of the B2 horizon similar to that in the Briggsdale soils.

The Bew soils are the only Brown soils in Treasure County that formed from deep clay material. Bew soils have a grayish-brown or brown clay loam A horizon; a brown, prismatic-blocky clay B2t horizon; and lime segregated as nodules in the clay B3ca and Cca horizons. Characteristics of the Brown soils, particularly the textural B2t horizon, are strongly expressed in the Bew soils.

The Treasure soils have developed from deep, calcareous sandy loam parent material. They have a sandy loam A horizon, a brown, prismatic heavy sandy clay loam or light sandy clay B2t horizon; and a sandy loam C horizon with lime segregated as nodules in the upper part. The B2t horizon has at least twice as much clay as the overlying A horizon. Treasure soils have as little expression of the B2 horizon as is found in Brown soils developed from sandy loam material.

The Hesper soils have a heavy silty clay loam or light silty clay B2t horizon that is expressed to about the same degree as the B2 horizon of the Briggsdale soils. Hesper soils, however, have developed in parent material containing a high proportion of silt and very fine sand.

Brown soils in Treasure County that have developed from material weathered in place are in the Cushman, Renohill, and Terry series. The parent material of these soils differs.

The Cushman soils have a grayish-brown loam A horizon, a brown, prismatic light clay loam B2t horizon, and lime accumulated as nodules in the loam material. Their profile characteristics are similar to those of Fort Collins soils, but the Cushman soils have a thinner solum and have formed in material weathered in place from the weakly consolidated loam shale that is at a depth of 22 to 32 inches.

The Renohill soils, like the Nunn soils, have well-expressed A and B2 horizons in a horizon of segregated lime. The Renohill soils, however, have a thinner solum than the Nunn soils and have developed from material weathered in place from the weakly consolidated shale at

a depth of 26 to 40 inches. Nunn soils developed in deep clay loam.

The Terry soils, like the Treasure soils, have formed from sandy loam parent material, but it is residuum of weakly consolidated sandstone rather than the deep, transported material of the Treasure soils. Terry soils have a grayish-brown sandy loam A horizon, a light sandy clay loam B2t horizon, and lime segregated in the sandy loam material. Sandstone is at a depth of less than 32 inches. In the Cushman, Renohill, and Terry soils, horizon expression is medial.

Most striking in the Bew, Briggsdale, Hesper, and Treasure soils is the much larger amount of clay in the B2 horizon than in the A horizon. These soils have an abrupt or nearly abrupt boundary between the A and B horizons, and the amount of clay below the A horizon increases as depth increases. In the Brown soils in Treasure County having a textural B2 horizon, the clay in this horizon is more the result of intense weathering of material in place than it is of eluviation of clay from the A horizon. Probably the only clay that has been translocated is in the form of films or coats on the peds of the B2 horizon. The main eluviation in the A horizon has been the stripping of the organic matter from the sand and silt grains.

Grumusols

Grumusols are intrazonal soils that developed in parent material containing a high proportion of clay, normally more than 50 percent. They have weakly expressed or no horizonation below the A horizon. Grumusols are characterized by (1) a high percentage of clay throughout; (2) deep wide cracks that form upon drying; (3) grooved and polished faces, or slickensides, within the subsoil; and (4) sloughing of the granular material of the surface layer into the cracks that extend deep in the subsoil. The slickensides are the result of movement of one surface against an adjacent surface. When Grumusols are wet, they swell; when they dry, they shrink and form wide cracks.

The two kinds of Grumusols that occur in Treasure County are those that have a granular surface and those that have a crust on the surface. The Promise soils and the Marias and Pierre soils that are not saline-alkali have a granular surface layer and slickensides below a depth of 10 to 14 inches. Granules on the surface are continuously formed, particularly when these soils freeze and thaw. Marias and Pierre soils that are saline-alkali are Grumusols having a crusty surface and, below a depth of 4 to 6 inches, exchangeable sodium amounting to more than 15 percent. The surface crust is durable, continuous, and ¼ to 1 inch thick. It forms again as soon as these soils dry following a rain or an irrigation. Bleached grains of silt and sand adhere to the surface of these crusts and impart a grayish cast.

Solonchak soils

The Solonchak great soil group is intrazonal and includes very strongly saline soils that have developed under impeded or imperfect drainage. In this county the water table is high at all times and in some places is induced by excess seepage. Soluble salts have accumulated on or near the surface. Commonly, salts are crusted, or are efflorescent in spots, on the surface. These soils are without horizonation, except for the granular structure in the upper part of the profile that is the result of flocculation caused by excess soluble salts.

In this county the Laurel and Sage soils are representative of the Solonchak great soil group. Their surface crust of salt, granulated upper subsoil, and strong accumulation of soluble salts are characteristic of Solonchak soils. The water table is within 2 feet of the surface at some time during the year, mainly because of seepage from irrigation. Laurel soils have formed from loam and clay loam materials, whereas the Sage soils have formed from clay material.

Solonetz soils

Solonetz soils are intrazonal. In Treasure County these soils are of two kinds, soils that are solodized and those that are not. Solodization makes the B2 horizon less alkaline. Soils that are not solodized are in the Hysham series, and soils that are solodized are in the Arvada, Beckton, Gilt Edge, Hoven, McKenzie, and Winnett series.

The Hysham soils have developed from strongly alkaline loam and clay loam alluvium on well-drained fans. These soils have a light-colored A horizon less than 3 inches thick. It is underlain by a subsoil that has columnar or blocky structure and is extremely hard, strongly alkaline, and medium textured. Organic matter stains the structural aggregates of the B2 horizon with a few dark films, but there is no evidence of translocation and accumulation of clay. The surface layer and the subsoil have about the same texture but differ in stratification. The entire profile is strongly or very strongly alkaline; pH is 9.0 or higher. In most places a few seams of soluble salts are visible below a depth of about 12 inches.

In the solodized Solonetz soils, the normal profile generally consists of a light-colored A horizon that is underlain abruptly by a columnar B2t horizon containing considerably more clay than the A or C horizon. Below the solum, salts have accumulated. The B2 horizon generally has more than 15 percent exchangeable sodium.

The Hoven, Arvada, and Winnett soils have a light-gray loam A2 horizon, 1 to 6 inches thick, that is underlain abruptly by a columnar, strongly alkaline clay B2t horizon. The structural columns are stained on the outside by organic matter. The lower B and upper C horizons contain accumulations of salts and gypsum and are strongly alkaline. The Arvada soils have formed in alluvium of loam, clay loam, and clay texture. Hoven soils have formed from clay that was deposited in shallow, undrained basins. Loam or clay loam weathered in place from the underlying shale is the parent material of the Winnett soils.

The Gilt Edge soils have morphological features similar to those of the Arvada and Winnett but have different chemical properties. The B2 horizon of the Gilt Edge soils is neutral to moderately alkaline rather than strongly alkaline. In the B2 horizon, exchangeable sodium is less than 10 percent and the calcium to magnesium ratio is narrow. A horizon of segregated lime in the lower B and upper C horizons clearly separates the solum from the gypsum segregated in the lower C horizon. Sodium sulfate and other monovalent salts have been completely leached from the upper 5 to 8 feet of these soils. Gilt Edge soils show an advanced stage in solodization in which the chemistry has been completely changed without an accompany-

ing change in the morphology. These soils have developed in clay material on old landforms.

In Beckton soils solodization is even more advanced than it is in Gilt Edge soils. Beckton soils have developed from material similar to that of the Arvada soils. The Beckton soils have a light-colored A horizon that contains an abundance of bleached silt and sand grains. They have an A2&B2 horizon, a B2&A2 horizon, or both. It is underlain by a prismatic-blocky, clayey B2t horizon. A horizon of segregated lime clearly separates the solum from accumulations of gypsum in the lower part of the C horizon. The transitional A2&B2 or B2&A2 horizon presumably has formed from the degradation of a columnar B2 horizon that probably existed at one time. The B2 horizon is neutral to slightly alkaline, has a low percentage of exchangeable sodium, and has a narrow calcium to magnesium ratio. Unlike the Gilt Edge soils, Beckton soils have had chemical changes accompanied by changes in their morphology.

Soloth soils

Soloth soils are intrazonal. In them solodization is more advanced than it is in the solodized Solonetz soils. In Soloth soils the light-colored A2 horizon has been thickened at the expense of the B2 horizon and has been recalcified. The soils of the Shonkin series are the only Soloth soils in Treasure County.

The Shonkin soils have formed from clay deposited in shallow, undrained basins or depressions that are subject to periodic flooding and ponding. These soils have a light-gray, platy loam B2 horizon that is 6 to 9 inches thick and is underlain by an A2&B2 or a B2&A2 transitional horizon. Abundant bleached silt and sand grains are on structural aggregates and extend to a depth of 20 inches or more. The B2t horizon is brown, prismatic-blocky clay. Bleached material appears as frosting on the structural aggregates of the B2t horizon or as threads or seams along vertical faces in the upper part. The horizon of segregated lime is normally below a depth of 30 inches. Shonkin soils have a thicker A2 horizon than the Beckton soils and a transitional horizon (A2&B2 or B2&A2) that extends deeper into the profile.

Alluvial soils

The Alluvial great soil group is azonal and consists of soils that have developed from alluvium that was deposited recently on flood plains and, more recently, on fans. In places these soils are subject to periodic flooding that deposits a thin layer of fresh sediment on the surface. Consequently, these soils are stratified at or near the surface, and the deposits have not had time to be modified much by the soil-forming processes. Alluvial soils are calcareous from the surface, and they lack genetically related horizons. They directly inherit their characteristics from the sediments.

In this county, Alluvial soils are in the Banks, Bowdoin, Glendive, Havre, and Lohmiller series. The soils of each series are differentiated on the basis of texture of the subsoil below a depth of 10 inches down to a depth of 20 to 30 inches. The subsoil is coarse sand in the Banks soils, sandy loam or loamy fine sand in the Glendive soils, loam or silt loam in the Havre soils, silty clay loam, clay loam, or light clay in the Lohmiller soils, and fine clay in the Bowdoin soils.

Lithosols

The Lithosols are in the azonal order and consist of shallow to moderately deep soils that weathered in place from the weakly consolidated to the indurated bedrock. The weathered material is 5 to 30 inches thick. These soils have no horizonation or have only a very thin or weak A1 or Cca horizon. Consequently, these soils are much like the geologic material from which they have weathered. Relief is responsible for the lack of genetic horizons, for these soils are on steep slopes or in convex areas where runoff is rapid.

The Lithosols in Treasure County are in the Bainville, Flasher, Lismas, Midway, Travessilla, Tullock, and Wibaux series. The kind of soil is determined by the texture of the subsoil, the thickness and color of the A horizon, and the degree to which the bedrock is consolidated. The Lismas soils have a clay subsoil that is underlain by a substratum of platy clay shale. Flasher and Tullock soils have a sandy subsoil underlain by weakly consolidated sandstone. The Flasher soils are distinguished from the Tullock soils only by their thicker, darker colored A1 horizon that contains more organic matter than the A1 horizon of Tullock soils. Both the Bainville and Midway soils are underlain by weakly consolidated shale, but the Bainville soils have a loam or silt loam subsoil, and the Midway soils have a clay loam or silty clay loam subsoil. The Travessilla and Wibaux soils are underlain by hard indurated bedrock at a depth of less than 12 inches. The Travessilla soils are over hard sandstone bedrock, whereas the Wibaux soils are reddish in color and underlain by hard porcelanite or clinker beds.

Regosols

Regosols are azonal soils in which clearly defined horizons have not developed in the thick unconsolidated material that is not underlain by bedrock at a shallow or moderate depth. These soils generally are calcareous from the surface downward, and they have a thin A1 horizon or a weak horizon of segregated lime.

The Regosols in Treasure County are in the Nihill and the Dwyer series. Local relief prevents genetic horizons from forming in the Nihill soils, and loose sand resists horizonation in the Dwyer soils.

Descriptions of the Soil Series

In this subsection all the soil series represented in the county are described in detail. Each of these descriptions includes a profile at a specified location in the county. This profile represents the central concept, or is typical, of the series. Following the profile, there are given the range of characteristics of the horizons in the profile as they occur in the county, the kind of topography, the drainage and permeability, the vegetation, and the use of the soils in the series.

Arvada series

The Arvada series consists of Solonetz soils that have been solodized. These soils developed from deep, transported loam, clay loam, or clay material. The typical profile has an A2 horizon of light brownish-gray loam that is 6 inches thick and is underlain by a strongly alkaline, columnar light clay B2t horizon. The prismatic-

blocky silty clay loam B3 horizon is streaked with salts and is underlain by a calcareous clay loam Csa or Ccs horizon that has common seams of salts and gypsum. The C horizon is clay loam.

The Arvada soils are more strongly alkaline and have a more strongly saline substratum than the Gilt Edge soils and contain less clay in the B2t horizon. Their B2t horizons are more distinct and more clayey than those of the Hysham soils. The Arvada soils occur with the Gilt Edge and Laurel soils.

Typical profile of Arvada loam about 660 feet south and 660 feet east of the NW. corner of the SW¼ of sec. 24, T. 6 N., R. 34 E.; in grassland on slope of 2 percent:

A2—0 to 6 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; moderate, thin, platy structure; vesicular in upper inch; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; abrupt boundary.

B21t—6 to 9 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, columnar structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; distinct clay films; noncalcareous; pH 9.4; clear boundary.

B22t—9 to 13 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium, prismatic structure that separates to moderate, medium, angular blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; distinct clay films; noncalcareous; pH 9.4; clear boundary.

B3—13 to 17 inches, light olive-brown (2.5Y 5/3) silty clay loam, olive brown (2.5Y 4/3) when moist; moderate, medium, prismatic-blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; patchy clay films; weakly calcareous; pH 9.4; gradual boundary.

C1cs—17 to 35 inches, olive (5Y 5/3) clay loam, olive (5Y 4/3) when moist; massive; very hard when dry, friable when moist, sticky and plastic when wet; calcareous; numerous seams of gypsum; pH 9.0.

IIC2—35 to 60 inches, olive (5Y 5/3), stratified loam and clay loam, olive (5Y 4/3) when moist; massive; hard to very hard when dry, friable when moist; calcareous; pH 9.0.

Range in characteristics: Loam, clay loam, and clay types occur in the county. The thickness of A1 and A2 horizons combined is ½ inch to 7 inches. When dry, the A2 horizon has a color with value of 6 to 8. Structure of the B2 horizon is moderate to strong and columnar, prismatic-blocky, or blocky. The B2 horizon ranges from neutral to very strongly alkaline (pH 7.0 to 9.5) in reaction and from heavy clay loam to clay in texture. About 36 to 65 percent of the B2 horizon is clay. The B2 horizon is 3 to 10 inches thick. The boundary between the A and the B2 horizons is abrupt or is gradual, and, in some places, there is a 4- to 7-inch AB or BA transition horizon that has blocks coated with gray silt. The B3 horizon is speckled with salts and gypsum or with nodules of lime. The upper part of the C horizon is either a strongly saline Csa horizon with common streaks of salts, or it is a Ccs horizon containing nodules of lime and, in some places, a few nests of gypsum within 40 inches of the surface. The C horizon ranges from loam to clay.

Topography: Nearly level to sloping fans and terraces.

Drainage and permeability: Good drainage; slow to very slow permeability in the subsoil.

Vegetation: Alkali sacaton, inland saltgrass, western wheatgrass, and greasewood.

Use: Mainly range; a few small areas under irrigation.

Bainville series

In the Bainville series are Lithosols that are light-colored, calcareous loams and silt loams developed from material weathered in place from weakly consolidated shale. The only change from the weathered parent material reflected in the soil profile is a very thin, slightly darkened A1 horizon.

Bainville soils occur with the Cushman, Midway, Flasher, Tullock, and Travessilla soils. Bainville soils lack the B2 horizon that occurs in the Cushman soils. The subsoil of Bainville soils is loam or silt loam, whereas that of the Midway soils is clay loam or silty clay loam. The Bainville soils are not so sandy as the Flasher and Tullock soils, which are Lithosols weathered from weakly consolidated sandstone or sandy shale. They lack the hard sandstone that occurs in the Travessilla soils at a depth of less than 20 inches.

Typical profile of Bainville silt loam along county road in the NW. corner of the SW¼ of sec. 26, T. 3 N., R. 36 E.; in grassland:

A1—0 to 4 inches, light olive-brown (2.5Y 5/3) silt loam, olive brown (2.5Y 4/3) when moist; weak, thick, platy structure; slightly hard when dry, very friable when moist; weakly calcareous; pH 8.5; clear, irregular lower boundary.

C—4 to 17 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/3) when moist; very weak, coarse, blocky structure that breaks to thick, platy structure in lower part; hard when dry, very friable when moist; strongly calcareous; pH 8.5; gradual boundary.

CR—17 to 24 inches, pale-yellow (5Y 7/3) silt loam, olive (5Y 5/3) when moist; abundant, platy, soft shale or sandstone that is easily broken with finger; strongly calcareous; pH 8.5.

R—24 inches +, unweathered, olive-colored, sandstone or loamy shale; fine grained; strongly calcareous; weakly consolidated.

Range in characteristics: Loam and silt loam types occur in the county. The A1 horizon is noncalcareous in some places where it is more than 3 inches thick. The value of the color of the A1 horizon is 5 or 6 (dry) and 3.5 (moist). Weakly consolidated shale occurs at a depth of 5 to 30 inches. In some places a stratum of hard rock occurs at a depth of more than 30 inches. Below the A1 or Ap horizon, but above a depth of 30 inches, texture ranges from very fine sandy loam to light clay loam that is less than 30 percent clay.

Topography: Slopes are convex on crests of ridges and hills and are plane and steep on the sides of hills and valleys.

Drainage and permeability: Excessive drainage; rapid runoff; moderate permeability.

Vegetation: Mainly short grasses but some mid and tall grasses and some brush and trees in coves.

Use: Mainly range that yields well; milder slopes are farmed along with larger areas of Cushman soils.

Banks series

The Banks series consists of shallow Alluvial soils that developed from coarse-textured alluvium. These soils have a light brownish-gray very fine sandy loam A horizon, a loamy fine sand or fine sand C horizon, and, within 14 inches of the surface, a substratum of loose sand or sand and gravel.

The Banks soils have a coarser textured subsoil and are shallower to sand and gravel than the Glendive, Havre, and Lohmiller soils. They lack the B2 and Cca horizons that occur in the Beaverton soils.

Typical profile of Banks very fine sandy loam in the SE¼ of sec. 11, T. 6 N., R. 35 E.; in brushy pasture:

A1—0 to 4 inches, light brownish-gray (2.5Y 6/2) very fine sandy loam, grayish brown (2.5Y 5/2) when moist; soft when dry, very friable when moist; calcareous; pH 8.4.

C1—4 to 10 inches, light brownish-gray (2.5Y 6/2) loamy fine sand and fine sand, grayish brown (2.5Y 5/2) when moist; loose; calcareous; pH 8.4.

IIC2—10 to 30 inches, loose, incoherent sand, a very small percentage of fines, and about 10 to 20 percent gravel.

Range in characteristics: The texture of the surface layer ranges from loam to loamy fine sand and from gravelly loam to gravelly loamy fine sand. The finer textured part of the profile is not more than 8 inches thick, and the depth to loose sand or to sand and gravel ranges from 8 to 14 inches. Where a dark-colored A1 horizon occurs, it is not more than 4 inches thick.

Topography: Level flood plains.

Drainage and permeability: Variable drainage; occasional overflow; rapid permeability in the subsoil.

Vegetation: Brush, cottonwood, and an understory of grasses.

Beaverton series

The Beaverton series consists of Brown soils that developed in a shallow mantle of loam over loose sand and gravel. In the Beaverton soils there is an A1 horizon consisting of 2 inches of grayish-brown gravelly loam, a B2t horizon of brown, angular blocky clay loam, and a Cca horizon of segregated lime. The substratum occurs at a depth of 14 to 22 inches and consists of loose sand and gravel.

Beaverton soils are shallower to the sand and gravel substratum than the Wanetta soils. They have a B2 horizon and a Cca horizon, which are absent in the Banks soils.

Typical profile of Beaverton gravelly loam just southeast of the NW. corner of the NE¼ of sec. 27, T. 6 N., R. 34 E.; in grassland:

A1—0 to 2 inches, grayish-brown (2.5Y 5/2) gravelly loam, very dark grayish brown (2.5Y 3/2) when moist; weak, thin, platy structure; soft when dry, very friable when moist; noncalcareous; abrupt boundary.

B2t—2 to 7 inches, dark grayish-brown (10YR 4/2) gravelly clay loam that is brown (10YR 5/3) if crushed; when moist, dark brown (10YR 3/3) in place and brown (10YR 4/3) crushed; moderate, very fine, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; continuous clay films on ped surfaces; noncalcareous; clear boundary.

B3ca—7 to 12 inches, grayish-brown (10YR 5/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; many threads of segregated lime; clear boundary.

IIC1ca—12 to 16 inches, grayish-brown (10YR 5/2) very gravelly sandy loam, dark grayish brown (10YR 4/2) when moist; single grained; loose; strongly calcareous; gradual boundary.

IIIC2—16 to 24 inches +, mixture of gravel and loose sand.

Range in characteristics: Only gravelly loam has been mapped in this county. The A horizon ranges from 2 to 4 inches in thickness. Its color has a value of 5 when the horizon is dry and 3 or more when the horizon is moist. Hue is 10YR or 2.5Y. The B2 horizon is 30 to 40 percent clay and has moderate to strong structure. Its color has a value of 4 or 5 (dry) and 3 or 4 (moist), a chroma of 3 or 4, and a hue of 10YR or 2.5Y. The B3ca and IIC1ca horizons are distinct or prominent. When they are dry, their color has a value of 5 or more. The depth to the substratum of loose sand and gravel is 14 to 22 inches. The percentage of gravel on the surface and in the B2 horizon ranges from less than 5 percent to about 30 percent, by volume.

Topography: High gravel-capped benches that have nearly level slopes.

Drainage and permeability: Good drainage; excessive internal drainage; moderate permeability in the subsoil.

Vegetation: Mixed short and mid grasses, including blue grama and needle-and-thread; also, threadleaf sedge, big sagebrush, and cactus.

Use: Primarily range, but a few isolated areas are farmed along with larger areas of deeper soils.

Beckton series

The Beckton series consists of well-drained Solonetz soils that have been strongly solodized. These soils developed in deep loam and clay loam material that was transported. In the typical profile, the Ap horizon is light brownish-gray clay loam that is underlain by a strong, prismatic-blocky clay B2t horizon in which the blocks in the upper part are coated with gray silt. A calcareous clay B3 horizon is underlain by a clay loam Cca horizon that contains threads and nodules of lime. In the lower part of the C horizon are stratified material and threads or nests of gypsum.

The silt-coated blocks that occur in the upper part of the B2 horizon of the Beckton soils, and that indicate solodization, do not occur in the Nunn soils. The Beckton soils have a neutral and slightly alkaline, prismatic-blocky B2 horizon in which salts and gypsum have accumulated below the lime segregations, whereas the Arvada soils have a strongly alkaline and very strongly alkaline, columnar B2 horizon in which the percentage of exchangeable sodium and the salinity are high. Also, salts have accumulated in the lower part of the B and in the upper part of the C horizons of the Arvada soils. Beckton soils lack the abrupt boundary between the A and B horizons that occurs in the Briggsdale soils. In addition, the bleached silt and sand extend deeper in the solum in the Beckton soils than in the Briggsdale soils. In the Briggsdale soils, the bleached materials are only in the A1 horizon.

Typical profile of Beckton clay loam about 100 feet east of the NW. corner of the SW¼ of sec. 17, T. 6 N., R. 36 E.; in irrigated field:

Ap—0 to 6 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, platy structure that separates to strong, fine, granular structure; very hard when dry, friable when moist, sticky and plastic when wet; abundant bleached silt and sand; noncalcareous.

B2t—6 to 15 inches, dark grayish-brown (2.5Y 4/2) clay that is light olive brown (2.5Y 5/3) if crushed; when moist, very dark grayish brown (2.5Y 3/2) in place and olive brown (2.5Y 4/4) crushed; strong, medium, prismatic structure that separates easily to strong, fine and medium, angular blocky structure; extremely hard when dry, friable when moist, sticky and very plastic

when wet; thick continuous clay films on all structural surfaces; upper 2 to 4 inches have a light-grayish cast caused by clear silt and very fine sand; pH 7.8; noncalcareous; clear boundary.

B3—15 to 22 inches, grayish-brown (2.5Y 5/2) light clay that is light yellowish brown (2.5Y 6/3) if crushed; when moist, dark grayish brown (2.5Y 4/2) in place and light olive brown (2.5Y 5/3) crushed; moderate, medium, prismatic structure that separates to strong, medium, angular blocky structure; very hard when dry, firm when moist, sticky and very plastic when wet; thin clay films; calcareous; pH 8.4; clear boundary.

C1ca—22 to 30 inches, olive-gray (5Y 5/2) heavy clay loam, olive gray (5Y 4/2) when moist; moderate, medium and coarse, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; calcareous; few threads of lime; pH 8.6; gradual boundary.

C2ca—30 to 45 inches, light olive-gray (5Y 6/2) clay loam, olive gray (5Y 5/2) when moist; massive; very hard when dry, friable when moist, sticky and plastic when wet; calcareous; threads and nodules of lime; pH 8.8; gradual boundary.

IIC3cs—45 to 62 inches, pale-olive (5Y 6/3), stratified loam, silt loam, and very fine sandy loam, olive (5Y 5/3), when moist; slightly hard when dry, very friable when moist; calcareous; few threads and nests of soluble salts and gypsum.

Range in characteristics: In this county the surface layer is clay and clay loam, but Beckton soils are mapped only in a complex with Nunn soils. The Ap horizon contains few to common bleached grains the size of silt and sand. When dry, the Ap horizon has a color with a value of 6 or 7, a chroma of 2 or 3, and a hue of 2.5Y and 10YR.

The B2t horizon is 38 to 40 percent clay and has moderate to strong structure. When dry, the B2 horizon has a color with a value of 4 or 5, a chroma of 2 or 3, and a hue of 2.5Y or 10YR. The B2 horizon is 8 to 12 inches thick. The thickness of the Ap and B2t horizons combined is 10 to 16 inches. In the Cca horizon the segregations of lime are few to common and are in the form of seams and nodules. Stratified material occurs below a depth of 40 inches. A few to common seams or nests of gypsum are present below 40 inches.

Topography: Level terraces or fan terraces.

Drainage and permeability: Good drainage; moderately slow to slow permeability in the subsoil.

Vegetation: Western wheatgrass, blue grama, silver sagebrush.

Use: Irrigated cropland and grazing.

Bew series

The Bew series consists of Brown soils that developed in deep, transported clay material. In the typical profile the Ap horizon is brown, granular clay loam and is underlain by a brown, prismatic-blocky clay B2t horizon. A prismatic clay B3ca horizon is underlain by a clay Cca horizon that contains nodules of segregated lime. The C horizon is clay.

The Bew soils have more clay in the B2t horizon and throughout the profile than the Nunn soils, which developed from clay loam instead of from clay material. Bew soils have strongly expressed A and B horizons, whereas the Marias and Promise soils are Grumusols and do not have a B horizon. The columnar B2 horizon that occurs in the Gilt Edge soils is not present in the Bew soils. Bew soils occur with the Shonkin and Hoven soils.

Typical profile of Bew clay loam 750 feet north of the center of sec. 3, T. 6 N., R. 35 E.; in seeded abandoned cropland:

Ap—0 to 5 inches, brown (10YR 5/3) clay loam, brown (10YR 3/3) when moist; weak, thick, platy structure that separates to moderate, very fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 7.4.

B2t—5 to 13 inches, brown (10YR 4/3) clay that is yellowish brown (10YR 5/4) if crushed; when moist, dark brown (10YR 3/3) in place and dark yellowish brown (10YR 4/4) crushed; strong, fine and medium, prismatic structure that breaks easily to strong, fine, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; thick continuous clay films on all ped surfaces; noncalcareous; pH 8.0; clear boundary.

B3ca—13 to 18 inches, light olive-brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) when moist; strong, medium, prismatic structure that breaks to moderate, medium and coarse, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; clay films on vertical and horizontal faces; weakly calcareous; few threads of lime; pH 8.4; gradual boundary.

C1ca—18 to 22 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; strong, medium, prismatic structure that breaks to moderate, medium and coarse, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; few distinct clay films; moderately calcareous; few threads and nodules of lime; pH 8.4; gradual boundary.

C2ca—22 to 46 inches, olive-gray (5Y 5/2) light clay, olive gray (5Y 4/2) and olive (5Y 4/3) when moist; massive or weak, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; moderately calcareous; few threads and nodules of lime; pH 8.5; gradual boundary.

IIC3—46 to 72 inches, olive-gray (5Y 5/2) clay loam, olive gray (5Y 4/2) when moist; massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; few fine threads of lime and few nests of gypsum in lower part; pH 9.0.

Range in characteristics: Above the Cca horizon, the solum is 16 to 20 inches thick. The B2t horizon is 50 to 55 percent clay, or about 18 to 25 percent more clay than the A1 or Ap horizon. The B2t horizon has a color with a value of 5 or 4, a chroma of 3 or 4, and a hue of 2.5Y or 10YR. In some places the texture of the substratum below a depth of 30 inches is a heavy clay loam. Below a depth of 40 inches, the substratum is clay, stratified loam to clay loam, or gravelly loam. In undisturbed areas the A1 horizon consists of 2 to 3 inches of loam and has many bleached grains of silt and sand.

Topography: Nearly level to undulating high terraces north of the Yellowstone River.

Drainage and permeability: Good drainage; moderately slow permeability in the subsoil.

Vegetation: Native and seeded grasses.

Use: Most areas have been farmed in past years and are now seeded to crested wheatgrass.

Bowdoin series

The Bowdoin series consists of well-drained, nonsaline and nonsodic heavy clay Alluvial soils that intergrade toward Grumusols. These soils have a very thin, crusty clay surface layer and a massive or weak, blocky clay subsoil.

The Bowdoin soils have more clay throughout than the Lohmiller soils. They do not have a granular surface layer

and a blocky subsoil as do the Marias and Promise soils. Bowdoin soils are not strongly alkaline (sodic) in the subsoil, as are the saline-alkali Marias soils.

Typical profile of Bowdoin clay located in SW. corner of the SW¼ of sec. 27, T. 7 N., R. 37 E.; in pasture:

A1—0 to 1 inch, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; strong, very fine, angular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; clear boundary.

C1—1 inch to 18 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, medium and coarse, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.2.

C2—18 to 42 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; very few splotches of gypsum; weakly calcareous; pH 8.2.

IIC3—42 to 62 inches, pale-yellow (2.5Y 7/4), stratified loam, very fine sandy loam, and fine sandy loam, grayish brown (2.5Y 5/2) when moist; soft when dry, friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 9.0.

Range in characteristics: The thickness of the clay over the stratified sediments ranges from 32 to 42 inches. Below a depth of 18 to 24 inches, there are few or no visible accumulations of gypsum and other salts. The surface layer and upper subsoil are 55 to 65 percent clay.

Topography: Level low terraces or high bottom lands.

Drainage and permeability: Good drainage but slow surface runoff; very slow permeability.

Vegetation: Western wheatgrass and big sagebrush.

Use: Mainly native pasture; a few areas are farmed along with other soils.

Briggsdale series

The Briggsdale series consists of deep, well-drained Brown soils that intergrade toward Planosols. Briggsdale soils developed from deep, transported, well-graded loam material. In the typical profile, the A2 horizon consists of 2 inches of light brownish-gray loam and is underlain by a transitional AB horizon that is 2 inches of grayish-brown loam. The B2t horizon of strong, prismatic-blocky heavy clay loam or light clay is underlain by a clay loam B3 horizon that is underlain, in turn, by a clay loam Cca horizon containing nodules of lime. The C horizon is loam.

The Briggsdale soils have more clay in the B2t horizon than do the Fort Collins soils. Also, a thin A2 horizon has developed in the Briggsdale soils, but not in the Fort Collins soils. Briggsdale soils have less clay in the B2t horizon and throughout their profile than have the Bew soils, which are Brown soils formed from clay material. The B2t horizon of Briggsdale soils is more strongly expressed texturally and structurally than that of the Nunn soils. The Nunn soils developed in clay loam rather than loam material. The Briggsdale soils have not been solodized as have the Beckton soils, which have gray (dry) AB and BA horizons above the B2t horizons. Briggsdale soils are not so silty as the Hesper soils.

Typical profile of Briggsdale loam on east side of road just south of the center of the NW¼ of sec. 34, T. 7 N., R. 34 E.; in grassland:

A2—0 to 2 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, thin, platy structure; soft when dry, very friable when moist; abundant bleached silt and very fine sand; noncalcareous; pH 7.0; clear boundary.

AB—2 to 4 inches, grayish-brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; strong, thin, platy structure that separates to strong, very fine, subangular blocky structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.0; abrupt boundary.

B2t—4 to 14 inches, brown (10YR 4/3) light clay that is brown (10YR 5/3) if crushed; when moist, dark brown (10YR 3/3) in place and brown (10YR 4/3) crushed; moderate, medium, prismatic structure that breaks easily to strong, fine and very fine, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; thick continuous clay films; noncalcareous; pH 7.6; clear boundary.

B3—14 to 18 inches, brown (10YR 5/3) clay loam, brown (10YR 4/3) when moist; moderate, medium, prismatic structure that separates to moderate, medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; patchy clay films; calcareous; few threads of lime; pH 8.6.

C1ca—18 to 46 inches, pale-yellow (2.5Y 7/4) light clay loam, light olive brown (2.5Y 5/4) when moist; weak, coarse, prismatic structure to massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; common nodules of segregated lime; pH 8.5; gradual boundary.

C2—46 to 60 inches, light yellowish brown (2.5Y 6/3) loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; few threads of lime; pH 8.6.

Range in characteristics: Only Briggsdale loam has been mapped in this county. In places the A2 horizon does not occur, and in these places bleached particles the size of silt and sand are abundant in the A1 horizon and give it a distinct gray appearance. The A1 horizon has a color with a value of 5 or more when dry and 3 or more when moist; chroma is 2 or 3, and hue is 10YR or 2.5Y. The B2t horizon is 7 to 10 inches thick. It is 38 to 45 percent clay and contains 15 to 20 percent more clay than the A1 or Ap horizon. The color of the B2 horizon has a value of 4 or 5, a chroma of 2 to 4, and a hue of 10YR or 2.5Y. In some places the blocks in the upper ½ inch to 1½ inches of the B2 horizon have a frosted appearance that is imparted by bleached silt and sand. The thickness of the A2 and the AB horizons combined is 3 to 6 inches. The thickness of the noncalcareous solum ranges from 12 to 20 inches. The Cca horizon contains few to many soft nodules of segregated lime. Nests or seams of gypsum occur below 50 inches in some places. A substratum of shale occurs below a depth of 3 feet in places.

Topography: Nearly level to sloping concave slopes, shallow swales in uplands, and shallow heads of drains.

Drainage and permeability: Good drainage; moderately slow permeability in the subsoil.

Vegetation: Western wheatgrass, blue grama, and sagebrush.

Use: Nonirrigated cropland and rangeland.

Cherry series

The Cherry series consists of Brown soils that have a very thin solum. These soils developed in deep, transported, moderately fine textured material. Below their grayish-brown clay loam A1 or Ap horizon, the horizons of these soils are only weakly expressed. These horizons are

a B2 horizon, C1ca and C2ca horizons, and a C3 horizon. The clay loam B2 horizon is a color horizon, structural horizon, or both. The C1ca and C2ca horizons are clay loam containing a few threads or nodules of lime. The C3 horizon is clay loam.

The surface layer of these soils is darker colored than the rest of the solum and is darker colored than the surface layer of Lohmiller soils. Also, Cherry soils have a structural B2 horizon and, in the C horizon, have segregated lime or contain more lime than in the A1 or Ap horizon. On the other hand, the Lohmiller soils are nearly uniform in color and in content of lime, and they do not have a structural B2 horizon. Cherry soils lack the textural B2t horizon that occurs in the Nunn soils. They are finer textured throughout than the McRae soils, which are Brown soils that formed in loam material. Cherry soils do not have the weakly consolidated shale substratum that underlies the Renohill soils.

Typical profile of Cherry clay loam ⅛ mile north and 500 feet west of the SE. corner of the SW¼ of sec. 4, T. 6 N., R. 36 E.; in grassland:

A1—0 to 3 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 8.0; clear boundary.

B2—3 to 8 inches, olive-brown (2.5Y 4/3) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium and coarse, prismatic structure; hard when dry, friable when moist, sticky and plastic when wet; thin patchy to continuous clay films; noncalcareous; pH 8.0; clear boundary.

C1ca—8 to 14 inches, light olive-brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) when moist; weak, medium and coarse, prismatic structure; hard when dry, friable when moist, sticky and plastic when wet; moderately calcareous; few threads of nodules of segregated lime; pH 8.4; gradual boundary.

C2ca—14 to 26 inches, light olive-brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; moderately calcareous; few threads or nodules of segregated lime; pH 8.4; gradual boundary.

C3—26 to 40 inches, light olive-brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) when moist; massive; very hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous; pH 8.4; clear boundary.

IIC4—40 to 60 inches, light yellowish-brown (2.5Y 6/3), stratified loam, silt loam, and very fine sandy loam, olive brown (2.5Y 4/3) when moist; soft to slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous.

Range in characteristics: Clay loam is the dominant type, but the clay type is also mapped. The B2 horizon, which is 4 to 8 inches thick, has color with a value of 4 or 5 (dry), a chroma of 2 to 4, and a hue of 2.5Y. The B2 horizon is weakly calcareous in places. In cultivated areas the A1 and B2 horizons are mixed into the Ap horizon, which is noncalcareous or only weakly calcareous. The normal horizon sequence in cultivated areas is Ap, Cca, and C. The stratified coarser textured material occurs below a depth of 20 inches.

Topography: Nearly level to sloping fans and terraces.

Drainage and permeability: Good drainage; in irrigated areas the level of ground water is within 5 feet of the surface during part of the year; moderately slow permeability in the subsoil.

Vegetation: Mixed mid and short grasses.

Use: Primarily irrigated and nonirrigated cropland and grazing.

Cushman series

The Cushman series consists of Brown soils that have a very thin solum and developed from loam material weathered in place from the underlying weakly consolidated shale. The typical profile has a thin, grayish-brown loam A1 horizon, a brown, prismatic light clay loam B2t horizon, prismatic light clay loam or loam B3ca and Cca horizons containing segregated lime, and an R horizon of weakly consolidated shale.

Cushman soils are not so clayey throughout their profile as are the Renohill soils but have a solum of the same thickness. A B horizon and a distinct Cca horizon occur in the Cushman soils, but not in the Bainville. The Cushman soils are not so sandy as the Terry soils. The shale substratum at a moderate depth differentiates the Cushman soils from the Fort Collins soils.

Typical profile of Cushman loam 25 feet south and 10 feet west of the NE. corner of sec. 6, T. 7 N., R. 34 E.; in grassland on slope of 4 percent:

A1—0 to 2 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.0; clear boundary.

B2t—2 to 7 inches, brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; thin clay films; noncalcareous; pH 7.4; clear boundary.

B3ca—7 to 12 inches, pale-brown (10YR 6/3) light clay loam, brown (10YR 5/3) when moist; moderate, medium, prismatic structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; common soft masses or nodules of segregated lime; pH 8.4; gradual boundary.

C1ca—12 to 20 inches, light brownish-gray (2.5Y 6/2) heavy loam or light clay loam, grayish brown (2.5Y 5/2) when moist; weak, coarse, prismatic structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; common masses of segregated lime; pH 8.5; gradual boundary.

C2ca—20 to 24 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/3) when moist; massive in the upper part and platy structure in lower; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fragments of sandstone and shale; calcareous; few nodules of segregated lime; pH 8.5; clear boundary.

R—24 to 30 inches, olive-colored, interbedded loamy shale and sandstone; weakly consolidated.

Range in characteristics: Only the loam type is mapped in this county. Shale or sandstone is at a depth of 16 to 32 inches, and the noncalcareous solum extends to a depth of 6 to 10 inches. The A1 horizon is 2 to 4 inches thick. The B2 horizon is 25 to 32 percent clay and has moderate or strong, prismatic or blocky structure. When dry, it has a color with a value of 4 or 5, a chroma of 3 or 4, and a hue of 2.5Y or 10YR. The B3ca horizon does not occur or is very thin in some places. The Cca horizon has few to common segregations of lime. The underlying material is weakly consolidated and consists of silt loam or sandy shale or sandstone. In cultivated areas all or nearly all of the material in the A1 and B2 horizons is mixed into

the Ap horizon. The normal sequence of the horizons is Ap, B2ca, Cca, and R.

Topography: Nearly level to rolling, eroded uplands.

Drainage and permeability: Good drainage; moderate permeability in the subsoil.

Vegetation: Western wheatgrass, prairie junegrass, needle-and-thread, blue grama, other grasses, and big sagebrush.

Use: Nonirrigated cropland and rangeland.

Dwyer series

In the Dwyer series are Regosols that consist of light-colored, calcareous, loose sand that was laid down by the wind. These soils have an A1 horizon that consists of 2 inches of slightly darkened fine sand and is underlain by a fine sand subsoil.

Weakly consolidated sandstone does not occur within 30 inches of the surface, as it does in the Tullock soils. The subsoil of the Dwyer soils is looser and sandier than that of the Glendive soils, but it is not so coarse textured as the subsoil of the Banks soils.

Typical profile of Dwyer fine sand ⅛ mile north and 100 feet east of the SW. corner of the SE¼ of sec. 10, T. 6 N., R. 35 E.:

A1—0 to 2 inches, grayish-brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) when moist; single grain; loose; calcareous.

C1—2 to 60 inches, light brownish-gray (2.5Y 6/2) fine sand, grayish brown (2.5Y 5/2) when moist; single grain; loose; calcareous.

Range in characteristics: Only the fine sand type is mapped in this county. The A1 horizon ranges from 0 to 5 inches in thickness. It is noncalcareous in places. In the lower subsoil there is some evidence that the content of lime has increased. A few fine pebbles occur in places.

Topography: Wind-laid material that is rolling to choppy on the surface.

Drainage and permeability: Excessive internal drainage; rapid permeability.

Vegetation: Mid and tall grasses, mainly sand reedgrass, Indian ricegrass, and needle-and-thread.

Use: Entirely native pasture.

Edgar series

The Edgar series consists of Brown soils that have a very thin solum and developed from transported, deep, well-graded loam material. The typical profile has a grayish-brown loam A horizon, a light olive-brown, prismatic loam B2ca horizon, and a loam Cca horizon in which nodules of segregated lime are common. The C horizon is also loam. The Edgar soils developed from material similar to that from which the Fort Collins soils developed, but the Edgar soils have a thinner solum and contain less clay in their B2 horizon. Edgar soils have a solum of the same thickness as that of the McRae soils, but the B2 horizon of Edgar soils is more strongly expressed, and the Cca horizon is more distinct and contains more segregations of lime. Edgar soils are not so fine textured as the Cherry soils and have more distinct horizons of segregated lime.

Typical profile of Edgar loam near the center of the NW¼ of sec. 7, T. 6 N., R. 38 E.; in cultivated field:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/3) when moist; moderate, fine, granular structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.4.

B2ca—7 to 12 inches, light olive-brown (2.5Y 5/4) loam, olive brown (2.5Y 4/4) when moist; moderate, medium, prismatic structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; thin patchy clay films; calcareous, few nodules of segregated lime; pH 8.2; clear boundary.

C1ca—12 to 34 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/3) when moist; massive; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; common soft masses of segregated lime; pH 8.4; gradual boundary.

IIC2—34 to 60 inches, pale-yellow (2.5Y 7/4) light clay loam or heavy loam, light olive brown (2.5Y 5/4) when moist; massive; hard when dry, very friable when moist, sticky and plastic when wet; calcareous; pH 8.6.

Range in characteristics: Only the loam type is mapped in this county. The noncalcareous A and B horizons have a combined thickness of 6 to 12 inches. The A horizon has a color with a value of 5 or more (dry) and more than 3.5 (moist), a chroma of 2 or 3, and a hue of 10YR or 2.5Y. The thin noncalcareous B2 horizon is absent in many places. Where it occurs, its color has a chroma of 3 or 4 and a hue of 2.5Y or 10YR. The Cca has common to many soft nodules of segregated lime that, when dry, have a color with a value of 6 or more. Where a contrasting substratum occurs, it is at a depth of 24 to more than 40 inches. A few pebbles are on the surface and in the profile in places. In grassland, the solum has an A1 horizon of light brownish-gray loam 2 to 3 inches thick and a B2 horizon of brown, prismatic loam 4 to 6 inches thick.

Topography: Nearly level to strongly rolling benches of uplands.

Drainage and permeability: Good drainage; moderate permeability in the subsoil.

Vegetation: Mid and short grasses consisting of blue grama, western wheatgrass, prairie junegrass, needle-and-thread, and fringed sagewort.

Use: Irrigated and nonirrigated cropland and rangeland.

Fattig series

In the Fattig series are Brown soils that have a thick solum. These soils developed in material that weathered in place from carbonaceous loamy shale and sandstone of Tertiary or Cretaceous age. They have a dark-gray loam A1 horizon, a very dark gray, prismatic-blocky, clayey B2t horizon, and a substratum of calcareous, weakly consolidated, loamy shale, siltstone, or sandstone.

Fattig soils have a thicker solum and a darker colored A horizon than the Cushman and the Renohill soils. Also, the B2t horizon of Fattig soils contains more clay than that of the Cushman soils, and it is more strongly expressed than the B2t horizon of the Renohill soils.

Typical profile of Fattig loam 350 feet west and 50 feet south of the NE. corner of sec. 23, T. 8 N., R. 32 E.; in grassland:

A1—0 to 3 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; moderate, fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 6.5; clear boundary.

B21t—3 to 14 inches, very dark gray (10YR 3/1) clay loam, black (10YR 2/1) when moist; moderate, medium, prismatic structure that separates to strong, fine and

medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; thick continuous clay films; noncalcareous; pH 6.8; gradual boundary.

B22t—14 to 25 inches, dark-gray (10YR 4/1) clay loam, black (10YR 2/1) when moist; moderate, medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; thick clay films; noncalcareous; pH 7.1; gradual boundary.

B23t—25 to 38 inches, very dark gray (10YR 3/1) heavy clay loam or light clay mottled with light olive brown (2.5Y 5/4), black (10YR 2/1) mottled with olive brown (2.5Y 4/4) when moist; moderate, medium and coarse, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; distinct clay films; noncalcareous; pH 7.2; gradual boundary.

IIR—38 to 48 inches, pale-yellow (2.5Y 7/3) weakly consolidated, calcareous siltstone and sandstone, light olive brown (2.5Y 5/3) when moist.

Range in characteristics: Loam is the only type mapped in this county. The A1 horizon has a color with a value of 3 or 4 (dry) and 1 or 2 (moist) and a chroma of 1 or 2. The B2 horizon is 35 to 45 percent clay and has a color with a value of 3 or 4 and a chroma of 1 or 2. The depth to the unweathered bedrock is 24 to 40 inches.

Topography: Nearly level to rolling, eroded uplands.

Drainage and permeability: Good drainage; moderately slow permeability in the subsoil.

Vegetation: Mixed mid and short grasses that include western wheatgrass, blue grama, and needle-and-thread; also fringed sagewort and big sagebrush.

Use: Native rangeland.

Flasher series

The Flasher series consists of dark-colored, sandy Lithosols that developed from material weathered in place from the underlying weakly consolidated sandstone or compact beds of sand. These soils have a dark, grayish-brown A1 or Ap horizon, a light yellowish-brown, strongly calcareous subsoil, and, at a depth of 26 inches, a substratum of weakly consolidated sandstone.

Flasher soils have a thicker and darker colored A horizon than the Tullock and the Dwyer soils. The solum of the Flasher soils is not so loose and sandy as that of the Dwyer soils, and the sandstone substratum is nearer the surface. The Flasher soils have a darker colored A horizon than the Bainville soils and are more sandy throughout. They do not have a B horizon, as do the Terry soils.

Typical profile of Flasher fine sandy loam about 450 feet north and 100 feet west of the SE. corner of the NE¼ of sec. 9, T. 3 N., R. 38 E.; in cultivated field:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist; noncalcareous; pH 8.2.

C1—8 to 26 inches, light yellowish-brown (2.5Y 6/3) light fine sandy loam or heavy loamy fine sand, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; strongly calcareous; pH 8.5; gradual boundary.

R—26 to 60 inches, light yellowish-brown (2.5Y 6/3) light fine sandy loam or loamy fine sand, light olive brown (2.5Y 5/4) when moist; massive; evidence of weak consolidation and compaction when dry; hard when dry, very friable when moist; strongly calcareous.

Range in characteristics: Fine sandy loam and loamy fine sand types are mapped in this county. The A1 horizon ranges from 6 to 12 inches in thickness and is noncalcareous or weakly calcareous. Its color has a value of 4 or 5 (dry) and 2 or 3 (moist), a chroma of 2 or 3, and a hue of 2.5Y or 10YR. A calcareous AC horizon, 3 to 7 inches thick, occurs in many places. The C horizon is fine sandy loam to loamy fine sand and is moderately to strongly calcareous. The color of the C horizon has a value of 6 or more (dry) a chroma of 3 or 4, and a hue of 2.5Y or 5Y. In some places there are a few threads or nodules of lime in the upper part of the C horizon. The substratum is at a depth ranging from 12 to 40 inches. It consists of weakly consolidated beds of sand or moderately consolidated sandstone that can be crushed easily with the fingers.

Topography: Rolling to strongly rolling or hilly, eroded uplands.

Drainage and permeability: Excessive internal drainage; rapid permeability in the subsoil.

Vegetation: Mid and tall grasses consisting of sand reedgrass, needle-and-thread, Indian ricegrass, and other grasses.

Use: Nonirrigated cropland and rangeland.

Fort Collins series

The Fort Collins series consists of Brown soils that developed in deep, transported loam material. These soils have a grayish-brown loam A1 or Ap horizon, a dark-brown or olive-brown, prismatic clay loam B2t horizon, and a thin calcareous, prismatic heavy loam B3 horizon. Next in the profile is a loam Cca horizon that contains some segregated lime. It is underlain by a calcareous loam C horizon consisting of stratified alluvium.

The Fort Collins soils have a thicker solum and contain more clay in the B2 horizon than the McRae and Edgar soils. The A2 horizon that occurs in the Briggsdale soils is missing in the Fort Collins soils, and there is less clay in the B2t horizon. Fort Collins soils do not have a loose sand and a gravel substratum at a moderate depth as do the Wanetta soils. The percentage of sand in the Fort Collins soils is not high as it is in the Treasure soils. Weakly consolidated shale does not occur at a moderate depth in the Fort Collins soils, as it does in the Cushman soils.

Typical profile of Fort Collins loam 20 feet east and 1,200 feet north of the SE. corner of the SW¼ of sec. 12, T. 7 N., R. 34 E.; in grassland:

A1—0 to 4 inches, grayish-brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; moderate, platy structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 7.1; clear boundary.

B2t—4 to 12 inches, olive-brown (2.5Y 4/3) clay loam that is light olive brown (2.5Y 5/3) if crushed; when moist, olive brown (2.5Y 3/3) in place and olive brown (2.5Y 4/3) crushed; strong, medium, prismatic structure that breaks to moderate, medium, angular blocky structure; hard when dry, friable when moist; slightly sticky and slightly plastic when wet; moderate continuous clay films on vertical faces, patchy clay films on horizontal faces; noncalcareous; pH 7.7; clear boundary.

B3—12 to 15 inches, light olive-brown (2.5Y 5/4) heavy loam, olive brown (2.5Y 4/4) when moist; moderate, medium, prismatic structure that separates to weak, medium and coarse, angular blocky structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; thin patchy clay films; weakly calcareous; pH 8.2; clear boundary.

C1ca—15 to 36 inches, pale-olive (5Y 6/3) loam, olive gray (5Y 5/2) when moist; weak, blocky structure in upper part and massive in lower part; slightly hard when

dry, very friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; few threads and nodules of segregated lime; pH 8.5; gradual boundary.

C2—36 to 60 inches, pale-olive (5Y 6/3) loam, olive (5Y 5/3) when moist; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; few thin strata of fine and very fine sandy loam; moderately calcareous; pH 8.6.

Range in characteristics: Loam is the only type mapped in the county. The A1 or Ap horizon has a color with a value of 5 or more (dry) and 2 or more (moist), a chroma of 2 or 3, and a hue of 2.5Y or 10YR. The B2t horizon, which is 27 to 34 percent clay, contains about 5 to 10 percent more clay than the A1 or Ap horizon. It has moderate to strong structure. The B2t horizon is 7 to 10 inches thick and, when dry, has a color with a value of 4 or 5, a chroma of 3 or 4, and a hue of 2.5Y or 10YR. In the Cca horizon are few to common threads or seams or a few soft nodules of segregated lime. A very thin loam AB transitional horizon, 2 to 3 inches thick, occurs in many places. The C horizon is generally loam, but it may be as coarse as loamy fine sand or as fine as silty clay at a depth below 20 inches. In places the profile contains a higher proportion of silt and very fine sand than does the typical profile.

Topography: Nearly level to gently sloping terraces and fan terraces and slightly convex fans.

Drainage and permeability: Good drainage; moderate to moderately rapid permeability.

Vegetation: Western wheatgrass, blue grama, needle-and-thread, prairie junegrass, big sagebrush.

Use: Small grains alternated with summer fallow and suitable irrigated crops. Many areas still in native range.

Gilt Edge series

The Gilt Edge series consists of Solonetz soils that have been solodized. These soils developed in deep, transported clay material. They have a 5- to 7-inch, pale-brown or light-gray A2 horizon and a brown, neutral to moderately alkaline, columnar clay B2t horizon. A prismatic clay B3ca horizon is underlain by a clay Cca horizon that contains nodules of segregated lime. The C horizon is clay and contains seams and nests of gypsum in the lower part.

The Gilt Edge soils have a light-colored A2 horizon and a columnar B2t horizon, whereas the Bew soils are without an A2 horizon and have a strong, prismatic-blocky clay B2t horizon that shows no evidence of solodization. Gilt Edge soils have more clay in the B2t and C horizons than the Arvada soils and, unlike those soils, are not strongly alkaline throughout and do not contain a large amount of salts. The Gilt Edge soils do not have a thick gray A2 horizon, as do the Shonkin soils. Also, Gilt Edge soils have an abrupt boundary between the A and B2 horizons, whereas the Shonkin soils have a gradual or clear boundary between those horizons and also have an A&B horizon, a B&A horizon, or both.

Typical profile of Gilt Edge loam 30 feet north of road about 0.1 mile east of the SW. corner of the SE¼ of sec. 24, T. 7 N., R. 35 E.; in grassland:

A21—0 to 4 inches, pale-brown (10YR 6/3) loam with light gray (10YR 7/2) in pockets; when moist, brown (10YR 4/3) with grayish brown (10YR 5/2) in pockets; strong, very thin, platy structure that breaks to moderate, very fine, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; pockets and tongues of bleached silica throughout; bleached silica on underside of plates; noncalcareous; pH 6.5; clear boundary.

A22—4 to 5 inches, white (10YR 8/2) loam, light brownish gray (10YR 6/2) when moist; strong, very thin, platy structure; vesicular; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.5; abrupt boundary.

B21t—5 to 7 inches, grayish-brown (10YR 5/2) clay that is yellowish brown (10YR 5/4) if crushed; when moist, dark grayish brown (10YR 4/2) in place and dark yellowish brown (10YR 4/4) crushed; strong, fine, columnar structure that separates with difficulty to weak, fine, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; thick continuous clay films on all ped surfaces; noncalcareous; pH 8.0; clear boundary.

B22t—7 to 13 inches, brown (10YR 5/3) clay that is yellowish brown (10YR 5/4) if crushed; when moist, dark brown (10YR 4/3) in place and dark yellowish brown (10YR 4/4) crushed; moderate, medium, prismatic structure that separates easily to strong, fine and medium, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; thick continuous clay films on all ped surfaces; noncalcareous; pH 7.5; clear boundary.

B3ca—13 to 19 inches, light olive-brown (2.5Y 5/3) clay that is light yellowish brown (2.5Y 6/3) if crushed; when moist, olive brown (2.5Y 4/3) in place and light olive brown (2.5Y 5/3) crushed; moderate, medium, prismatic structure that separates easily to strong, medium, angular blocky structure; extremely hard when dry, firm when moist, sticky and very plastic when wet; thick continuous clay films on vertical faces, patchy clay films on horizontal faces; weakly calcareous; few masses of lime; pH 8.6; diffuse boundary.

C1ca—19 to 24 inches, olive (5Y 5/3) clay, olive (5Y 4/3) when moist; weak, coarse, prismatic structure to massive; extremely hard when dry, firm when moist, sticky and plastic when wet; weakly calcareous; few nodules of lime; pH 8.8; gradual boundary.

C2cacs—24 to 32 inches, light olive-gray (5Y 6/2) clay, olive gray (5Y 4/2) when moist; massive; extremely hard when dry, friable when moist, sticky and plastic when when wet; weakly calcareous; few nodules of segregrated lime, streaks and masses of gypsum; pH 8.8; diffuse boundary.

C3cs—32 to 40 inches, light brownish-gray (2.5Y 6/2) light clay or heavy clay loam, olive brown (2.5Y 4/3) when moist; massive; extremely hard when dry, friable when moist, sticky and plastic when wet; weakly calcareous; few masses of gypsum; pH 8.6; few pebbles in lower part.

IIIC4—40 inches +, very gravelly loam in upper part, becoming coarser with depth; pebbles have lime casts.

Range in characteristics: An A1 horizon, less than 2 inches thick, occurs in places. The layers in the A horizon have a combined thickness of 2 to 7 inches. The columnar B21t horizon is 2 to 4 inches thick. In some places it separates more easily into blocks than the horizon described. About 48 to 60 percent of the B21t horizon is clay. In some places a B&A horizon, ½ inch to 1½ inches thick, occurs just about the B21t horizon. The B2 horizon has a color with a value of 4 or 5, a chroma of 2 to 4, and a hue of 10YR and 2.5Y. It ranges from 6 to 10 inches in thickness. In the Cca horizon are few to common soft nodules of segregated lime. The material below a depth of about 40 inches is clay, stratified material of varied texture, or gravelly material.

Topography: Nearly level to gently undulating terraces and benches that are mantled with clay.

Drainage and permeability: Good drainage; slow permeability in the subsoil.

Vegetation: Short and mid grasses consisting of western wheatgrass, prairie junegrass, blue grama, and needle-and-thread; big sagebrush.

Use: Entirely range. Small areas that were farmed are now abandoned.

Glendive series

The Glendive series consists of well-drained, light-colored, calcareous, moderately coarse textured Alluvial soils. The profile most representative of these soils has a light brownish-gray fine sandy loam Ap horizon and a similarly colored fine sandy loam subsoil that extends to a depth of 30 inches or more.

The subsoil of Glendive soils is coarser textured than that of the Havre soils but not so coarse textured as the subsoil of the Banks soils. Glendive soils do not have a B2 horizon, as do the Treasure soils, and they lack the substratum of bedrock at a moderate depth that underlies the Tullock soils.

Typical profile of Glendive fine sandy loam 1,600 feet south of the center of sec. 26, T. 6 N., R. 35 E.; in cultivated field:

Ap—0 to 8 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; calcareous; pH 8.4.

C1—8 to 32 inches, light yellowish-brown (2.5Y 6/3) fine sandy loam, olive brown (2.5Y 4/3) when moist; massive, some stratification in lower part; soft when dry, very friable when moist, nonsticky and nonplastic when wet; calcareous; pH 8.4.

C2—32 to 60 inches, light yellowish-brown (2.5Y 6/3) stratified loamy fine sand and fine sandy loam, light olive brown (2.5Y 5/3) when moist; massive; soft when dry, loose when moist, nonsticky and nonplastic when wet; calcareous; pH 8.4.

Range in characteristics: The types of Glendive soils mapped in this county are fine sandy loam, loamy fine sand, loam, clay loam, and clay. The color of the surface layer has a value of 5 or more (dry) and more than 3 (moist). Hue is 2.5Y or 5Y. The degree of stratification throughout the profile varies; lenses of loam or loamy fine sand occur, but the texture is uniform in places. The differences of color and of texture in the profile are related to the degree of stratification. On some of the large fans, these soils are noncalcareous to a depth of 15 inches but a Cca horizon occurs that has a few threads of lime and a color B horizon is indicated.

Topography: Level flood plains and level to sloping fans and terraces.

Drainage and permeability: Moderately good and good drainage; moderately rapid permeability. Overflows of short duration occur occasionally, during ice jams or when runoff is exceedingly high.

Vegetation: Needle-and-thread, western wheatgrass, blue grama, and other mixed mid and short grasses. Along major streams, brush and cottonwoods are common.

Use: Irrigated and nonirrigated cropland; range.

Havre series

The Havre series consists of light-colored, calcareous, medium-textured Alluvial soils. These soils have a light brownish-gray loam Ap horizon and a similarly colored loam subsoil that extends to a depth of 20 inches or more.

The subsoil of the Havre soils is loam or silt loam, whereas that of the Lohmiller soils is clay loam or silty clay loam. Havre soils have a finer textured subsoil than the Glendive soils. The subsoil of Glendive soils is fine sandy loam or loamy fine sand. The Havre soils lack the weak B and Cca horizons that occur in the McRae soils.

Typical profile of Havre loam located near the NE. corner of the SE¼ of sec. 36, T. 7 N., R. 36 E.; in cultivated field:

Ap—0 to 9 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, granular structure; slightly hard when dry, very friable when moist; calcareous; pH 8.4.

C1—9 to 16 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard when dry, very friable when moist; calcareous; pH 8.4.

C2—16 to 42 inches, light yellowish-brown (2.5Y 6/3), stratified loam and very fine sandy loam, light olive brown (2.5Y 5/3) when moist; soft when dry, very friable when moist; calcareous; pH 8.4.

C3—42 to 60 inches, stratified loam, very fine sand, fine sandy loam, and loamy fine sand; calcareous; pH 8.4.

Range in characteristics: Loam, clay loam, and clay types are mapped in the county, as are saline, moderately deep, and high phases. Below a depth of 10 inches, the subsoil is loam, silt loam, very fine sandy loam, or is a stratification of those materials. In large areas a substratum of sandy loam or loamy fine sand occurs at a depth of 22 to 28 inches. At a depth below 20 inches, a stratum of finer textured materials occurs in some places. In some areas clay underlies these soils at a depth of 40 inches or more. Depth to gravel is as little as 14 inches.

Topography: Level flood plains and terraces, sloping fans at the mouth of small streams and steep, eroded edges of benches.

Drainage and permeability: Moderately good to good drainage; seasonally high level of ground water as a result of irrigation; moderate permeability.

Vegetation: Mid, short, and tall grasses.

Use: Primarily irrigated cropland, flood irrigated hayland, and nonirrigated cropland. Extensive areas along the smaller streams are still in native grasses.

Hesper series

The Hesper series consists of Brown soils that developed in deep, transported silt loam or poorly graded loam. These soils have an A1 horizon of thin, grayish-brown loam and a B2t horizon of brown, prismatic-blocky heavy silty clay loam or light silty clay. The Cca horizon is silt loam containing nodules of segregated lime, and the C2ca horizon is silt loam or loam.

These soils have more clay in their B2t horizon than the Fort Collins soils and have a higher percentage of silt throughout. They lack the distinct gray A2 horizon that occurs in the Briggsdale soils and are more silty than those soils.

Typical profile of Hesper loam in the NW¼ of sec. 11, T. 5 N., R. 36 E.; in grassland:

A1—0 to 3 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, thin, platy structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; the upper side of plates coated with bleached silt, light brownish gray (10YR 6/2) when dry; high proportion of silt and very fine sand; noncalcareous; pH 6.5; clear boundary.

B1—3 to 6 inches, grayish-brown (10YR 5/2), and dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure that separates to moderate, thin, platy structure; bleached silt on upper plates; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; thin continuous clay films on all surfaces; noncalcareous; pH 6.7; clear boundary.

B21t—6 to 9 inches, brown (10YR 4/3) heavy silty clay loam that is brown (10YR 5/3) if crushed; when moist, dark brown (10YR 3/3) in place and brown (10YR 4/3) crushed; moderate, medium and fine, prismatic structure that separates easily to strong, fine and very fine, subangular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; thick continuous clay films on all faces; noncalcareous; pH 7.2; clear boundary.

B22—9 to 15 inches, brown (10YR 5/3) heavy silty clay loam that is pale brown (10YR 6/3) if crushed; when moist, brown (10YR 4/3) in place and brown (10YR 5/3) crushed; moderate, medium, prismatic structure that separates easily to strong, fine, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; thick continuous clay films on all surfaces; noncalcareous; pH 7.8; clear boundary.

B3—15 to 18 inches, grayish-brown (2.5Y 5/2) light silty clay loam, olive brown (2.5Y 4/3) when moist; moderate, medium, prismatic structure that separates to moderate, medium and fine, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; thin clay films; moderately calcareous; pH 8.2; clear boundary.

C1ca—18 to 28 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/3) when moist; moderate, medium and fine, subangular blocky structure; very hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; few threads and soft nodules of segregated lime; pH 8.4; diffuse boundary.

C2ca—28 to 57 inches, olive-gray (5Y 5/2) silt loam, olive gray (5Y 4/2) when moist; massive; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; few threads of segregated lime.

IIC3—57 to 62 inches, pale-olive (5Y 6/3) very fine sandy loam; soft when dry, very friable when moist, slightly sticky and nonplastic when wet; moderately calcareous; few threads of segregated lime; pH 8.5.

Range in characteristics: Loam is the only type mapped in this county. The A1 or Ap horizon has a value of 5 (dry) and 3 (moist) and a chroma of 2 or 3. The B2t horizon is 8 to 12 inches thick. It is 36 to 42 percent clay and has about 10 to 15 percent more clay than the A1 or Ap horizon. Its structure is moderate or strong. The B2t horizon has a value of 5 or 4, a chroma of 3 or 4, and a hue of 10YR. In some places nodules of lime occur in the B3 horizon. The Cca horizon contains few to common segregations of lime and a few pebbles in some areas. The noncalcareous part of the solum is 12 to 16 inches thick. Silt and very fine sand typically make up 50 percent or more of the A, B, and upper C horizons. Of this material, at least 40 percent is silt. However, on the terraces just outside Yellowstone Valley, these soils have slightly more fine and medium sand and a few pebbles. A gravelly loam substratum is present at a depth of as little as 30 inches in places.

Topography: Undulating to rolling high benches.

Drainage and permeability: Good drainage; moderate permeability in the subsoil.

Vegetation: Mid and short grasses that include western wheatgrass, needle-and-thread, prairie junegrass, and blue grama.

Use: Nonirrigated cropland and rangeland.

Hoven series

The Hoven series consists of well-drained to somewhat poorly drained Solonetz soils that have been solodized. These soils developed in clay deposited in shallow undrained basins and on level terraces, sloping fans, and undulating to rolling uplands. Except in the shallow undrained basins, these soils are saline.

The typical profile in the nonsaline Hoven soils has a 1- to 3-inch, light-gray loam A2 horizon, a columnar clay B2t horizon, and a clay Cca horizon. The Cca horizon has some spots of lime and gypsum in the lower part. The lower subsoil is mottled with brownish colors.

The nonsaline Hoven soils have a thinner A2 horizon than the Shonkin soils and a denser, more compact B2t horizon. They are more poorly drained than the Gilt Edge soils and have a more strongly alkaline B2t horizon. The Hoven soils occur with the Arvada, Gilt Edge, Marias, and McKenzie soils.

Typical profile of nonsaline Hoven clay near the NE. corner of the SE¼ of sec. 33, T. 7 N., R. 35 E.; in shallow depression:

A2—0 to 2 inches, light-gray (5Y 7/2) loam, olive gray (5Y 5/2) when moist; common, distinct, yellowish-brown mottles; massive; vesicular; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 7.0; abrupt boundary.

B2t—2 to 12 inches, light olive-gray (5Y 6/2) heavy clay, olive gray (5Y 4/2) when moist; few, yellowish-brown mottles; weak, coarse, columnar structure that grades to moderate, coarse, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous; pH 8.0; gradual boundary.

B3—12 to 16 inches, light olive-gray (5Y 6/2) heavy clay, olive gray (5Y 4/2) when moist; weak, coarse, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous; pH 8.2; gradual boundary.

C1ca—16 to 26 inches, light olive-gray (5Y 6/2) heavy clay, olive gray (5Y 4/2) when moist; massive; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; calcareous; few soft nodules of lime; pH 8.6; diffuse boundary.

C2ca—26 to 60 inches, light olive-gray (5Y 6/2) heavy clay, olive gray (5Y 5/2) when moist; massive, extremely hard when dry, very firm when moist, very sticky and very plastic when wet; calcareous; few to common seams and nests of gypsum; pH 8.8.

Range in characteristics: Only the clay type is mapped in this county. The A2 horizon is 1 to 3 inches thick. The B2 horizon has blocky or columnar structure. In most places salts and gypsum have accumulated at a depth below 24 inches. In the A2 horizon and in the upper subsoil, mottles range from none to many. In some places shale or gravelly material underlies these soils below a depth of 4 feet.

Topography: Shallow, flat undrained basins and depressions on upland terraces and in shale uplands.

Drainage and permeability: Good drainage to somewhat poor drainage; water ponds on the surface in the basins; very slow permeability.

Vegetation: Primarily western wheatgrass but a few sedges are in basins. Most areas are barren or have a

sparse to scattered growth of Sandberg bluegrass, western wheatgrass, greasewood, and Gardner saltbush.

Use: Only range.

Hysham series

The Hysham series consists of calcareous Solonetz soils that developed from transported loam or clay loam and have little horizonation. The normal soil profile in grassland has a very thin, light brownish-gray loam A1 horizon and a thin, light yellowish-brown, calcareous B2 horizon of loam that has coarse, columnar structure. The C horizon consists of stratified loamy material. The pH throughout the profile is 9.0 or more.

In Hysham soils there is no A2 horizon as there is in Arvada soils, and the B2 horizon does not differ from the A horizon in texture. Strong alkalinity and very hard or extremely hard consistence differentiate Hysham soils from the Havre and Lohmiller soils. Unlike the Laurel soils, Hysham soils do not have a high level of ground water, a granular, strongly saline horizon of salt accumulation, and a salt crust on the surface. The Hysham soils occur with the Havre and Lohmiller soils in this county.

Typical profile of Hysham loam 1,000 feet east and 100 feet north of the center of sec. 24, T. 6 N., R. 34 E.; in grassland:

A1—0 to 3 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; upper ½ inch is a vesicular, massive crust, but lower part has weak, fine to thick, platy structure; soft when dry, very friable when moist; weakly calcareous; pH 9.0; clear boundary.

B2—3 to 8 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/3) when moist; moderate, coarse, columnar structure; outside of columns thinly coated with clay and very slippery when wet; inside of columns are less sticky and plastic; extremely hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; pH 9.5; clear boundary.

B3—8 to 12 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/3) when moist; weak, coarse, angular blocky structure; very hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 9.5; clear boundary.

C1—12 to 32 inches, light yellowish-brown (2.5Y 6/3), stratified very fine sandy loam to silt loam, light olive brown (2.5Y 5/3) when moist; massive; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; few threads of salt in lower part; pH 9.6.

C2—32 to 60 inches, light yellowish-brown (2.5Y 6/3), stratified loam, very fine sandy loam, and silt loam, yellowish brown (2.5Y 5/3) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 9.3.

Range in characteristics: Loam, clay loam, and clay types are mapped in this county, but they are only in complexes with Havre and Lohmiller soils. The A1 horizon is 1 to 4 inches thick. Its color has a value of 5 or more (dry) and more than 2 (moist). A very thin incipient A2 horizon is present in some places. The B2 horizon is 3 to 5 inches thick. It has medium or coarse columnar structure to medium or coarse blocky structure and is very hard to extremely hard in consistence. In places the B2 horizon has slightly more clay than the A1 horizon and has brown streaks or bands of organic matter on the faces of the peds. In some places there are mycelial segregations of lime and salts below a depth of 10 inches. In cultivated areas, all the A1 and B2 horizons and most of the B3 horizon have been mixed to form the Ap horizon and the Hysham soils appear as gray areas with a hard, cloddy, crusty surface. Layers coarser or finer textured than loam occur at a depth below 24 inches.

Topography: Level flood plains to gently sloping fans and terraces.

Drainage and permeability: Good drainage; slow permeability in the subsoil.

Vegetation: Western wheatgrass, Sandberg bluegrass, sagebrush, and pricklypear.

Use: Mainly native pasture, but some areas are in cultivation.

Laurel series

The Laurel series consists of Solonchak soils that developed from loam and clay loam materials. A strong, granular A1sa horizon and a massive Csa horizon occur below the salt crust on the surface. These soils are strongly saline at the surface and through the profile. A thin powdery crust of salts covers the surface in many areas. The profile is loam or clay loam in the upper 20 to 30 inches but is variably stratified below.

The Laurel soils occur with the Havre, Glendive, and Lohmiller soils. Laurel soils are not so clayey as the Sage soils. Unlike the Hysham soils, Laurel soils have a ground water table, granular structure, strong salinity, and a salt crust on the surface.

Typical profile of Laurel clay loam about 1,100 feet east of the SW. corner of the SE¼ of sec. 3, T. 6 N., R. 36 E.:

A11sa—0 to 2 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; strong, fine, granular structure; slightly hard when dry, very friable when moist, sticky and plastic when wet; calcareous; abundant specks and streaks of soluble salts; 1/16 to ⅛ inch of salt crust on the surface.

A12sa—2 to 16 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; strong, fine and very fine, granular structure; soft when dry, very friable when moist, sticky and plastic when wet; calcareous; abundant specks, streaks, and seams of soluble salts and gypsum, few crystals of pure gypsum; pH 8.7; gradual boundary.

C1sa—16 to 22 inches, light yellowish-brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) when moist; massive; hard when dry, very friable when moist, sticky and plastic when wet; calcareous; common specks and streaks of soluble salts and gypsum; pH 9.0; diffuse boundary.

C2—22 to 26 inches, light yellowish-brown (2.5Y 6/3), loam with few thin lenses of clay loam, light olive brown (2.5Y 5/3) when moist; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; few specks and seams of soluble salts; pH 9.0; diffuse boundary.

C3—26 to 60 inches, light yellowish-brown (2.5Y 6/3), stratified loam, silt loam, and very fine sandy loam, light olive brown (2.5Y 5/3) when moist; yellowish-brown mottles are few in upper part, and common in lower part; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 9.0.

Range in characteristics: Loam and clay loam types are mapped in this county. The content of salts throughout the profile is high or very high. Many areas have a crust of salts over the entire surface, but in other areas this crust is only in scattered spots. Within short distances, the horizons of these soils vary greatly in arrangement and thickness. At varied depths in a 5-foot profile, there are sedimentary layers or old buried surface horizons as dark

or darker than the present surface soil. In many places strata of sandy material occur below a depth of 40 inches or less. In many areas the Laurel soils have a 1- to 3-inch light brownish-gray or light-gray, vesicular loam A2 horizon, a brown columnar or prismatic-blocky, noncalcareous B2t horizon, and a granular Csa horizon at a depth below 6 to 8 inches. In these areas, salt does not crust the surface and the water table is deeper than normal.

Topography: Nearly level low terraces and valley floors and shallow, broad swales on the better drained terraces.

Drainage: Somewhat poor drainage; normally slow runoff. Runoff from higher terraces causes ponding in some areas for short periods. The level of ground water table varies from near the surface during the irrigation season to a depth of more than 5 feet late in fall and in winter.

Vegetation: Inland saltgrass, alkali sacaton, western wheatgrass, and other salt-tolerant plants. Many areas are nearly barren except for a sparse growth of the more salt-tolerant grasses and forbs.

Use: Primarily native pasture. Some areas have been partly reclaimed by deep drainage and leaching, and they produce fair yields of alfalfa, sugarbeets, oats, and barley.

Lismas series

The Lismas series consists of Lithosols that weathered in place from platy clay shale. These soils have a very thin, granular clay A1 horizon, a massive or weak, blocky clay subsoil, and a platy clay shale substratum at a depth of less than 20 inches.

The Lismas soils are shallower to shale than the nearby Pierre soils. They have a clay subsoil, whereas the Midway soils have a clay loam subsoil.

Typical profile of Lismas clay near the NE. corner of sec. 8, T. 5 N., R. 37 E.:

A1—0 to 2 inches, pale-olive (5Y 6/3) clay, olive (5Y 4/3) when moist; strong, very fine, granular structure; very hard when dry, firm when moist, sticky and plastic when wet; weakly calcareous; pH 8.0.

C—2 to 8 inches, pale-olive (5Y 6/3) clay, olive (5Y 4/3) when moist; moderate, coarse, angular blocky structure; very hard when dry, friable when moist; few soft chips of shale; calcareous; pH 8.2.

CR—8 to 12 inches, pale-olive (5Y 6/3) clay, olive (5Y 4/3) when moist; massive; hard when dry, friable when moist; many soft fragments of shale; calcareous; pH 8.6.

R—12 to 28 inches, olive-gray (5Y 4/2), when dry or moist, soft, platy clay shale only sightly altered by weathering in upper 4 to 6 inches; gypsum between plates.

Range in characteristics: The surface layer is granular in most places. Depth to unweathered shale ranges from 4 to 16 inches. In most places these soils are only slightly alkaline through the profile, but where they occur with the saline-alkali Pierre soils, Lismas soils are strongly alkaline, have a crusty surface, and contain many nests of gypsum in the subsoil and upper substratum.

Topography: Rolling to hilly or strongly dissected uplands.

Drainage and permeability: Excessive drainage; rapid runoff; slow and very slow permeability in the subsoil.

Vegetation: Primarily mid and short grasses that include western wheatgrass, blue grama, big sagebrush, green needlegrass in the nonsaline areas and alkali sacaton, greasewood, and other halophytes in the saline-alkali areas.

Use: Only rangeland.

Lohmiller series

The Lohmiller series consists of well-drained, light-colored, calcareous Alluvial soils. In these soils a pale-olive clay loam generally makes up the Ap horizon and the upper subsoil and extends to a depth of 20 inches or more.

In the upper 20 to 30 inches, these soils have more clay than the Havre soils but not so much as the Bowdoin soils. The Lohmiller soils are similar to the Cherry soils in texture but lack the weak B2 and Cca horizons that occur in those soils.

Typical profile of Lohmiller clay loam 400 feet south and 50 feet west of the NE. corner of the SE¼ of sec. 27, T. 5 N., R. 34 E.; in cultivated field:

Ap—9 to 9 inches, pale-olive (5Y 6/3) clay loam, olive (5Y 4/3) when moist; very hard when dry, friable when moist, sticky and plastic when wet; calcareous; pH 8.4.

C1—9 to 36 inches, pale-olive (5Y 6/3) clay loam with thin lenses of loam or silt loam, olive (5Y 4/3) when moist; very hard when dry, friable when moist, sticky and plastic when wet; calcareous; pH 8.4.

C2—36 to 60 inches, light yellowish-brown (2.5Y 6/3), stratified loam, silt loam, and fine sandy loam, light olive brown (2.5Y 5/3) when moist; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 8.6.

Range in characteristics: Clay loam and clay types are mapped in this county. The Ap horizon has a hue of 5Y or 2.5Y and a value of 5 or more (dry) and more than 3 (moist). The subsoil has about the same value as the Ap horizon. Stratified materials that are finer or coarser textured than the material described occur at a depth below 12 to 16 inches, but between depths of about 10 and 30 inches, texture generally is clay loam or light clay in which the content of clay is 30 to 45 percent.

Topography: Level flood plains and sloping fans and slopes.

Drainage and permeability: Moderately good to good drainage; moderately slow permeability.

Vegetation: Mixed short and mid grasses consisting mainly of western wheatgrass, blue grama, big sagebrush, and silver sage.

Use: Mainly a wide variety of irrigated crops and nonirrigated small grain and hay. Small areas are still in native grasses.

Marias series

The Marias series consists of deep, well-drained, light-colored clay Grumusols that are saline-alkali in many places. The saline-alkali soils have on the surface a massive crust, ¼ to ½ inch thick, and they are strongly alkaline below a depth of 7 inches. Marias soils that are not saline-alkali are only slightly or moderately alkaline.

The Marias soils that are not saline-alkali have a grayish-brown, granular clay A horizon. The upper subsoil is calcareous blocky clay that has a few nodules of lime below 10 to 15 inches. The subsoil is massive below a depth of 22 to 26 inches. Slickensides occur below a depth of 10 inches.

Marias soils that are not saline-alkali are not so dark colored in the A horizon and upper subsoil as are the

Promise soils. A substratum of unweathered shale does not occur at a depth of less than 40 inches, as it does in the Pierre soils. Less clay is in the profile of Marias soils that are not saline-alkali than is in the profile of the Bowdoin soils.

Typical profile of Marias clay about 200 feet north and 400 feet west of SE. corner of sec 7, T. 3 N., R. 36 E.; in grassland:

A1—0 to 4 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; strong, fine and very fine, granular structure; very hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; pH 8.0; clear boundary.

B2—4 to 24 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure that separates to moderate, fine and medium, angular blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; distinct slickensides below 10 inches; weakly calcareous; pH 8.4; gradual boundary.

C2ca—24 to 44 inches, olive (5Y 5/3) clay, olive (5Y 4/3) when moist; weak, angular blocky structure to massive; extremely hard when dry, firm when moist, very sticky and very plastic when wet; calcareous; few nodules of lime; pH 8.5; gradual boundary.

IIC3cs—44 to 60 inches, pale-olive (5Y 6/3) clay loam, olive (5Y 5/3) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; calcareous; pH 8.5.

Range in characteristics: The clay loam lower subsoil and the nodules of lime are missing in some places. Where the nodules of lime occur, they are at a depth of 12 to 24 inches.

Topography: Rolling, eroded uplands.

Drainage and permeability: Good drainage; slow permeability in the subsoil.

Vegetation: Mixed mid and short grasses consisting of western wheatgrass, Sandberg bluegrass, green needlegrass, and scattered big sagebrush.

Use: Mainly grazing, but small areas are used for native hay or to produce small grain.

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Saline-alkali Marias soils developed in clay that was transported or was deeply weathered in place from saline-alkali shale. Typically, these soils have a massive surface crust that is ¼ to ½ inch thick and that is underlain by a granular or platy clay A12 horizon. To a depth of 14 to 20 inches, the subsoil is fine, blocky sodic clay that has a pH of 8.7 or more. The C horizon is massive sodic clay containing nests and seams of gypsum.

These Marias soils are differentiated from other Marias soils by the very thin, durable surface crust and the strongly alkaline reaction within 7 inches of the surface. They are deeper to shale than the saline-alkali Pierre soils. Unlike the Sage soils, saline-alkali Marias soils are not wet and do not have a crust of salts on the surface or a flocculated, strongly saline subsoil. They are not so dense and barren as the saline Hoven soils, with which they occur in many places.

Typical profile of Marias clay, saline-alkali, 200 feet north and 100 feet west of the SE. corner of the NE¼ of sec. 31, T. 8 N., R. 35 E.; in grassland:

A11—0 to ¼ inch, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive crust (not salts) with hexagonal shapes 2 to 4 inches in diameter; surface is light brownish gray and has abundant clear sand grains; crust is grayish brown on underside, where clusters of granules adhere; hard when dry, friable when moist, very sticky and very plastic when wet; noncalcareous; pH 8.0; abrupt boundary.

A12—¼ inch to 4 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, platy structure that grades to strong, thin, platy structure that separates very easily to moderate, very fine, subangular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; very weakly calcareous; pH 8.3; clear, smooth boundary.

B2—4 to 20 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; moderate, medium to fine, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; patches of clay films on concave surfaces; faces on all ped surfaces have a light-reflecting sheen the same in color as the inside of the peds; few very fine pores; plentiful roots in upper part; weakly calcareous; pH 8.6 to 8.8; clear, irregular boundary.

C1cs—20 to 26 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; weak, medium, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and plastic when wet; very few roots; many, medium to large white nests of gypsum crystals; weakly calcareous; pH 8.0; gradual boundary.

C2cs—26 to 60 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; weak, medium, angular blocky structure in upper part and massive in lower part; extremely hard when dry, very firm when moist, very sticky and plastic when wet; common clusters of gypsum crystals decrease with depth; weakly calcareous; pH 8.0 on 1 : 5 dilution.

Range in characteristics: The crust is continuous over the surface. It is ¼ to ½ inch thick under sparse grasses and is ½ to 1 inch thick under greasewood and saltbush. The upper part of the crust is dense and massive, but clusters of plates and granules adhere to the underside of the upper part and form a moderately porous lower part. If the crust is destroyed by tillage or trampling, it readily reforms after wetting and drying. Beneath the crust, the A12 horizon ranges from moderate and strong, thin and medium, platy structure to moderate and strong, very fine, granular structure. The underlying horizons range from moderate, medium, blocky structure to strong, fine, blocky structure. When dry, the horizons have vertical cracks 6 to 10 inches apart. At a depth of 16 to 36 inches, gypsum crystals occur and range from abundant to very few. The soil profile is noncalcareous in some places. In other places it is moderately calcareous and fine or medium segregations of lime make up less than 1 percent of the soil mass below the A12 horizon. In places bedded clay shale occurs at a depth of more than 40 inches. The A12 horizon differs from the underlying horizons in color by less than 1 unit of value. Below the A12 horizon, value is 5 or 6 (dry) and 3 to 5 (moist), chroma is 2 or 3, and hue is 2.5Y or yellower. Where carbonaceous shale occurs, color is darker; value is 3 or 4, and chroma is 1 or 2.

Topography: Nearly level to sloping or gently rolling uplands or valley plains consisting of residual or transported materials. Local differences in elevation are as much as 20 feet. Smooth slopes are 300 to more than 1,000 feet long. Slopes are only 50 to 200 feet long where these soils occur with the saline-alkali Pierre and Lismas soils in hilly terrain.

Drainage and permeability: Good drainage; slow to rapid runoff; very slow infiltration and permeability; very deep level of ground water.

Vegetation: Greasewood, Gardner saltbush, big sagebrush, and plains prickly-pear cactus spaced 5 to 20 feet apart. Between shrubs is a sparse cover, mainly of western wheatgrass, Sandberg bluegrass, and some green needlegrass.

Use: Mainly native pasture, but small acreages are used for irrigated crops.

McKenzie series

The McKenzie series consists of Solonetz soils that are barren or nearly barren, saline and sodic clays developed from saline-alkali clay. In this county these soils occur with the saline Hoven soils. In most places the A2 horizon of McKenzie soils consists of one-quarter to 1 inch of light-gray, vesicular, massive loam that has a glazed appearance. The subsoil is dense and massive or has weak blocky structure. It is strongly alkaline clay and, at a depth of 6 to 10 inches, contains accumulations of gypsum that are similar to those in the saline Hoven soils.

The McKenzie soils have a denser, more massive subsoil than the Marias soils, saline-alkali, and have salts closer to the surface. The McKenzie soils are dry, have compact, massive horizons of accumulated gypsum and salt, but do not have a salt crust on the surface, whereas Sage soils are wet, have a salt crust on the surface, and have soft, granular horizons of salt accumulation at or near the surface.

Typical profile of McKenzie clay about one-fourth mile west and 100 feet north of the SE. corner of the NE¼, sec. 30, T. 7 N., R. 37 E.; in barren area:

A2—0 to ½ inch, light-gray (5Y 7/2) silt loam, olive gray (5Y 5/2) when moist; massive; vesicular; hard when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 8.1; abrupt boundary.

C1—½ inch to 4 inches, light brownish-gray (2.5Y 6/2) clay, olive brown (2.5Y 4/3) when moist; weak, fine, angular blocky structure to massive; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; threads of bleached silt and very fine sand; calcareous; pH 9.2; clear boundary.

C2cs—4 to 12 inches, light brownish-gray (2.5Y 6/2) clay, olive brown (2.5Y 4/3) when moist; weak, medium, angular blocky structure to massive; extremely hard when dry, very firm when moist, very stocky and very plastic when wet; weakly calcareous; many seams and nests of accumulated gypsum; pH 8.8; diffuse boundary.

C3cs—12 to 42 inches, pale-olive (5Y 6/3) clay, olive (5Y 5/3) when moist; massive; extremely hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; common to few seams and nests of gypsum; pH 8.8; diffuse boundary.

IIC4sacs—42 to 60 inches, pale-olive (5Y 6/3), stratified silty clay loam, silt loam, and silty clay, olive (5Y 5/3) when moist, slightly hard to hard when dry, friable when moist, slightly sticky to sticky when wet; calcareous; few nests and threads of gypsum and other soluble salts; pH 9.5.

Range in characteristics: Only the clay type is mapped in the county. The A2 horizon is one-fourth inch to 2 inches thick. Its color has a value of 7 or 8 and a chroma of 1 to 3. The upper part of the C horizon is massive or has blocky or weak, very coarse, columnar structure. Its hue is 5Y or 2.5Y. The depth to the C2cs horizon is 4 to 8 inches. The subsoil has a pH of 8.8 to 9.5.

Topography: Level terraces, sloping fans, and undulating to rolling uplands.

Drainage and permeability: Good drainage; rapid runoff; very slow permeability in the subsoil.

Vegetation: In most areas 70 percent or more of the surface is barren. The plants that do grow include greasewood, western wheatgrass, and Sandberg bluegrass.

Use: Range.

McRae series

The McRae series consists of deep, well-drained Brown soils having a very thin solum that developed from well-graded, transported, calcareous loam material. The typical profile has a very thin, light brownish-gray loam A1 horizon, a light olive-brown, prismatic loam B horizon, a loam Cca horizon that has a few threads of lime, and a calcareous loam C horizon.

The McRae soils have less clay in their B2 horizon than the Fort Collins soils, though the parent materials of the two kinds of soils are similar. McRae soils are not so clayey throughout as are the Cherry soils, which developed from transported clay loam material. The B2 and Cca horizons of McRae soils differentiate them from the Havre soils. Although the sola of the McRae soils and the Edgar soils have about the same thickness, the McRae soils have a weaker B2 horizon and lack the distinct nodules of lime in their Cca horizon.

Typical profile of McRae loam about 900 feet east and 200 feet south of the center of sec. 6, T. 2 N., R. 38 E.; in grassland:

A1—0 to 2 inches, light brownish-gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak, platy structure that separates to moderate, very fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.5; clear boundary.

B2—2 to 9 inches, light olive-brown (2.5Y 5/3) loam, olive brown (2.5Y 4/3) moist; moderate, medium, prismatic structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous in upper 5 inches and weakly calcareous in lower part; clear boundary.

C1ca—9 to 22 inches, olive (5Y 5/3) loam, olive (5Y 4/3) when moist; weak, coarse, prismatic structure; hard when dry, very friable when moist, slightly sticky and plastic when wet; calcareous; common threads of lime; pH 8.4; gradual boundary.

C2—22 to 60 inches, pale-olive (5Y 6/3) loam, olive (5Y 5/3) when moist; massive; some strata of very fine sandy loam; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 8.5 to 8.7.

Range in characteristics: The A1 horizon ranges from 2 to 4 inches in thickness. Its color has a value of 5 or 6 (dry) and 3 or more (moist) and a chroma of 2 or 3. Where a B2 horizon occurs, it is 4 to 10 inches thick and has a dry rubbed color with a value of 4 or 5, a chroma of 3 or 4, and a hue of 2.5Y or 10YR. The B2 horizon is noncalcareous or only weakly calcareous. Where the B2 horizon is noncalcareous, it has thin films of clay that are patchy to continuous. Only a few threads or nodules of lime occur in the Cca horizon. The B2 horizon is missing in some places, and in these places, these Brown soils are separated from Alluvial soils only on the basis of the noncalcareous A1 horizon and some redistribution of lime. The combined thickness of the A horizon and, where it occurs, the B horizon is generally 5 to 10 inches, but in a few places it is as much as 15 inches. In cultivated areas, all or nearly all of the A and B horizons are mixed and form an Ap horizon that is noncalcareous or weakly cal-

careous. A contrasting substratum of shale or other material occurs below 30 inches in places.

Topography: Nearly level terraces to strongly sloping fans and foot slopes.

Drainage and permeability: Good drainage; moderate permeability in the subsoil.

Vegetation: Mixed mid and short grasses consisting of western wheatgrass, needle-and-thread, prairie junegrass, and bluegrass.

Use: Irrigated and nonirrigated cropland and rangeland.

Midway series

The Midway series consists of light-colored Lithosols that weathered in place from the underlying weakly consolidated shale. These soils normally have a very thin, light yellowish-brown A1 horizon, an olive clay loam subsoil, and a substratum of weakly consolidated shale.

The Midway soils occur with the Bainville, Lismas, and Renohill soils. They have a clay loam subsoil, whereas the Bainville soils have a loam or silt loam subsoil. The Midway soils are not so clayey in their subsoil as are the Lismas soils, and they lack B and Cca horizons of the Renohill soils, which developed from clay loam residuum.

Typical profile of Midway clay loam at center of sec. 17, T. 2 N., R. 37 E.; in grassland:

A1—0 to 2 inches, light yellowish-brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) when moist; moderate, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; calcareous; pH 8.4; clear boundary.

C—2 to 12 inches, olive (5Y 5/3) clay loam, olive (5Y 4/3) when moist; weak, fine and medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; calcareous; pH 8.4; gradual boundary.

CR—12 to 16 inches, olive-gray (5Y 5/2) shaly heavy clay loam or light clay, olive gray (5Y 4/2) when moist; weak, coarse, blocky structure that separates to coarse, platy structure; very hard when dry, friable when moist; calcareous; pH 8.4; diffuse boundary.

R—16 to 32 inches, olive (5Y 5/3), weakly consolidated, platy light clay shale, olive (5Y 4/3) when moist; clay shale interbedded with loamy or sandy shale below 26 inches; shale easily broken with fingers when moist, but when dry, is very hard and tends to break to blocks; roots of plants between the plates in the upper part and in cracks in the lower part; few nodules of lime and gypsum.

Range in characteristics: The A1 horizon is 0 to 4 inches thick. When this horizon is dry, its color has a value of 5 or 6 and a chroma of 2 to 4. The subsoil is light clay in places. Unweathered shale is at a depth ranging from 5 to 30 inches. The shale underlying these soils is either conforming or nonconforming. In some places a few nodules of lime are present in the C horizon or in the upper part of the R horizon.

Topography: Rolling to steep, broken, eroded uplands.

Drainage and permeability: Excessive drainage; moderately slow to slow permeability.

Vegetation: Mid and short grasses and scattered big or silver sagebrush. The grasses included bluebunch wheatgrass, western wheatgrass, and blue grama.

Use: Almost entirely in range, but small areas are cultivated with larger areas of other soils.

Nihill series

The Nihill series consists of light-colored, loamy skeletal Regosols that developed from very gravelly loam material. These soils typically have a thin A1 horizon of light brownish-gray, noncalcareous gravelly loam and a very gravelly loam subsoil in which lime crusts the pebbles below a depth of 6 to 10 inches.

Nihill soils have more gravel throughout than the Havre soils and a higher percentage of coarse fragments than the Wanetta soils. A B2 horizon has not formed in the Nihill soils, as it has in the Wanetta.

Typical profile of Nihill gravelly loam about one-half mile northwest of the center of sec. 24, T. 6 N., R. 37 E.; on slope of 30 percent:

A1—0 to 3 inches, light brownish-gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) when moist; weak, fine, crumb structure; slightly hard when dry, very friable when moist, nonsticky and slightly plastic when wet; noncalcareous; pH 7.5; about 40 percent gravel by volume; clear boundary.

C1—3 to 9 inches, light olive-brown (2.5Y 5/3) very gravelly loam, olive brown (2.5Y 4/3) when moist; weak, coarse, subangular blocky structure; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 8.0; about 40 percent gravel by volume; gradual boundary.

C2ca—9 to 26 inches, light olive-brown (2.5Y 5/3) very gravelly loam, olive brown (2.5Y 4/3) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; calcareous; lime crusts on underside of gravel that are thinner as depth increases; pH 8.4; about 60 percent gravel by volume; diffuse boundary.

C2—26 to 40 inches, light olive-brown (2.5Y 5/3) very gravelly sandy loam that grades to gravelly sand as depth increases, olive brown (2.5Y 4/3) when moist; massive; soft when dry, loose when moist, nonsticky and nonplastic when wet; calcareous; thin lime crusts on underside of gravel in upper part of horizon, but none in lower part; pH 8.4; about 60 to 70 percent gravel by volume.

Range in characteristics: The A1 horizon ranges from 1 to 4 inches in thickness. When dry, the A1 horizon has a value of 5 or 6 and a chroma of 2 or 3. It is calcareous in some places. The C1 horizon does not occur in some places, but where it does, it is calcareous or noncalcareous. Where the C1 horizon is missing, the Cca horizon is immediately below the A1. The Cca horizon has a variable value and chroma. The content of gravel ranges from 25 to 70 percent, by volume, throughout the profile. Depth to the looser, coarser textured substratum ranges from 16 to more than 30 inches. Shale underlies these soils at a depth of less than 36 inches in many places.

Topography: Steeply sloping, dissected and eroded edges and remnants of high gravel terraces.

Drainage and permeability: Excessive drainage; moderate to rapid permeability.

Vegetation: Mixed mid and short grasses consisting of needle-and-thread, western wheatgrass, bluebunch wheatgrass, and blue grama intermingled with threadleaf sedge and green sagewort.

Use: Entirely range.

Nunn series

The Nunn series consists of Brown soils that developed in deep, transported clay loam material. The typical profile has a grayish-brown, granular clay loam Ap horizon and a dark-brown, prismatic light clay B2t horizon.

The prismatic clay loam B3ca horizon is underlain by a clay loam Cca horizon that contains segregated lime. The C horizon is calcareous clay loam.

The Nunn soils have more clay throughout their profile than the Fort Collins soils and less clay than the Bew soils. The B2t horizon of Nunn soils is textural, whereas the B2 horizon of the Cherry soils, which developed from clay loam material, is only structural, or color, or both. The Nunn soils have a thicker solum than the Renohill soils and lack the shale substratum at a moderate depth. Unlike the Beckton soils, the Nunn soils lack the distinct graying that bleached silt and sand grains impart to the A horizon and the upper B horizon. The graying in the Beckton soils indicates solodization.

Typical profile of Nunn clay loam 220 feet north and 50 feet west of the SE. corner of the SW¼ of sec. 8, T. 6 N., R. 37 E.; on slope of 3 percent:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular structure; very hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 7.4.

B21t—6 to 10 inches, dark-brown (10YR 4/3) light clay that is brown (10YR 5/3) if crushed; when moist, dark brown (10YR 3/3) in place and brown (10YR 4/3) crushed; strong, medium, prismatic structure that separates to moderate, medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; moderately thick clay films on all ped surfaces; noncalcareous; pH 7.6; clear boundary.

B22t—10 to 14 inches, brown (10YR 5/3) light clay that is yellowish brown (10YR 5/4) if crushed; when moist, dark brown (10YR 4/3) in place and dark yellowish brown (10YR 4/4) crushed; strong, medium, prismatic structure that separates to moderate, medium, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; moderately thick continuous clay films; noncalcareous; pH 7.8; clear boundary.

B3ca—14 to 20 inches, light olive-brown (2.5Y 5/3) heavy clay loam with brown (10YR 5/3) organic stains, olive brown (2.5Y 4/3) when moist; moderate, medium, prismatic structure that separates to weak, medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; thin patchy clay films on vertical faces; calcareous; threads and nodules of segregated lime; pH 8.2; gradual boundary.

C1ca—20 to 25 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, prismatic structure that separates to weak, medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; calcareous; threads and nodules of segregated lime; pH 8.4; gradual boundary.

C2ca—25 to 40 inches, light yellowish-brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) when moist; weak, coarse, prismatic structure; hard when dry, friable when moist, sticky and plastic when wet; moderately calcareous; common threads and nodules of segregated lime; pH 8.4; gradual boundary.

C3—40 to 60 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) when moist; massive; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 8.4 to 8.6.

Range in characteristics: Clay loam and clay types are mapped in this county, but silty clay and silty clay loam do occur. The A horizon has a color with a value of 5 or more (dry) and 3 or more (moist). The B2 horizon has moderate to strong structure. Its content of clay is estimated at about 38 to 45 percent and is about 6 to 10 percent more than the content of clay in the A1 or Ap horizon. When dry, the B2 horizon has a color with a value of 4 or 5 and a chroma of 3 or 4. The Cca horizon has few to common masses or threads of lime. The A and B horizons have a hue of 2.5Y and 10YR, but the C horizon has a hue of 5Y in some places. In deeply cultivated fields, the A1 and all or nearly all the B2t horizons have been mixed and form the Ap horizon. The Ap horizon is noncalcareous or weakly calcareous in cultivated fields. The noncalcareous part of the solum ranges from 9 to 16 inches in thickness.

Topography: Nearly level to sloping fans and terraces.

Drainage and permeability: Good drainage; in irrigated areas the water table is within 5 feet of the surface during part of the year, and some areas are seeped; moderately slow permeability in the subsoil.

Vegetation: Mid and short grasses.

Use: Diversified irrigated crops; nonirrigated small grain and summer fallow; native range.

Pierre series

The Pierre series consists of moderately deep Grumusols. Pierre soils developed from residuum weathered in place from platy clay shale. These soils are saline-alkali in some places.

Pierre soils that are not saline-alkali have an olive-gray, granular A1 horizon, an olive-gray, blocky subsoil, and a substratum of platy clay shale.

The Pierre soils occur with the Lismas and Marias soils. They are deeper to shale than the Lismas soils and are shallower than the Marias and Promise soils.

Typical profile of Pierre clay just east of the NW corner of the SW¼ of sec. 25, T. 6 N., R. 36 E.; on slope of 10 percent:

A1—0 to 4 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; moderate, fine and very fine, granular structure; very hard when dry, friable when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.3; clear boundary.

C1—4 to 8 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; moderate, very fine, subangular blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.3; gradual boundary.

C2—8 to 16 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; weak to moderate, medium, angular blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.3; few indistinct slickensides; gradual boundary.

CR—16 to 24 inches, light olive-gray (5Y 6/2) clay with fragments of shale, olive gray (5Y 4/2) when moist; massive; some evidence of horizontal cleavage; weakly calcareous; pH 8.4; gradual boundary.

R—24 to 32 inches, light olive-gray (5Y 6/2), platy clay shale, weathered in upper part; olive gray (5Y 4/2) when moist; weakly calcareous; roots penetrate to about 24 inches between shale plates.

Range in characteristics: The A1 horizon has a color with a value of 5 or 6 (dry) and more than 3 (moist), a chroma of 2 or 3, and a hue of 5Y or 2.5Y. In some places the A1 horizon and the upper part of the C horizon are noncalcareous. In other places a few nodules of lime or gypsum occur below a depth of 10 to 14 inches. The C horizon has strong, blocky structure. Below a depth of about 10 inches are distinct slickensides. The depth to unweathered shale is 16 to 40 inches.

Topography: Strongly rolling, eroded uplands.

Drainage and permeability: Good drainage; very slow permeability in the subsoil.

Vegetation: Primarily western wheatgrass, bluebunch wheatgrass, and big sagebrush.

Use: Entirely range.

* * * * *

Saline-alkali Pierre soils have a very thin, light brownish-gray crust of massive clay on the surface. The subsoil is grayish-brown, strongly alkaline clay that is massive or has weak blocky structure. A grayish-brown clay Ccs horizon has formed that has common to many segregations of gypsum. The substratum of platy clay shale is at a depth of 16 to 40 inches.

Unlike the Pierre soils that are not saline-alkali, saline-alkali Pierre soils have a strongly alkaline subsoil and, on the surface, a very thin, continuous, durable crust that reforms after each rain.

Typical profile of Pierre clay, saline-alkali, about one-fourth mile east and 50 feet south of northern corner of sec. 26, T. 7 N., R. 37 E.; in grassland:

A11—0 to ¼ inch, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive crust in hexagonal shapes 2 to 4 inches across; abundant clear sand grains on top side of crust and clusters of granules firmly adhering to underside; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 8.0; abrupt boundary.

A12—¼ inch to 2 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 3/2) when moist; shale chips are fine, granular structure or very fine, subangular blocky structure; very hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; pH 8.4; clear, smooth boundary.

C1—2 to 7 inches, grayish-brown (2.5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.6; clear, irregular boundary.

C2cs—7 to 20 inches, grayish-brown (2.5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) when moist; shale chips are few in upper part but are abundant in lower part; massive; vertical cracks 4 to 10 inches apart; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.6 to 8.8; common crystals of gypsum in vertical seams ¼ inch thick and 1 inch to 4 inches apart; plentiful roots; gradual, irregular boundary.

CRcs—20 to 28 inches, very dark gray (5Y 3/1) shaly clay, black (5Y 2/1) when moist; shale horizontally platy; vertical seams of clay that are 1 to 4 inches thick and have thin layers of clay between plates of shale; many masses of gypsum crystals; pH 8.6 to 8.8; few roots; gradual boundary.

R—28 to 30 inches +, very dark gray (5Y 3/1) platy clay shale, black (5Y 2/1) when moist; coarse blocky with longer horizontal axis consisting of closely fitted plates of shale 1/32 to ¼ inch thick; extremely hard when dry, extremely firm when moist, but brittle when either dry or moist; shale plates are nonporous; weakly calcareous; a few to common thin horizontal and vertical seams of gypsum crystals; few roots.

Range in characteristics: Clay is the only type of saline-alkali Pierre soils mapped in the county. The massive, durable crust covers the entire surface. It ranges from ⅛ to ¼ inch in thickness under the sparse grass between the greasewood but is as much as 1 inch thick under the greasewood or saltbush. The structure of the A12 horizon is platy to very fine, blocky. Gypsum occurs in the C and R horizons at a depth of 10 to 16 inches and ranges in amount from very few nests or seams to abundant thick seams or masses. The surface crust readily reforms after wetting and drying even if it has been destroyed by trampling. Color in the profile has a hue of 2.5Y or 5Y, a chroma of less than 4, and a value of 5 to 6 (dry). In 1:10 dilution the pH ranges from 8.6 to 9.0 at or near the surface to more than 9.0 in the subsoil. These soils are noncalcareous or only weakly calcareous throughout. Clay shale that has blocky-platy structure occurs at a depth ranging from 16 to 40 inches.

Topography: Crests of ridges, mid and upper slopes of undulating to rolling uplands, and mid and lower slopes of hilly uplands; in dissected shale uplands. Local differences in elevation range from 5 to 50 feet. Slopes range from 2 to 20 percent and are mainly 50 to 300 feet long.

Drainage: Excessive to good drainage; rapid runoff; very slow infiltration.

Vegetation: Plants of greasewood and big sagebrush are 5 to 15 feet apart, and between these plants there is a sparse grass cover that covers 2 to 5 percent of the surface. Grasses are western wheatgrass, a little bluegrass, and much wild onion.

Use: Only range.

Promise series

The Promise series consists of deep, dark-colored, granular clay Grumusols. These soils have a dark grayish-brown, granular clay A1 or Ap horizon, an olive-gray, blocky clay upper subsoil, and a massive clay lower subsoil. When moist, the upper subsoil is darker than the lower. Distinct slickensides occur below a depth of 10 to 14 inches.

The Promise soils have a darker colored A horizon and upper subsoil than the Marias soils.

Typical profile of Promise clay 660 feet east and 400 feet south of the NW. corner of the NE¼ of sec. 4, T. 3 N., R. 36 E.; in grassland:

A1—0 to 4 inches, dark grayish-brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine and very fine, granular structure; very hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous; pH 8.0; abrupt boundary.

B2—4 to 20 inches, olive-gray (5Y 5/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, very coarse, prismatic structure that breaks to weak and moderate, medium, angular blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; distinct slickensides below 10 inches; weakly calcareous; gradual boundary.

C2—20 to 34 inches, olive-gray (5Y 5/2) clay, dark grayish brown (2.5Y 4/2) when moist; massive; extremely hard when dry, firm when moist, very sticky and very plastic when wet; distinct slickensides; weakly calcareous; pH 8.5; diffuse boundary.

C3cs—34 to 44 inches, olive-gray (5Y 5/2) clay, olive gray (5Y 4/2) when moist; massive; very hard when dry, firm when moist, very sticky and very plastic when wet; weakly calcareous; pH 8.4; common nests of gypsum; gradual boundary.

R—44 to 55 inches, partly weathered, black, carbonaceous platy clay shale; pH 8.5.

Range in characteristics: The A1 horizon is 3 to 5 inches thick. Its color has a value of 4 or 5 (dry) and 3 (moist) and a chroma of 2 or 3. A very thin, noncalcareous B2 horizon occurs in some places. The depth to the weakly consolidated shale is more than 40 inches. Below

30 inches, materials are as coarse as clay loam in places. Slickensides generally occur in the C1 horizon below a depth of 10 to 14 inches. The segregations of lime are missing in some places.

Topography: Rolling, eroded uplands.

Drainage and permeability: Good drainage; slow or very slow permeability in the subsoil.

Vegetation: Mixed mid and short grasses consisting of western wheatgrass, Sandberg bluegrass, green needlegrass; also scattered big sagebrush.

Use: Mainly range, but small areas are used for nonirrigated small grain or alfalfa.

Renohill series

The Renohill series consists of Brown soils having a very thin solum that developed from clay loam material weathered in place from the underlying weakly consolidated shale. The typical profile has a grayish-brown, granular clay loam A horizon and a light olive-brown, prismatic-blocky heavy clay loam or light clay B2t horizon. The thin B3ca horizon consists of prismatic clay loam that contains nodules of lime. Nodules of lime are common in the clay loam Cca horizon. The substratum of weakly consolidated clay loam shale is at a moderate depth.

The Renohill soils have a solum of the same thickness as that in the Cushman soils but have more clay throughout the profile. In Renohill soils, the B2 horizon is not so clayey as that in the Pierre soils. Renohill soils have a shale substratum at a depth of 26 to 40 inches, whereas the Nunn soils formed in deep transported clay loam materials and do not have a shale substratum at a moderate depth. Unlike the Midway soils, the Renohill soils have B2, B3ca, and Cca horizons.

Typical profile of Renohill clay loam in the NW. corner of the SE¼ of sec. 7, T. 7 N., R. 35 E.:

A1—0 to 4 inches, grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 7.0; clear boundary.

B2t—4 to 9 inches, light olive-brown (2.5Y 5/3) heavy clay loam, very dark grayish brown (2.5Y 3/2) when moist; strong, medium, prismatic structure that separates to moderate, fine, angular blocky structure; very hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; pH 7.6; clear boundary.

B3ca—9 to 14 inches, light yellowish-brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) when moist; moderate, medium, prismatic structure; hard when dry, friable when moist, sticky and plastic when wet; calcareous; common nodules of lime segregation; pH 8.4; gradual boundary.

Cca—14 to 30 inches, pale-olive (5Y 6/3) clay loam, olive (5Y 4/3) when moist; massive; hard when dry, friable when moist, sticky and plastic when wet; calcareous; common nodules of segregated lime; pH 8.5; gradual boundary.

R—30 to 40 inches +, pale-olive, softly consolidated, bedded clay loam shale; platy structure.

Range in characteristics: Clay loam is the only type mapped in the county. The A1 horizon, which is 3 to 5 inches thick, has a color with a value of 5 or 6 (dry) and 3 or more (moist), a chroma of 2 or 3, and a hue of 2.5Y or 10YR. The B2t horizon is 36 to 45 percent clay and has moderate to strong structure. It is 5 to 8 inches thick. The color of the B2t horizon has a value of 4 or 5 (dry), a chroma of 2 or 3, and a hue of 2.5Y or 10YR. The B3ca horizon is 4 to 8 inches thick and contains few to common soft nodules of lime. Soft nodules of lime are common or many in the Cca horizon. The A1 and B2 horizons combined are more than 10 inches thick in only a few places. The depth to the beds of soft shale is 26 to 40 inches.

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Topography: Rolling to strongly rolling uplands.

Drainage and permeability: Good drainage; moderately slow permeability in the subsoil.

Vegetation: Western wheatgrass, prairie junegrass, blue grama, needle-and-thread, and scattered big sagebrush.

Use: Primarily range, but a few areas are farmed.

Sage series

The Sage series consists of Solonchak soils. Sage soils have strongly saline, granular clay A1sa and upper Csa horizons in which streaks and specks of salts and gypsum are many. Salts and gypsum have accumulated in the massive clay C2 horizon.

The Sage soils have more clay in their subsoil than the Laurel soils, which have a loam or clay loam subsoil. They are wetter and more saline than the Bowdoin soils. Sage soils are wetter and more saline than the saline Hoven soils, though not so dense and compact.

Typical profile of Sage clay about 1,000 feet south and 500 feet west of the NE. corner of sec. 7, T. 6 N., R. 36 E., in pasture:

A1sa—0 to 6 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; strong, fine and medium, granular structure; very hard when dry, friable when moist, very sticky and very plastic when wet; calcareous; common to many streaks, seams, and specks of salts and gypsum, thin salt crust or powdery salt on surface; pH 9.2; diffuse boundary.

C1sa—6 to 26 inches, light brownish-gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; strong, very fine, subangular blocky or granular structure; extremely hard when dry, firm when moist; very sticky and very plastic when wet; calcareous; many streaks, seams, and nests of soluble salts and gypsum; pH 9.0; diffuse boundary.

C2—26 to 50 inches, light yellowish-brown (2.5Y 6/3 clay, light olive brown (2.5Y 5/3) when moist; massive; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; calcareous; common to many streaks and nests of soluble salts and gypsum; pH 8.7; gradual boundary.

IIC3—50 to 60 inches, light yellowish-brown (2.5Y 6/3), stratified loam, very fine sandy loam, and clay loam, light olive brown (2.5Y 5/3) when moist; many, fine, distinct, yellowish-brown mottles; calcareous; few nests of gypsum.

Range in characteristics: Clay and silty clay types are mapped in this county. The A1sa and C1sa horizons combined are 18 to 30 inches thick. Depth to stratified materials ranges from 30 to more than 60 inches but is generally 40 to 50 inches. A salt crust occurs, but it is not continuous over the entire surface. In many areas, these soils lack the flocculated granular upper horizons and have a 1- to 2-inch gray loam A2 horizon, a noncalcareous, blocky clay B2t horizon, and a granular clay Csa horizon. The Csa horizon is below a depth of 6 to 8 inches.

Topography: Level terraces and flood plains.

Drainage and permeability: Moderately good and good drainage; water table at or near the surface most of the year as a result of seeped irrigation water; very slow permeability.

Vegetation: Sparse cover of salt-tolerant weeds and grasses in the salt-crusted, wetter areas and western wheatgrass, inland saltgrass, alkali sacaton, and greasewood in the drier areas.

Use: Only pasture.

Shonkin series

The Shonkin series consists of somewhat poorly drained, light-colored Soloth soils that developed from clayey material deposited in shallow undrained basins and depressions. The typical profile of Shonkin soils has a light brownish-gray or gray loam A2 horizon 6 to 9 inches thick. The A&B horizon is grayish-brown, prismatic-platy silty clay loam which has a very thin frosting of bleached grains of silt and sand on all the ped surfaces. The B2t horizon of brown, strong, blocky clay is underlain by a B3 horizon of light brownish-gray blocky heavy clay loam or clay. The Cca horizon is clay or clay loam containing segregated or disseminated lime.

The Shonkin soils are distinguished from the Hoven soils by their thicker A2 horizon, their A&B horizon, and their strong blocky or prismatic-blocky structure in the B2t horizon. Hoven soils have a denser B horizon that has weak to strong, columnar structure or weak and moderate blocky structure. Shonkin soils are more poorly drained and have a thicker A2 horizon than the Gilt Edge soils and have a blocky-prismatic rather than a columnar B2t horizon.

Typical profile of Shonkin loam 35 feet southeast of the NW. corner of sec. 22, T. 5 N., R. 34 E.; in cultivated field:

A21p—0 to 7 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; weak, very fine, granular structure, strongly vesicular clods; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 8.0.

A22—7 to 9 inches, light-gray (10YR 6/1) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, coarse, prismatic structure that separates to moderate, medium, platy structure; hard when dry, very friable when moist, sticky and slightly plastic when wet; sand and silt on and within peds are mostly clear and unstained; noncalcareous; pH 7.8; clear boundary.

A&B—9 to 12 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark brown (10YR 3/3) when moist; medium prismatic structure that separates to moderate, thin, platy structure; thick coatings of clear silt and sand on ped surfaces and in threads through the soil mass; hard when dry, firm when moist, sticky and slightly plastic when wet; noncalcareous; pH 7.4; clear boundary.

B2t—12 to 28 inches, dark grayish-brown (10YR 4/2) clay that grades to brown (10YR 5/3), dark brown (10YR 3/3) when moist; moderate, medium, prismatic structure that separates easily to strong, medium to fine, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; thick, continuous clay films on all ped faces; noncalcareous; pH 7.8 to 8.0; gradual boundary.

B3—28 to 39 inches, light brownish-gray (2.5Y 6/2) heavy clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, medium, angular blocky structure; hard when dry, friable when moist, sticky and slightly plastic when wet; noncalcareous; pH 8.4; clear boundary.

IIC1cs—39 to 50 inches, light brownish-gray (2.5Y 6/2) clay loam to pale-olive (5Y 6/3) sandy clay loam, dark grayish brown (2.5Y 4/2) to olive (5Y 5/3) when moist; massive; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; disseminated lime flour; pH 8.4; gradual boundary.

IIIC2—50 to 58 inches, grayish-brown (2.5Y 5/3), stratified fine sandy loam and loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 8.4; gradual boundary.

Range in characteristics: Silt loam and loam types occur, but only the loam type is mapped in this county. The A2 horizon is 6 to 9 inches thick. Its color has a value of 6 or more (dry) and more than 3 (moist), a chroma of 1 or 2, and a hue of 10YR or 2.5Y. In places where the upper A1 horizon is darker colored than normal, common to many reddish-brown stains coat the root channels in the A and A&B horizons. The B2t horizon is 10 to 20 inches thick. When it is dry, its color has a value of 4 or 5, a chroma of 2 to 4, and a hue of 2.5Y or 10YR. The structure of the B2t horizon is predominantly strong, fine, angular blocky to moderate, medium and fine, prismatic, or it is weak columnar to moderate, medium and fine, blocky. Where the B2 horizon has a columnar structure, the upper parts of the columns are streaked and banded with clear silt and sand grains to a depth of at least 1 inch below the top of the columns. The content of clay in the B2t horizon ranges from about 45 to 55 percent and is 20 to 30 percent greater than the content of clay in the A horizon. Shonkin soils are only weakly calcareous in the lower part of a 5-foot profile, or they are moderately or strongly calcareous at a depth of 26 to 30 inches and have crystals of gypsum in the lower part of the profile. The substratum ranges from clay to sand and gravel in a 5-foot profile. The solum has very few or no coarse fragments and a very low percentage of medium and coarse sands. In the northwestern part of the county, the color of these soils has been influenced by the dark carbonaceous shale.

Topography: Flat floors of shallow broad basins and small depressions.

Drainage: Somewhat poor drainage; moderate internal drainage, as is indicated by the moderate or greater depth to lime; water ponded for a week to a month during rainy periods in spring and in fall; ground water is at an undetermined depth below 5 feet during the dry season.

Vegetation: Western wheatgrass.

Use: Mainly native hay and pasture, but some areas are cultivated to small grain.

Terry series

The Terry series consists of Brown soils that developed in moderately sandy material weathered in place from weakly consolidated sandstone. The typical profile has a grayish-brown fine sandy loam A1 horizon and a brown, prismatic light sandy clay loam B2t horizon. The B3ca horizon is yellowish-brown, prismatic sandy clay loam containing nodules of lime. It is underlain by a very fine sandy loam Cca horizon that contains nodules of segregated lime. The substratum is at a moderate depth and consists of weakly consolidated sandstone.

The Terry soils have less clay in the B2t horizon than Treasure soils, which do not have a sandstone substratum at a moderate depth. A B2 horizon occurs in the Terry soils, but not in the Tullock soils. The Terry soils have a higher percentage of sand throughout than the Cushman soils.

Typical profile of Terry fine sandy loam 1,320 feet west and 150 feet north of the SE. corner of the NE¼ of sec. 6, T. 8 N., R. 36 E.:

A1—0 to 5 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.5; clear boundary.

B2t—5 to 14 inches, brown (10YR 5/3) light sandy clay loam, dark brown (10YR 3/3) when moist; moderate, medium and coarse, prismatic structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.1; clear boundary.

B3ca—14 to 20 inches, yellowish-brown (10YR 5/4) light sandy clay loam, dark yellowish brown (10YR 4/4) when moist; moderate, medium, prismatic structure; hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; few nodules of segregated lime; pH 8.2; clear boundary.

Cca—20 to 26 inches, light yellowish-brown (2.5Y 6/3) fine sandy loam, olive brown (2.5Y 4/3) when moist; weak, coarse, prismatic structure; slightly hard when dry, very friable when moist, slightly sticky and nonplastic when wet; strongly calcareous; nodules of segregated lime; pH 8.4; clear boundary.

R—26 to 32 inches, pale-yellow, weakly to moderately consolidated sandstone that is weathered in the upper few inches; calcareous.

Range in characteristics: The A1 horizon, which is 4 to 6 inches thick, is a fine sandy loam or sandy loam. In some places loamy fine sand occurs in the upper 1 to 3 inches of the A1 horizon. The A1 horizon has a color with a value of 5 or more (dry) and 3 or more (moist) and a chroma of 2 or 3. The B2t horizon is heavy fine sandy loam to sandy clay loam 6 to 10 inches thick. It is about 18 to 25 percent clay, which is about 4 to 8 percent more clay than occurs in the A1 or Ap horizon. Structure of the B2t horizon is moderate to strong, prismatic. The B2t horizon has a color with a value of 4 or 5 (dry), a chroma of 3 or 4, and a hue of 10YR or 2.5Y. Few to common nodules of lime are in the Cca horizon. The depth to unweathered sandstone is 22 to 32 inches.

Topography: Undulating to rolling uplands that have slopes of 3 to 10 percent.

Drainage and permeability: Good drainage; moderate permeability in the subsoil.

Vegetation: Needle-and-thread, blue grama, western wheatgrass, and prairie junegrass.

Use: Primarily range, but a few small areas are cultivated.

Travessilla series

The Travessilla series consists of light-colored loam or sandy loam Lithosols that weathered in place from hard sandstone. These soils have a very thin, grayish-brown loam or sandy loam A1 horizon, a calcareous loam or sandy loam C horizon, and an R horizon of hard sandstone.

The Travessilla soils occur with the Cushman soils but, unlike them, do not have a B2 horizon. The substratum of Travessilla soils is hard sandstone, whereas the Tullock soils have a substratum of weakly consolidated sandstone. Travessilla soils lack the reddish colors of the Wibaux soils, which are Lithosols developed from beds of red clinkers or porcelanite.

Typical profile of Travessilla loam about one-fourth of a mile east of the NW. corner of sec. 5, T. 6 N., R. 34 E.; in grassland:

A1—0 to 2 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; weak, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 7.5; clear boundary.

C—2 to 12 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) when moist; massive; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; few fragments of sandstone that increase with depth; calcareous; pH 8.3; clear boundary.

R—12 to 20 inches +, indurated platy sandstone with lime crust on under side; roots form a mat on and under plates.

Range in characteristics: Travessilla soils are not mapped separately in this county, but loam, stony loam, and sandy loam occur. The A1 horizon is less than 4 inches thick. When dry, its color has a value of 5 or 6 and a chroma of 2 or 3. The A1 horizon is calcareous or noncalcareous. The depth to the sandstone is 5 to 16 inches. In many places fragments of sandstone are on or near the surface and throughout the profile.

Topography: Rolling to steep, eroded uplands.

Drainage: Excessive drainage.

Vegetation: Mixed mid and short grasses, including western wheatgrass, needle-and-thread, and blue grama; also threadleaf sedge.

Use: Range except for small areas that are cultivated within larger areas of better soils.

Treasure series

The Treasure series consists of well-drained Brown soils that developed from deep, transported, moderately sandy material. The typical profile has a grayish-brown fine sandy loam A1 or Ap horizon and a dark yellowish-brown, prismatic, heavy sandy clay loam B2t horizon. The B3ca horizon is brown, prismatic light sandy clay loam containing nodules of lime. It is underlain by a Cca horizon of olive-gray fine sandy loam that has common segregations of lime. The C horizon is calcareous fine sandy loam.

These soils have strongly expressed A, B2t, and Cca horizons, whereas the Glendive soils have only a C horizon below the Ap. Treasure soils have a higher percentage of fine and medium sand throughout than the Fort Collins soils, which are Brown soils developed from loam material. A sandstone substratum does not occur at a moderate depth, as it does in the Terry soils.

Typical profile of Treasure fine sandy loam about 500 feet south and 400 feet west of the NE. corner of sec. 24, T. 6 N., R. 37 E.; in cultivated field on slope of 3 percent:

Ap—0 to 5 inches, grayish-brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 6.5; abrupt boundary.

B21—5 to 14 inches, dark yellowish-brown (10YR 4/4) heavy sandy clay loam that is brown (10YR 5/3) if crushed; when moist, dark yellowish brown (10YR 3/4) in place and brown (10YR 4/3) crushed; strong, medium, prismatic structure that separates to moderate, medium and coarse, angular blocky structure; very hard when dry, friable when moist, slightly sticky and plastic when wet; clay thickly coats the sand grains and films the surface of peds, and it forms bridges between the sand grains; noncalcareous; pH 7.1; clear boundary.

B22t—14 to 18 inches, yellowish-brown (10YR 5/4) heavy sandy clay loam that is light olive brown (2.5Y 5/3) if crushed; when moist, dark yellowish brown (10YR 4/4) in place and olive brown (2.5Y 4/3) crushed;

strong, medium, prismatic structure that separates to weak, medium and coarse, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; clay thickly coats the sand grains and films the surfaces of the peds, and it forms bridges between the sand grains; noncalcareous; pH 7.6; clear boundary.

B3ca—18 to 24 inches, brown (10YR 5/3) light sandy clay loam that is grayish brown (2.5Y 5/2) if crushed; when moist, dark brown (10YR 4/3) in place and olive brown (2.5Y 4/3) crushed; moderate, coarse, prismatic structure; very hard when dry, very friable when moist, nonsticky and nonplastic when wet; thin patchy clay films; moderately calcareous; few threads and soft nodules of segregated lime; pH 8.2; gradual boundary.

C1ca—24 to 38 inches, light olive-gray (5Y 6/2) heavy fine sandy loam, olive gray (5Y 5/2) when moist; massive; hard when dry, very friable when moist, nonsticky and nonplastic when wet; strongly calcareous; common threads and soft masses of segregated lime; pH 8.4; gradual boundary.

C2—38 to 60 inches, pale-olive (5Y 6/3) fine sandy loam, olive (5Y 4/3) when moist; massive; slightly hard when dry, very friable when moist, nonsticky and nonplastic when wet; moderately calcareous; pH 8.4.

Range in characteristics: Both fine sandy loam and sandy loam occur, but only fine sandy loam is mapped in the county. The color of the surface horizon has a value of 5 or more (dry) and 3 or more (moist) and a chroma of 2 or 3. The B2t horizon, which is 10 to 15 inches thick, is 30 to 40 percent clay and more than 45 percent sand. This horizon has 12 to 20 percent more clay than the A1 or the Ap horizon. The structure of the B2t horizon is moderate or strong prismatic that does not break to blocky in some places. The color of the B2t horizon has a value of 4 or 5 and a chroma of 3 to 5. The hue of the A and B horizons is 10YR or 2.5Y. The C1ca horizon, which is 12 to 20 inches thick, is weak in places where there are few or no soft masses of lime. The C horizon is a light sandy clay loam in some places. Below a depth of 32 to 40 inches, the material grades to loamy fine sand or fine sand in some places. A substratum of sandstone or other contrasting material occurs below 40 inches in places. In grassland, the usual sequence of horizons is A1, A3 or B1, B2t, B3ca, Cca, and C. The A1 horizon is 2 to 4 inches thick, and the B1 horizon is 4 to 6 inches thick.

Topography: Nearly level to moderately steep fans and foot slopes.

Drainage and permeability: Good drainage; moderate permeability in the subsoil.

Vegetation: Needle-and-thread, western wheatgrass, bluebunch wheatgrass, and threadleaf sedge.

Use: Nonirrigated cropland and native range.

Tullock series

The Tullock series consists of light-colored, sandy Lithosols that developed from material weathered in place from calcareous, weakly consolidated sandstone or compact sand. The typical profile has an A1 horizon consisting of light brownish-gray fine sandy loam 4 inches thick. The subsoil is light yellowish-brown, strongly calcareous fine sandy loam or loamy fine sand. A substratum of weakly consolidated sandstone occurs at a moderate depth.

The Tullock soils have a thinner, lighter colored A horizon than the Flasher soils. Unlike the Terry soils, Tullock soils lack a B2t horizon. They are deeper to bedrock than the Travessilla soils, which have a substratum of hard rather than soft sandstone. The substratum of bedrock at a moderate depth differentiates Tullock soils from the Glendive soils. Tullock soils have a sandier subsoil than the Bainville soils.

Typical profile of Tullock fine sandy loam about one-fourth mile east of the center of sec. 31, T. 7 N., R. 35 E.; in grassland:

A1—0 to 4 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; weakly calcareous; pH 8.4; clear boundary.

C1—4 to 28 inches, light yellowish-brown (2.5Y 6/3) fine sandy loam or heavy loamy fine sand, light olive brown (2.5Y 5/3) when moist; massive; soft when dry, very friable when moist, nonsticky and nonplastic when wet; strongly calcareous; pH 8.5.

R—28 to 42 inches, light yellowish-brown (2.5Y 6/3), weakly consolidated sandstone of about loamy sand or fine sand texture, light olive brown (2.5Y 5/3) when moist; slightly compact; strongly calcareous.

Range in characteristics: Fine sandy loam and loamy fine sand occur, but only fine sandy loam is mapped in this county. The A1 horizon, which is less than 5 inches thick, has a color with a value of 5 or 6 (dry) and 4 or 5 (moist) and a chroma of 2 or 3. The A1 horizon is calcareous or noncalcareous. The C horizon is fine sandy loam to loamy fine sand that, when dry, has a color with a value of 6 or 7 and a chroma of 2 to 4. It is moderately to strongly calcareous. The depth to soft sandstone is 10 to 40 inches. In a few places hard sandstone or shale underlies these soils at a depth of less than 30 inches.

Topography: Rolling to hilly, eroded uplands.

Drainage and permeability: Excessive drainage; rapid permeability in the subsoil.

Vegetation: Mixed grasses consisting of needle-and-thread, western wheatgrass, sandreed, and Indian ricegrass. The sandreed and Indian ricegrass are in the more sandy areas.

Use: Primarily range, but a few small areas are farmed along with larger areas of other soils.

Wanetta series

The Wanetta series consists of moderately deep, well-drained Brown soils. Wanetta soils developed from transported, well-graded loam material that is underlain by loose sand and gravel at a moderate depth. The typical profile has a grayish-brown loam A1 or Ap horizon, a brown, prismatic clay loam B2t horizon, a light olive-brown heavy loam B3 horizon, a loam Cca horizon that contains many nodules of accumulated lime, and a substratum of sand and gravel.

The sand and gravel substratum at a moderate depth differentiates Wanetta soils from the Fort Collins soils. Wanetta soils are deeper over sand and gravel than are the Beaverton soils.

Typical profile of Wanetta loam, deep, ¼ mile south and 2/10 mile west of the NE. corner of sec. 13, T. 6 N., R. 37 E.; in cultivated field:

Ap—0 to 6 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, crumb structure; soft when dry, very friable when moist, nonsticky and nonplastic when wet; noncalcareous; pH 7.0.

B2t—6 to 14 inches, brown (10YR 4/3) clay loam that is light yellowish brown (10YR 5/4) if crushed; when moist,

dark brown (10YR 3/3) in place and dark yellowish brown (10YR 4/4) crushed; strong, medium, prismatic structure that separates to moderate, medium, angular blocky structure; very hard when dry, friable when moist, slightly sticky and slightly plastic when wet; moderately thick clay films; noncalcareous; pH 7.4; clear boundary.

B3—14 to 17 inches, light olive-brown (2.5Y 5/3) heavy loam, olive brown (2.5Y 4/3) when moist; moderate, medium, prismatic structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; thin patchy clay films; noncalcareous; pH 7.8; clear boundary.

C1ca—17 to 32 inches, light brownish-gray (2.5Y 6/2) loam, light olive brown (2.5Y 5/3) when moist; massive; hard when dry, very friable when moist; strongly calcareous; many soft masses of lime; pH 8.4; lower 2 to 4 inches contain about 30 to 40 percent gravel; gradual boundary.

IIC2—32 to 40 inches, very gravelly loamy sand; moderately calcareous; lime crusts on pebbles.

IIIC3—40 to 60 inches, loose sand and gravel; calcareous.

Range in characteristics: Loam is the only type mapped in the county. Undisturbed profiles have a loam A1 horizon, 2 to 4 inches thick, and a loam AB horizon, 3 to 5 inches thick. The Ap horizon has a color with a value of 5 or more (dry) and 3 or more (moist), a chroma of 2 or 3, and a hue of 2.5Y or 10YR. The B2t horizon is 28 to 35 percent clay. The content of clay in the B2t horizon is about 5 to 10 percent more than that in the Ap horizon and as much as 15 percent more than that in the A1 horizon. The structure of the B2t horizon ranges from moderate to strong. The B2 horizon has a color with a value of 4 or 5 (dry), a chroma of 3 or 4, and a hue of 10YR. The noncalcareous part of the solum ranges from 12 to 20 inches in thickness. The Cca horizon is distinct in some areas, and in areas where these soils are shallower than normal, lime may have accumulated in the upper part of the gravel substratum. The depth to the sand and gravel substratum ranges from 22 to 42 inches.

Topography: Nearly level to sloping terraces.

Drainage and permeability: Good drainage; moderate permeability in the subsoil.

Vegetation: Short and mid grasses.

Use: Nonirrigated crops and native range.

Wibaux series

The Wibaux series consists of reddish-colored Lithosols that formed in material weathered from porcelanite or clinker beds. These soils typically have a brown channery loam or stony loam A1 horizon, 3 to 4 inches thick, and a reddish-brown channery or stony loam subsoil that is underlain by fractured indurated bedrock at a depth of about 10 to 14 inches. The Wibaux soils are redder than the Travessilla soils.

Typical profile of Wibaux stony loam:

A1—0 to 3 inches, brown (7.5YR 5/4) stony loam, dark brown (7.5YR 3/3) when moist; weak, fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 8.2; clear boundary.

C—3 to 12 inches, reddish-brown (5YR 5/4) stony loam, reddish brown (5YR 4/3) when moist; weak, coarse, prismatic structure; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; calcareous; pH 8.4; abrupt boundary.

R—12 inches +, shattered indurated porcelanite beds that are partly weathered in upper part and have crusts of lime on fragments.

Range in characteristics: The coarse fragments in the profile range from the size of shale through the size of stones. Color is in a hue of 7.5YR to 2.5YR. Depth of bedrock is 5 to 14 inches.

Topography: Steep and rough, broken lands.

Drainage and permeability: Excessive drainage; moderate permeability in the subsoil.

Vegetation: Mixed and short grasses consisting mainly of bluebunch wheatgrass, western wheatgrass, and blue grama; also scattered pines.

Use: Entirely grazing.

Winnett series

The Winnett series consists of Solonetz soils that have been solodized. Winnett soils developed in material weathered in place from weakly consolidated loam, clay loam, or sandy clay loam shale. The typical profile has a very thin or no A1 horizon, a light-gray loam A2 horizon, a columnar clay B2t horizon, and a prismatic heavy clay loam B3cs horizon that has seams of gypsum. The Ccs horizon is clay loam containing segregations of gypsum, and the substratum of weakly consolidated shale is at a moderate depth.

The Winnett soils occur with the Cushman, Fattig, and Terry soils. Winnett soils have a columnar B2t horizon, whereas the Cushman and Terry soils do not. The shale substratum at a depth within 40 inches differentiates the Winnett soils from the Arvada soils.

Typical profile of Winnett loam about 800 feet north and 600 feet east of the SW. corner of sec. 33, T. 3 N., R. 36 E.; in grassland:

A1—0 to 2 inches, grayish-brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; moderate, fine, granular structure; soft when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; pH 6.5; clear boundary.

A2—2 to 6 inches, light brownish-gray (2.5Y 6/2) and light-gray (2.5Y 7/2) loam, dark grayish brown (2.5Y 4/2) when moist; moderate, thin, platy structure; slightly hard when dry, very friable when moist, slightly sticky and plastic when wet; noncalcareous; pH 6.8; abrupt boundary.

B2t—6 to 16 inches, dark grayish-brown (2.5Y 4/2) silty clay, olive brown (2.5Y 3/3) when moist; strong, medium, columnar structure in upper 4 inches; prismatic-blocky structure in lower part; extremely hard when dry, firm when moist, sticky and plastic when wet; thick, continuous clay films; noncalcareous; pH 8.8.; clear boundary.

B3cs—16 to 22 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam, dark grayish brown (2.5Y 4/2) when moist; strong, medium, prismatic structure that separates to moderate, medium, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; patchy clay films; calcareous; few seams and nests of gypsum; pH 9.0; gradual boundary.

Ccs—22 to 30 inches, light brownish-gray (2.5Y 6/3) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; very hard when dry, friable when moist, sticky and plastic when wet; calcareous; common nests of gypsum; pH 9.2; gradual boundary.

R—30 to 40 inches, olive-colored, weakly consolidated clay loam shale; nests of gypsum in upper part.

Range in characteristics: Loam, clay loam, clay, and sandy loam types occur in the county, but only loam is mapped separately. The thickness of the A1 and the A2 horizons combined is 1 to 7 inches. The B2t horizon, which is 5 to 12 inches thick, is a heavy clay loam, clay,

sandy clay loam, or sandy clay. The content of clay in the B2t horizon ranges from 37 to 50 percent. The B2t horizon has moderate to strong, columnar or prismatic-blocky structure. The boundary between the A and B horizons is abrupt, or there is a 4- to 6-inch blocky A&B or B&A transitional horizon that has peds coated with bleached grains of sand and silt. The B2 horizon is neutral to strongly alkaline. The upper C horizon has segregations of lime or gypsum above the shale and is nonsaline to moderately saline. The depth to shale is 24 to 40 inches.

Topography: Undulating to rolling, eroded uplands.

Drainage and permeability: Good drainage; very slow permeability in the subsoil.

Vegetation: Mixed mid and short grasses, including western wheatgrass, blue grama, and prairie junegrass; also big sagebrush.

TABLE 7.—*Analytical data*

Soil	Horizon	Depth	Particle-size distribution: Sand (2.0–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (<0.002 mm.)	Moisture tension at 15 atmos.	Moisture at saturation	Reaction: Saturated paste	1:5	1:10
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*pH*	*pH*	*pH*
Fort Collins loam (600 ft. west and 50 ft. south of NW. corner of NE¼ sec. 21, T. 6 N., R. 36 E.). *Survey No.* S56–Mont–52–8; *laboratory No.* 4819–4826.	Ap	0–10	13.6	22.0	41.5	22.9	9.4	43.3	7.7	8.2	8.3
	B3ca	10–18	2.5	9.2	59.0	29.3	11.3	52.1	7.8	8.4	8.6
	C1ca	18–28	3.7	8.7	53.8	33.8	12.0	53.5	7.9	8.7	8.8
	C2ca	28–36	4.3	3.8	46.1	45.8	15.6	62.4	8.1	8.7	8.8
	C3	36–42	2.3	6.8	58.3	32.6	11.8	52.9	8.2	8.8	8.9
	C4	42–50	6.4	18.8	54.4	20.4	7.8	42.5	8.2	8.8	8.9
	C5	50–62	20.3	30.5	31.5	17.7	6.9	39.5	8.0	8.7	8.9
Fort Collins loam (200 ft. west and 40 ft. south of NW. corner of NE¼ sec. 16, T. 6 N., R. 36 E.). *Survey No.* S56–Mont–52–9; *laboratory No.* 4827–4834.	Ap	0–9	10.0	17.6	47.3	25.1	10.2	47.4	7.6	8.2	8.4
	B3	9–12	10.2	18.9	47.4	23.5	10.9	44.4	7.8	8.5	8.5
	C1ca	12–21	7.4	23.8	36.0	32.8	8.6	43.4	8.0	8.6	8.7
	C2ca	21–34	.7	1.9	50.1	47.3	14.8	64.9	8.3	8.8	8.9
	IIC3	34–45	.2	.7	49.9	49.2	15.7	67.6	8.4	9.0	9.2
	IIC4	45–59	2.14	3.2	50.3	44.1	16.0	58.9	8.1	8.8	9.1
	IIIC5	59–67	30.3	20.0	26.3	23.4	8.8	38.5	8.0	8.9	9.2
Marias clay (about 1,400 ft. south and 500 ft. east of NW. corner of NE¼ sec. 2, T. 3 N., R. 36 E.). *Survey No.* S56–Mont–52–6; *laboratory No.* 4804–4810.	A1	0–4	9.1	11.2	32.1	46.6	18.7	68.6	6.8	7.1	7.2
	B21	4–9	7.7	9.6	32.2	50.5	20.1	72.2	7.4	7.7	8.1
	B22	9–15	7.0	9.3	34.7	49.0	21.6	73.2	7.6	8.3	8.3
	B3	15–24	7.0	8.9	36.3	47.8	20.0	70.4	7.8	8.4	8.5
	C1cs1	24–31	5.6	9.2	40.0	45.2	19.1	75.6	7.8	8.4	8.4
	IIC2cs2	31–44	11.3	17.8	36.9	34.0	14.1	61.4	7.9	8.4	8.6
	IIC3cs3	44–60	17.4	18.3	31.3	33.0	13.4	59.4	7.9	8.5	8.7
Marias clay, saline-alkali (720 ft. north and 20 ft., west of SE. corner of SE¼ sec. 6, T. 7 N., R. 36 E.). *Survey No.* S56–Mont–52–3; *laboratory No.* 4785–4791.	A1	0–4	2.7	4.7	47.3	47.3	18.7	69.5	7.2	7.6	7.8
	B21	4–11	1.2	4.1	41.3	53.4	20.8	73.0	7.8	8.7	8.8
	B22	11–19	.9	3.7	40.7	54.7	22.1	76.5	7.9	8.7	9.0
	B3	19–26	.9	3.5	40.6	54.8	20.7	81.5	7.8	8.4	8.6
	C1cs	26–34	.7	5.9	41.2	52.2	20.0	74.2	7.7	8.0	8.1
	C2	34–46	.4	5.8	45.4	48.4	17.8	74.6	7.6	8.0	8.3
	C3	46–60	.2	7.4	45.0	47.4	17.4	76.3	7.7	8.5	9.0
Marias clay, saline-alkali (200 ft. north and 100 ft. west of NE. corner of SE¼ sec. 31, T. 8 N., R. 35 E.). *Survey No.* S56–Mont–52–4; *laboratory No.* 4792–4797.	A1	0–4	1.6	5.0	41.8	48.9	17.1	62.1	7.7	8.3	8.6
	B21	4–12	3.5	4.6	38.9	53.0	19.6	69.7	7.9	8.5	8.8
	B22	12–20	2.9	3.5	37.5	56.1	20.7	78.0	8.0	8.8	9.1
	C1cs	20–26	2.4	3.0	38.4	56.2	20.1	78.7	7.7	8.0	8.1
	C2	26–40	5.2	3.0	38.6	56.2	19.2	75.9	7.7	8.0	8.1
	C3	40–60	2.4	3.2	32.2	57.2	18.6	71.8	7.7	8.1	8.3
Marias clay, saline-alkali, fans (300 ft. north and 100 ft. west of NW. corner of SE¼ sec. 16, T. 7 N., R. 36 E.). *Survey No.* S56–Mont–52–1; *laboratory No.* 4770–4776.	A1	0–2	3.0	4.2	40.7	52.1	16.7	63.0	7.5	8.0	8.0
	B21	2–12	2.2	3.4	40.8	53.6	19.2	65.6	8.0	8.8	8.8
	B22	12–20	1.8	3.1	40.0	55.1	22.2	72.0	8.0	8.6	9.1
	B3	20–30	1.5	2.8	41.0	54.7	20.0	76.8	8.0	8.7	9.0
	C1	30–34	1.3	2.9	40.9	54.9	20.0	75.1	8.0	8.5	8.9
	C2cs	34–46	1.4	2.7	43.7	52.2	19.1	70.2	7.8	8.0	8.1
	C3cs	46–60	.9	2.2	47.7	49.2	22.0	70.8	7.8	8.0	8.1

Use: Mainly for range, but small areas are farmed along with larger areas of better soils.

Mechanical and Chemical Analyses

The data obtained by mechanical and chemical analyses for selected soils in Treasure County are given in table 7. Descriptions of the profiles of the selected soils are in the preceding subsection, listed in the alphabetic order by series name. The data in table 7 are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful for estimating water-holding capacity, wind erosion, fertility, tilth, and other practical aspects of soil management. The data on reaction, electrical conductivity, and percentage of exchangeable sodium are helpful in evaluating the possibility of reclaiming and managing saline-alkali areas.

for selected soil profiles

Organic matter		Soluble salts			$CaCO_3$ equivalent	Cation exchange capacity (NH_4Ac)	Extractable cations					Exchangeable Na	Saturation extract: soluble	
Organic carbon	Nitrogen	Estimated salt	Electrical conductivity EC×10³ millimhos per cm. at 25° C.	Gypsum			Ca	Mg	H	Na	K		Na	K
		Percent		*Meq./100 gm.*	*Percent*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Percent*	*Meq./li.*	*Meq./li.*
0.96	0.096	<0.20	0.9	------	2	16.1	------	5.2	------	0.4	0.8	2	2.8	0.5
.85	.081	<.20	.9	------	13	16.2	------	------	------	.4	.4	2	2.8	.2
.58	.059	<.20	.9	------	13	16.7	------	------	------	.5	.4	2	2.6	.1
.43	--------	<.20	.9	------	10	21.6	------	------	------	.6	.5	2	2.6	.1
.33	--------	<.20	.9	------	10	17.4	------	------	------	.4	.4	2	2.7	.2
.24	--------	<.20	1.0	------	10	12.8	------	------	------	.4	.3	2	2.6	.2
.59	--------	<.20	1.0	------	8	13.1	------	------	------	.3	.3	2	2.4	.2
1.48	.134	<.20	1.0	------	2	18.4	------	5.9	------	.3	1.2	2	2.4	.7
.91	.091	<.20	.9	------	3	15.5	------	------	------	.4	.8	2	2.6	.4
.64	.062	<.20	.9	------	7	13.2	------	------	------	.3	.3	2	2.6	.2
.58	.060	<.20	.9	------	10	21.5	------	------	------	.9	.5	3	3.8	.1
.47	--------	<.20	1.1	------	8	24.2	------	------	------	2.0	.5	6	7.3	.1
.47	--------	<.20	1.1	------	6	22.3	------	------	------	2.4	.5	8	8.2	.1
.35	--------	<.20	1.2	------	5	13.5	------	------	------	1.4	.4	8	8.5	.2
1.61	.132	<.20	.6	------	--------	34.7	21.1	14.6	1.3	.1	1.3	--------	.3	.3
1.02	.088	<.20	.6	1	--------	36.8	------	------	------	.4	.6	1	1.1	.1
.84	.071	<.20	.6	2	--------	35.2	------	------	------	.9	.6	2	2.1	.1
.67	.062	<.20	.7	4	--------	33.4	------	------	------	1.6	.6	4	4.0	.1
.51	--------	<.20	1.2	5	--------	30.8	------	------	------	2.0	.6	5	6.9	.1
.37	--------	<.20	1.9	7	--------	23.8	------	------	------	1.6	.5	5	8.5	.2
.31	--------	<.20	1.8	7	--------	25.0	------	------	------	1.7	.5	5	8.0	.3
1.88	.158	.24	3.0	------	1	34.8	------	11.1	------	.8	1.7	1	4.8	.5
.78	.071	<.20	1.0	------	2	34.6	------	------	------	2.9	.8	7	6.6	--------
.66	.056	<.20	2.0	------	2	33.6	------	------	------	5.0	.9	12	14.0	.1
.66	.060	.39	4.3	------	2	33.5	------	------	------	6.0	1.0	11	28.2	.2
.36	--------	.56	6.5	120	2	29.3	------	------	------	5.4	.8	9	39.0	.4
.34	--------	.56	6.5	5	2	30.7	------	------	------	6.2	.7	11	37.5	.6
.38	--------	.33	3.7	------	2	30.9	------	------	------	6.2	.7	14	25.0	.4
.98	.087	<.20	.8	------	1	32.7	------	8.7	------	1.6	1.3	4	4.2	.1
.72	.055	<.20	1.2	------	2	32.3	------	------	------	4.5	.8	12	8.7	--------
.62	.060	.22	2.2	------	2	32.7	------	------	------	6.8	1.0	17	17.2	.1
.44	.043	.56	6.9	81	1	29.3	------	------	------	6.7	.9	12	42.5	.3
.41	--------	.56	6.9	7	1	30.2	------	------	------	7.2	1.0	13	42.5	.3
.36	--------	.56	7.0	3	1	29.4	------	------	------	7.2	.9	14	45.3	.3
1.75	.153	<.20	.9	------	1	24.3	------	8.2	1.3	.7	2.0	2	2.3	.3
.72	.065	<.20	.9	------	2	30.8	------	------	------	3.5	.8	10	7.2	--------
.71	.069	<.20	1.7	------	2	30.6	------	------	------	5.7	.9	15	13.3	.1
.53	.059	.26	3.3	------	2	29.5	------	------	------	6.9	1.1	17	25.0	.1
.34	--------	.48	4.6	------	2	29.0	------	------	------	6.8	1.2	15	33.8	.2
.26	--------	.56	6.9	16	2	27.7	------	------	------	6.6	1.1	13	41.5	.4
.26	--------	.56	6.6	9	1	27.4	------	------	------	6.4	1.1	12	44.0	.4

TABLE 7.—*Analytical data for*

Soil	Horizon	Depth	Particle-size distribution: Sand (2.0–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (<0.002 mm.)	Moisture tension at 15 atmos.	Moisture at saturation	Reaction: Saturated paste	1:5	1:10
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*pH*	*pH*	*pH*
Marias clay, saline-alkali, fans (280 ft. south and 80 ft. west of NE. corner of NE¼ sec. 18, T. 7 N., R. 36 E.). *Survey No.* S56-Mont-52-2; *laboratory No.* 4777–4784.	A1	0–3	0.9	2.1	38.0	59.0	19.2	64.4	7.6	8.0	8.1
	B21	3–10	.5	1.9	38.0	59.6	22.7	71.0	8.0	8.4	8.8
	B22	10–17	.5	1.9	37.0	60.6	22.9	84.5	8.1	8.8	9.0
	B3	17–24	.6	1.8	37.2	60.4	23.5	89.0	8.1	8.8	9.0
	C1	24–31	.5	2.3	36.7	60.5	23.8	90.3	8.1	8.8	9.0
	C2cs	31–38	.6	2.9	37.9	58.6	21.7	88.3	7.9	8.2	8.3
	C3cs	38–54	1.0	4.0	39.4	55.6	20.4	78.2	7.8	8.1	8.2
	C4cs	54–60	2.0	4.5	40.1	53.4	18.6	71.5	7.8	8.0	8.5
Nunn clay loam (0.15 mi. east of NE. corner of NW¼ sec. 20, T. 6 N., R. 36 E.). *Survey No.* S56-Mont-52-7; *laboratory No.* 4811–4818.	Ap	0–9	13.2	15.2	45.2	27.4	10.7	45.9	7.6	8.0	8.2
	B3	9–17	9.8	15.9	43.9	30.4	11.0	54.3	7.9	8.4	8.6
	C1ca	17–23	7.7	13.7	49.0	29.6	10.5	50.9	8.1	8.7	8.9
	C2ca	23–34	.9	2.7	61.2	35.2	12.6	57.9	8.3	8.9	8.9
	C3	34–45	.5	2.0	46.9	50.6	16.2	72.1	8.4	9.0	9.0
	C4	45–50	1.5	7.7	57.6	33.2	12.0	55.9	8.3	9.1	9.0
	C5	50–62	8.1	23.6	50.7	17.6	6.6	36.8	8.2	9.1	9.1
Nunn silty clay loam (400 ft. south and 100 ft. west of SE. corner of SE¼ sec. 9, T. 6 N., R. 36 E.). *Survey No.* S56-Mont-52-10; *laboratory No.* 4835–4842.	Ap	0–7	3.6	10.8	47.6	38.0	14.0	57.2	7.3	7.7	7.8
	B3ca	7–11	1.3	3.3	53.2	42.2	14.5	66.9	7.7	8.0	8.5
	C1ca	11–17	4.6	12.0	53.9	29.5	13.4	50.6	7.9	8.6	8.7
	C2ca	17–24	1.3	4.7	55.1	38.9	10.0	58.8	8.1	8.8	8.9
	C3	24–30	2.8	10.8	52.9	33.5	12.0	54.8	8.4	9.2	9.3
	C4	30–45	2.1	5.6	56.8	35.5	12.4	63.3	8.3	9.3	9.4
	IIC5	45–64	11.9	13.8	48.0	26.3	8.6	49.6	7.9	8.6	8.8
Promise clay (north side of road, 660 ft. east and 400 ft. south of NE. corner of NW¼ sec. 4, T. 3 N., R. 36 E. *Survey No.* S56-Mont-52-5; *laboratory No.* 4798–4803.	A1	0–4	4.7	9.5	37.9	47.9	20.2	70.2	7.5	7.9	8.1
	B21	4–10	4.1	9.3	37.8	48.8	20.3	71.6	7.6	8.5	8.5
	B22	10–20	4.6	7.9	38.0	49.5	21.2	74.3	7.8	8.5	8.8
	C1cs	20–34	3.6	6.4	39.4	50.6	20.7	83.4	7.8	8.6	8.7
	C2cs	34–44	1.7	6.8	45.1	46.2	19.8	70.7	7.6	7.9	8.4
	IIC3	44–55	1.4	2.8	30.9	64.9	24.6	82.5	7.4	8.3	8.5

Field and laboratory methods

All samples used to obtain the data in table 7 were collected from carefully selected pits. The samples are considered representative of the soil material that is made up of particles less than three-fourths inch in diameter, but in table 7 only particles less than 2 millimeters in size are listed. Estimates of the fraction of the sample consisting of particles larger than three-fourths inch were made during the sampling, and mention of these particles may be made in the profile descriptions. The material made up of particles less than three-fourths inch was rolled, crushed, and sieved by hand to remove fragments larger than 2 millimeters in diameter.

Unless otherwise noted, all laboratory analyses are made on material that passes the 2 millimeter sieve and are reported on an oven-dry basis. In table 7 values for exchangeable sodium and potassium are for amounts of sodium and potassium that have been extracted by the ammonium acetate method minus the amounts that are soluble in the saturation extract.

Standard methods of the Lincoln Soil Survey Laboratory were used to obtain the data in table 7. Determinations of clay were made by the pipette methods (*5*, *6*, *7*). Moisture tension measurements were made on sieved samples (*9*).

The measurements of reaction were made on the saturated paste and on 1:5 and 1:10 solutions in water by the glass electrode. Organic carbon was determined by wet combustion using a modification of the Walkley-Black method (*9*) and nitrogen by a modified procedure of the Association of Official Agricultural Chemists (*3*). Electrical conductivity of the saturation extract was measured on a Wheatstone bridge and is reported in millimhos per cm. at 25°C.x10^3 (*9*). Percentage of salt was estimated using Bureau of Soils cup (*9*). Gypsum was determined by precipitation with acetone (*9*). Calcium carbonate equivalent was determined by measurement of the volume of carbon dioxide evolved from soil samples treated with concentrated HCl (*9*). Cation-exchange capacity was determined by direct distillation of adsorbed ammonia (*8*). Calcium was extracted as calcium oxalate and magnesium as magnesium ammonium phosphate (*8*). Extractable sodium and potassium were determined on original ammonium acetate extracts with a Beckman DU flame spectrophotometer. The triethonolamine method was used to determine extractable hydrogen (*8*).

selected soil profiles—Continued

Organic matter		Soluble salts			$CaCO^3$ equivalent	Cation exchange capacity (NH_4Ac)	Extractable cations					Exchangeable Na	Saturation extract: soluble	
Organic carbon	Nitrogen	Estimated salt	Electrical conductivity EC×10³ millimhos per cm. at 25° C.	Gypsum			Ca	Mg	H	Na	K		Na	K
		Percent		*Meq./100 gm.*	*Percent*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Percent*	*Meq./li.*	*Meq./li.*
1.13	0.095	<0.20	0.7	------	1	35.7	------	13.6	0.4	1.3	1.9	3	3.4	0.2
.75	.065	<.20	.8	------	2	36.0	------	------	------	3.3	1.1	8	5.9	.1
.67	.058	.22	2.2	------	2	34.2	------	------	------	7.3	1.0	17	16.8	.1
.64	.061	.33	3.4	------	2	34.0	------	------	------	8.6	1.3	18	26.9	.1
.49	--------	.36	3.8	------	2	33.6	------	------	------	8.5	1.4	18	28.9	.2
.34	--------	.65	7.5	5	2	32.6	------	------	------	8.4	1.4	13	48.0	.3
.26	--------	.65	7.6	7	2	31.2	------	------	------	7.8	1.3	12	49.5	.3
.26	--------	.60	7.1	1	1	29.4	------	------	------	7.2	1.2	13	47.0	.4
1.00	.100	<.20	.9	------	3	17.7	------	7.0	------	.4	.9	2	2.7	.4
.61	.067	<.20	.8	------	11	15.7	------	------	------	.4	.4	2	2.1	.2
.43	.045	<.20	.8	------	12	14.9	------	------	------	.4	.4	2	2.4	.2
.40	.040	<.20	.8	------	13	17.3	------	------	------	.5	.4	2	2.4	.1
.34	--------	<.20	1.0	------	8	24.2	------	------	------	1.6	.5	5	5.3	.1
.38	--------	<.20	1.1	------	9	18.8	------	------	------	1.7	.4	7	7.6	.1
.26	--------	<.20	1.2	------	11	11.4	------	------	------	1.3	.2	9	8.1	.1
1.47	.134	<.20	.8	------	--------	25.5	15.2	9.4	.9	.4	1.9	1	2.1	.7
.89	.123	<.20	.8	------	7	24.7	------	------	------	.5	.5	1	2.4	.1
.58	.063	<.20	.8	------	9	17.4	------	------	------	.4	.3	2	2.5	.1
.58	.058	<.20	.9	------	10	19.7	------	------	------	.6	.4	2	3.2	.1
.46	--------	<.20	1.0	------	10	17.1	------	------	------	1.5	.3	6	6.8	.1
.42	--------	<.20	1.4	------	8	19.5	------	------	------	3.1	.4	12	11.2	.1
.34	--------	.34	6.5	------	8	15.1	------	------	------	2.8	.3	7	34.0	.2
1.72	.123	<.20	.7	------	1	40.4	------	9.8	------	.4	.8	1	1.2	.1
1.47	.097	<.20	.7	------	4	39.1	------	------	------	1.5	.6	3	3.5	.1
1.09	.063	<.20	.9	------	5	37.5	------	------	------	3.5	.6	8	6.2	.1
.89	.049	.22	2.2	------	5	36.5	------	------	------	4.8	.6	10	13.8	.1
.66	--------	.56	7.0	50	4	35.9	------	------	------	5.1	.5	8	31.5	.4
2.86	--------	.29	3.0	------	1	33.4	------	18.0	2.2	6.7	.8	10	19.8	.3

Additional Facts About the County

This section is provided for those not familiar with Treasure County. It describes physiography and relief, drainage, climate, agriculture, and other subjects of general interest.

Physiography and Relief

Treasure County lies entirely within the Great Plains. South of the Yellowstone River, the county slopes northwestward toward the river. Elevation ranges from 3,910 in the southeastern part of the county to about 2,600 feet at the point in the eastern part where the Yellowstone River leaves the county. Geologic beds of soft shale and sandstone have been disturbed in only a small area south of the Yellowstone River, mostly east of Sarpy Creek. In this small area the beds have been eroded and deeply dissected by streams. Along the streams are steep, nearly barren walls of valleys and narrow, almost knifelike ridges. Rough, broken land and tracts resembling badlands are common. Whiskey Butte and many other buttes are capped with resistant sandstone and stand high above the general relief. In the southeastern part of this southern area, near the county line, the hilly relief is transitional to the Little Wolf Mountains.

The northern part of the county is rolling to hilly as a result of the truncation of an anticline by erosion and of subsequent dissection by streams. The erosion has exposed dark, heavy shale. The truncated anticline runs from the northwest to the southeast and is flanked by partly upturned, young sedimentary rocks. Adding to the roughness of this area are a few hills, the steep slopes of valleys, narrow divides, and a few high buttes. North of the Yellowstone River, the general slope of the eastern part of the county is southeastward from an elevation of 2,960 feet near the northeastern corner of the county.

Throughout the uplands of the county, streams are numerous. The valleys of most of these streams are narrow, but some have nearly level floors that are 50 to 200 feet wide. These floors are covered with alluvium of varied thickness. Channels with vertical walls are common.

Most conspicuous in the county is the nearly level benchland underlain by gravel. North of the Yellowstone River the benches parallel the river and are about 100 to 200 feet above the flood plain. The sediments of these benches and the first terraces above Hysham Bench were laid down

by the river when it flowed at a higher elevation. The benches were left after the stream eroded away the original surface. South of the river, the deposits of gravel are older and the benches are progressively higher as one travels southward. Some of these benches are well preserved and in recent times have been covered by a deep mantle of eolian deposits. Others have been so severely dissected and eroded that only rounded remnants remain. These remnants are covered by a deep layer of sand and gravel that varies in thickness.

Drainage

All the streams in Treasure County flow into the Yellowstone River. The Yellowstone and the Bighorn Rivers are the only streams in the county that are not dry for part of the year. Their sources are in mountains outside of the county. The other streams in the county flow only for short periods when the snow is melting or when runoff is exceptionally great. Except for Sarpy, Tullock, Muggins, and Alkali Creeks, the smaller streams in the county originate within the county in the deeply dissected uplands. All of the smaller streams parallel the ridges.

The large and small streams in the northern part of the county have cut into the heavy, dark Cretaceous shale. The valleys of these streams generally are deep and narrow, and their floors are covered with alluvium of varied thickness. The principal streams in the northern part of the county are Alkali, Froze to Death, and Starve to Death Creeks. They flow generally southeastward and empty into the Yellowstone River. The numerous tributaries of these streams have deeply dissected the soft Tertiary and Cretaceous shale and sandstone.

South of the Yellowstone River, the county is drained primarily by Sarpy and Tullock Creeks and their tributaries, though these streams are dry most of the year. Sarpy Creek flows generally northeastward near the eastern boundary of the county. It empties into the Yellowstone River near Sanders, about 7 miles downstream from Hysham. Sarpy Creek, its tributaries Bear, Beaver, and Horse Creeks, and smaller streams drain the eastern part of the county south of the Yellowstone River. Tullock Creek and its many tributaries drain the western part. Tullock Creek flows generally northwestward across the southwestern part of the county and empties into the Bighorn River about 2 miles upstream from the confluence of the Bighorn and the Yellowstone Rivers (*4*).

Water Supply

The Yellowstone and the Bighorn Rivers are the only streams in the county that flow permanently throughout the year. The flow of the Yellowstone River is more constant than that of the Bighorn, partly because irrigation in the upper part of the Bighorn lowers the water level late in summer. However, the only dependable water for irrigation is from these rivers. Ditches have been dug to irrigate valleys on both the north and south sides of the Yellowstone River. Numerous private ditches that are direct diversions or have pumping systems normally supply the areas adjacent to both rivers with an adequate supply of water.

Large systems irrigate hardly any of the tributary valleys, for most of the streams in the county do not provide enough water for irrigation. In the valleys of these tributaries, the farmer or rancher depends largely on the floodwater for an occasional irrigation during periods of high runoff. This source of water is not dependable, because in some years runoff does not provide enough water for flood irrigation.

The Yellowstone River provides the domestic supply of water for the town of Hysham, and wells or springs supply many farms and ranches. Because the water in some areas is saline, some ranchers and farmers must haul water for many miles to fill their cisterns. These cisterns are arranged so that they collect rainwater that runs off the farmhouse or ranchhouse.

Water for range cattle is provided mainly by damming small drainageways so that runoff from the watershed is collected and held in small ponds. The dams are built so that the ponds are located in places that help distribute the grazing. These ponds range from a few feet to more than 20 feet in depth and from a fraction of an acre to more than 10 acres in area. Because many of the smaller ponds may dry up before the grazing season is over, water management is important.

In areas where small dams cannot be economically built, the ranchers drill wells. Most wells require a motor to pump the water into a storage tank, but a few wells are artesian. Most of the wells are deep, but the flow of water is generally small. In places a flowing well of water has been left by companies prospecting for oil. These wells are good sources of water. Their content of salts varies from place to place, but generally the water is suitable for livestock.

Springs are not important sources of water, for they are few in the county. Those that have been found are used to supply water for domestic use and for livestock.

Climate

Treasure County, lying slightly more than 300 miles east of the Continental Divide, has a continental climate with chinook winds in winter and a favorable distribution of precipitation during the growing season. Chinook winds are warm, dry winds that blow down the sides of mountains. Summers are hot and dry in the county, and winters are moderately cold and dry. Although the range in elevation in the county is small, there are some variations in climate from place to place. Table 8 summarizes the normal monthly and annual temperature and precipitation at Hysham, in the valley of the Yellowstone River.

The average temperature in winter is somewhat lower in the western part of the county than it is in the eastern, and the growing season in the valley of the Yellowstone River is shorter in the western part of the county than it is in the eastern. Along the river, the temperature during summer afternoons is slightly higher, particularly east of Hysham, than it is in the higher areas north and south of the river. The highest temperatures in the county are along the Yellowstone River and are within the range of 100° F. to 110° for at least a few days each year. July, the hottest month, has an average temperature of about 73°

[5] Prepared with the assistance of R. A. DIGHTMAN, State climatologist, U.S. Weather Bureau.

TABLE 8.—*Temperature and precipitation at Hysham, Montana*

[Elevation, 2,650 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1952)	Wettest year (1946)	Average snowfall
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
January	18.6	70	—48	0.43	0.52	0.46	4.6
February	23.9	70	—34	.35	.23	.03	5.4
March	31.8	81	—29	.79	.04	1.03	4.8
April	46.0	97	5	.58	.10	.26	5.7
May	56.4	98	14	1.38	1.38	2.30	.2
June	64.2	101	30	2.58	1.48	3.11	(3)
July	72.8	111	38	1.42	.50	2.78	(3)
August	70.7	108	35	.86	.49	.91	0
September	59.8	102	21	1.09	.30	3.69	.3
October	48.5	91	9	.93	0	2.95	2.9
November	33.7	75	—28	.33	.25	.14	2.6
December	25.7	71	—36	.47	.09	.61	5.6
Year	46.1	111	—48	11.21	5.38	18.27	32.1

[1] Temperature based on an 18-year record through 1962.
[2] Precipitation based on an 18-year record through 1962.
[3] Trace.

in most of the county, an average maximum temperature of about 90°, and an average minimum of about 55°. Occasionally, the daily mean temperature is within a range of 80° to 85°, but only infrequently does this high temperature hold for two or more successive days. Crops are wilted during these hot spells, but they revive when the weather cools or when irrigation water is applied. During the day from early in July to mid-August, the weather is oppressive for only a few days, and even then cool nights bring relief.

Winters are cold during most years, particularly in the northeastern part of the county, which is closer to the winter cold fronts. Commonly, the temperature drops below zero. But at frequent, irregular intervals, the chinook winds blow and, within a few hours, cause a rapid rise in temperature that may bring about thawing. These winds, however, are not so frequent in Treasure County as they are farther west, and they do not last as long.

From figure 11 can be found the percentage of probability that a temperature of 16°, 20°, 24°, 28°, or 32° will

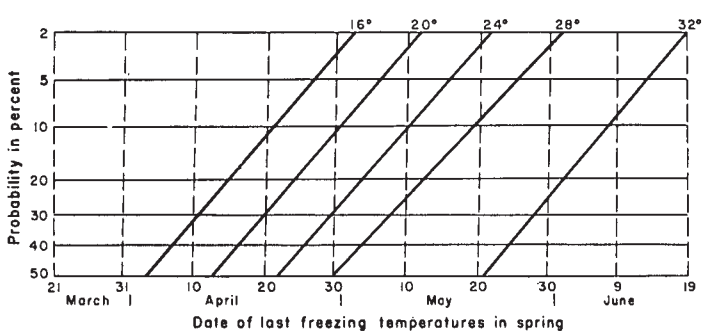

***Figure 11.*—Percentage of probability that a temperature of 16°, 20°, 24°, 28°, or 32° will occur at Hysham after any date between March 21 and June 19.**

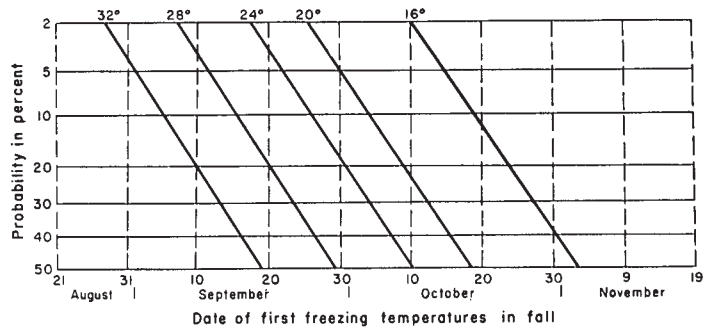

***Figure 12.*—Percentage of probability that a temperature of 16°, 20°, 24°, 28°, or 32° will occur at Hysham before any date between August 21 and November 19.**

occur after any date between March 21 and June 19. For example, if you wish to find the date for which the probability of a 24° temperature is 30 percent, look vertically downward from the intersection of the diagonal 24° line and the horizontal 30 percent line. The date is about April 29. Figure 12 is used in the same way as figure 11, but the information it gives is probability of a specified temperature before any date between August 21 and November 19.

At Hysham the frost-free period ranges from 90 days to more than 140 days, but over a long period the average is 121 days—from May 21 to September 19 (*11*). This average period is a week shorter in nearby areas both to the east and west of Hysham. Also, the frost-free period is slightly shorter than at Hysham in the small valleys north and south of the Yellowstone River, particularly where the distance between the tops of hills and ridges is fairly long.

Fortunately, the distribution of the annual rainfall throughout the year is favorable for producing crops and pasture. At Hysham, about 70 percent of the total precipitation occurs from April to September, or during the growing season. More than half of this falls between April 1 and June 30. Variations of this distribution are slight throughout the county. Most of the usable precipitation comes in showers, but in almost every April a snowfall adds to the supply of moisture. During winter, however, the small amount of snow contributes little to the total annual precipitation. Except along the Wolf Mountains, the monthly snowfall in local areas seldom exceeds 10 inches and transportation and the feeding of livestock are problems only where snow drifts. Just as wetness early in spring helps crops grow, the dryness after mid-July is favorable for the ripening of grain and the curing of hay. During most summers harvesting can proceed without being hindered by rain.

Hailstorms are more common than other storms and cause damage in some part of the county almost every year, but a complete loss of crops or buildings is uncommon. Hailstorms occur most frequently in the vicinity of Alkali Creek and Myers. Lightning and wind that often accompany these storms also cause some damage. Tornadoes are not a major hazard because they only occur about once in 40 years, but when one does occur, it is very destructive.

Evaporation has not been measured in the county, but the estimated water evaporated from irrigation canals and

reservoirs averages about 27 inches during the period from April 1 through September 30. Evaporation varies according to the area of water exposed and the kind and amount of protection given by vegetation and other means. It can vary from 21 inches in cool, wet years to as much as 35 inches in very dry, windy years.

The number of sunny days in Treasure County is about the same as in other counties along the Yellowstone River. From sunrise to sunset, the cloud cover averages 60 percent. In general, it is cloudiest in winter and spring and clearest late in summer and early in fall. In July cloud cover averages only about 40 percent, permitting nearly 80 percent of possible sunshine. Fog occurs for part of a day on 10 to 12 days a year.

Records on relative humidity are not available in the county, but estimates indicate that relative humidity is generally low. At the driest time of the day, afternoons, relative humidity averages about 30 percent in summer. On only an occasional summer afternoon is it hot and humid enough to be uncomfortable. High relative humidity occurs only with fog and before showers, and it generally lasts only a few hours.

The prevailing wind, particularly in winter, is from a direction between west and southwest, but the wind may blow from any direction. Fairly strong winds from the northeast usually accompany the cold spells in winter and the rains late in spring and early in summer. The speed of the wind averages about 10 miles per hour throughout most of the county. Although damaging winds may accompany thunderstorms in summer, the county is not considered a windy one and seldom has winds of more than 70 miles an hour.

Agriculture

By the time Treasure County was organized in 1919, agriculture was well established and a considerable acreage was used for nonirrigated cereal grains. Before and following World War I there was an influx of homesteaders, who exploited the fertile grasslands and made them susceptible to blowing during the dry years of the early 1920's. Because most of the farms were too small to survive these dry years, most of the nonirrigated cropland was converted to rangeland that was used to produce livestock. The farmers who irrigated were able to continue farming during the dry years.

In the early days, as today, the hay and other staple crops were grown mainly under irrigation. The first irrigation ditch was constructed in 1903 in Pease Bottom, which is on the north side of the Yellowstone River about 7 miles northwest of Hysham. Since 1903, four other irrigation ditches have been installed.

About 19,600 acres are irrigated in Treasure County, and an additional 6,000 acres can be irrigated with the existing facilities. The total irrigated area—about 25,600 acres—does not include the land along the Yellowstone River that is in trees and brush and can be leveled, cleared, and used for crops. A few acres of this land and of land just above existing ditches are brought into cultivation from time to time.

The water for the five main irrigation ditches is diverted directly from the Yellowstone and the Bighorn Rivers by means of either anchored brush and rock dams or by diversion dams of reinforced concrete.

The supply of water for irrigation is adequate in most years. Hay, pasture, and small grain are irrigated by methods of controlled surface flooding, and row crops are irrigated by the furrow method.

Flood irrigation is used on about 1,900 acres, which are in the narrow valleys of intermittent tributaries. Normally, only about one irrigation can be expected each year, but in some years there is no runoff from the tributaries and, therefore, no irrigation. Most of the land irrigated in this way is used to produce hay, but in the more favorable years a crop of alfalfa can be harvested for seed.

In some parts of the valley of the Yellowstone River, seepage is the main problem. Many acres that were once productive are now unproductive because they are waterlogged and saline. Some of the areas that were waterlogged have been drained and reclaimed, and additional drainage is planned.

The main sources of agricultural income are (1) livestock, mainly beef cattle; (2) irrigated crops; and (3) nonirrigated cereal grain. Of these, livestock is the most important.

Livestock

Beef cattle, the main source of income in the county, are grazed on the rangeland outside of the irrigated valleys. Feeding cattle in feedlots on the irrigated farms has been increasing. The number of cattle fluctuates from year to year and depends mainly on the condition of the range and market prices.

Bands of sheep are grazed in the areas north of the Yellowstone River, and a few sheep are raised on the irrigated farms. The number of sheep and lambs in the county has seldom exceeded 5,000 in any one year.

Horses are kept primarily for riding. Swine, milk cows, chickens, and other animals are raised for use on the farm or for sale to the local markets.

Crops

Table 9 lists the acreage of principal irrigated crops grown in the county in stated years. For the same years, the acreage of the principal nonirrigated crops is listed in table 10. The data in these tables are from the U.S. Census of Agriculture.

Cash crops, both irrigated and nonirrigated, are next to livestock in importance as a source of income in the county. Many kinds of crops can be grown under irrigation, and in this county alfalfa, sugarbeets, small grain,

TABLE 9.—*Acreages of principal irrigated crops in stated years*

Crop	1949	1954	1959
Alfalfa (hay)	3, 572	5, 001	3, 812
Alfalfa (seed)	1, 341	908	(1)
Barley	1, 212	1, 830	2, 090
Corn (all)	155	1, 332	1, 711
Dry beans	45	234	546
Oats	833	869	50
Sugarbeets	2, 185	3, 388	3, 224
Spring wheat	436	780	1, 131
Winter wheat	235	1, 305	544

[1] Data not available.

TABLE 10.—*Acreages of principal nonirrigated crops in stated years*

Crop	1949	1954	1959
Alfalfa (hay)	6, 069	4, 598	5, 577
Alfalfa (seed)	3, 303	3, 088	(1)
Barley	1, 525	1, 842	826
Corn (all)	502	360	103
Oats	725	495	246
Spring wheat	1, 041	388	328
Winter wheat	4, 528	2, 254	3, 201

[1] Data not available.

corn, and dry beans are grown. Other crops are grown with these crops in rotations and are sold off the farm or are fed to livestock on the farm.

The acreages and yields of crops change from year to year. The acreages planted to sugarbeets have gradually increased since 1946. The average yield of sugarbeets increased from 13 tons per acre in 1946 to 16 tons per acre in 1961. Yields of all crops have increased over the years. This increase in yields per acre is a result of improved farming methods, including the use of more fertilizer.

Winter wheat is the principal cash crop on nonirrigated soils. Spring wheat is seeded mainly when the fall season is not favorable for seeding winter wheat, or when the wheat has been winterkilled or has been blown out. Instead of spring wheat, barley or oats may be planted to replace the winter wheat. Corn is grown mainly for silage.

Transportation and Markets

The main line of the Northern Pacific Railway follows the valley of the Yellowstone River as it crosses the county from east to west. On this railroad livestock and crops are shipped to markets in and out of the State. The sugarbeets raised in the county are shipped by rail for processing at the sugar factory at Billings, 75 miles to the west.

U.S. Highway No. 10 (Interstate Highway No. 94), one of the main highways across the State, crosses the county from east to southwest and is the only hard-surfaced road in the county. All trucks hauling livestock to markets at Billings and Miles City use this highway. Regularly scheduled bus service is provided by the Northland Greyhound Bus Lines.

Secondary farm-to-market roads include about 60 miles of graded and gravel roads that were built by the Montana Highway Commission but are maintained by the county. In addition, the county has built many semisurfaced or dirt roads, some of which are impassable at times.

Early History and Population

Treasure County is one of the newest and smallest counties in Montana. It was established from part of Rosebud County and officially organized April 1, 1919. Hysham, the county seat, was named for Charles J. Hysham, a cattleman from Nebraska. The first store on the present townsite was a hardware store erected by John C. Lyndes in 1909. Except for a small tract of land farmed by John Guy in 1870, the county remained as the Indians had left it until 1882, when the Northern Pacific Railway reached the county and facilitated settlement and transportation of goods to market. The part of the county south of the Yellowstone River was within the original boundaries of the Crow Indian Reservation.

In 1960, the county had a population of 1,345. The two largest towns are Hysham, in the central part of the county, and Sanders in the eastern part. All farm and ranch residents are provided with rural mail delivery from the post offices at Hysham, Sanders, Bighorn, and Myers. All population is classified as rural, and most of it is in Hysham and in the Yellowstone Valley.

Community Facilities

Because people are few and scattered in Treasure County, consolidating schools has been a trend. Presently, there are only four grade schools and two high schools in the county. The high schools are at Hysham. Also at Hysham are two churches, but there are no hospitals in the county. The nearest hospital is in Rosebud County at Forsyth, 27 miles to the east.

Most homes have electricity supplied by the Mid-Yellowstone Valley Electrical Cooperative, which is financed by the Rural Electrification Administration. Some of the remote ranch houses have private electric plants. All farms and ranches in the valley of the Yellowstone River and many outside of it are served by a local rural telephone cooperative, which has its exchange at Hysham. This service is rapidly being expanded throughout the county.

Native Woodland

The native trees in the county are evergreen softwoods and deciduous hardwoods. The most important softwoods are western pine, limber pine, and juniper. The pines grow in scattered stands in steep and rough, broken areas south of the Yellowstone River. Cottonwood, the most extensive hardwood, grows in a continuous belt along the Yellowstone and the Bighorn Rivers. It has an understory of willow, rosebush, and buffaloberry. Alder, boxelder, and willow occur in many narrow valleys of streams.

Wildlife [6]

Treasure County supports waterfowl, upland and other game birds, rodents and furbearers, big game, and fish.

Ducks live in the marshy areas along the Yellowstone and the Bighorn Rivers and around the farm ponds that were constructed to provide water for livestock. These areas are also habitats for coot, killdeer, sandpiper, blackbird, heron, and many other birds that frequent areas near water. Geese from Canada frequently stop over on the Yellowstone River as they migrate in spring and fall. A few of them remain in summer to nest.

The uplands are habitats for sage grouse, sharptail grouse, mourning doves, meadow larks, horned larks, lark buntings, and many insectivorous birds. Marsh and sparrow hawks are in the county the year round, and several other kinds of hawks stop over as they migrate. Some golden eagles live in the county, and their number is in-

[6] By LOUIS M. MOOS, biologist, Soil Conservation Service.

creased in winter by migrants. Pheasants are abundant on the irrigated bottom lands along the Yellowstone and the Bighorn Rivers. Along these and other streams, excellent habitats are provided by ditchbanks, marshy areas, idle fields, and brushy areas.

Also in the uplands are rabbit, skunk, raccoon, ground squirrel, and other small animals. During winter jackrabbits are shot or trapped for their fur or to be fed to mink. Beaver and muskrat live along the water courses, and a few bobcats and coyotes roam the county.

Deer, antelope, and other big game also roam the county. Antelope is found mostly on the north side of the Yellowstone River, and deer on the south side. Mule deer are common and at times are numerous enough to damage crops, especially alfalfa planted for seed. Some whitetail deer roam the bottom land of the Yellowstone River. The construction of farm ponds provides more watering places that have helped distribute the game throughout the county.

Some of the ponds have been stocked with fish, mainly large-mouth black bass and bluegill. Trout can be stocked in ponds that are at least 10 feet deep and have a water temperature of less than 75° F. Walleye and catfish are the most important game fish in the Yellowstone and the Bighorn Rivers.

Gravel, Oil, and Coal

Treasure County is almost entirely agricultural, but a number of homes are heated with coal taken from small mines on Sarpy and Tullock Creeks. Large quantities of sand and gravel are quarried and used in road construction or are stockpiled for future use. Sand and gravel, some of which is trucked out of the county, are also produced for construction other than roads. Agate is found in varying amounts around the gravelly edges of benches, especially in gravel pits.

Oil and gas companies have recently seismographed the entire county and have drilled a number of test wells. Although oil has been discovered, no large wells have been brought in.

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 plants is reduced.

Alkalinity. See Reaction, soil.

Alluvial soil. A group of soils developed in stratified alluvium and having no definable genetic horizons.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Border method (irrigation). Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

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.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

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; soil will not hold together in a mass.

Friable.—When moist, soil crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, soil crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, soil 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, soil adheres to other material; tends to stretch somewhat and pull apart, rather than pull free from other material.

Hard.—When dry, soil moderately resists pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, soil breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; soil little affected by moistening.

Gravel. (1) Agricultural classification of fragments between 2 millimeters and 3 inches in size. (2) In engineering gravel is coarse-grained soil material of which more than 50 percent is retained on the No. 4 sieve.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes and that differs in one or more ways from adjacent horizons in the same profile. These are the major soil horizons:

A horizon.—The mineral horizon at the surface. It contains an accumulation of organic matter, has been leached of soluble minerals and clay, or shows the effects of both.

B horizon.—The horizon in which clay minerals or other material has accumulated, that has developed a characteristic blocky or prismatic structure, or that shows the effects of both processes.

C horizon.—The unconsolidated material immediately under the true soil. In chemical, physical, and mineral composition it is presumed to be similar to the material from which at least part of the overlying solum has developed, unless the C designation is preceded by a Roman numeral.

R horizon.—Rock underlying the C horizon, or underlying the B horizon if no C horizon is present.

Roman numerals are prefixed to the master horizon or layer designations (A, B, C, R) to indicate lithologic discontinuities either within or below the solum. The first, or uppermost, material is not numbered, for the Roman numeral I is understood; the second, or contrasting, material is numbered II, and others are numbered III, IV, and so on, consecutively downward. Thus for example, a sequence from the surface downward might be A2, B1, IIB2, IIB3, IIC1, IIIC2.

Following are symbols used with the letters designating the master horizons, and the meaning of these symbols.

ca—accumulation of calcium.

cs—accumulation of calcium sulfate.

p—plow layer.

sa—accumulation of salts more soluble than calcium sulfate.

t—illuvial clay.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *Very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Poorly graded soil (engineering). A soil material consisting mainly of particles nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See Horizon, soil.

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.

In words the degree of acidity and alkalinity is expressed thus (*12*):

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5		
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
Neutral	6.6 to 7.3		

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium. It is measured by electrometric method and is expressed in terms of millimhos of conductivity or in percentage as follows:

EC x 10³	*Percentage of salt*	*Class*
0–4	Less than 0.15	Nonsaline
4–8	0.15 to 0.35	Slightly saline
8–15	0.35 to 0.65	Moderately saline
15–25	0.65 to 1.20	Strongly saline
More than 25	More than 1.20	Very strongly saline

Sodic soil. A soil that generally has a strongly alkaline reaction (pH more than 8.6) and that contains sufficient exchangeable sodium to interfere with growth of most plants and to cause deterioration of soil structure.

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 organisms acting upon parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plants and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Substratum. Any layer beneath the solum, or true soil; the C or R horizon.

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, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Well-graded soil (engineering). A soil or soil material consisting of particles that have a wide range in size or diameter. The density and bearing capacity of a well-graded soil can be easily increased by compaction. Contrasts with poorly graded soil.

Literature Cited

(1) American Association of State Highway Officials.
1961. standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 v., 401 and 617 pp., illus.

(2) American Society for Testing Materials.
1958. procedures for testing soils. Comm. D–18 on Soils for Engineering Purposes. 544 pp., illus.

(3) Association of Official Agricultural Chemists.
1954. official and tentative methods of analysis. Washington, D.C., ed. 6:4.

(4) Hall, George M. and Howard, C. S.
1929. ground water in yellowstone and treasure counties, montana. Water Supply Paper 599, U.S. Geol. Sur. 118 pp., illus.

(5) Kilmer, V. J. and Alexander, L. T.
1949. methods of making mechanical analyses of soils. Soil Sci. 68: 15–24.

(6) ——— and Mullins, J. F.
1954. improved stirring and pipetting apparatus for mechanical analyses of soils. Soil Sci. 77: 437–441 pp., illus.

(7) Olmstead, L. B., Alexander, L. T., and Middleton, H. E.
1930. a pipette method of mechanical analysis of soils based on improved dispersion procedure. U.S. Dept. Agr. Tech. Bul. 170, 22 pp., illus.

(8) Peech, M., Alexander, L. T., Dean, L. A., and Reed, J. F.
1947. methods of soil analysis for soil-fertility investigation. U.S. Dept. Agr. Circ. 757, 25 pp.

(9) Richards, L. A., ed.
1954. diagnosis and improvement of saline and alkali soils. U.S. Dept. of Agr. Handbk. 60, 160 pp., illus.

(10) United States Department of Agriculture.
1938. soils and men. U.S. Dept. Agr. Ybk., 1232 pp., illus.

(11) ———
1941. climate and man. U.S. Dept. Agr. Ybk., 1248 pp., illus.

(12) ———
1951. soil survey manual. U.S. Dept. Agr. Handbk. No. 18, 503 pp., illus.

(13) Waterways Experiment Station, Corps of Engineers.
1953. the unified soil classification system. Tech. Memo. No. 3–357, 2 v. and appendix.

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GUIDE TO MAPPING UNITS

[See table 1, p. 6, for approximate acreage and proportionate extent of the soils; see table 2, p. 45, for predicted average yields of principal irrigated crops and table 3, p. 54, for predicted average yields of principal nonirrigated crops; see subsection beginning on p. 60 for windbreak suitability groups; and see subsection beginning on p. 63 for information significant to engineering]

Map symbol	Soil	Described on page	Irrigated capability unit		Nonirrigated capability unit		Range site		Windbreak suitability group
			Symbol	Page	Symbol	Page	Name	Page	Number
Ar	Arvada loam, 0 to 3 percent slopes--	7	IVs-1	43	VIe-3	51	Silty	57	8
Av	Arvada complex----------	7	-----	--	VIe-3	51	Silty	57	8
Ax	Arvada-Laurel complex----------	7	VIs-2	44	VIs-4	52	Panspots	59	8
Ba	Badlands----------	8	-----	--	VIIs-5	53	Badlands	60	8
Bb	Bainville loam, 8 to 15 percent slopes----------	8	-----	--	VIe-3	51	Silty	57	7
Bc	Bainville loam, 15 to 35 percent slopes----------	8	-----	--	VIe-4	52	Thin Silty	58	8
Bf	Bainville-Tullock complex----------	8							
	Bainville soil----------	--	-----	--	VIe-4	52	Thin Silty	58	8
	Tullock soil----------	--	-----	--	VIe-4	52	Thin Sandy	58	8
Bm	Bainville-Midway complex, 8 to 15 percent slopes----------	9							
	Bainville soil----------	--	-----	--	VIe-3	51	Silty	57	7
	Midway soil----------	--	-----	--	VIe-3	51	Clayey	58	7
Bn	Bainville-Midway complex, 15 to 35 percent slopes----------	9							
	Bainville soil----------	--	-----	--	VIe-4	52	Thin Silty	58	8
	Midway soil----------	--	-----	--	VIe-4	52	Thin Clayey	58	8
Bo	Bainville-Shale outcrop complex-----	9	-----	--	VIIe-2	52	Thin Breaks	59	8
Bs	Banks soils----------	9	VIs-1	44	VIs-3	52	Shallow to Gravel	59	7
Bt	Beaverton gravelly loam----------	10	-----	--	VIs-3	52	Shallow to Gravel	59	7
Bu	Bew clay loam----------	10	-----	--	IIIe-4	49	Clayey	58	6
Bw	Bowdoin clay----------	11	IVs-3	43	VIe-3	51	Clayey	58	6
Bx	Briggsdale loam, 2 to 4 percent slopes----------	11	-----	--	IIIc-1	50	Silty	57	1
By	Briggsdale loam, 4 to 8 percent slopes----------	11	-----	--	IIIe-2	48	Silty	57	1
Ca	Cherry clay, 0 to 1 percent slopes--	12	IIs-2	40	-----	--	-------	--	2
Cb	Cherry clay, 1 to 3 percent slopes--	12	IIIe-	41	IIIe-4	49	Clayey	58	2
Cc	Cherry clay, 3 to 8 percent slopes--	12	IVe-2	42	IIIe-5	49	Clayey	58	2
Cd	Cherry clay, moderately deep, 0 to 1 percent slopes----------	12	IIs-2	40	-----	--	-------	--	1
Cf	Cherry clay, moderately deep, 1 to 3 percent slopes----------	12	IIIe	41	IIIe-4	49	Clayey	58	1
Cg	Cherry clay, moderately deep, 3 to 8 percent slopes----------	12	IVe-2	42	IIIe-5	49	Clayey	58	1
Ch	Cherry clay loam, 0 to 1 percent slopes----------	11	I-1	39	-----	--	-------	--	2
Ck	Cherry clay loam, 1 to 3 percent slopes----------	11	IIe-1	39	IIIc-1	50	Clayey	58	2
Cm	Cherry clay loam, shallow, 0 to 1 percent slopes----------	11	I-1	39	------	--	-------	--	1
Cn	Cherry-Laurel clay loams----------	11							
	Cherry soil----------	--	IIs-3	40	IVs-5	51	Clayey	58	2
	Laurel soil----------	--	IIs-3	40	IVs-5	51	Clayey	58	4
Cp	Cushman loam, 2 to 4 percent slopes----------	12	-----	--	IIIc-1	50	Silty	57	3
Cr	Cushman loam, 4 to 8 percent slopes----------	13	-----	--	IIIe-2	48	Silty	57	3
Cs	Cushman loam, 8 to 15 percent slopes----------	13	-----	--	IVe-3	50	Silty	57	

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil	Described on page	Irrigated capability unit		Nonirrigated capability unit		Range site		Windbreak suitability group
			Symbol	Page	Symbol	Page	Name	Page	Number
Ct	Cushman-Bainville loams, 4 to 8 percent slopes	13							
	Cushman soil	--	-----	--	IIIe-2	48	Silty	57	3
	Bainville soil	--	-----	--	IIIe-2	48	Silty	57	7
Cu	Cushman-Bainville loams, 8 to 15 percent slopes	13							
	Cushman soil	--	-----	--	IVe-3	50	Silty	57	3
	Bainville soil	--	-----	--	IVe-3	50	Silty	57	7
Cv	Cushman-Terry fine sandy loams, 2 to 8 percent slopes	13	-----	--	IIIe-6	49	Sandy	57	3
Cw	Cushman-Tullock complex, 8 to 15 percent slopes	13							
	Cushman soil	--	-----	--	IVe-3	50	Silty	57	3
	Tullock soil	--	-----	--	IVe-3	50	Sandy	57	3
Cx	Cushman-Travessilla loams, 2 to 8 percent slopes	14							
	Cushman soil	--	-----	--	IVe-6	51	Silty	57	7
	Travessilla soil	--	-----	--	IVe-6	51	Shallow Limy	59	7
Cy	Cushman-Winnett complex	14							
	Cushman soil	--	-----	--	IVe-5	50	Silty	57	3
	Winnett soil	--	-----	--	IVe-5	50	Silty	57	8
Dw	Dwyer fine sand	14	-----	--	VIe-2	51	Sands	57	1
Ed	Edgar loam, 1 to 8 percent slopes	14	-----	--	IIIe-2	48	Silty	57	1
Eg	Edgar loam, 8 to 15 percent slopes	14	-----	--	IVe-3	50	Silty	57	3
Fa	Fattig loam	15	-----	--	IIIc-1	50	Silty	57	3
Fc	Fattig-Travessilla complex	15							
	Fattig soil	--	-----	--	IVe-6	51	Silty	57	3
	Travessilla soil	--	-----	--	IVe-6	51	Shallow Limy	59	7
Ff	Flasher fine sandy loam, 4 to 20 percent slopes	15	-----	--	IVe-4	50	Sandy	57	3
Fh	Flasher fine sandy loam, 20 to 35 percent slopes	15	-----	--	VIe-4	52	Thin Sandy	58	8
Fm	Flasher loamy fine sand	16	-----	--	VIe-2	51	Sands	57	3
Fn	Fort Collins loam, 0 to 1 percent slopes	16	I-1	39	IIIc-1	50	Silty	57	1
Fo	Fort Collins loam, 1 to 4 percent slopes	16	IIe-1	39	IIIc-1	50	Silty	57	1
Fr	Fort Collins loam, 4 to 8 percent slopes	16	IVe-1	41	IIIe-2	48	Silty	57	1
Fs	Fort Collins loam, sandy substratum, 0 to 1 percent slopes	17	I-1	39	-----	--	------	--	1
Ft	Fort Collins loam, sandy substratum, 1 to 3 percent slopes	17	IIe-1	39	-----	--	------	--	1
Ga	Gilt Edge clay loam	17	-----	--	IIIs-2	49	Silty	57	6
Gb	Gilt Edge-Arvada complex	17							
	Gilt Edge soil	--	-----	--	VIs-4	52	Panspots	59	6
	Arvada soil	--	-----	--	VIs-4	52	Panspots	59	8
Gc	Glendive clay	18	IIs-2	40	-----	--	--------	--	1
Gg	Glendive clay loam	18	IIs-1	40	-----	--	--------	--	1
Gh	Glendive fine sandy loam	17	IIs-1	40	IVe-4	50	Sandy	57	1
Gm	Glendive fine sandy loam, fans	18	-----	--	IVe-4	50	Sandy	57	1
Gn	Glendive fine sandy loam, shallow	18	IVs-4	44	-----	--	-----	--	7
Go	Glendive loam	18	IIs-1	40	-----	--	Silty	57	1
Gs	Glendive loamy fine sand	18	IIIs-1	41	VIe-2	51	Sands	57	1
Gv	Glendive and Banks soils	18							
	Glendive soil	--	-----	--	VIs-3	52	Sandy	57	1
	Banks soil	--	-----	--	VIs-3	52	Shallow to Gravel	59	7
Ha	Havre clay	20	IIs-2	40	IIIe-4	49	Clayey	58	1

GUIDE TO MAPPING UNITS--Continued

Map symbol	Soil	Described on page	Irrigated capability unit		Nonirrigated capability unit		Range site		Windbreak suitability group
			Symbol	Page	Symbol	Page	Name	Page	Number
Hb	Havre clay, saline	20	IIs-3	40	IVs-5	51	Clayey	58	4
Hc	Havre clay loam	19	I-1	39	IIIc-1	50	Clayey	58	1
Hd	Havre clay loam, high	20	I-1	39	IIIc-1	50	Clayey	58	1
Hf	Havre clay loam, saline	20	IIs-3	40	IVs-5	51	Clayey	58	4
Hg	Havre loam	19	I-1	39	IIIc-1	50	Silty	57	1
Hh	Havre loam, high	19	I-1	39	IIIc-1	50	Silty	57	1
Hl	Havre loam, moderately deep	19	IIs-1	40	-----	--	-----	--	3
Hm	Havre loam, saline	19	IIs-3	40	IVs-5	51	Silty	57	4
Hn	Havre and Glendive soils	20							
	Havre soil	--	I-1	39	IIIc-1	50	Silty	57	1
	Glendive soil	--	IIs-1	40	IVe-4	50	Sandy	57	1
Ho	Havre and Lohmiller soils	20							
	Havre soil	--	-----	--	VIe-3	51	Silty	57	1
	Lohmiller soil	--	-----	--	VIe-3	51	Clayey	58	1
Hp	Havre and Lohmiller soils, 8 to 15 percent slopes	21							
	Havre soil	--	VIe-1	44	IVe-3	50	Silty	57	3
	Lohmiller soil	--	VIe-1	44	IVe-3	50	Clayey	58	3
Hr	Havre and Lohmiller soils, 15 to 35 percent slopes	21							
	Havre soil	--	-----	--	VIe-4	52	Thin Silty	58	8
	Lohmiller soil	--	-----	--	VIe-4	52	Thin Clayey	58	8
Hs	Havre and Lohmiller soils, saline	21							
	Havre soil	--	-----	--	VIe-3	51	Silty	57	4
	Lohmiller soil	--	-----	--	VIe-3	51	Clayey	58	4
Ht	Havre-Hysham loams	19							
	Havre soil	--	IIs-3	40	IVs-5	51	Silty	57	1
	Hysham soil	--	IIs-3	40	IVs-5	51	Silty	57	8
Hu	Hesper loam, 1 to 4 percent slopes	21	-----	--	IIIc-1	50	Silty	57	1
Hv	Hesper loam, 4 to 8 percent slopes	21	-----	--	IIIe-2	48	Silty	57	1
Hw	Hilly gravelly land	22	-----	--	VIIs-2	53	Gravel	60	8
Hx	Hoven clay	22	-----	--	VIw-3	52	Overflow	57	5
Hy	Hoven and McKenzie soils	22	-----	--	VIIs-4	53	Saline Upland	60	8
Hz	Hysham-Havre loams	23							
	Hysham soil	--	IVs-1	43	VIe-3	51	Silty	57	8
	Havre soil	--	IVs-1	43	VIe-3	51	Silty	57	1
La	Laurel clay loam	23	IVw-1	42	VIw-2	52	Saline Subirrigated	57	8
Lb	Laurel loam	23	IVw-1	42	VIw-2	52	Saline Subirrigated	57	8
Lc	Lismas clay	24	-----	--	VIIs-1	52	Shallow Clay	59	8
Ld	Lismas-Pierre clays, saline-alkali	24							
	Lismas soil	--	-----	--	VIIs-1	52	Shallow Clay	59	8
	Pierre soil	--	-----	--	VIs-4	52	Dense Clay	59	8
Lf	Lismas-Midway complex	24	-----	--	VIe-4	52	Thin Clayey	58	8
Lg	Lismas-Shale outcrop complex	24	-----	--	VIIs-5	53	Shale	60	8
Lh	Lohmiller clay	25	IIs-2	40	IIIe-4	49	Clayey	58	2
Lm	Lohmiller clay, high	25	IIs-2	40	IIIe-4	49	Clayey	58	2
Ln	Lohmiller clay, wet	25	IVw-1	42	VIw-1	51	Subirrigated	56	5
Lo	Lohmiller clay loam	24	I-1	39	IIIc-1	50	Clayey	58	2
Lr	Lohmiller clay loam, 1 to 3 percent slopes	24	IIe-1	39	IIIc-1	50	Clayey	58	1
Ls	Lohmiller clay loam, fans, 0 to 1 percent slopes	25	I-1	39	IIIc-1	50	Clayey	58	1
Lt	Lohmiller clay loam, high	25	I-1	39	IIIc-1	50	Clayey	58	2
Lu	Lohmiller-Hysham clays	25							
	Lohmiller soil	--	IIs-3	40	IVs-5	51	Clayey	58	1
	Hysham soil	--	IIs-3	40	IVs-5	51	Clayey	58	8

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Map symbol	Soil	Described on page	Irrigated capability unit		Nonirrigated capability unit		Range site		Windbreak suitability group
			Symbol	Page	Symbol	Page	Name	Page	Number
Ly	Lohmiller-Hysham clay loams--------	25							
	Lohmiller soil----------	--	IIs-3	40	IVs-5	51	Clayey	58	1
	Hysham soil----------	--	IIs-3	40	IVs-5	51	Clayey	58	8
Ma	Marias clay, saline-alkali, 0 to 1 percent slopes----------	26	IVs-2	43	VIs-4	52	Dense Clay	59	8
Mb	Marias clay, saline-alkali, 1 to 10 percent slopes----------	26	-----	--	VIs-4	52	Dense Clay	59	8
Mc	Marias clay, fans, saline-alkali--	26	VIs-2	44	VIs-4	52	Dense Clay	59	8
Md	Marias-Hoven clays, saline--------	26	VIs-2	44	VIs-4	52	Panspots	59	8
Me	Marias-Pierre clays, saline-alkali----------	26	-----	--	VIs-4	52	Dense Clay	59	8
Mf	Marias and Promise clays----------	26	-----	--	IIIe-5	49	Clayey	58	6
Mk	McRae loam----------	27	-----	--	IVe-3	50	Silty	57	3
Ml	McRae-Bainville loams, 8 to 20 percent slopes----------	27							
	McRae soil----------	--	-----	--	IVe-3	50	Silty	57	3
	Bainville soil----------	--	-----	--	VIe-3	51	Silty	57	7
Mm	McRae-Bainville loams, 20 to 35 percent slopes----------	27							
	McRae soil----------	--	-----	--	VIe-3	51	Silty	57	8
	Bainville soil----------	--	-----	--	VIe-4	52	Thin Silty	58	8
Mn	McRae and Havre loams, 0 to 1 percent slopes----------	27	I-1	39	IIIc-1	50	Silty	57	1
Mo	McRae and Havre loams, 1 to 4 percent slopes----------	27	IIe-1	39	IIIc-1	50	Silty	57	1
Mp	McRae and Havre loams, 4 to 8 percent slopes----------	28	IVe-1	41	IIIe-2	48	Silty	57	1
Mr	Midway clay loam, 8 to 15 percent slopes----------	28	-----	--	VIe-3	51	Clayey	58	7
Ms	Midway clay loam, 15 to 35 percent slopes----------	28	-----	--	VIe-4	52	Thin Clayey	58	8
Mt	Midway-Bainville complex----------	28							
	Midway soil----------	--	-----	--	VIIe-1	52	Thin Clayey	58	8
	Bainville soil----------	--	-----	--	VIIe-1	52	Thin Silty	58	8
Mu	Midway-Nihill gravelly loams------	28							
	Midway soil----------	--	-----	--	VIIe-1	52	Thin Clayey	58	8
	Nihill soil----------	--	-----	--	VIIe-1	52	Thin Silty	58	8
Mv	Midway-Shale outcrop complex------	29	-----	--	VIIe-2	52	Thin Breaks	59	8
Na	Nihill gravelly loam----------	29	-----	--	VIe-4	52	Thin Silty	58	8
Nc	Nunn clay, 0 to 1 percent slopes--	30	IIs-2	40	-----	--	----------	--	2
Nd	Nunn clay, 1 to 3 percent slopes--	30	IIIe-1	41	IIIe-4	49	Clayey	58	2
Nm	Nunn clay, 3 to 8 percent slopes--	30	IVe-2	42	IIIe-5	49	Clayey	58	2
Nn	Nunn clay loam, 0 to 1 percent slopes----------	29	I-1	39	-----	--	------	--	--
No	Nunn clay loam, 1 to 3 percent slopes----------	29	IIe-1	39	IIIc-1	50	Clayey	58	2
Nu	Nunn clay loam, 3 to 8 percent slopes----------	30	IVe-1	41	IIIe-2	48	Clayey	58	2
Nx	Nunn-Beckton complex, 0 to 1 percent slopes----------	30	IIs-2	40	-----	--	------	--	2
Pa	Pierre clay----------	30	-----	--	IVe-7	51	Clayey	58	6
Pc	Pierre-Lismas clays----------	31							
	Pierre soil----------	--	-----	--	VIe-3	51	Clayey	58	6
	Lismas soil----------	--	-----	--	VIIs-1	52	Shallow Clay	59	8
Pk	Pierre-Lismas clays, saline-alkali----------	31							
	Pierre soil----------	--	-----	--	VIs-4	52	Dense Clay	59	8
	Lismas soil----------	--	-----	--	VIIs-1	52	Shallow Clay	59	8
Rn	Renohill clay loam----------	31	-----	--	IIIe-2	48	Clayey	58	3

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Map symbol	Soil	Described on page	Irrigated capability unit		Nonirrigated capability unit		Range site		Windbreak suitability group
			Symbol	Page	Symbol	Page	Name	Page	Number
Rw	Riverwash	31	-----	--	VIIIs-1	53	----------	--	8
Sa	Sage clay	32	IVw-1	42	VIw-2	52	Saline Subirrigated	57	8
Sc	Sage silty clay	32	IVs-1	43	VIw-2	52	Saline Subirrigated	57	8
Sh	Shale outcrop	32	-----	--	VIIIs-1	53	----------	--	8
Sk	Shonkin loam	32	-----	--	IIIc-1	50	Overflow	57	5
Tf	Terry-Tullock fine sandy loams	32	-----	--	IIIe-6	49	Sandy	57	3
Tm	Terry-Treasure fine sandy loams	33							
	Terry soil	--	-----	--	IIIe-6	49	Sandy	57	3
	Treasure soil	--	-----	--	IIIe-6	49	Sandy	57	1
Tn	Terry-Winnett complex	33							
	Terry soil	--	-----	--	IVe-5	50	Sandy	57	3
	Winnett soil	--	-----	--	IVe-5	50	Sandy	57	8
Tp	Travessilla-Tullock fine sandy loams	33							
	Travessilla soil	--	-----	--	VIs-3	52	Shallow Limy	59	8
	Tullock soil	--	-----	--	VIe-4	52	Thin Sandy	58	8
Tr	Travessilla-Rock outcrop complex	33	-----	--	VIIs-3	53	Very Shallow	60	8
Ts	Treasure fine sandy loam, 2 to 4 percent slopes	34	-----	--	IIIe-6	49	Sandy	57	1
Tu	Treasure fine sandy loam, 4 to 8 percent slopes	34	-----	--	IIIe-6	49	Sandy	57	1
Tv	Tullock fine sandy loam, 4 to 20 percent slopes	34	-----	--	VIe-3	51	Sandy	57	3
Wb	Wanetta loam, 1 to 4 percent slopes	34	-----	--	IIIe-3	48	Silty	57	3
Wc	Wanetta loam, 4 to 8 percent slopes	34	-----	--	IIIe-3	48	Silty	57	3
Wd	Wanetta loam, deep, 0 to 2 percent slopes	35	-----	--	IIIc-1	50	Silty	57	3
Wm	Wanetta loam, deep, 2 to 4 percent slopes	35	-----	--	IIIc-1	50	Silty	57	3
Wn	Wanetta loam, deep, 4 to 8 percent slopes	35	-----	--	IIIe-2	48	Silty	57	3
Wr	Wibaux-Rock outcrop complex	35	-----	--	VIIs-3	53	Very Shallow	60	8
Wt	Winnett complex	36	-----	--	VIs-4	52	Panspots	59	8
Wx	Winnett-Fattig complex	36							
	Winnett soil	--	-----	--	VIs-4	52	Panspots	59	8
	Fattig soil	--	-----	--	VIs-4	52	Panspots	59	3

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