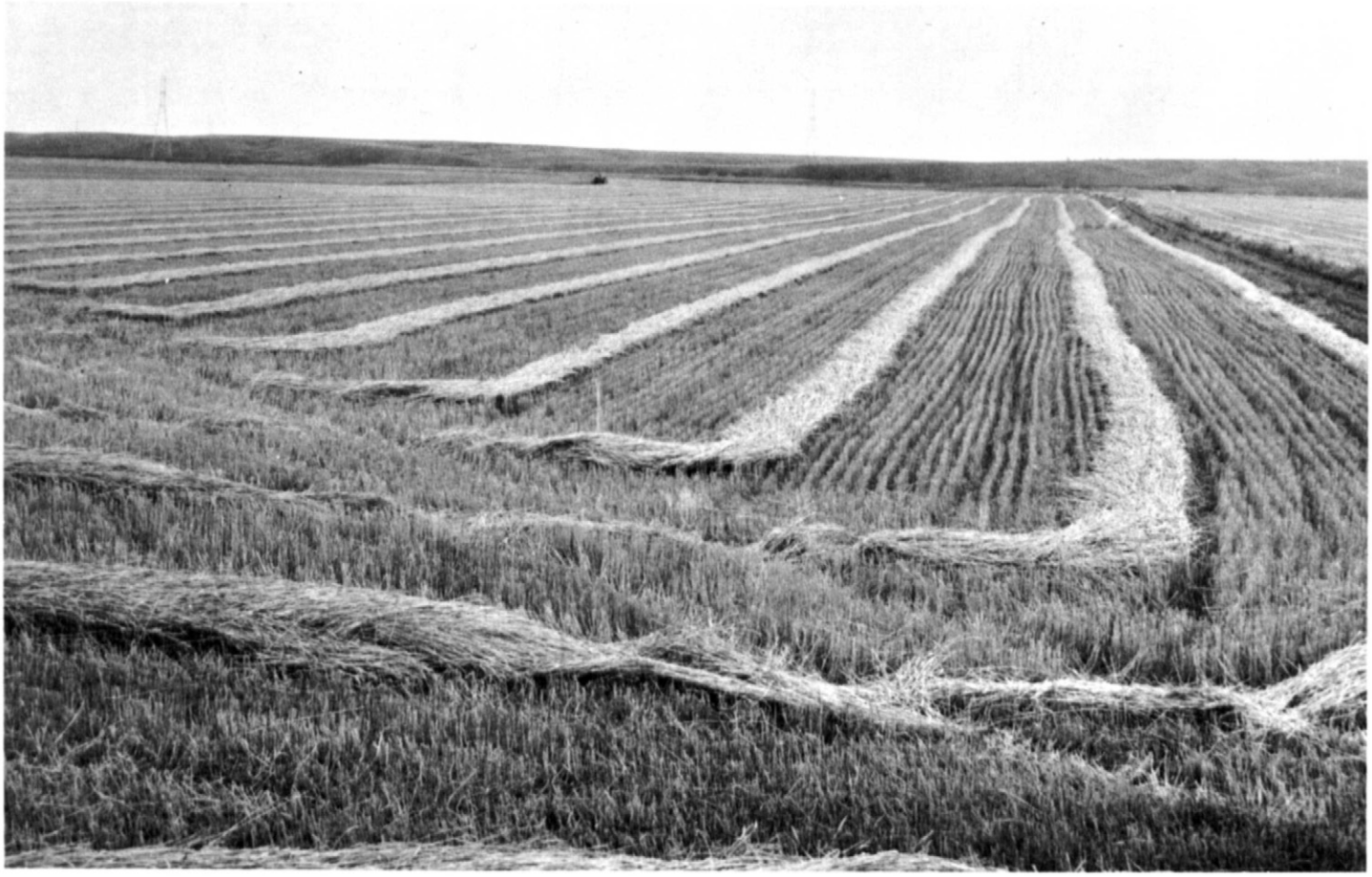
Issued December 1966

SOIL SURVEY
CODINGTON COUNTY
South Dakota



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

Major fieldwork for this soil survey was done in the period 1957–59. Soil names and descriptions were approved in 1964. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1964. This survey of Codington County was made as part of the technical assistance furnished by the Soil Conservation Service to the Codington Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY REPORT

THIS SOIL SURVEY of Codington County contains information that can be applied in managing farms 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 Codington 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 a 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, Capability Units, and Range Sites" 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, range site, or any other group 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 on 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 "Use of the Soils for Windbreaks," where the soils of the county are grouped according to their suitability for trees.

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

Farmers and others interested in native grassland can find, under "Management of Native Grassland," 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 Uses of Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

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

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

Newcomers in Codington 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," which gives additional information about the county.

Cover picture: Harvesting small grains in a field of Lamoure silty clay loam.

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NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on the next page.

Issued December 1966

EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

Series 1957, No. 23, Las Vegas-Eldorado Area, Nev.
Series 1958, No. 34, Grand Traverse County, Mich.
Series 1959, No. 42, Judith Basin Area, Mont.
Series 1960, No. 31, Elbert County, Colo. (Eastern part)
Series 1961, No. 42, Camden County, N.J.
Series 1962, No. 13, Chicot County, Ark.
Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the number shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF CODINGTON COUNTY, SOUTH DAKOTA

BY TOIVO J. OLLILA, LORENZ M. FOX, LAURENCE L. KOBRIGER, AND DEAN R. PURRINGTON,
SOIL CONSERVATION SERVICE

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

CODINGTON COUNTY is in the northeastern part of South Dakota (fig. 1). It has an area of 442,240 acres. Watertown, the county seat and the largest town, is in the south-central part of the county. Other towns are Henry, Florence, South Shore, Wallace, Kranzburg, and Waverly.

The county is in the north-central part of the Coteau des Prairies, a plateau shaped like a flatiron that is the most conspicuous land feature in the eastern part of South Dakota. The county is divided just east of its center by the Big Sioux River, which flows southward to the Missouri River. This river drains all but about 15 square miles in the extreme northeastern corner of the county. Drainage in the northeastern corner is eastward into the Minnesota River through the northern branch of the Yellowbank River.

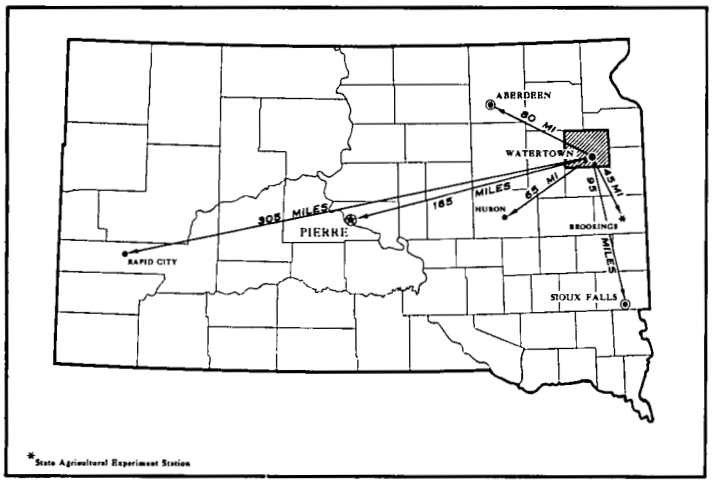

Figure 1.—**Location of Codington County in South Dakota.**

Agriculture is diversified in this county, and farm income is divided almost equally between income received from the sale of livestock and that received from the sale of crops. Corn, oats, barley, flax, spring wheat, potatoes, and alfalfa are the main crops. About 68 percent of the farmland in the county is used for crops; 25 percent is used for pasture and wild hay; and 7 percent is used for farmsteads, windbreaks, and other purposes.

How This Soil Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Codington 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. Kranzburg and Poinsett, 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. Poinsett loam and Poinsett silt loam are two soil types in the Poinsett series. The difference in texture of their surface layers is apparent from their names.

Some soil 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, Vienna silt loam, 3 to 6 percent slopes, is one of several phases of Vienna silt loam, a soil type that ranges from nearly level to sloping.

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 woodland, 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, Poinsett-Waubay silty clay loams, 0 to 3 percent slopes. Another kind of mapping unit is the undifferentiated soil group, which consists of two or more soils not separated on the map, because differences among them are small, their practical value is limited, or they are too difficult to reach. An example is Oldham and Parnell silty clay loams. 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 Clayey saline land or Terrace escarpments, 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 it is readily useful to different groups of readers, among them farmers, ranchers, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil survey reports. On basis of yield and practice tables and other data, the soil scientists set up trial groups, and then test their groupings 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

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

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The seven soil associations in Codington County are described briefly in this section. More detailed information about the individual soils in each association can be obtained by studying the detailed soil map and by reading the section "Descriptions of the Soils."

1. Poinsett-Waubay-Oldham Association

Nearly level or gently undulating, medium-textured and moderately fine textured soils formed in silty and loamy glacial drift

In this association are nearly level or gently undulating, deep, silty, dark-colored soils of the uplands in the western part of the county. The association lacks well-defined stream patterns; water from runoff collects in sloughs, lakes, and closed depressions (fig. 2). The slopes in the gently undulating areas are short and irregular. This association occupies about 26 percent of the county.

Figure 2.—**Aerial view of an area of association 1. Many closed depressions are in this association, and there is no well-defined pattern of surface drainage.**

The Poinsett soils are on uplands (fig. 3) and are the most extensive soils in this association. They are medium textured and well drained, and they formed in silty and loamy glacial drift. The Poinsett soils are productive and are easily farmed.

The Waubay soils are on flats and in shallow swales below the Poinsett soils. They are moderately fine textured and are moderately well drained. The Waubay soils are highly productive.

The Oldham soils are in closed depressions throughout the association. They are moderately fine textured. They take in water slowly and are somewhat poorly drained. Where drainage has been improved, or in the drier years where it has not, moderate yields are obtained on these soils, but wetness or flooding may delay seeding or damage growing crops in the wetter years.

Minor soils of this association are the Parnell, La Prairie, and Buse. The Parnell soils, in depressions, are moderately fine textured, slowly permeable, and poorly drained. The La Prairie soils, in upland swales, are medium textured or moderately fine textured and are moderately well drained. The Buse soils have steep slopes and are medium textured and excessively drained. They are shallow over glacial material.

Corn, flax, small grains, and alfalfa are grown on the Poinsett and Waubay soils of this association. Yields are moderate to high, but the choice of crops to grow on the Oldham soils is limited by the hazard of wetness and flooding. Yields are satisfactory, however, in the drier years. The short, irregular slopes and the many closed

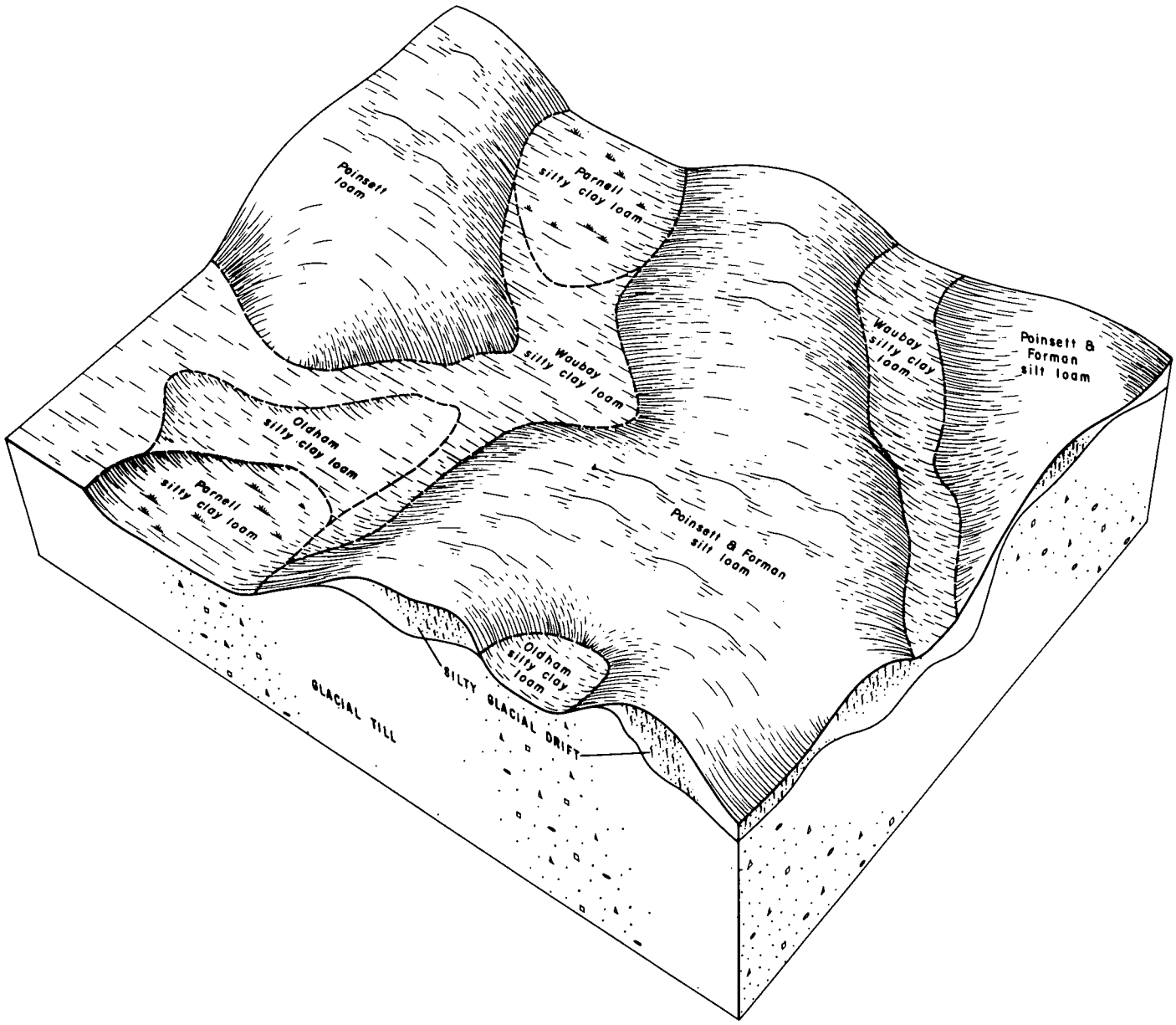

Figure 3.—**Diagram showing the relative position of the major soils in association 1.**

depressions within the association restrict the use of contour farming, terracing, and other practices that would help control runoff and erosion. Excess water is a problem in the depressions.

2. Poinsett-Buse-Parnell Association

Undulating or steep, medium-textured and moderately fine textured soils formed in silty and loamy glacial drift

This association occupies silty areas where many lakes, sloughs, and closed depressions dot the landscape. It is mainly in the western part of the county. The soils are more undulating than those of association 1 but are less steep than those of association 5. This association makes up about 12 percent of the county.

The Poinsett soils are on uplands and are sloping or undulating. They are deep, medium textured, and well drained, and they formed in silty and loamy glacial drift.

The Buse soils are steep. They are medium textured, well drained to excessively drained, and shallow over glacial material. In many places these soils are too steep for cultivation.

The Parnell soils are in closed depressions. They are deep, dark colored, moderately fine textured, and slowly permeable, and they are poorly drained. These soils are too wet for cultivation, except in the driest years.

Minor soils of this association are the Forman, Waubay, and Oldham. The Forman soils are in nearly level or undulating areas and are deep, medium textured, and well drained. They formed in moderately fine textured glacial till. The Waubay soils, in upland swales, are deep, dark colored, moderately fine textured, and moderately well drained. The Oldham soils, in closed depressions, are deep, dark colored, and moderately fine textured. They are slowly permeable and are somewhat poorly drained.

Small grains, flax, corn, and alfalfa are the crops commonly grown on the gently sloping and moderately sloping soils of this association, and yields of those crops are moderate. The poorly drained soils in depressions and the steep soils are used for hay or pasture. Controlling erosion from runoff on the sloping soils of this association is difficult because the short, irregular slopes and the many closed depressions restrict the use of such practices as contour farming and terracing. The poorly drained soils in the depressions can be farmed only in drier years.

3. Brookings-Kranzburg-Vienna Association

Nearly level to sloping, medium-textured and moderately fine textured soils formed in loess and loamy glacial till

In this association are soils on broad ridgetops and on long, smooth side slopes that end along drainageways. The drainageways empty into the Big Sioux River and its tributaries. The soils are deep, loamy, and mainly nearly level or gently sloping (fig. 4). This association makes up about 25 percent of the county.

The Brookings soils are nearly level and are on upland flats. They are dark colored, moderately fine textured, and moderately well drained. They formed in 1½ to 4 feet of loess over glacial till.

The Kranzburg soils are in smooth, gently sloping to sloping areas. They are moderately fine textured and well drained, and they formed in 15 to 40 inches of loess over glacial till.

The Vienna soils are on uplands. They are nearly level to sloping, medium textured, and well drained. They formed in loamy glacial till.

Lamoure, La Prairie, Hidewood, Buse, and Egeland are minor soils in this association. The Lamoure soils, on stream bottoms, are dark colored, moderately fine textured, and somewhat poorly drained. The La Prairie soils, formed in colluvium in upland swales, are dark colored and medium textured to moderately fine textured. The Hidewood soils, in slight depressions, are dark colored, moderately fine textured, and somewhat poorly drained. The Buse soils are steep, medium textured, and well drained to excessively drained. They are shallow over glacial material. The Egeland soils, on uplands and stream terraces, are moderately coarse textured and well drained.

The major soils of this association are easily farmed. They produce moderate to high yields of corn, potatoes, flax, small grains, and alfalfa. The long, smooth slopes are well suited to contour farming, contour stripcropping, and terracing, which help to control runoff and erosion. Seeding drainageways to grass also helps to control gully erosion.

4. Forman-Buse-Parnell Association

Gently undulating to rolling, medium-textured and moderately fine textured soils formed in clay loam glacial till

This association (fig. 5) is on gently undulating to rolling uplands along indefinite glacial moraines in the eastern and northeastern parts of the county. The soils are at a higher elevation and are more rolling than those of association 3 to the west, but they are at a lower elevation and are less steep than the hilly soils to the east. Irregular slopes and many closed depressions make up the landscape. This association occupies about 8 percent of the county.

The Forman soils are on uplands. They are gently sloping or moderately sloping, and the slopes are short and choppy in many places. These soils are deep, medium textured, and well drained, and they formed in moderately permeable glacial till. A few to many cobbles and other stones are on the surface and throughout the profile.

The Buse soils are steep and are stony in many places. These soils are medium textured, are well drained to excessively drained, and are shallow over glacial material.

The Parnell soils are in closed depressions and are poorly drained. They are deep, dark colored, and moderately fine textured.

Minor soils of this association are the Oldham, Sioux, and Waubay. The Oldham soils, in closed depressions, are deep, dark colored, and moderately fine textured. They are slowly permeable and somewhat poorly drained. The Sioux soils, on hilltops and in stream valleys, are rapidly permeable and formed in shallow, gravelly glacial outwash. The Waubay soils, on upland flats and in shallow swales, are deep, dark colored, and moderately fine textured, and they are moderately well drained.

Flax, small grains, and alfalfa are grown on the Forman and Waubay soils, and yields are moderate to high. The stony, steep, and poorly drained soils are used for hay or pasture. Controlling runoff and erosion on this associa-

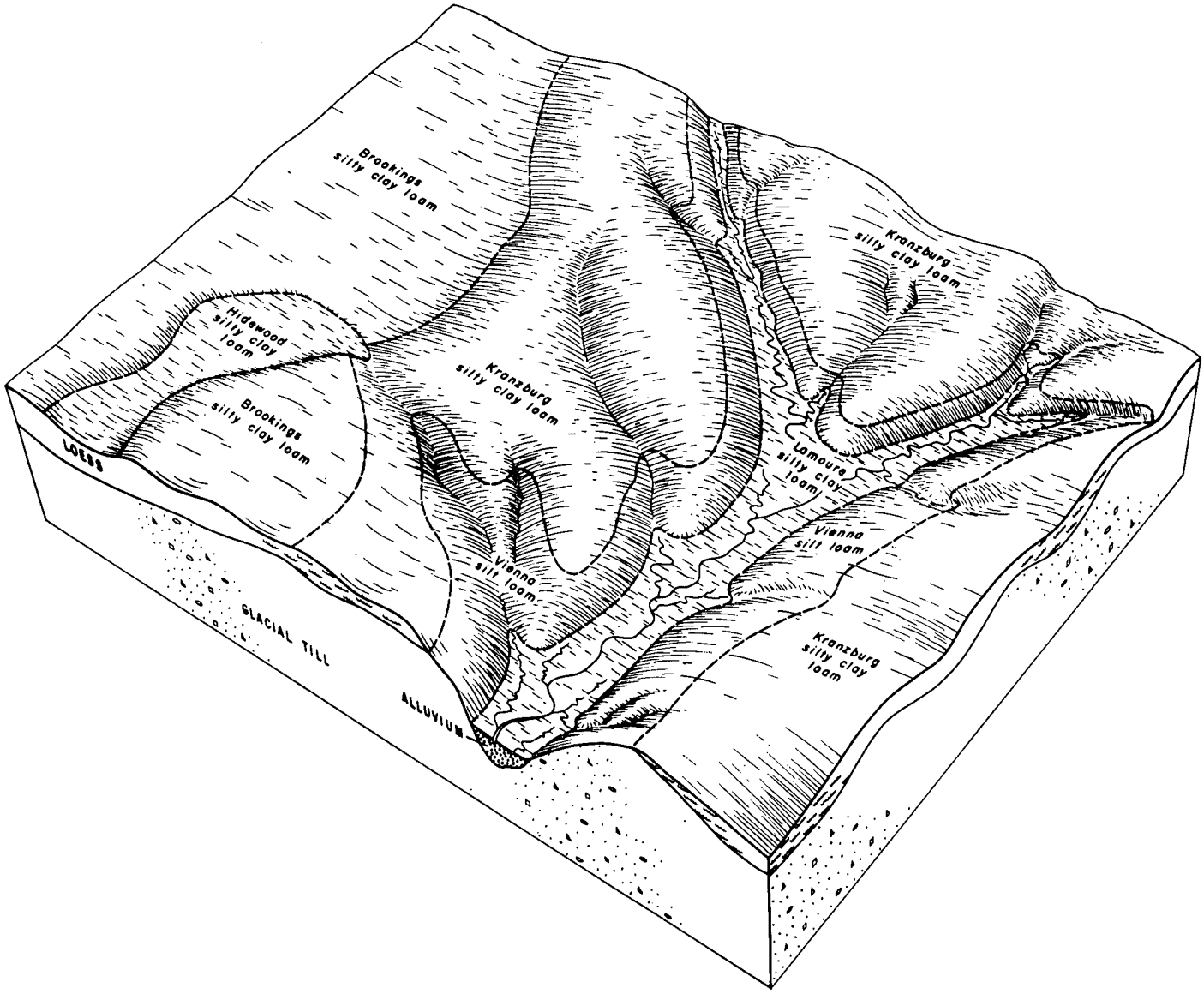

Figure 4.—**Diagram showing the relative position of the major soils in association 3.**

tion is difficult because many of the slopes are too irregular for contour farming, contour stripcropping, or terracing. In addition, numerous cobbles and other stones hamper tillage in many fields. Each year, stone picking is a common task on many farms in this association.

5. Buse-Sioux Association

Rolling or steep, medium-textured and moderately coarse textured soils formed in glacial drift

This association is on rolling to steep glacial moraines and on the steep sides of stream valleys. Many areas are stony (fig. 6), and closed depressions are common along the glacial moraines. The soils of this association formed in glacial till, silty glacial drift, or gravelly glacial outwash. This association makes up about 7 percent of the county.

The Buse soils are steep, medium textured, and well drained to excessively drained. They formed in loamy or silty glacial material and are shallow over glacial drift.

The Sioux soils are rapidly permeable. They formed in gravelly glacial outwash and are less than 10 inches deep over gravel.

Parnell, Poinsett, Forman, and Vienna are minor soils in this association. The Parnell soils are in closed depressions and are poorly drained. They are deep, dark colored, moderately fine textured, and slowly permeable. The Poinsett soils are on uplands and are deep, medium textured, and well drained. They formed in silty and loamy glacial drift. The Forman and Vienna soils, also on uplands, are deep, medium textured, and well drained, and they formed in glacial till.

The steep, irregular slopes, stones, and thin layer of soil material over gravel or glacial drift, in addition to the excess water and low fertility, limit the use of most of this

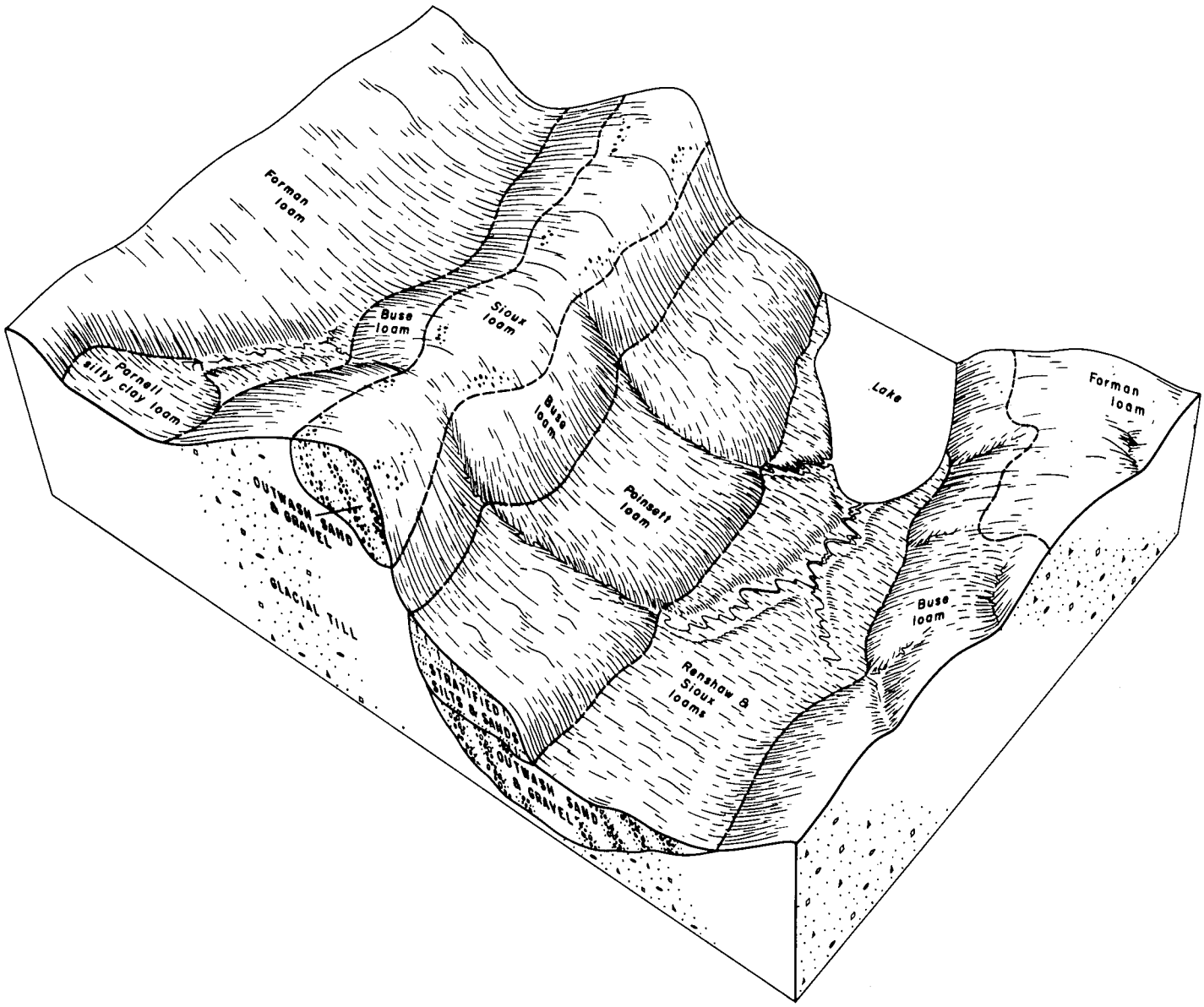

Figure 5.—**Diagram showing the relative position of the major soils in association 4.**

association to pasture or hay. On small tracts of deep soils, however, moderate yields of small grains, flax, or alfalfa are obtained. The soils in depressions are generally too wet for cultivation. On selected sites within this association, contour farming and terracing may be practiced to control runoff and erosion. Contour furrows will increase the intake of water on native pastures that are free of stones.

6. Estelline-Fordville-Renshaw Association

Nearly level or gently sloping, medium-textured and moderately coarse textured soils underlain by sand and gravel; on stream terraces and outwash plains

This association is made up of nearly level or gently sloping soils on stream terraces and outwash plains (fig. 7). The areas are along the Big Sioux River and its tributaries, in the area called Antelope Valley near South Shore, and in areas northwest of Lake Pelican and Lake Kampeska. This association occupies 15 percent of the county.

The Estelline soils are on outwash plains. They are deep, medium textured, and well drained, and they are moderately permeable. The loess in which they formed is 36 to 48 inches deep over sand and gravel.

The Fordville soils are on stream terraces (fig. 8). They are moderately deep, medium textured or moderately coarse textured, and well drained. The alluvial material in which they formed is 20 to 36 inches deep over outwash gravel.

The Renshaw soils are droughty, somewhat excessively drained, and low in fertility. They formed in 10 to 20 inches of loamy or sandy alluvium that overlies sand and gravel.

Minor soils of this association are the Sioux, Lamoure, and Egeland. The Sioux soils are on stream terraces, outwash plains, and ridgetops. They are excessively

Figure 6.—**A typical landscape in association 5. Buse soils occupy the steep side slopes, and Sioux soils are on the ridgetops. Poorly drained Parnell soils are in the depression.**

drained and are shallow over gravel. The Lamoure soils are on bottom lands and are deep, dark colored, moderately fine textured, and somewhat poorly drained. The Egeland soils are on uplands and stream terraces and are deep and moderately coarse textured.

Potatoes, corn, flax, small grains, and alfalfa are grown extensively on the Estelline and Fordville soils. Yields on the Estelline soils are moderate to high, and those on the Fordville and Renshaw soils are low to moderate. Conserving water and controlling wind erosion are major problems on these soils. Wind stripcropping can be used to reduce erosion in the nearly level areas, and contour stripcropping can be used in the sloping areas. Where enough water is available, irrigation helps to increase yields.

7. Lamoure-Rauville Association

Nearly level, moderately fine textured soils on flood plains

This association consists of soils on the bottom lands of the Big Sioux River and its tributaries. The soils are nearly level, somewhat poorly drained to very poorly drained, and occasionally flooded. They formed in dark-colored, moderately fine textured alluvium that is underlain in places by sand and gravel at a depth of 36 inches or more. This association occupies about 7 percent of the county.

The Lamoure soils are deep, dark colored, and moderately fine textured. They are somewhat poorly drained.

The Rauville soils are deep and moderately fine textured, and they are very poorly drained. The water table is at or near the surface during much of the growing season.

Minor soils of this association are the Fordville, Renshaw, and Sioux. Also in this association are areas of Clayey saline land along the southern end of Long Lake. This land type consists of poorly drained, moderately saline lakebed material. It is nearly level, stony in places, and too saline and too wet for cultivation.

Corn, flax, small grains, and alfalfa are grown on some areas of the Lamoure soils. If the weather is favorable, yields are generally moderate, but wetness or flooding in spring may delay planting. Also, a large amount of rainfall in summer may damage crops or prevent harvest.

Yields of forage are high on the soils of this association. The Rauville soils are too wet for cultivated crops, but forage plants that tolerate wetness make high yields. Moderate yields of low-quality forage are produced on Clayey saline land.

Descriptions of the Soils

This section is provided for those who want information about the soils in the county. It describes the single soils, or mapping units; that is, the areas on the detailed soil map that are bounded by lines and are identified by a symbol. For more general information about the soils, the reader can refer to the section "General Soil Map," in which the broad patterns of soils in the county are described. The acreage and proportionate extent of each soil mapped in the county are given in table 1. Their location is shown on the soil map at the back of the report.

In the descriptions that follow, the soils in a series are first discussed as a group by describing important features that apply to all the soils in the series. The location of the soils in the county is given, as well as the position of the soils on the landscape. Some of the nearby or similar soils are named and compared with the soils in the series being described. After the general description of the series is a broad statement that tells how the soils are used.

Following the description of each series are descriptions of each soil in the series. Generally these descriptions tell how the profile of the soil described differs from the one described as representative of the series. They also tell about the use and suitability of the soil and something about its management needs.

Detailed, layer-by-layer descriptions of soil profiles are not given in this section. A detailed description of a representative profile for each series is described in the section "Genesis, Classification, and Morphology of Soils." Some of the terms used in the soil descriptions are defined in the section "How This Soil Survey Was Made." Other terms are described in the Glossary at the back of this report.

Brookings Series

The Brookings soils are deep, dark, moderately fine textured, and moderately well drained. They developed in about 18 to 48 inches of silty clay loam loess over glacial till. These soils are nearly level. They are on uplands or in shallow swales in the central and southeastern parts of the county.

In a typical profile of a Brookings soil, the surface layer is very dark gray silty clay loam that has fine granular structure. This layer has a moderately high content of organic matter and is friable when moist. It is about 13 inches thick.

The subsoil is dark grayish-brown silty clay loam that has moderate prismatic structure and is firm when moist. It is about 16 inches thick.

The underlying material is light olive-brown loam or clay loam glacial till that is moderately calcareous and contains many mottles of brown and olive. The glacial till is friable when moist and has no defined soil structure.

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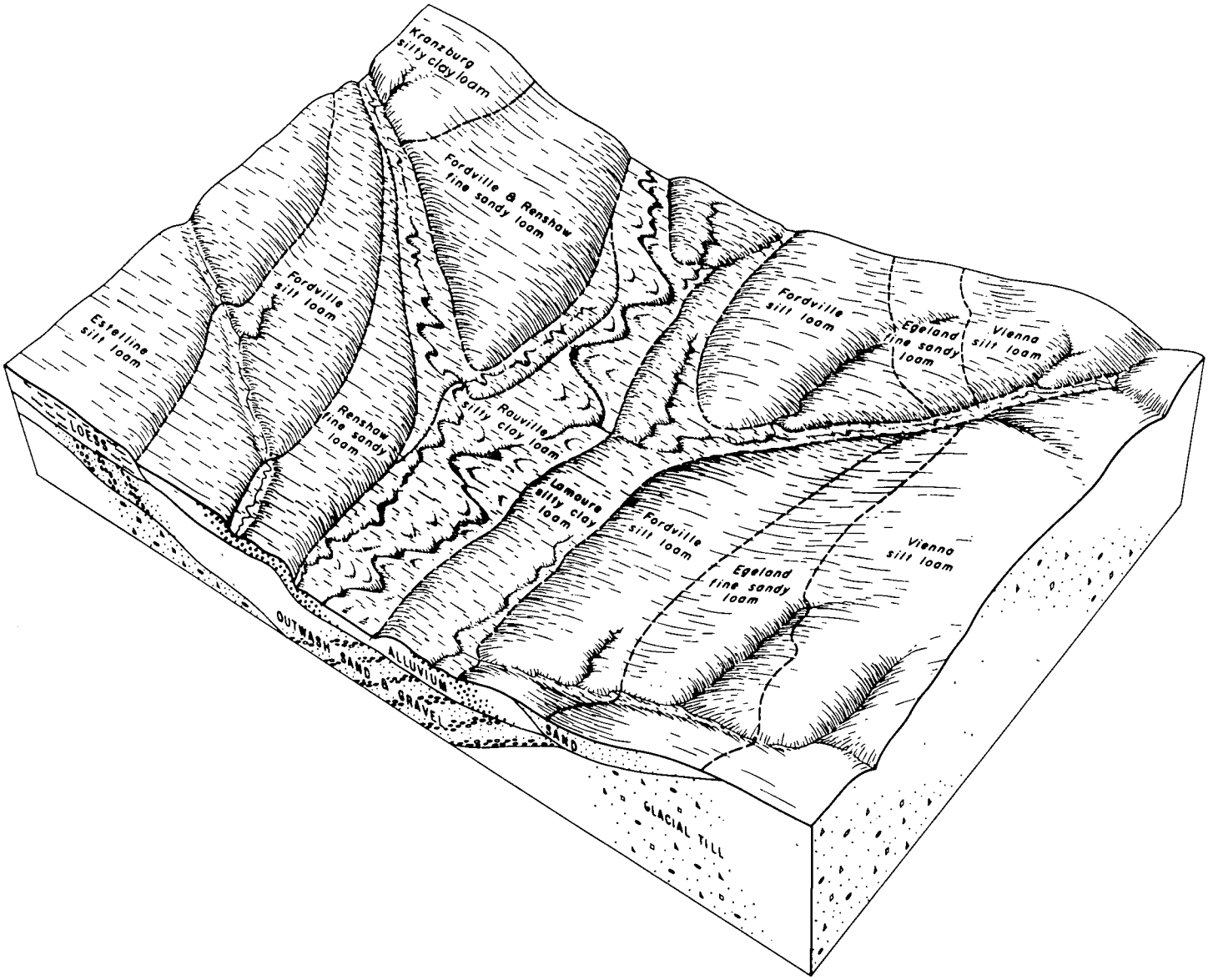

Figure 7.—**Diagram showing the relative position of the major soils in association 6 in the valley of the Big Sioux River.**

Figure 8.—**A field of Fordville silt loam, 0 to 3 percent slopes, within association 6. Small grains have been grown in this field.**

The thickness of the loess over glacial till ranges from 18 to 48 inches or more. In places a thin layer of gravelly or cobbly material lies between the loess and the glacial till. Mottling is generally below a depth of 26 inches.

The Brookings soils occur with the Kranzburg and Hidewood soils. They are less well drained than the Kranzburg soils, but they are better drained than the Hidewood soils.

The Brookings soils are fertile and are easily farmed. They take in water rather slowly but hold it well. Runoff is slow because these soils are nearly level.

These soils are among the most productive in the county. Except for small areas in feedlots, farmsteads, or shelterbelts, almost all of the acreage is cultivated.

Brookings silty clay loam (0 to 3 percent slopes) (Bc).—The profile of this soil is similar to the one described for the series. This soil is on upland flats and in shallow swales. It is in the central and southeastern parts of the

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

Soil	Acres	Percent
Brookings silty clay loam	35, 248	8. 0
Brookings-Hidewood silty clay loams	2, 346	. 5
Buse loam, 9 to 15 percent slopes	614	. 1
Buse loam, 15 to 35 percent slopes	683	. 2
Buse stony loam	3, 968	. 9
Buse-Poinsett silt loams, 9 to 15 percent slopes	8, 433	1. 9
Buse-Sioux loams, 6 to 15 percent slopes	1, 505	. 3
Buse-Sioux stony loams	4, 978	1. 1
Buse-Vienna loams, 6 to 15 percent slopes	3, 769	. 9
Buse-Vienna-Sioux stony loams	1, 320	. 3
Clayey saline land	779	. 2
Egeland fine sandy loam, 0 to 3 percent slopes	1, 225	. 3
Egeland fine sandy loam, 3 to 9 percent slopes	2, 645	. 6
Estelline silt loam, 0 to 3 percent slopes	14, 205	3. 2
Estelline silt loam, 3 to 6 percent slopes	2, 508	. 6
Fordville silt loam, 0 to 3 percent slopes	33, 189	7. 5
Fordville silt loam, 3 to 6 percent slopes	3, 450	. 8
Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes	1, 931	. 4
Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes	1, 495	. 3
Forman cobbly loam, 3 to 6 percent slopes	4, 237	1. 0
Forman cobbly loam, 6 to 9 percent slopes	3, 649	. 8
Forman loam, 0 to 3 percent slopes	1, 309	. 3
Forman loam, 3 to 6 percent slopes	8, 435	1. 9
Forman loam, 6 to 9 percent slopes	2, 594	. 6
Kranzburg silty clay loam, 3 to 6 percent slopes	24, 068	5. 4
Lamoure silty clay loam	22, 364	5. 1
Lamoure silty clay loam, channeled	4, 869	1. 1
La Prairie silt loam	5, 241	1. 2
Oldham silty clay loam	2, 732	. 6
Oldham and Parnell silty clay loams	12, 782	2. 9
Oldham and Parnell silty clay loams, wet	5, 600	1. 3
Poinsett loam, 0 to 3 percent slopes	2, 533	. 6
Poinsett loam, 3 to 7 percent slopes	632	. 1
Poinsett silt loam, 3 to 6 percent slopes	49, 499	11. 2
Poinsett-Buse-Forman loams, 6 to 9 percent slopes	21, 930	5. 0
Poinsett-Forman silt loams, 3 to 6 percent slopes	18, 029	4. 1
Poinsett-Waubay silty clay loams, 0 to 3 percent slopes	26, 050	5. 9
Rauville silty clay loam	3, 438	. 8
Renshaw-Sioux complex, 0 to 3 percent slopes	2, 873	. 6
Renshaw-Sioux complex, 3 to 6 percent slopes	3, 004	. 7
Terrace escarpments	3, 102	. 7
Vienna silt loam, 0 to 3 percent slopes	6, 378	1. 4
Vienna silt loam, 3 to 6 percent slopes	35, 509	8. 0
Vienna silt loam, 6 to 9 percent slopes	16, 786	3. 8
Waubay silty clay loam	15, 602	3. 5
Waubay-Forman silty clay loams, 0 to 3 percent slopes	923	. 2
Marsh (indicated by symbol on soil map)	8, 361	1. 9
Marsh, saline (indicated by symbol on soil map)	154	(1)
Open water (less than 40 acres in size)	5, 266	1. 2
Total	442, 240	100. 0
Open water (greater than 40 acres in size)	14, 720	--------

[1] Less than 0.05.

county. Included in the areas mapped as this soil are small areas of well-drained Kranzburg silty clay loam, 3 to 6 percent slopes, and of somewhat poorly drained Hidewood silty clay loam, 0 to 3 percent slopes.

This Brookings soil is highly productive and easily tilled. Corn, potatoes, flax, small grains, and alfalfa grown on it make high yields. Runoff is slow, and the risk of erosion is slight; this soil can be cropped intensively with only slight risk of damage if ordinary good farming practices are used. (Capability unit I–1, Silty range site, windbreak suitability group 2)

Brookings-Hidewood silty clay loams (0 to 3 percent slopes) (Bh).—Brookings silty clay loam makes up about 60 percent of this complex, and Hidewood silty clay loam makes up the rest. These soils occur in an intricate pattern on flats and in small, indefinite depressions or swales; the Brookings soil is on the flats, and the Hidewood soil is in the depressions or swales. Their profiles are like the profiles described for the Brookings and Hidewood series. Included in the areas mapped as this complex are small areas of well-drained Kranzburg silty clay loam, 3 to 6 percent slopes.

The Brookings soil is moderately well drained, and the Hidewood soil is somewhat poorly drained. Flooding in the depressions is the main limitation to the use of these soils.

Much of the acreage is used for pasture or hay because wet spots hamper farming, but moderate yields of corn, small grains, flax, or hay are obtained. In some places small areas of the Hidewood soil are farmed with adjacent soils. (Brookings soil is in capability unit I–1, Silty range site, and windbreak suitability group 2; Hidewood soil is in capability unit IVw–1, Overflow range site, and windbreak suitability group 4)

Buse Series

In the Buse series are steep or undulating, well-drained to excessively drained soils that are stony in many places. These soils developed in loamy glacial till or silty glacial drift and are shallow over that material. They are on glacial moraines or along the steep sides of drainageways throughout the county. Their profile is not well developed.

In a typical profile of a Buse soil, the surface layer is very dark gray, friable loam about 5 inches thick. This layer has fine granular structure and is calcareous to the surface in many places.

The subsoil is dark grayish-brown, friable, calcareous loam or clay loam that has weak prismatic structure and is about 6 inches thick. This is a transitional layer between the surface layer and the underlying material. The underlying material is calcareous grayish-brown loamy glacial till or silty glacial drift. It is structureless and is friable to firm when moist.

In most places the soil material is thin over glacial till, but it is as thick as 15 inches in some places. The texture of the surface layer is generally loam, but it ranges from fine sandy loam to light clay loam. The number of stones ranges from few to many. Although these soils are generally calcareous to the surface, in small areas they are free of lime to a depth of 8 inches.

Buse soils occur with the Forman, Poinsett, Sioux, and Vienna soils. They are steeper, are less deep, and have less well-defined horizons than the Forman, Poinsett, and Vienna soils. The Buse soils contain less gravel than the Sioux soils.

The Buse soils are moderately permeable. Runoff from the steep slopes is rapid.

Steepness, stoniness, or low fertility make most areas of these soils better suited to hay or pasture than to cultivated crops. Yields of grass are good.

Buse loam, 9 to 15 percent slopes (BmD).—The profile of this soil is similar to the one described for the series. This soil is in small patches in rolling areas throughout the county. In cultivated areas spots of the light-colored subsoil are exposed. Included in the areas mapped as this soil are small areas of Forman loam, 6 to 9 percent slopes, and Vienna silt loam, 6 to 9 percent slopes.

Yields of small grains, corn, and flax are low. This soil must be carefully managed if it is to be farmed without erosion, and such practices as terracing and contour farming are essential. Legumes and grasses grown for forage are better suited than cultivated crops. Either tame or native grasses produce good yields of forage if this soil is well managed. (Capability unit IVe–1, Shallow range site, windbreak suitability group 2)

Buse loam, 15 to 35 percent slopes (BmE).—This soil is on glacial end moraines and on steep valley walls throughout the county. It is excessively drained and is shallow over glacial material. Included in the areas mapped as this soil are small areas of Forman, Vienna, and Sioux soils.

The steep slopes, extreme hazard of erosion, and low fertility make this soil suited only to native hay or pasture. Yields of forage are low. Grazing must be controlled to maintain a good cover of grass that will help to prevent erosion. Contour furrows will increase the intake of water in the pastures that have smooth slopes. (Capability unit VIe–1, Shallow range site, windbreak suitability group 2)

Buse stony loam (9 to 35 percent slopes) (Bo).—This soil is excessively drained and is in rolling to steep areas of the upland in the western part of the county. The profile is similar to the one described for the series, but it contains many stones.

Included in the areas mapped as this soil are small areas of deep, well-drained Poinsett and Forman soils that have slopes of 6 to 9 percent. Also included are small areas of gravelly, excessively drained Sioux soils.

This Buse soil is too stony for cultivation. It can be used only for native pasture, and yields of forage are low. Grazing must be carefully controlled. This allows the better native grasses to grow vigorously and to produce the maximum amount of forage for pasture. Stoniness and the steep slopes prevent the use of terraces or other measures for conserving water or controlling erosion. (Capability unit VIIs–1, Shallow range site, windbreak suitability group 5)

Buse-Poinsett silt loams, 9 to 15 percent slopes (BpD).—The soils of this complex occur in such an intricate pattern that it is not practical to separate them on the soil map. The areas consist of about 60 percent Buse silt loam; 25 percent Poinsett silt loam, 6 to 9 percent slopes; and 15 percent other soils. These soils are in the western part of the county and are on rolling hills and around the margins of large sloughs and lakes. The Buse soils are moderately steep, excessively drained, and shallow over glacial material. They have a profile like the one described for the Buse series. The Poinsett soils are on sloping ridgetops and are deep and well drained. They have a profile like the one described for the Poinsett series. Included in the areas mapped as this complex are small areas of Forman loam, 6 to 9 percent slopes; Oldham silty clay loam, 0 to 3 percent slopes; and Buse stony loam, 9 to 15 percent slopes.

Most of this complex is used for hay or pasture. Small patches are included in cultivated fields, but yields of small grains, flax, and corn are low. Terracing and contour farming are essential, along with careful management, if these soils are to be farmed without excessive water erosion. Probably the best use of the soils is for growing legumes and grasses for forage. Either tame or native grasses produce moderate yields of forage if the soils are well managed. (The Buse soil is in capability unit IVe–1 and Shallow range site, and the Poinsett soil is in capability unit IIIe–1 and Silty range site; both soils are in windbreak suitability group 2)

Buse-Sioux loams, 6 to 15 percent slopes (BsD).—About 60 percent of this complex is Buse loam, 25 percent is Sioux loam, and 15 percent is other soils. These soils are on ridgetops and knolls and are scattered throughout the eastern part of the county. The Buse soil is sloping to moderately steep, well drained, and shallow over glacial material. This soil formed in glacial till and has a profile similar to the one described for the Buse series. The Sioux soil is in gravelly pockets and on ridgetops. It developed in glacial outwash and is shallow over that material. A typical profile of a Sioux soil is described under the Sioux series.

Included in the areas mapped as this complex are small areas of undulating Forman and Vienna soils. The included soils are deep, medium textured, and well drained.

Most of the areas of this complex are used for pasture or hay, but small patches are included in cultivated fields. Yields are low where these soils are used for small grains, flax, and corn. The pockets of gravel, steep slopes, and thin surface layer make such practices as terracing impractical. Consequently, controlling erosion is difficult unless a good cover of grass is maintained. Growing legumes and grasses for forage is the best use of these soils. Either tame or native grasses produce moderate yields under good management. Grazing must be controlled in the native pastures to encourage the growth of the taller, more productive grasses. (The Buse soil is in capability unit IVe–1 and windbreak suitability group 2, and the Sioux soil is in capability unit VIIs–1 and windbreak suitability group 5; both soils are in the Shallow range site)

Buse-Sioux stony loams (9 to 35 percent slopes) (Bu).—This complex consists of about 60 percent Buse stony loam, 25 percent Sioux loam, and about 15 percent other soils. These soils are rolling to steep and are on glacial end moraines in the eastern and central parts of the county. They are similar to Buse-Sioux loams, 6 to 15 percent slopes, except that they are generally steeper and more stony.

These soils are best used for native pasture. Grazing must be controlled to maintain a good cover of grass and to encourage the growth of the more productive tall

grasses. (Both soils are in capability unit VIIs–1, Shallow range site, and windbreak suitability group 5)

Buse-Vienna loams, 6 to 15 percent slopes (BvD).—Buse loam makes up about 60 percent of this complex, and Vienna loam makes up the rest. These soils are in undulating to rolling areas in the central and southeastern parts of the county. The Buse soil occurs in small patches surrounded by the Vienna soil. It is well drained and is shallow over glacial material. Its profile is similar to the one described for the Buse series. The Vienna soil is deep and well drained. Its profile is similar to the one described for the Vienna series.

Most of this complex is used for hay or pasture. Small patches are included in cultivated fields, but yields of corn, small grains, and flax are low. If these soils are to be farmed without excessive erosion, they must be carefully managed, and such practices as terracing and contour farming are essential. Either tame or native grasses produce good yields of forage under proper management. (The Buse soil is in capability unit IVe–1 and Shallow range site, and the Vienna soil is in capability unit IIIe–1 and Silty range site; both soils are in windbreak suitability group 2)

Buse-Vienna-Sioux stony loams (6 to 15 percent slopes) (Bx).—About 50 percent of this complex is Buse stony loam, 30 percent is Vienna loam, and 20 percent is Sioux loam. These soils are sloping to moderately steep and occupy isolated ridges and knolls in the central and southeastern parts of the county. The areas consist of pockets of gravel, stony ridgetops, and patches of moderately steep, shallow soils scattered within areas of deep sloping soils. The Buse soils are moderately steep, stony, and shallow over glacial material; the Sioux soils make up the gravelly patches; and the Vienna soils are deep, sloping, and well drained.

The many stones in these areas make cultivation difficult. Tame or native pasture is the best use of these soils. (The Buse and Sioux soils are in capability unit VIIs–1, Shallow range site, and windbreak suitability group 5; the Vienna soil is in capability unit IIIe–1, Silty range site, and windbreak suitability group 2)

Clayey Saline Land

Clayey saline land (0 to 3 percent slopes) (Cs).—This land type consists of wet soil material in nearly level clayey lakebeds from which the water has evaporated. The areas are mainly near Long Lake and Medicine Lake in the west-central part of the county. This land type is moderately saline and is calcareous in most places. Glacial boulders are common. Plant growth is spotty, and slickspots, or bare patches encrusted with salt, are common.

Salinity and poor drainage make this land type unsuitable for cultivation, and most areas are used for hay and pasture. Moderate yields of grass are obtained, but the grass is of poor quality. Grazing must be controlled to encourage the more productive and palatable grasses and to keep out saltgrass and weeds. (Capability unit VIw–2, Saline Lowland range site, windbreak suitability group 5)

Egeland Series

In the Egeland series are deep, well-drained, moderately coarse textured soils that developed in sand deposited by wind or glacial melt water. The soils are nearly level to sloping. They are on terraces in the valley of the Big Sioux River and around some lakes and are also on uplands adjacent to the eastern edge of the valley of the Big Sioux River.

In a typical profile of an Egeland soil, the surface layer is very dark gray, soft fine sandy loam that has granular structure and is about 8 inches thick. The subsoil is dark grayish-brown sandy loam or loam that is friable when moist and is about 14 to 20 inches thick. It has weakly prismatic structure. The underlying material is light brownish gray and pale yellow sandy loam or loamy sand that is calcareous in most places and is structureless and loose. In places loamy glacial till or silty glacial drift is at a depth of 30 inches or more.

The texture of the surface layer ranges from loamy sand to light loam, but only Egeland fine sandy loam has been mapped in this county. In general the texture of the subsoil and the underlying material is loamy sand to loam, but thin layers of silt are between the layers of sand in some places.

Egeland soils occur with the Estelline, Fordville, and Kranzburg soils. They are coarser textured than the Estelline soils; they developed in sandy rather than in silty material; and they are not underlain by gravel. The Egeland soils are coarser textured than the Kranzburg soils and are deeper than the Fordville soils. Also, they formed in deep sand or sandy loam over medium-textured glacial material rather than in medium-textured alluvium over gravel.

The Egeland soils take in water readily, but they have low water-holding capacity. Wind erosion is a major problem if these soils are not protected, and water erosion is a hazard in the sloping areas. Fertility is moderate, but these soils are droughty under dryland farming. If water is available, these soils can be irrigated.

Most of the acreage is used for corn, potatoes, small grains, flax, and alfalfa. Yields are moderate.

Egeland fine sandy loam, 0 to 3 percent slopes (EfA).—This soil is on upland flats in the central part of the county. It is also on nearly level terraces in the valley of the Big Sioux River. Its profile is similar to the one described for the series.

Included in the areas mapped as this soil are small areas of a soil that has a thicker surface layer and a thicker, darker subsoil than the Egeland soil. Also included are small, nearly level areas of Fordville, La Prairie, and Estelline soils.

Under careful management moderate yields of corn, potatoes, small grains, flax, and alfalfa are obtained on this soil. Wind stripcropping or contour stripcropping can be used to check wind and water erosion. Crops that mature early or that resist drought are best adapted because of the low water-holding capacity. Where enough water is available, this soil can be irrigated. (Capability unit IIIs–1, Sandy range site, windbreak suitability group 1)

Egeland fine sandy loam, 3 to 9 percent slopes (EfB).—This soil is on uplands along the edge of the valley of the Big Sioux River. It is also near the town of South Shore in the northeastern corner of the county. The surface layer is slightly thinner than the one in the profile described for the series. Also, glacial till or silty glacial drift is within 3 feet of the surface in many places.

Included in the areas mapped as this soil are areas of a

soil in concave or gently sloping positions. This included soil has a thicker surface layer and a thicker, darker subsoil than the Egeland soil. Also included are small gently sloping to sloping areas of Fordville and Kranzburg soils.

Yields of corn, potatoes, small grains, flax, and alfalfa are low to moderate on this Egeland soil. Practices that control erosion are needed because of the moderate slopes and loose surface layer. If this soil is farmed year after year, such practices as terracing, contour stripcropping, and maintaining a cover of vegetation are essential to prevent damage to the soil. Growing cover crops, grasses, or legumes a large part of the time in the cropping system helps to conserve the soil and to increase fertility. Crops that mature early or that resist drought are better suited than other crops because the water-holding capacity is low. If enough water is available, sprinkler irrigation can be used on the less sloping areas. (Capability unit IIIe–2, Sandy range site, and windbreak suitability group 1)

Estelline Series

In the Estelline series are deep, medium-textured, well-drained soils that formed in 36 to 60 inches of silty loess over a substratum of sand or gravel. These soils are nearly level or gently sloping. They are on outwash plains and river terraces in the central part of the county.

In a typical profile (fig. 9) of an Estelline soil, the surface layer is very dark gray, friable silt loam that has granular structure and is about 8 inches thick. The subsoil is dark grayish-brown, firm silty clay loam that has prismatic structure and is 15 to 30 inches thick. The underlying material is light brownish-gray, structureless, friable, calcareous silt loam. This material, in turn, is underlain by loose sand and gravel.

Estelline soils occur with the Kranzburg, Egeland, and Fordville soils. They have a gravelly substratum, rather than a substratum of glacial till like that underlying the Kranzburg soils. Their surface layer and subsoil are finer textured than those of the Egeland soils. They are deeper over gravel than the Fordville soils.

These soils are well drained. They take in water readily.

Most of the acreage of the Estelline soils is used to grow corn, potatoes, flax, small grains, and alfalfa. These soils have a good potential for irrigation where enough water is available.

Estelline silt loam, 0 to 3 percent slopes (EsA).—The profile of this soil is the one described for the series. This soil is on outwash plains and broad stream terraces. The sandy and gravelly outwash in these areas is covered by 36 to 60 inches of silty loess or alluvium. Included in the areas mapped as this soil are small areas of Fordville silt loam and of a moderately well drained soil along drainageways.

This Estelline soil is fertile and is easily tilled. Yields of corn, potatoes, flax, small grains, and alfalfa are moderate to high under good management. Runoff is slow, and the risk of erosion is slight. The potential for irrigation is high where enough water is available. (Capability unit I–1, Silty range site, windbreak suitability group 2)

Estelline silt loam, 3 to 6 percent slopes (EsB).—This soil is on outwash plains and along shallow drainageways in the central part of the county. Its profile is similar to the profile described for the series, but the surface layer and subsoil are slightly thinner and the slopes are steeper. Included in the areas mapped as this soil are small areas of Fordville silt loam, Fordville fine sandy loam, and Egeland and Kranzburg soils that all have slopes of 3 to 6 percent.

Figure 9.—**A profile of Estelline silt loam.**

If this Estelline soil is well managed, yields of corn, potatoes, flax, small grains, and alfalfa are moderate. Such practices as contour farming and contour stripcropping are needed to reduce runoff and erosion. Under dryland farming some crops that mature late may be damaged by a shortage of moisture because the substratum is gravelly. Sprinkler irrigation can be used in areas where enough water is available. (Capability unit IIe–1, Silty range site, windbreak suitability group 2)

Fordville Series

In the Fordville series are nearly level or gently sloping, moderately deep soils that are medium textured or moderately coarse textured and are well drained. These soils developed in alluvium that is underlain by mixed sand and gravel at a depth of 20 to 36 inches (fig. 10). They are

on gently undulating stream terraces and outwash plains in the central and eastern parts of the county.

In a typical profile of a Fordville soil, the surface layer is dark-gray, very friable silt loam that has granular structure and is about 6 inches thick. The subsoil is dark grayish-brown, friable silt loam that has prismatic structure and is about 24 inches thick. The underlying material is grayish, friable sandy loam or loam that is structureless and is calcareous in many places. Below this sandy loam is mixed sand and gravel.

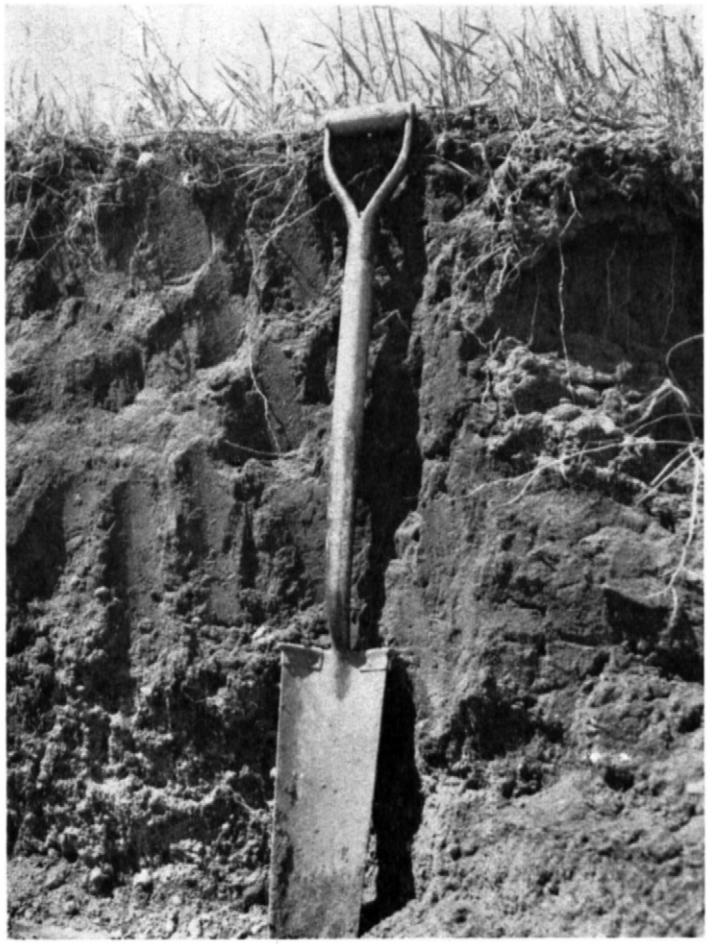

***Figure 10.*—Typical profile of a Fordville soil.**

The texture of the surface layer ranges from sandy loam to silt loam. In places the texture of the subsoil is moderately sandy. The depth to gravel ranges from 20 to 36 inches. Where the depth to gravel is between 20 and 24 inches, the zone of lime accumulation is in the upper part of the gravelly material. Where the gravel is farther down than 24 inches, lime is generally above the gravelly material.

Fordville soils occur with the Estelline, Renshaw, and Egeland soils. They are shallower over gravel and are more droughty than the Estelline soils and are deeper over gravel than the Renshaw soils. The Fordville soils formed in alluvium over gravel, rather than in deep sand or sand underlain by medium-textured material like the Egeland soils.

The Fordville soils are well drained and take in water readily. Because their water-holding capacity is low, however, these soils are droughty.

Much of the acreage is cultivated, and the yields of small grains, flax, potatoes, and corn are low to moderate under dryland farming. Where enough water is available, yields can be increased by irrigation.

Fordville silt loam, 0 to 3 percent slopes (FdA).—The profile of this soil is the one described for the Fordville series. This soil is on outwash plains and stream terraces in the central and eastern parts of the county. Small, nearly level areas of Estelline silt loam, Egeland fine sandy loam, and Fordville fine sandy loam are included in the areas mapped as this soil.

Yields of potatoes, corn, flax, and small grains are moderate, but the low water-holding capacity makes this Fordville soil droughty. Yields may be increased by irrigation if enough water is available. Wind stripcropping is needed to help reduce wind erosion. (Capability unit IIIs–2, Silty range site, windbreak suitability group 3)

Fordville silt loam, 3 to 6 percent slopes (FdB).—This soil is on outwash plains and on gently undulating stream terraces in the central and eastern parts of the county. It consists of 20 to 36 inches of silty loess or alluvium over sand and gravel. Depth to gravel varies more in the gently undulating areas than in the more nearly level areas.

Small areas of Fordville fine sandy loam and of Renshaw and Egeland soils are included in the areas mapped as this soil. The included soils have slopes of 3 to 6 percent.

Yields of corn, potatoes, flax, and small grains are low to moderate, but this Fordville soil is droughty because the water-holding capacity is low. In addition, runoff causes erosion unless such practices as contour farming or contour stripcropping are used. This soil can be irrigated if enough water is available. (Capability unit IIIe–4, Silty range site, windbreak suitability group 3)

Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes (FfA).—Fordville fine sandy loam makes up about 60 percent of this complex, and Renshaw fine sandy loam makes up the rest. These soils occur in too intricate a pattern to be separated on the soil map. They are on stream terraces in the central and eastern parts of the county. In those areas the somewhat sandy alluvium is underlain by gravel at a depth of 10 to 36 inches. The Fordville soil has a profile like the one described for the series. A profile similar to that of the Renshaw soil is described under the Renshaw series. Included in the areas mapped as this complex are small, nearly level areas of Fordville silt loam and of Sioux and Egeland soils.

Yields of corn, potatoes, small grains, and flax are low to moderate on the soils of this complex. Alfalfa, forage crops, or crops that mature early are better suited to these soils than other crops. Where water is available, yields may be increased by irrigating and by applying fertilizer. Wind stripcropping will help to control wind erosion.

(The Fordville soil is in capability unit IIIe–3 and Sandy range site, and the Renshaw soil is in capability unit IVs–1 and Shallow range site; both soils are in windbreak suitability group 3)

Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes (FfB).—About 50 percent of this complex is Fordville fine sandy loam, and the rest is Renshaw fine sandy loam. These soils are on gently undulating stream terraces in the central and eastern parts of the county. They are similar

to Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes, but they are steeper, have a thinner surface layer, and are more variable in depth over gravel. Included in the areas mapped as this complex are small areas of Sioux and Fordville silt loams.

Droughtiness and the risk of erosion severely limit the soils of this complex for the production of crops that mature late in the growing season. Where corn, small grains, and flax are grown, yields are low. Alfalfa and other forage crops produce moderate yields. Contour stripcropping or wind stripcropping helps to control erosion on these soils. Where water is available, sprinkler irrigation may increase yields. (The Fordville soil is in capability unit IIIe–3 and Sandy range site, and the Renshaw soil is in capability unit IVs–1 and Shallow range site; both soils are in windbreak suitability group 3)

Forman Series

In the Forman series are deep, medium-textured, moderately permeable soils that are well drained. These soils developed in moderately fine textured glacial till. They are in nearly level or undulating areas in the western and northeastern parts of the county.

In a typical profile of a Forman soil, the surface layer is friable, very dark gray loam that has granular structure and is about 4 to 6 inches thick. The subsoil is brown clay loam that is firm when moist, has prismatic structure, and is about 18 inches thick. This layer generally contains streaks and tongues of darker colored material from the surface layer, and it is calcareous in the lower part. The underlying material is pale-yellow, structureless, calcareous clay loam glacial till that is friable to firm when moist.

The texture of the surface layer ranges from loam to clay loam. In places the underlying glacial till contains pockets of loamy, gravelly, or sandy material. In many areas numerous stones and cobbles are on the surface and in this soil.

The Forman soils occur with the Poinsett, Waubay, and Buse soils. They are similar to the Poinsett soils but developed in glacial till rather than in silty glacial drift. The Forman soils are better drained and coarser textured than the Waubay soils, and they are lighter colored throughout most of their profile than those soils. They have a thicker surface layer and subsoil than the Buse soils.

The Forman soils are fertile. They take in water readily and hold it well.

Where cobbles and stones are not numerous enough to make tillage difficult, small grains, flax, corn, and alfalfa are grown successfully. The soils in stony areas are used for pasture.

Forman cobbly loam, 3 to 6 percent slopes (FmB).—This soil is in gently undulating areas in the northeastern part of the county. Its profile is like the one described for the series, except that it contains many cobbles and stones. Included in the areas mapped as this soil are small areas of Forman loam, Buse stony loam, and Waubay silty clay loam that are in the same general area.

Moderate yields of small grains, flax, corn, and alfalfa are obtained on this Forman soil. Runoff, erosion, and the many stones (fig. 11), however, limit the use for cultivated crops. The short, irregular slopes make it difficult to practice contour farming, contour stripcropping, and terracing that would control runoff and erosion. Also, the many stones must be removed before this soil can be cultivated. As a result, much of the acreage is used for pasture. (Capability unit IIIe–5, Silty range site, windbreak suitability group 2)

Figure 11.—**A pasture of Forman cobbly loam, 3 to 6 percent slopes. The stones piled along the fence have been picked from the cultivated field on the left.**

Forman cobbly loam, 6 to 9 percent slopes (FmC).—This soil is in undulating areas in the northeastern part of the county. Its profile is similar to the one described for the Forman series, except that it contains many cobbles and stones and has a thinner surface layer and subsoil.

The areas mapped as this soil include small areas of Buse stony loam, Forman loam, and Sioux loam. The included soils have slopes of 6 to 9 percent.

Yields of small grain, flax, and alfalfa are moderate, but erosion is a serious hazard on this Forman soil. Many plowed fields have a patchy color because the subsoil is exposed. If this soil is cultivated continuously, terracing, contour stripcropping, sodding of waterways, and other good management practices are essential for controlling erosion. (Capability unit IIIe–5, Silty range site, windbreak suitability group 2)

Forman loam, 0 to 3 percent slopes (FnA).—This soil is in nearly level areas of uplands in the northeastern part of the county. It has a profile like the one described for the series.

Included in the areas mapped as this soil are small areas of Waubay silty clay loam and Forman cobbly loam. The included soils have slopes of 0 to 3 percent.

Yields of corn, flax, small grains, and alfalfa are high. This soil takes in water readily and holds it well. Runoff is slow, and the risk of erosion is slight. Under good management, this soil can be farmed intensively with only a slight risk of damage. (Capability unit I–1, Silty range site, windbreak suitability group 2)

Forman loam, 3 to 6 percent slopes (FnB).—This soil is in gently undulating areas in the northeastern part of the county. It has a thinner surface layer and is steeper than Forman loam, 0 to 3 percent slopes. Runoff and the risk of erosion are greater than on the less sloping Forman soil. Included in the areas mapped as this soil are

small, gently undulating areas of Forman cobbly loam and Waubay silty clay loam.

Yields of corn, flax, small grains, and alfalfa are moderate to high, but runoff and erosion are major problems on this Forman soil. Such practices as contour farming, contour stripcropping, terracing, and sodding of waterways help to check runoff and erosion. (Capability unit IIe–1, Silty range site, windbreak suitability group 2)

Forman loam, 6 to 9 percent slopes (FnC).—This soil is in undulating areas in the northeastern part of the county. Its surface layer and subsoil are thinner than those in the profile described for the Forman series. The areas mapped as this soil include small areas of Buse loam, Forman cobbly loam, and Sioux loam.

If this Forman soil is well managed, moderate yields of small grains, flax, corn, and alfalfa are produced, but erosion is a serious hazard. In many plowed fields that have been cropped year after year, patches of buckskin-colored subsoil are exposed. Such practices as terracing, contour farming, contour stripcropping, and sodding of waterways help to control runoff and erosion if they are combined with other good management practices. (Capability unit IIIe–1, Silty range site, windbreak suitability group 2)

Hidewood Series

The soils of the Hidewood series are deep, moderately fine textured, and somewhat poorly drained. They are in nearly level areas and in small, shallow depressions and swales in the central and southeastern parts of the county. These soils developed in 30 to 50 inches of silty material underlain by glacial till.

In a typical profile of a Hidewood soil, the surface layer is very dark gray, friable silty clay loam that has granular structure and is about 9 to 11 inches thick. The subsoil is dark-gray, firm silty clay loam or silty clay that has prismatic structure and is about 11 inches thick. The underlying material is mottled gray to olive, calcareous, friable clay loam. This material, in turn, is underlain by calcareous glacial till at a depth of 30 to 50 inches.

In this county the Hidewood soils are mapped only in a complex with Brookings soils. They occur as small areas intermixed with the Brookings soils, and it is not feasible to show them separately on the soil map. Hidewood soils are less well drained than the Brookings soils.

The Hidewood soils are farmed with surrounding areas of better drained soils. Corn, small grains, and flax produce moderate yields in drier years, but crops are often drowned in wet seasons. Yields of hay and pasture are high.

Kranzburg Series

In the Kranzburg series are deep, moderately fine textured, well-drained soils that developed in 15 to 40 inches of loess over glacial till. These soils have long, smooth, gentle slopes. They are in the central and southeastern parts of the county.

In a typical profile of a Kranzburg soil, the surface layer is very dark grayish-brown, friable silty clay loam that is about 7 inches thick and has granular structure. The subsoil is brownish, friable silty clay loam about 20 inches thick. It has prismatic structure and is calcareous in the lower part. The underlying material is calcareous loam or clay loam glacial till.

The thickness of the loess over glacial till ranges from 15 to 40 inches. In places where the loess is less than 24 inches thick, the subsoil is partly in the underlying glacial till. A thin cobbly or gravelly layer lies between the loess and the glacial till in some places.

The Kranzburg soils occur with the Brookings, La Prairie, Vienna, and Buse soils. They formed in material similar to that in which the Brookings and La Prairie soils formed, but they are better drained and are lighter colored than those soils. The Kranzburg soils have a profile similar to that of the Vienna soils, but they formed in loess over glacial till rather than entirely in glacial till. They have a thicker surface layer and subsoil than the Buse soils and are deeper to unaltered glacial till.

The Kranzburg soils are fertile and are easily farmed. They take in water readily and hold it well. Runoff and erosion are moderate because of the long, gentle slopes.

Most of the acreage is used to grow corn, potatoes, small grains, flax, and alfalfa. Yields are moderate to high.

Kranzburg silty clay loam, 3 to 6 percent slopes (KrB).—This is the only Kranzburg soil mapped in the county. It is on long, smooth, gentle slopes on the uplands in the central and southeastern parts of the county. Included in the areas mapped as this soil are small areas of Brookings, La Prairie, Vienna, and Buse soils.

This Kranzburg soil is easily tilled and is productive. Corn, potatoes, small grains, flax, and alfalfa grown on it make moderate to high yields under good management. Runoff causes a moderate hazard of erosion on the long slopes. This soil is well suited to contour farming, contour stripcropping (fig. 12), terracing, and use of sodded waterways that will help to control runoff and erosion. (Capability unit IIe–1, Silty range site, windbreak suitability group 2)

Figure 12.—**Contour stripcropping in a field of Kranzburg silty clay loam, 3 to 6 percent slopes.**

Lamoure Series

In the Lamoure series are nearly level, deep, dark-colored, moderately fine textured soils that are somewhat poorly drained. These soils developed in water-deposited sediment on bottom lands throughout the county.

In a typical profile of a Lamoure soil, the surface layer is very dark gray, friable, calcareous silty clay loam that

has granular structure and is about 11 inches thick. It grades to dark-gray or gray, calcareous silty clay loam that has weak, coarse, prismatic structure. The underlying material is grayish-brown clay loam, sandy loam, or gravelly sandy alluvium.

The texture of the surface layer ranges from silt loam to silty clay loam. In places sand and gravel are at a depth of less than 36 inches.

The Lamoure soils occur with the Rauville and Estelline soils. They are better drained than the Rauville soils but are less well drained than the Estelline soils.

Lamoure soils are fertile. They take in water slowly but hold it well. Their use for cultivated crops is limited, however, by the slow runoff, seasonal flooding, and high water table. Many areas are cut by entrenched, meandering stream channels, and the water table is commonly within 36 inches of the surface during part of the growing season.

Where meandering channels are not present, much of the acreage of these soils is used for growing corn, small grains, flax, and alfalfa. Areas that are cut by stream channels or that are subject to flooding are used for hay or pasture.

Lamoure silty clay loam (0 to 3 percent slopes) (La).—The profile of this soil is like the one described for the Lamoure series. This soil is somewhat poorly drained and is on bottom lands along the major streams throughout the county. Included in the areas mapped as this soil are small areas of Lamoure silty clay loam, channeled, and of poorly drained Rauville and well-drained Estelline soils.

The high water table, slow runoff, and flooding from runoff in spring and from heavy rains in summer make farming hazardous on these Lamoure soils. Yields of corn, flax, and small grains are moderate in seasons when rainfall is below average or average. Seeding is delayed, however, or crops are drowned in wetter years. High yields of forage are obtained. Constructing diversions or dikes and improving stream channels are ways of controlling excess water and of lowering the water table in some areas of the soil. (Capability unit IVw–1, Subirrigated range site, windbreak suitability group 4)

Lamoure silty clay loam, channeled (0 to 3 percent slopes) (Lc).—This soil is on bottom lands throughout the county (fig. 13). The areas are cut by entrenched meandering stream channels and are susceptible to flooding. The profile is similar to the one described for the series, except that the texture and drainage are variable. Small areas of Rauville, Fordville, and Renshaw soils are included in the areas mapped as this soil.

The flooding and the entrenched, meandering channels make cultivation impractical on this Lamoure soil. Most of the areas are used for pasture or hay, and yields of forage are high. The few patches that can be farmed produce moderate yields of corn, small grains, and flax, but flooding may delay seeding or drown growing crops. (Capability unit VIw–1, Overflow range site, windbreak suitability group 4)

La Prairie Series

The La Prairie series consists of deep, dark-colored, medium-textured to moderately fine textured soils that are moderately well drained. These soils developed in upland swales in material washed from the adjacent slopes. They occur in narrow bands along upland drainageways and in swales throughout the county.

Figure 13.—**A view of Lamoure silty clay loam, channeled, along a meandering creek. Steep Buse soils are on the walls of the valley.**

In a typical profile of a La Prairie soil, the surface layer is very dark gray, friable silt loam that has granular structure and is generally about 42 inches thick. This soil does not have a distinct subsoil. The underlying material is olive-brown or light olive-brown clay loam mottled with brown and white. It is friable, structureless, and calcareous in many places. The thickness of the surface layer ranges from 24 to about 60 inches.

The La Prairie soils occur with the Poinsett, Vienna, Kranzburg, and Forman soils. They have a thicker, darker colored surface layer and are less well drained than those soils.

The La Prairie soils are fertile and moderately permeable, and they hold water well. They occur only in small patches, however, and are generally farmed with adjacent soils. Some areas are shaped and seeded, so that they can be used as sodded waterways.

La Prairie silt loam (0 to 3 percent slopes) (Lp).—This is the only La Prairie soil mapped in this county. It occurs in narrow bands in upland swales throughout the county. Included in the areas mapped as this soil are small areas of Poinsett, Vienna, Forman, and Kranzburg soils.

High yields of corn, small grains, flax, and alfalfa are obtained on this La Prairie soil. Also, many areas are used for sodded waterways in fields where terracing or contour stripcropping are practiced. Major problems where this soil is used for crops are lodging of small grains and occasional flooding after severe rains. (Capability unit IIw–1, Silty range site, windbreak suitability group 2)

Oldham Series

In the Oldham series are deep, dark-colored, moderately fine textured soils that are slowly permeable and are moderately well drained or somewhat poorly drained. These soils developed in water-deposited silt and clay. They

are in nearly level, closed depressions or in slight depressions in the northeastern and western parts of the county.

In a typical profile of an Oldham soil, the surface layer is very dark gray, friable silty clay loam that has granular structure and is about 8 inches thick. The subsoil is dark-gray or olive-gray silty clay about 24 inches thick. It is firm when moist, has prismatic or blocky structure, and is calcareous in the lower part. The underlying material is mottled light-gray or olive, calcareous silty clay.

The texture of the surface layer ranges from silty clay loam to silty clay. The depth to calcareous material varies. In some places these soils are calcareous to the surface.

Oldham soils occur with the Poinsett, Waubay, and Parnell soils. They are finer textured and are darker colored to a greater depth than the Poinsett soils and are less well drained than those soils. They are more poorly drained than the Waubay soils. The Oldham soils are better drained than the Parnell soils.

The Oldham soils take in water slowly but hold it well. Runoff is slow. Most of the acreage of these soils is used for growing corn, small grains, flax, and alfalfa.

Oldham silty clay loam (0 to 3 percent slopes) (Od).—The profile of this soil is the one described for the Oldham series. This soil is in nearly level areas in slight depressions in the western part of the county. Included in the areas mapped as this soil are small areas of well-drained Poinsett and poorly drained Parnell soils.

Yields of corn, small grains, and flax are moderate on this Oldham soil. Runoff and the slow intake of water, however, may delay seeding or make tillage difficult in wetter seasons. Land shaping or improving surface drainage may reduce the hazards of wetness in some areas. (Capability unit IIw–1, Overflow range site, windbreak suitability group 2)

Oldham and Parnell silty clay loams (0 to 3 percent slopes) (Op).—This undifferentiated unit is made up of Oldham and Parnell silty clay loams. These soils do not occur in a consistent pattern, nor is the proportionate distribution the same in all areas. They are in closed depressions in the western and northeastern parts of the county. The Oldham soil is somewhat poorly drained, and the Parnell soil is poorly drained. The Oldham soil has a profile like the one described for the Oldham series. A profile similar to that of the Parnell soil is described under the Parnell series. Small areas of moderately well drained Waubay soils and well drained Poinsett soils are included in the areas mapped as this undifferentiated unit.

These Oldham and Parnell soils are productive, but wetness and frequent flooding make farming them extremely hazardous. Where these soils are used for hay or pasture, however, yields of forage are high. Also, in many areas, corn, small grains, and flax are grown with a fair degree of success. Unless artificial drainage can be established and maintained to remove the excess water, these soils are better suited to hay or pasture than to other crops. Diversions or terraces can be used on the surrounding slopes to provide a means of reducing overflow and flooding on these soils. (The Oldham soil is in capability unit IIw–1 and windbreak suitability group 2, and the Parnell soil is in capability unit Vw–1 and windbreak suitability group 5; both soils are in the Overflow range site)

Oldham and Parnell silty clay loams, wet (0 to 3 percent slopes) (Ow).—This undifferentiated unit is made up of Oldham and Parnell silty clay loams in closed depressions in the western and northwestern parts of the county. These soils are poorly drained or very poorly drained. Included in the areas mapped as these soils are small areas of permanent marsh.

These soils are too wet or too frequently flooded for cultivation, except in the driest years. Where the soils are used for hay or pasture, however, yields of forage from moisture-tolerant grasses are high. The yield and quality of this forage can be increased by seeding reed canarygrass and other grasses that tolerate excessive moisture. (The Oldham soil is in capability unit IIw–1 and windbreak suitability group 2, and the Parnell soil is in capability unit Vw–1 and windbreak suitability group 5; both soils are in the Overflow range site)

Parnell Series

The Parnell series consists of deep, dark-colored, moderately fine textured soils that are poorly drained. These soils developed in silt and clay. They are in closed depressions in the western and northeastern parts of the county.

In a typical profile of a Parnell soil, the surface layer is very dark gray, friable silty clay loam that has granular structure and is about 7 inches thick. The subsoil is black or dark-gray, firm silty clay loam that has blocky structure and is about 22 inches thick. The underlying material is mottled olive-gray, calcareous, firm, structureless silty clay loam.

In general, drainage is poor, but it ranges to very poor. In many places a thin layer of peaty or mucky, partly decomposed organic material is on the surface.

In this county the Parnell soils are mapped only in undifferentiated units with the Oldham soils. They are more poorly drained than the Oldham soils. They are better drained and support more palatable vegetation than permanent marsh and intermittent lakes.

Except in the driest years, the Parnell soils are too wet for cultivation, but yields of forage are high. Many areas have been seeded to reed canarygrass. In those areas yields of tame hay or pasture are excellent.

Poinsett Series

The soils in the Poinsett series are deep, medium textured, moderately permeable, and well drained. They developed in silty or loamy glacial drift. These soils are in nearly level or undulating areas in the western and northeastern parts of the county.

In a typical profile of a Poinsett soil, the surface layer is very dark gray, friable silt loam that has granular structure and is about 7 inches thick. The subsoil is grayish-brown, friable silty clay loam that has prismatic structure, is calcareous in the lower part, and is about 20 inches thick. The underlying material is pale-olive to light-gray, friable, structureless silt loam that is calcareous and is mottled with yellowish brown and black in many places.

The texture of the surface layer ranges from very fine sandy loam to silty clay loam. Depth to glacial till ranges from 15 to 48 inches, and depth to limy material

ranges from 12 to 36 inches. Most areas of these soils are free of stones, but a few pebbles and stones may occur in any of the areas. In a few places the subsoil and the underlying material contain thin layers of sand or clay.

The Poinsett soils occur with the Forman, Buse, Waubay, Oldham, and Egeland soils. They developed in silty or loamy glacial drift, rather than in clay loam glacial till like that in which the Forman soils developed. The Poinsett soils have a thicker surface layer and subsoil than the Buse soils. They are better drained than the Waubay and Oldham soils and are less coarse textured than the Egeland soils.

The Poinsett soils take in water readily and hold it well. They are moderately fertile and are easily farmed where the slopes are gentle. Runoff and erosion are hazards in the sloping areas. These soils are used to grow corn, small grains, flax, and alfalfa.

Poinsett loam, 0 to 3 percent slopes (PmA).—This is a medium-textured, well-drained soil that developed in silty and loamy glacial drift. Its profile is similar to the one described for the Poinsett series, except that it has a loam surface layer. This soil is on nearly level lake plains. It is near Long Lake and Goose Lake in the western part of the county and near Punished Womans Lake in the northeastern corner of the county. Included in the areas mapped as this soil are small areas of Oldham and Egeland soils.

This Poinsett soil is fertile. Where corn, potatoes, small grains, flax, and alfalfa are grown on it, yields are high. Runoff is slow. This soil can be farmed intensively with only slight risk of damage if ordinary good farming methods are practiced. (Capability unit I–1, Silty range site, windbreak suitability group 2)

Poinsett loam, 3 to 7 percent slopes (PmB).—This soil is mainly near Punished Womans Lake. Its profile is like the one described for the series, except that the surface layer and subsoil are slightly thinner and the surface layer is loam. In places erosion has removed as much as 50 percent of the surface layer. Light-colored patches of subsoil are exposed in some plowed fields. Included in the areas mapped as this soil are small areas of moderately sandy Egeland soils.

Most of the areas of this Poinsett soil are used to grow corn, flax, small grains, and alfalfa, and yields are moderate to high. Runoff and a moderate hazard of erosion are the main problems in managing this soil. Such practices as terracing, contour stripcropping, and sodding of waterways help to control runoff and erosion. (Capability unit IIe–1, Silty range site, windbreak suitability group 2)

Poinsett silt loam, 3 to 6 percent slopes (PnB).—This soil has a profile like the one described for the Poinsett series. It is in gently undulating areas underlain by silty glacial drift in the western part of the county. These areas do not have a well-defined pattern of surface drainage, and water from runoff collects in the many closed depressions. Included in the areas mapped as this soil are small areas of Waubay and Forman soils.

Most areas of this Poinsett soil are used to grow corn, small grains, flax, and alfalfa, and yields are moderate to high. Runoff and the risk of erosion are the main problems in managing this soil. The short, undulating slopes make construction of terraces or contour strips difficult in most areas. Where these practices are practical, they should be used to help control runoff and erosion. (Capability unit IIe–1, Silty range site, windbreak suitability group 2)

Poinsett-Buse-Forman loams, 6 to 9 percent slopes (PoC).—About 50 percent of this complex is Poinsett loam, 20 percent is Buse loam, another 20 percent is Forman loam, and about 10 percent is other kinds of soil. These soils occur in an intricate pattern in undulating areas in the western part of the county. In many cultivated fields, erosion has exposed patches of light-colored subsoil. The Poinsett soil has a profile similar to the one described for the series, except that the surface layer is loam. A profile of the Buse and Forman soils is described under the Buse and Forman series.

Yields of corn, small grains, flax, and alfalfa are moderate, but runoff and erosion are serious hazards. If these soils are farmed year after year, terracing, contour farming, or contour stripcropping, along with careful management, are essential to prevent losses of soil and water. (The Poinsett and Forman soils are in capability unit IIIe–1, Silty range site, and windbreak suitability group 2; the Buse soil is in capability unit IVe–1, Shallow range site, and windbreak suitability group 2)

Poinsett-Forman silt loams, 3 to 6 percent slopes (PsB).—About 60 percent of this complex is Poinsett silt loam, 25 percent is Forman silt loam, and 15 percent is other soils. These soils are mainly in the western part of the county on short, irregular slopes. The Poinsett soil developed in silty material, and it surrounds the Forman soil, which occurs in small areas underlain by glacial till. The profiles of these soils are similar to those described for the Poinsett and Forman series. Included in the areas mapped as this complex are small areas of Waubay and Buse soils.

Most of this complex is used to grow corn, small grains, flax, and alfalfa, and yields are moderate to high. Runoff and erosion are the main problems in managing these soils. Contour farming, contour stripcropping, and terracing can be used to reduce losses of soil and water on the smoother slopes. (Both soils are in capability unit IIe–1, Silty range site, and windbreak suitability group 2)

Poinsett-Waubay silty clay loams, 0 to 3 percent slopes (PwA).—Poinsett silty clay loam makes up about 75 percent of this complex, and Waubay silty clay loam makes up the rest. These soils occur in an intricate pattern in the western part of the county. The Poinsett soil is well drained, and the Waubay soil is moderately well drained. The profiles of these soils are like the ones described for the Poinsett and Waubay series. Small areas of Oldham and Forman soils that have slopes of 0 to 3 percent are included in the areas mapped as this complex.

The soils of this complex can be farmed intensively with only slight risk of damage if ordinary good farming is practiced. Yields of corn, small grains, flax, and alfalfa are high. (The Poinsett soil is in capability unit I–1, and the Waubay soil is in capability unit IIw–1; both soils are in the Silty range site and in windbreak suitability group 2)

Rauville Series

In the Rauville series are deep, moderately fine textured soils that are very poorly drained. These soils developed in alluvial material along bottom lands. They are along

the Big Sioux River and its major tributaries in the central and eastern parts of the county.

In a typical profile of a Rauville soil, the surface layer is very dark gray, friable silty clay loam that has platy or blocky structure and is about 8 inches thick. This layer is calcareous in many places and is mottled with reddish brown. The subsoil is gray, calcareous silty clay loam. It has common mottles of yellowish brown and reddish brown and is about 26 inches thick. The underlying material is mainly gray alluvium that has a texture of silty clay, but in many places it contains seams of sandy and gravelly material. In many places a thin layer of peaty or mucky material is on the surface.

The Rauville soils occur with the Lamoure soils. They are more poorly drained than the Lamoure soils.

The Rauville soils are too wet for cultivation, but yields of forage are high. The water table is at or near the surface during much of the growing season.

Rauville silty clay loam (0 to 3 percent slopes) (Ra).—This is the only Rauville soil mapped in the county. It is very poorly drained and occurs on bottom lands along the Big Sioux River and its major tributaries. Included in the areas mapped as this soil are small, nearly level areas of Lamoure silty clay loam.

This Rauville soil is not suitable for cultivation, because it has a high water table and is frequently flooded. Where it is used for pasture or hay, yields are high. The quality of forage can be improved by seeding reed canarygrass. Improving the stream channels and constructing surface ditches may lower the water table in some areas. (Capability unit Vw–1, Wetland range site, windbreak suitability group 5)

Renshaw Series

The Renshaw series consists of medium-textured or moderately coarse textured, somewhat excessively drained soils that are nearly level to gently undulating. These soils developed in 10 to 20 inches of loamy to sandy material over gravelly outwash. They are on stream terraces and outwash plains throughout the county.

In a typical profile of a Renshaw soil, the surface layer is very dark gray, very friable loam that has granular structure and is about 7 inches thick. The subsoil is dark-brown, friable loam that has prismatic structure and is about 11 inches thick. The underlying material is loose, mixed sand and gravel (fig. 14) that varies in color and is generally calcareous. The texture of the surface layer and subsoil ranges from fine sandy loam to silt loam.

The Renshaw soils occur with the Sioux, Fordville, and Estelline soils. They are deeper and are less droughty than the Sioux soils. The Renshaw soils are shallower over gravel than the Fordville and Estelline soils. In this county the Renshaw soils are mapped only in complexes with the Fordville and Sioux soils.

The Renshaw soils take in water readily, but they have low water-holding capacity. They are subject to wind and water erosion if they are not managed carefully. Also, they are droughty and have rather low natural fertility.

Much of the acreage is used for small grains, flax, corn, and alfalfa, but yields are generally low. Satisfactory yields are obtained only in years when rainfall is above average.

Figure 14.—**A profile of Renshaw loam.**

Renshaw-Sioux complex, 0 to 3 percent slopes (RsA).—About 70 percent of this complex is Renshaw loam, and 30 percent is Sioux loam. These soils are nearly level and are on stream terraces and outwash plains throughout the county. The Renshaw soil has a profile like the one described for the series. A typical profile of the Sioux soil is described under the Sioux series. Small ridges and bands of gravelly material are included in the areas mapped as this complex.

The soils of this complex are used for small grains, flax, and alfalfa, and corn is grown in some places. Yields of these crops are low, except in years when moisture is favorable. Where these soils are used for hay or pasture, yields of forage are moderate.

Low water-holding capacity, droughtiness, low fertility, and wind erosion are major problems where these soils are farmed, especially where the Sioux soil is farmed. Such practices as wind stripcropping and planting a cover crop will reduce wind erosion, but the soils of this complex are better suited to hay or pasture than to cultivated crops. Where enough water is available, irrigating and applying fertilizer will increase yields, but the potential for irrigation is not high. (The Renshaw soil is in capability unit IVs–1 and windbreak suitability group 3; the Sioux soil is in capability unit VIIs–1 and windbreak suitability group 5; both soils are in the Shallow range site)

Renshaw-Sioux complex, 3 to 6 percent slopes (RsB).—About 50 percent of this complex is Renshaw loam, and

the rest is Sioux loam. The profiles of these soils are similar to those described for the Renshaw and Sioux series. Included in the areas mapped as this complex are small areas of Fordville and Estelline soils.

Yields of small grains, flax, and alfalfa are low on the soils of this complex, and yields of forage crops are also low. The soils are seriously limited in their use for cultivated crops by low water-holding capacity, droughtiness, low fertility, and risk of runoff and erosion. They are better suited to pasture or hay. If cultivated crops are grown, contour stripcropping, growing a cover crop, and growing grain crops that mature early are measures that provide some protection from erosion. The irrigation potential is low because these soils are shallow over gravel and have low water-holding capacity. As a result, frequent, short applications of water are required. (The Renshaw soil is in capability unit IVs–1 and windbreak suitability group 3; the Sioux soil is in capability unit VIIs–1 and windbreak suitability group 5; both soils are in the Shallow range site)

Sioux Series

In the Sioux series are shallow, medium-textured soils that are excessively drained and are nearly level to undulating. These soils developed in 10 inches or less of loamy or sandy material over gravel. They are on stream terraces and outwash plains and on rolling to steep ridges of glacial uplands throughout the county.

In a typical profile (fig. 15) of a Sioux soil, the surface layer is very dark gray, friable loam that has granular structure and is about 6 inches thick. Below the surface layer is a thin, transitional layer that rests on light-gray and brown, calcareous mixed sand and gravel.

The depth to gravel ranges from 5 to 10 inches. Some areas of these soils are stony.

The Sioux soils occur with the Renshaw soils on stream terraces and outwash plains and with the Buse and Vienna soils on uplands. The Sioux soils are shallower over gravel than the Renshaw soils. Their underlying material is coarser textured than that of the Buse and Vienna soils. In this county the Sioux soils are mapped only in complexes with the Buse, Renshaw, and Vienna soils.

Droughtiness and low fertility make the Sioux soils unsuitable for cultivation. Yields of the crops commonly grown in the area are low. Where these soils are used for pasture or hay, yields of forage are also low. Some areas that are steep and stony are suitable only for pasture.

Terrace Escarpments

Terrace escarpments (9 to 35 percent slopes) (Ts).—This land type is on escarpments and on short, steep slopes that separate different levels of the stream and lake terraces throughout the county. The areas are long and narrow.

This land type is shallow and gravelly. The soil material at the surface is loamy to sandy and gravelly, and it directly overlies loose gravelly material. Much of this land type consists of Sioux, Fordville, Renshaw, Buse, and other soils.

This land type is nonarable, because it is steep and shallow over gravel. Nearly all of the acreage is used for pasture and wildlife. Fertility is low. The only vegetation is a sparse stand of drought-resistant grasses. (Capability unit VIIs–1, Shallow range site, windbreak suitability group 5)

Figure 15.—**A profile of Sioux loam.**

Vienna Series

In the Vienna series are deep, medium-textured soils that are moderately permeable and well drained. These soils developed in loamy glacial till. They are mainly on long, smooth, nearly level to sloping uplands in the central and southeastern parts of the county.

In a typical profile of a Vienna soil, the surface layer is very dark gray, friable silt loam that has granular structure and is about 5 inches thick. The subsoil is very dark gray to light yellowish-brown, firm clay loam that has prismatic structure and is about 22 inches thick. This layer is calcareous in the lower part. The underlying material is predominantly light yellowish-brown, loamy glacial till (fig. 16).

The texture of the surface layer ranges from loam to silty clay loam. In some areas a layer of windblown silt less than 15 inches thick is at the surface. A few cobbles and other stones are in and on these soils. The underlying glacial till ranges from loam to clay loam in texture and from friable to firm in consistence.

The Vienna soils occur with the Kranzburg, Brookings, La Prairie, Buse, and Sioux soils. Their profile is similar to that of the Kranzburg soils, but it is coarser textured.

Also, the Vienna soils developed in glacial till rather than in a moderately thick layer of loess over glacial till. The Vienna soils are coarser textured and better drained than the Brookings and La Prairie soils. They have a thicker surface layer and subsoil than the Buse soils. They have a thicker surface layer than the Sioux soils, and their underlying material is glacial till rather than sand and gravel.

The Vienna soils take in water readily and hold it well. Almost all of the acreage is cultivated and is used to grow corn, potatoes, small grains, flax, and alfalfa.

Vienna silt loam, 0 to 3 percent slopes (VnA).—This soil has a profile like the one described for the Vienna series. It is nearly level and is on uplands in the central and southeastern parts of the county. Small areas of Brookings and Kranzburg soils are included in the areas mapped as this soil.

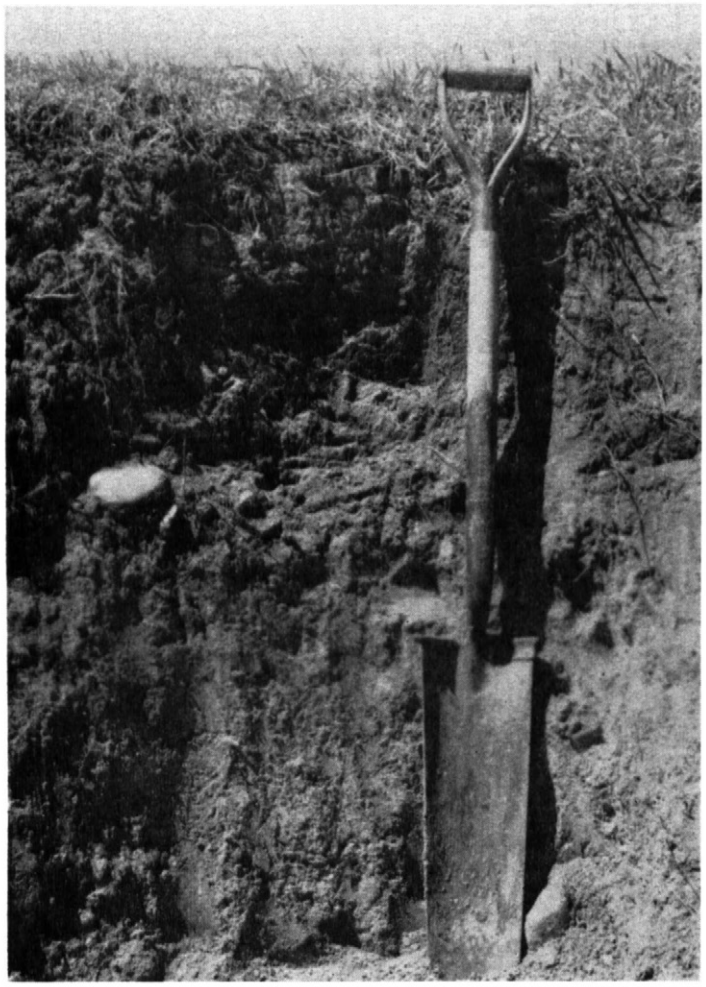

Figure 16.—**A profile of Vienna silt loam. This is a deep soil developed in loamy glacial till.**

This Vienna soil is used to grow corn, potatoes, small grains, flax, and alfalfa. Yields are high under good management. This soil is highly productive and has few limitations or hazards. If good farming methods are used, it can be farmed intensively with only slight risk of damage. (Capability unit I–1, Silty range site, windbreak suitability group 2)

Vienna silt loam, 3 to 6 percent slopes (VnB).—The profile of this soil is similar to the one described for the Vienna series. Included in the areas mapped as this soil are small areas of La Prairie and Kranzburg soils.

Most of the acreage is used to grow corn, potatoes, small grains, flax, and alfalfa, and yields are moderate to high. The long, smooth, gentle slopes create a moderate hazard of runoff and erosion on this soil. Contour stripcropping, terracing, and sodding of waterways are suitable practices that will help to control runoff and erosion. (Capability unit IIe–1, Silty range site, windbreak suitability group 2)

Vienna silt loam, 6 to 9 percent slopes (VnC).—The surface layer of this soil is thinner and lighter colored than that in the profile described for the Vienna series. In many cultivated fields, patches of the light-colored subsoil are exposed. Included in the areas mapped as this soil are small areas of Buse and Sioux soils that are steeper than this Vienna soil.

Moderate yields of corn, small grains, flax, and alfalfa are obtained on this soil. The steep slopes make erosion a serious hazard, however, and such measures as contour stripcropping, terracing, and sodding of waterways should be used. Including grasses and legumes frequently in the cropping system will add organic matter. (Capability unit IIIe–1, Silty range site, windbreak suitability group 2)

Waubay Series

In the Waubay series are deep, dark-colored soils that are moderately fine textured and are moderately well drained. These soils developed in silty glacial drift and in colluvial and alluvial deposits. They are on upland flats or in slight swales in the western and northeastern parts of the county.

In a typical profile of a Waubay soil, the surface layer is very dark gray, friable silty clay loam that has granular structure and is about 7 inches thick. The subsoil is very dark gray to olive, firm silty clay loam that has prismatic structure and is about 20 inches thick. It is calcareous and is mottled in the lower part. The underlying material is mottled, friable, calcareous silty clay loam.

The Waubay soils occur with the Poinsett, Forman, and Oldham soils. They are less well drained than the Poinsett and Forman soils and are better drained than the Oldham soils.

The Waubay soils take in water somewhat slowly, but they have good water-holding capacity. Runoff is slow in the nearly level areas, and water is occasionally ponded in the swales for a short time.

Much of the acreage of these soils is cultivated. Yields of corn, small grains, flax, and alfalfa are high.

Waubay silty clay loam (0 to 3 percent slopes) (Wa).—The profile of this soil is the one described for the Waubay series. This soil is on upland flats, in slight swales, and in indefinite drainageways in the western part of the county. Small areas of well-drained Poinsett and somewhat poorly drained Oldham soils are included in the areas mapped as this soil.

This Waubay soil is highly productive. Most of the acreage is used to grow corn, small grains, flax, and alfalfa, and yields are high. Wetness, however, is a slight hazard; runoff is slow on the flats and is ponded in the swales after heavy rains. Diversion terraces, sodded waterways, and

ditches help to remove excess water. (Capability unit IIw–1, Silty range site, windbreak suitability group 2)

Waubay-Forman silty clay loams, 0 to 3 percent slopes (WfA).—About 60 percent of this complex is Waubay silty clay loam, 25 percent is Forman silty clay loam, and 15 percent is other soils. These soils are nearly level. They occur in an intricate pattern of small flats, slight swales, and low ridges and knolls in the northeastern part of the county. The Waubay soils are moderately well drained and are on flats and in slight swales; the Forman soils are well drained and are on ridges and knolls. Included in the areas mapped as this complex are small areas of somewhat poorly drained Oldham soils in depressions.

The soils of this complex are highly productive, and most of the areas are cultivated. Yields of corn, small grains, flax, and alfalfa are high under good management. These soils are somewhat limited, however, by slow runoff on the Waubay soil after heavy rains. Sodded waterways, diversion terraces, or ditches will help to control excess water. (The Waubay soil is in capability unit IIw–1, and the Forman soil is in capability unit I–1; both soils are in the Silty range site and windbreak suitability group 2)

Use and Management of Soils

The soils of Codington County are used mainly for cultivated crops and for tame pasture or native grass. This section explains how the soils may be managed for these main purposes and gives the predicted yields per acre of the principal crops grown under two levels of management. In addition it explains how the soils can be managed for planting trees in windbreaks, providing habitats for wildlife, and building highways, dams, and similar engineering structures.

Capability Groups of Soils

The capability classification is a grouping that shows, in a general way, how suitable 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 close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country, indicates that the chief limitation is a 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, 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.

The eight classes in the capability system, and the subclasses and units in this county, are described in the list that follows.

Class I. Soils that have few limitations that restrict their use.
- Capability unit I–1. Nearly level, deep, medium-textured or moderately fine textured soils that are moderately permeable.

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. Gently sloping, deep, medium-textured or moderately fine textured soils that are moderately permeable.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Capability unit IIw–1. Nearly level, deep, dark-colored, medium-textured or moderately fine textured soils that are moderately well drained or somewhat poorly drained and are occasionally wet.

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. Gently sloping or undulating, deep, medium-textured, well-drained soils that are moderately permeable.
  - Capability unit IIIe–2. Gently sloping or moderately sloping, deep, moderately sandy soils that have moderately rapid permeability.
  - Capability unit IIIe–3. Nearly level or gently sloping, moderately sandy soils underlain by gravel at a depth of 20 to 36 inches.

Capability unit IIIe–4. Gently sloping, medium-textured soils underlain by sand and gravel at a depth of 20 to 36 inches.

Capability unit IIIe–5. Gently sloping or moderately sloping, deep, medium-textured soils that are moderately permeable and moderately stony.

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

Capability unit IIIs–1. Nearly level, deep, moderately sandy soils that have moderately rapid permeability.

Capability unit IIIs–2. Nearly level, medium-textured soils underlain by sand and gravel at a depth of 20 to 36 inches.

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. Sloping to moderately steep, medium-textured, moderately permeable soils that are shallow over glacial material.

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

Capability unit IVw–1. Nearly level, deep, dark-colored, moderately fine textured soils that are somewhat poorly drained.

Subclass IVs. Soils that have very severe limitations because they have low fertility and are droughty.

Capability unit IVs–1. Nearly level or gently sloping, medium-textured or moderately coarse textured soils underlain by sand and gravel at a depth of 10 to 20 inches.

Class V. Soils not likely to erode but 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.

Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.

Capability unit Vw–1. Nearly level, deep, dark-colored, moderately fine textured soils that are poorly drained.

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. Steep, medium-textured, moderately permeable soils that are shallow over glacial material.

Subclass VIw. Soils severely limited by excess water and generally unsuitable for cultivation.

Capability unit VIw–1. Nearly level, deep, moderately fine textured soils on bottom lands that are cut by channels and are frequently flooded.

Capability unit VIw–2. Miscellaneous land types that are moderately saline and that are frequently flooded or have a high water table.

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 VIIs. Soils very severely limited by stones or gravel near the surface.

Capability unit VIIs–1. Nearly level to steep, medium-textured or moderately coarse textured soils that are stony or very stony or are underlain by gravel at a depth of 5 to 10 inches.

Class VIII. Soils and landforms that, without major reclamation, have limitations that preclude their use for commercial production of plants and restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Codington County)

Management of Soils by Capability Units

In this section the soils of the county are placed in capability units. Because all of the soils of a unit have similar characteristics and limitations, all of them need about the same kind of management. Cropping systems and management practices that will maintain productivity and control erosion are suggested for the soils in each unit.

CAPABILITY UNIT I–1

The soils in this capability unit are deep, nearly level, medium-textured or moderately fine textured, and moderately permeable. They are well drained or moderately well drained and are on upland flats and on old lake plains. These soils are easily tilled and are highly productive if they are well managed. During thaws in spring and after heavy rains, some areas receive runoff from adjacent slopes. Water does not stand on the surface, however, and the additional moisture is beneficial to crops. The soils in this unit are—

(Bc)	Brookings silty clay loam.
(Bh)	Brookings-Hidewood silty clay loams (Brookings soil only).
(EsA)	Estelline silt loam, 0 to 3 percent slopes.
(FnA)	Forman loam, 0 to 3 percent slopes.
(PmA)	Poinsett loam, 0 to 3 percent slopes.
(PwA)	Poinsett-Waubay silty clay loams, 0 to 3 percent slopes (Poinsett soil only).
(VnA)	Vienna silt loam, 0 to 3 percent slopes.
(WfA)	Waubay-Forman silty clay loams, 0 to 3 percent slopes (Forman soil only).

Flax, small grains, corn, soybeans, potatoes, sorghum, bromegrass, sweetclover, and alfalfa can be grown on these soils. A good cropping system is one in which a green-manure crop is grown once every 3 or 4 years. Row crops should be grown no oftener than 3 consecutive years. Grasses and legumes need to be on the soils no less than 25 percent of the time.

The soils of this unit can be cropped intensively. Legumes should be included in the cropping sequence, however, and all crop residue returned to the soils so that it will supply organic matter and help to maintain fertility. Fertilizer ought to be applied according to the needs indicated by soil tests.

CAPABILITY UNIT IIe–1

In this capability unit are deep, medium-textured or moderately fine textured, well-drained soils that are gently sloping. These soils are moderately permeable. They take in water readily and have a good water-holding capacity. The main limitation is the risk of water erosion

where the soils are not protected. The soils in this unit are—

(EsB) Estelline silt loam, 3 to 6 percent slopes.
(FnB) Forman loam, 3 to 6 percent slopes.
(KrB) Kranzburg silty clay loam, 3 to 6 percent slopes.
(PmB) Poinsett loam, 3 to 7 percent slopes.
(PnB) Poinsett silt loam, 3 to 6 percent slopes.
(PsB) Poinsett-Forman silt loams, 3 to 6 percent slopes.
(VnB) Vienna silt loam, 3 to 6 percent slopes.

Flax, small grains, corn, soybeans, potatoes, bromegrass, sweetclover, and alfalfa are grown successfully on these soils. The cropping system should include a green-manure crop once every 3 years, and row crops should be grown no oftener than 2 years in succession. Grasses and legumes need to be on the soils no less than 25 percent of the time.

Contour tillage (fig. 17) conserves moisture and reduces erosion. Terraces may be needed on the long slopes. Grassed waterways in natural watercourses are a means of protecting these soils from runoff.

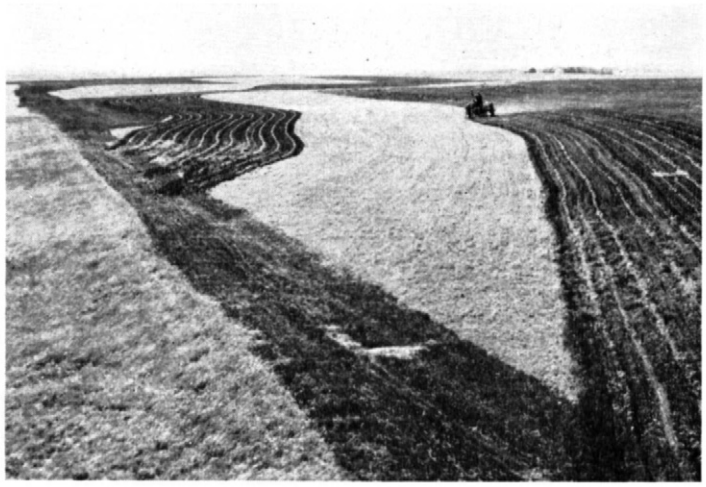

Figure 17.—**Contour farming on the deep, medium-textured soils of capability unit IIe-1.**

These soils respond well to good management. If they are properly tilled and fertilized, they can be cropped intensively and are highly productive.

CAPABILITY UNIT IIw-1

This capability unit is made up of deep, dark-colored, medium-textured or moderately fine textured soils that are in nearly level areas or in slight swales and depressions. These soils are moderately well drained or somewhat poorly drained. They receive runoff from adjacent slopes or have a seasonally high fluctuating water table. Seeding in spring is often delayed or the choice of crops is affected by flooding or wetness. The soils in this unit are—

(Lp) La Prairie silt loam.
(Od) Oldham silty clay loam.
(Op) Oldham and Parnell silty clay loams (Oldham soil only).
(Ow) Oldham and Parnell silty clay loams, wet (Oldham soil only).
(PwA) Poinsett-Waubay silty clay loams, 0 to 3 percent slopes (Waubay soil only).
(Wa) Waubay silty clay loam.
(WfA) Waubay-Forman silty clay loams, 0 to 3 percent slopes (Waubay soil only).

These are among the most stable and most productive soils in the county. They are used to grow flax, small grains, corn, soybeans, potatoes, sorghum, bromegrass, sweetclover, reed canarygrass, and alfalfa. The experience of farmers has shown that a green-manure crop grown on these soils once every 3 or 4 years is beneficial. Row crops should be grown no more than 2 consecutive years. Grasses and legumes need to be on the soils not less than 25 percent of the time.

If surface drainage is adequate and good tillage methods are used, these soils can be cropped intensively. Crops grown on them respond well to fertilizer. Tilling at the proper time and including grasses and legumes in the cropping system improve tilth. Diversion terraces, sodded waterways, or dikes are a practical means of diverting water from adjacent slopes.

CAPABILITY UNIT IIIe-1

In this capability unit are deep, medium-textured, well-drained soils that are moderately permeable. These soils are gently sloping or undulating; the slopes are near the maximum for safe cultivation year after year. Runoff and erosion are serious hazards if cropping is intensive. These soils take in water readily and have good moisture capacity. The soils in this unit are—

(BpD) Buse-Poinsett silt loams, 9 to 15 percent slopes (Poinsett soil only).
(BvD) Buse-Vienna loams, 6 to 15 percent slopes (Vienna soil only).
(Bx) Buse-Vienna-Sioux stony loams (Vienna soil only).
(FnC) Forman loam, 6 to 9 percent slopes.
(PoC) Poinsett-Buse-Forman loams, 6 to 9 percent slopes (Poinsett and Forman soils only).
(VnC) Vienna silt loam, 6 to 9 percent slopes.

Flax, small grains, corn, soybeans, potatoes, sorghum, bromegrass, sweetclover, and alfalfa can be grown on these soils. In many places, however, the supply of plant nutrients has been reduced by erosion. Organic matter, in the form of green manure, crop residue, or barnyard manure, is especially beneficial where these soils are cultivated. The green manure, crop residue, and barnyard manure will improve tilth and reduce runoff, as well as increase fertility. Grasses and legumes need to be included in the cropping system no less than one-fourth to one-third of the time. Fertilizer should be added according to the needs indicated by soil tests.

Controlling runoff, reducing erosion, and conserving moisture are the main problems in managing these soils. Contour farming, terracing, and sodding of waterways help to control runoff.

CAPABILITY UNIT IIIe-2

Only Egeland fine sandy loam, 3 to 9 percent slopes (EfB), is in this capability unit. This soil is deep, moderately sandy, and gently sloping or moderately sloping. It is well drained to somewhat excessively drained. The main limitations to its use are the susceptibility to wind erosion and droughtiness. The low water-holding capacity and moderately rapid permeability make this soil droughty.

Adapted crops are flax, small grains, corn, soybeans, potatoes, sorghum, sweetclover, alfalfa, and bromegrass. The cropping system should include a green-manure crop grown once every 3 years. Row crops should not be grown in consecutive years. Grasses and legumes need to be on the soil no less than one-fourth to one-third of the time.

Interseeding a cover crop between the rows of corn and sorghum will help to control erosion between growing sea-

sons. This is especially necessary where the row crop is harvested for silage. Stubble mulching is another practice that helps to control erosion, and such practices as contour farming, contour stripcropping, and terracing may also be used.

CAPABILITY UNIT IIIe-3

In this capability unit are nearly level or gently sloping, moderately sandy soils underlain by gravel at a depth of 20 to 36 inches. These soils are on terraces and outwash plains. The main limitations are the moderate hazard of wind erosion and droughtiness. The soils in this unit are—

(FfA) Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes (Fordville soils only).
(FfB) Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes (Fordville soil only).

Flax, small grains, soybeans, sorghum, alfalfa, sweetclover, and bromegrass are better adapted to these soils than other crops. Row crops should not be grown in consecutive years. A green-manure crop grown once every 3 years will help to maintain or increase the content of organic matter. Grasses and legumes need to be on the soil one-quarter to one-third of the time. Wind stripcropping and stubble mulching should be used to help control wind erosion.

CAPABILITY UNIT IIIe-4

Fordville silt loam, 3 to 6 percent slopes (FdB), is the only soil in this capability unit. This is a medium-textured, well-drained to somewhat excessively drained, gently sloping soil underlain by sand and gravel at a depth of 20 to 36 inches. It is on outwash plains and undulating stream terraces. A moderate hazard of wind and water erosion and droughtiness are the main limitations.

Flax, small grains, soybeans, sorghum, alfalfa, sweetclover, and bromegrass are better adapted to this soil than other crops. Row crops should not be grown in consecutive years. A green-manure crop grown once every 3 years will help to maintain or increase the content of organic matter. Grasses or legumes ought to be grown on this soil one-quarter to one-third of the time. Stubble mulching, wind stripcropping, and contour stripcropping are other needed practices.

CAPABILITY UNIT IIIe-5

The soils of this capability unit are deep, medium textured, well drained, and moderately permeable. They are gently sloping or moderately sloping and have many cobbles and other stones on the surface and throughout the profile. The stones limit the use of these soils because most of them must be removed from cropland to reduce damage to machinery and to facilitate cultivation. The risk of erosion on unprotected slopes is moderate if runoff is not controlled. The soils in this unit are—

(FmB) Forman cobbly loam, 3 to 6 percent slopes.
(FmC) Forman cobbly loam, 6 to 9 percent slopes.

The better adapted crops on these soils are flax, small grains, alfalfa, sweetclover, and bromegrass. A green-manure crop grown once every 3 years will help to maintain or increase the content of organic matter. Grasses or legumes ought to be on the soil one-fourth to one-third of the time. Terraces, contour stripcropping, and sodded waterways can be used to help control runoff and erosion.

CAPABILITY UNIT IIIs-1

Only Egeland fine sandy loam, 0 to 3 percent slopes (EfA), is in this capability unit. This soil is nearly level, deep, and moderately coarse textured, and it has moderately rapid permeability. The main limitation is droughtiness because the water-holding capacity is low. Also, the somewhat sandy texture makes this soil susceptible to wind erosion.

Crops adapted to this soil are flax, small grains, corn, soybeans, potatoes, sorghum, sweetclover, alfalfa, and bromegrass. Grasses and legumes need to be included in the cropping system no less than one-fourth of the time.

Interseeding the rows of corn and sorghum with a cover crop will help to control erosion between growing seasons. Stubble mulching may also be used to help protect this soil. Where enough water is available, irrigation is beneficial.

CAPABILITY UNIT IIIs-2

Fordville silt loam, 0 to 3 percent slopes (FdA), the only soil in this capability unit, is medium textured and is well drained to somewhat excessively drained. It is underlain by sand and gravel at a depth of 20 to 36 inches. This soil is nearly level and is on stream terraces and outwash plains. Droughtiness during prolonged dry periods and a moderate hazard of wind erosion are the main limitations.

Flax, small grains, soybeans, sorghum, alfalfa, sweetclover, and bromegrass are better adapted to this soil than other crops. Row crops should not be grown in consecutive years. A green-manure crop grown once every 3 years will help to maintain or increase the content of organic matter. Grasses and legumes may also be grown one-fourth to one-third of the time. Wind stripcropping and stubble mulching should be used to help control wind erosion.

CAPABILITY UNIT IVe-1

In this capability unit are sloping to moderately steep, medium-textured, well-drained soils that are shallow over glacial material. Runoff is excessive, and these soils erode rapidly if they are not protected. The soils are moderately permeable and take in water readily if runoff is controlled. They have steeper slopes and a thinner surface layer than the soils of capability unit IIIe-1. In cultivated fields patches of the light-colored subsoil are exposed where these soils are eroded or the surface layer is thin. The soils in this unit are—

(BmD) Buse loam, 9 to 15 percent slopes.
(BpD) Buse-Poinsett silt loams, 9 to 15 percent slopes (Buse soil only).
(BsD) Buse-Sioux loams, 6 to 15 percent slopes (Buse soil only).
(BvD) Buse-Vienna loams, 6 to 15 percent slopes (Buse soil only).
(PoC) Poinsett-Buse-Forman loams, 6 to 9 percent slopes (Buse soil only).

These soils are too erodible for intensive cultivation. Flax, small grains, corn, sorghum, alfalfa, sweetclover, and bromegrass can be grown part of the time, but grasses or legumes need to be grown at least half of the time. Because the supply of plant nutrients has been greatly reduced by erosion, organic matter in the form of green manure, crop residue, and barnyard manure is especially beneficial where these soils are cultivated.

Terracing, contour farming, and grassed waterways will help to control runoff and erosion. Stubble mulching helps to protect these soils between growing seasons.

CAPABILITY UNIT IVw-1

The soils in this capability unit are nearly level and are on stream bottoms and in shallow depressions. They are deep, dark colored, moderately fine textured, and somewhat poorly drained, and they take in water slowly. Their main limitations are wetness caused by flooding, a high water table, and runoff from surrounding soils. Wetness often delays planting in spring, and flooding after summer storms may damage the growing crop. The soils in this unit are—

(Bh) Brookings-Hidewood silty clay loams (Hidewood soil only).
(La) Lamoure silty clay loam.

Flax, small grains, corn, potatoes, sweetclover, alfalfa, bromegrass, reed canarygrass, creeping foxtail, tall wheatgrass, and alsike clover are suited to these soils. The best use of the soils, however, is for permanent grass. Row crops should be grown no more than 2 consecutive years. A green-manure crop grown once every 2 or 3 years helps to improve tilth and fertility.

In some areas surface drainage is needed before these soils can be used for cultivated crops; ditches and bedding may be required to remove the excess water. In places it is necessary to plow in fall because the soils are too wet in spring.

CAPABILITY UNIT IVs-1

In this capability unit are medium-textured or moderately coarse textured soils underlain by sand and gravel at a depth of 10 to 20 inches. These soils are nearly level or gently sloping and are on stream terraces and outwash plains. The main limitations are droughtiness, low productivity, and a moderate hazard of wind erosion. These soils have low water-holding capacity, but in most years low or moderate yields of crops that mature early are obtained. Much of the acreage is in cultivated crops, although the best use of these soils is for pasture or hay. The soils in this unit are—

(FfA) Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes (Renshaw soil only).
(FfB) Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes (Renshaw soil only).
(RsA) Renshaw-Sioux complex, 0 to 3 percent slopes (Renshaw soil only).
(RsB) Renshaw-Sioux complex, 3 to 6 percent slopes (Renshaw soil only).

Flax, small grains, soybeans, sorghum, alfalfa, sweetclover, and bromegrass are better suited to these soils than other crops. Row crops should not be grown in consecutive years. A green-manure crop grown once every 3 years will help to maintain or increase the content of organic matter. Grasses and legumes should be grown one-fourth to one-third of the time. Other suitable practices are wind stripcropping and stubble mulching.

CAPABILITY UNIT Vw-1

In this capability unit are deep, dark-colored, moderately fine textured soils that are slowly permeable and poorly drained. These soils are nearly level and are on bottom lands or in closed depressions. They are subject to flooding or to frequent overflow because they receive runoff from the surrounding soils. Also, the water table is at or near the surface during most of the year. The soils in this unit are—

(Op) Oldham and Parnell silty clay loams (Parnell soil only).
(Ow) Oldham and Parnell silty clay loams, wet (Parnell soil only).
(Ra) Rauville silty clay loam.

These soils are good for hay crops or pasture, and high yields of forage are obtained. They are too wet and too frequently flooded for cultivation, and artificial drainage generally is impractical. The vegetation may be improved by planting reed canarygrass or creeping foxtail. These plants provide an additional supply of forage during the hot summer months when cool-season grasses are dormant or semidormant. If the alkalinity is higher than medium, tall wheatgrass may be seeded in place of reed canarygrass or creeping foxtail. Changing the vegetation from river bulrush and other aquatic plants to grass will improve these areas as wildlife habitats.

CAPABILITY UNIT VIe-1

Buse loam, 15 to 35 percent slopes (BmE), the only soil in this capability unit, is medium textured, well drained, and moderately permeable. It is in hilly areas and is shallow over glacial material. Runoff is excessive, and care is needed to maintain a good cover of grass that will provide protection from erosion. This soil is too steep to be cultivated safely.

Because of its steep slopes and the severe hazard of erosion, this soil is best suited to native grass. Many of the areas are too steep for use of machinery for harvesting hay. Good range management is needed to maintain maximum grazing. Little bluestem, western wheatgrass, prairie sandreed, needle-and-thread, and sideoats grama are the predominant grasses where the range is in excellent condition.

CAPABILITY UNIT VIw-1

Only Lamoure silty clay loam, channeled (Lc), is in this capability unit. It is a deep, nearly level soil that is moderately fine textured and somewhat poorly drained or poorly drained. In some places it has a fluctuating water table. Some areas of this soil are on bottom lands and occur as narrow bands along small streams bordered by steep soils. Others are adjacent to the meandering channels of larger streams. The areas are cut by entrenched or meandering stream channels and are frequently flooded.

This soil is not suitable for cultivation, because the meandering channels and adjacent steep slopes make the areas inaccessible. The only practical use is for pasture or hay. High yields of forage of good quality are produced under good management.

CAPABILITY UNIT VIw-2

Only Clayey saline land (Cs) is in this capability unit. It is moderately fine textured and moderately saline, and it is poorly drained or very poorly drained. This land type is nearly level, and it is in lakebeds that are frequently flooded. Generally, the water table is high or fluctuating, and internal drainage is very slow. The native vegetation is mainly salt-tolerant grasses or sedges. Interspersed

with the areas of grass are many bare, salt-encrusted areas, or slickspots.

The high water table and salinity make this land type better suited to hay or pasture than to field crops. The forage is of poor quality, however, and yields are only moderate. Some areas may be improved by preparing a good seedbed and planting tall wheatgrass. Good pasture management will maintain optimum yields.

CAPABILITY UNIT VIIs-1

The soils in this capability unit are nearly level to steep, medium-textured or moderately coarse textured, and stony and gravelly. The Buse soils are stony or very stony and are shallow over glacial material. The Sioux soils are underlain by gravel at a depth of 5 to 10 inches. The soils are on gently sloping or moderately sloping river and lake terraces, on hilly and gravelly ridges, on hilly breaks between terrace levels, and in other rolling and hilly areas. Runoff is excessive. Erosion by wind and water are serious hazards if these soils are unprotected. The soils in this unit are—

(BsD) Buse-Sioux loams, 6 to 15 percent slopes (Sioux soil only).
(Bu) Buse-Sioux stony loams.
(Bo) Buse stony loam.
(Bx) Buse-Vienna-Sioux stony loams (Buse and Sioux soils only).
(RsA) Renshaw-Sioux complex, 0 to 3 percent slopes (Sioux soil only).
(RsB) Renshaw-Sioux complex, 3 to 6 percent slopes (Sioux soil only).
(Ts) Terrace escarpments.

These soils are too droughty, low in productivity, erodible, and stony to be suitable for crops, and they are suitable only for pasture or wildlife. Yields of native grasses are moderate. The dominant grasses in areas in good to excellent condition are little bluestem, western wheatgrass, prairie sandreed, needle-and-thread, and sideoats grama. Good range management is needed to obtain maximum yields. Many areas are too stony to allow use of any machinery.

Predicted Yields

Table 2 gives predicted, long-term, average yields per acre for the principal crops grown in the county. The yields shown are for two levels of management.

The yields shown in columns A were obtained under the kind of management most farmers in the county were practicing in 1958. Under that kind of management, the basic cropping sequence is row crops, small grains, small grains. Legumes and grasses are not grown, except in a long-time, grass-legume cropping system where the soils may be in grasses or legumes only 4 years out of a 20-year period. Grain stubble and other crop residue is plowed under or incorporated in the surface layer, but green-manure crops are not grown. Commercial fertilizer is not used or only a small amount is applied to row crops, but barnyard manure is applied where available. Contour farming, terracing, and other practices that conserve soil and water are not used.

Yields in columns B can be expected under improved management. This is assumed to be an efficient and economical system of cropping. Under this level of management, all appropriate practices that conserve soil and water are applied and a cropping system is used that maintains fertility and tilth and also protects the soils from erosion. Clean, high-quality seed of adapted disease-resistant varieties is planted. All crop residue is returned to the soil and is incorporated into the surface layer by tillage. Green-manure crops are grown and barnyard manure is added to increase fertility and to add organic matter. The results of laboratory tests and field trials are used as a basis for planning application of the most economical amounts and kinds of commercial fertilizer. An effective weed-control program is also an essential part of these farming operations.

Management of Native Grassland [1]

Most of the native grassland in this county is in small patches within a farm unit, but some larger areas occur on the hilly soils of glacial end moraines, on the soils along the main streams, and on soils around large sloughs. Of the approximately 100,000 acres of native grassland in the county, about 25,000 acres is used to produce wild hay and about 75,000 acres is pastured. This native grassland is all that remains of the virgin prairie that covered all of the area before the white settlers came. Much of this native pasture is on the Buse, Sioux, and other droughty soils.

The original vegetation was mostly tall and mid grasses that grew in summer. Mixed with the grasses were deep-rooted forbs. Prairie cordgrass, sedges, and rushes grew on the wet soils, and a mixture of mid and short grasses grew on the droughty soils. As long as the prairie grasses were grazed lightly, they remained essentially unchanged. The areas have been overstocked, however, and the plants have been literally eaten to the ground. Some of the small native pastures are now no more than exercise lots and have only a small amount of forage available for grazing.

Many of the areas of native pasture are too stony (fig. 18), steep, or wet for reseeding to be practical. Therefore, control of grazing is necessary to protect and maintain the present native vegetation and to assure a continued high yield of forage. The number of livestock and the length of time the pasture is grazed should be limited so that no more than half of each year's growth of forage is removed by grazing. If more than half of the top growth is removed, the better forage plants weaken and die and are replaced by weeds and by grasses of poorer quality. Each season the grasses must be allowed to store enough plant nutrients that their vigor will be maintained. This is possible only if enough leafy top growth remains for a long enough time to build up a reserve of plant nutrients.

Range sites and condition classes

The basic unit used to describe areas of native pasture is the range site. Range sites are distinctive kinds of rangeland that have different potential for producing native plants. Each range site has its own combination of environmental factors, which results in the plant community found only on that site. The range site retains its ability to produce this potential plant community, unless it is altered by overgrazing.

[1] Prepared with the assistance of JOHN FARLEY and RALPH COLE, range conservationists, Soil Conservation Service.

TABLE 2.—*Predicted average yields per acre of the principal crops grown under two levels of management*

[Yields in columns A are those to be expected under common management; yields in columns B are those to be expected under improved management. Absence of a yield figure indicates that the soil is not suited to the crop specified or that the crop is not commonly grown under the type of management indicated. Data were prepared by a committee of agronomists that included Fred E. Shubeck, Walter N. Parmeter, Fred Morris, J. Dwight Morrow, Reuben A. Wicks, and Orville E. Noeldner]

Soils	Corn		Oats		Barley		Spring wheat		Flax		Rye		Alfalfa		Brome		Native hay	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Brookings silty clay loam	41	53	43	62	30	42	19	23	12	18	20	30	2.0	2.8	1.0	1.7	0.7	1.0
Brookings-Hidewood silty clay loams:																		
Brookings soil	41	53	43	62	30	42	19	23	12	18	20	30	2.0	2.8	1.0	1.7	.7	1.0
Hidewood soil	27	33	30	40	21	28	12	16	9	15	10	22	.7	1.0	1.2	1.8	1.2	1.4
Buse loam, 9 to 15 percent slopes	12	19	16	25	15	20	6	9	4	6	6	10	1.0	1.5	.6	1.1	.6	.9
Buse loam, 15 to 35 percent slopes	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.5	1.0	.5	.8
Buse stony loam	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Buse-Poinsett silt loams, 9 to 15 percent slopes:																		
Buse soil	12	19	16	25	15	20	6	9	4	6	6	10	1.0	1.5	.6	1.1	.6	.9
Poinsett soil	27	33	30	39	21	30	12	17	7	11	13	19	1.6	2.1	.8	1.3	----	.9
Buse-Sioux loams, 6 to 15 percent slopes:																		
Buse soil	14	19	16	25	15	20	6	9	4	6	6	10	1.0	1.5	.6	1.1	.6	.9
Sioux soil	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.4	.7
Buse-Sioux stony loams	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Buse-Vienna loams, 6 to 15 percent slopes:																		
Buse soil	14	19	16	25	15	20	6	9	4	6	6	10	1.0	1.5	.6	1.1	.6	.9
Vienna soil	27	33	30	39	21	30	12	17	7	11	13	19	1.6	2.1	.8	1.3	.6	.9
Buse-Vienna-Sioux stony loams:																		
Buse soil	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Vienna soil	28	37	30	39	21	30	12	17	7	11	13	19	1.6	2.1	.8	1.3	.6	.9
Sioux soil	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Clayey saline land	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.6	.9
Egeland fine sandy loam, 0 to 3 percent slopes	25	30	30	45	20	30	13	17	8	12	13	17	1.4	1.9	.8	1.3	.8	1.0
Egeland fine sandy loam, 3 to 9 percent slopes	19	28	28	42	18	27	10	15	6	10	10	15	1.1	1.7	.5	1.0	.7	.9
Estelline silt loam, 0 to 3 percent slopes	32	42	41	60	28	40	18	22	11	17	18	27	1.7	2.5	.9	1.5	.7	1.0
Estelline silt loam, 3 to 6 percent slopes	26	34	39	58	26	38	14	20	10	14	15	23	1.6	2.4	.8	1.4	.7	1.0
Fordville silt loam, 0 to 3 percent slopes	23	31	30	45	20	30	11	15	7	11	11	17	1.1	1.7	.6	1.1	.6	1.0
Fordville silt loam, 3 to 6 percent slopes	22	30	28	42	18	28	10	15	6	10	10	16	1.0	1.6	.5	1.0	.6	.9
Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes:																		
Fordville soil	22	28	23	34	18	23	10	13	5	9	10	16	1.0	1.5	.5	1.0	.6	.9
Renshaw soil	10	13	15	25	12	16	6	9	3	5	5	8	.8	1.2	.5	.8	.5	.8
Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes:																		
Fordville soil	20	23	14	21	10	13	7	10	4	6	5	8	.6	1.0	.5	.7	.5	.8
Renshaw soil	8	11	12	21	9	12	5	9	3	5	4	8	.6	1.0	.5	.7	.5	.8
Forman cobbly loam, 3 to 6 percent slopes	26	36	26	36	20	28	12	17	8	15	13	23	1.6	2.2	.6	1.2	.6	.9
Forman cobbly loam, 6 to 9 percent slopes	24	35	26	36	20	28	12	17	8	15	13	23	1.6	2.2	.5	1.0	.6	.9
Forman loam, 0 to 3 percent slopes	37	48	42	60	29	41	18	22	11	17	19	29	2.0	2.8	1.0	1.7	.7	1.0
Forman loam, 3 to 6 percent slopes	33	42	36	54	27	36	16	21	10	15	16	24	1.7	2.2	.9	1.6	.7	1.0
Forman loam, 6 to 9 percent slopes	27	34	30	39	21	30	12	17	7	11	13	19	1.6	2.1	.8	1.3	.6	.9
Kranzburg silty clay loam, 3 to 6 percent slopes	34	42	36	54	27	36	16	21	10	15	16	24	1.7	2.2	.9	1.6	.7	1.0
Lamoure silty clay loam	27	34	30	40	21	28	12	16	9	15	10	22	.7	1.0	1.5	2.0	1.2	1.4
Lamoure silty clay loam, channeled	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.2	1.4
La Prairie silt loam	39	47	40	55	25	40	16	23	10	15	15	25	1.7	2.5	1.0	1.7	.8	1.2
Oldham silty clay loam	27	36	30	40	21	28	12	16	9	15	10	22	.7	1.0	1.2	1.8	1.2	1.4
Oldham and Parnell silty clay loams:																		
Oldham soil	27	36	30	40	21	28	12	16	9	15	10	22	.7	1.0	1.2	1.8	1.2	1.4
Parnell soil	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.1	1.3
Oldham and Parnell silty clay loams, wet	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.1	1.3
Poinsett loam, 0 to 3 percent slopes	37	46	42	60	29	41	18	22	11	17	19	29	2.0	2.8	1.0	1.7	.7	1.0
Poinsett loam, 3 to 7 percent slopes	34	42	36	54	27	36	16	21	10	15	16	24	1.7	2.2	.9	1.6	.7	1.0
Poinsett silt loam, 3 to 6 percent slopes	34	42	36	54	27	36	16	21	10	15	16	24	1.7	2.2	.9	1.6	.7	1.0

TABLE 2.—*Predicted average yields per acre of the principal crops grown under two levels of management*—Continued

Soils	Corn		Oats		Barley		Spring wheat		Flax		Rye		Alfalfa		Brome		Native hay	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Poinsett-Buse-Forman loams, 6 to 9 percent slopes:																		
Poinsett soil	27	33	30	39	21	30	12	17	7	11	13	19	1.6	2.1	0.8	1.3	0.6	0.9
Buse soil	15	19	16	25	15	20	6	9	4	6	6	10	1.0	1.5	.6	1.1	.6	.9
Forman soil	27	34	30	39	21	30	12	17	7	11	13	19	1.6	2.1	.8	1.3	.6	.9
Poinsett-Forman silt loams, 3 to 6 percent slopes:																		
Poinsett soil	34	42	36	54	27	36	16	21	10	15	16	24	1.7	2.2	.9	1.6	.7	1.0
Forman soil	32	38	36	54	27	36	16	21	10	15	16	24	1.7	2.2	.9	1.6	.7	1.0
Poinsett-Waubay silty clay loams, 0 to 3 percent slopes:																		
Poinsett soil	41	53	43	62	30	42	19	23	12	18	20	30	2.0	2.8	1.0	1.7	.7	1.0
Waubay soil	39	47	40	55	24	40	16	23	10	15	15	25	1.7	2.5	1.0	1.7	.8	1.2
Rauville silty clay loam	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.2	1.4
Renshaw-Sioux complex, 0 to 3 percent slopes:																		
Renshaw soil	10	13	15	25	12	16	6	9	3	5	5	8	.8	1.2	.5	.8	.5	.8
Sioux soil	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.4	.7
Renshaw-Sioux complex, 3 to 6 percent slopes:																		
Renshaw soil	10	12	15	25	12	26	6	9	3	5	5	8	.8	1.2	.5	.8	.5	.8
Sioux soil	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.4	.7
Terrace escarpments	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Vienna silt loam, 0 to 3 percent slopes	36	45	42	60	29	41	18	22	11	17	19	29	2.0	2.8	1.0	1.7	.7	1.0
Vienna silt loam, 3 to 6 percent slopes	32	40	36	54	27	36	16	21	10	15	16	24	1.7	2.2	.9	1.6	.7	1.0
Vienna silt loam, 6 to 9 percent slopes	28	37	30	39	21	30	12	17	7	11	13	19	1.6	2.1	.8	1.3	.6	.9
Waubay silty clay loam	39	47	40	55	24	40	16	23	10	15	15	25	1.7	2.5	1.0	1.7	.8	1.2
Waubay-Forman silty clay loams, 0 to 3 percent slopes:																		
Waubay soil	39	47	40	55	24	40	16	23	10	15	15	25	1.7	2.5	1.0	1.7	.8	1.2
Forman soil	37	48	42	60	29	41	18	22	11	17	19	29	2.0	2.8	1.0	1.7	.7	1.0

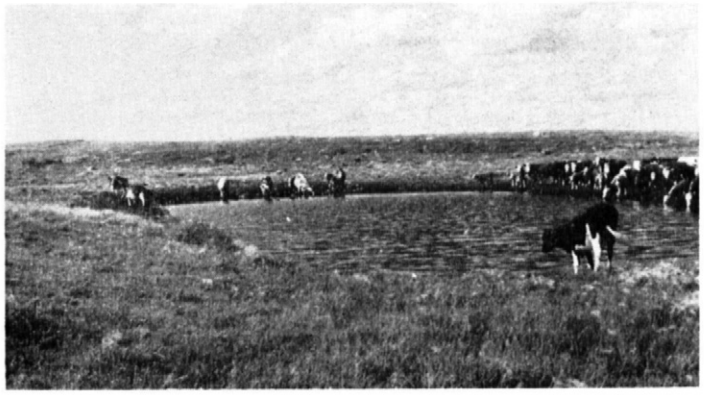

***Figure 18.*—A native pasture in good condition. The soils are too stony for cultivation, but they produce excellent native forage under careful management. The stock pond provides ample water for livestock and helps to distribute grazing.**

The condition of the native pasture is determined by comparing the present vegetation with the *climax vegetation*, that is, with the type and combination of plants that originally grew on the site before the area was disturbed by overgrazing. As a rule, the climax vegetation is the most productive combination of native plants that will grow on a site.

The range site may not have the best adapted native plants growing on it, because livestock select the larger or more palatable plants. If grazing is not carefully controlled, the better plants are eventually eliminated. The most palatable plants, called *decreasers*, are the first to be eliminated under heavy grazing. Less desirable, smaller or second-choice plants increase as the decreasers die out, and these plants are called *increasers*. If heavy grazing continues, even the second-choice plants will be thinned out or eliminated, and undesirable weeds, or *invaders*, will take over the site.

Four range condition classes have been defined to show the present state of the natural vegetation on a range site in relation to the native vegetation that could grow there. A range in excellent condition has from 76 to 100 percent of the vegetation that is characteristic of the climax vegetation on the same site; one in good condition, 51 to 75 percent; one in fair condition, 26 to 50 percent; and one in poor condition, less than 26 percent.

Trends in the condition of the native vegetation can be recognized in several ways. The following are signs of improvement in the condition of the range—

1. The native pasture has a good mulch.
2. The decreasers, or best grasses, are vigorous and are spreading.
3. The pasture has a good cover of grass, and there are no raw, eroding gullies.
4. Palatable indicator plants, such as leadplant, are noticeable.
5. Weeds and undesirable grasses appear to be decreasing.

A downward trend in the condition of the range is indicated by the following—

1. The better grasses are small and scattered. They show little evidence of recent reproduction.
2. Many bare spots occur; the mulch is poor.
3. Gullies are forming.
4. Undesirable indicator plants, such as gray sagewort, curlycup gumweed, and cactus, are beginning to invade.
5. The desirable indicator plants, such as leadplant, are beginning to disappear.

Principles of range management

The number of livestock that can graze a native pasture without damage to the grasses varies with the range site, the condition of the range, and the annual growing conditions. Grazing animals should be managed so that the better grasses grow well and maximum production is obtained from the available forage. The basic principles of range management are to control grazing by limiting the number of livestock and the length of time the pasture is used; by grazing the pasture lightly during the season when it is most likely to be damaged by heavy grazing; and by distributing livestock over the entire range.

Descriptions of range sites

The range sites in the county are described in the following pages. In each description are pointed out some of the ways the soils influence the growth of plants on the site. Also briefly described is the plant community that represents the potential for the site. The range sites are discussed in the decreasing order of the total annual yield for the site.

WETLAND RANGE SITE

Rauville silty clay loam (Ra) is the only soil in this range site. It is on bottom lands throughout the county and is subirrigated; water stands on the surface during part of the growing season. This is a deep, dark-colored, moderately fine textured soil that is very poorly drained.

This is potentially the most productive range site in the county. Moisture is received not only from the high water table but also as runoff from higher areas. The soil absorbs this moisture slowly, but it holds much of it available for plants.

Where this site is in excellent condition, prairie cordgrass, bluejoint reedgrass, northern reedgrass, reed canarygrass and slough sedge are the predominant plants. The main increasers in areas that are overgrazed are saltgrass, fowl bluegrass, Kentucky bluegrass, rushes, and the smaller sedges. Many areas have been seeded to reed canarygrass.

The estimated average total annual yield of all plants when air dry where this site is in excellent condition is 7,000 pounds per acre in dry years and 8,200 pounds per acre in years of normal rainfall.

SUBIRRIGATED RANGE SITE

Only Lamoure silty clay loam (La), on bottom lands, is in this range site. This soil is deep, dark colored, and moderately fine textured, and it is somewhat poorly drained or poorly drained. The water table is close to but is seldom above the surface.

This is potentially one of the most productive range sites in the county. The soil takes in water slowly, but it holds much of the moisture available for plants. The high water table helps to maintain the grass during droughty periods.

Where this site is in excellent condition, the plant cover consists mainly of cordgrass, big bluestem, switchgrass, prairie sandreed, northern reedgrass, bluejoint reedgrass, and other tall grasses. The main increasers in areas that are overgrazed are western wheatgrass, bluegrass, saltgrass, and sedges.

The estimated average total annual yield of all plants when air dry where this site is in excellent condition is 5,800 pounds per acre in dry years, 6,800 pounds per acre in years of normal rainfall, and 7,800 pounds per acre in wet years.

OVERFLOW RANGE SITE

In this range site are soils that regularly receive more moisture than most other soils of the county because they receive runoff from higher areas. These soils are in depressions in the western and northeastern parts of the county and on narrow bottom lands that are cut by meandering stream channels. They are deep, dark colored, and moderately fine textured, and they are somewhat poorly drained or poorly drained. In some places water is ponded on their surface during wet seasons. The soils in this range site are—

(Bh) Brookings-Hidewood silty clay loams (Hidewood soil only).
(Lc) Lamoure silty clay loam, channeled.
(Od) Oldham silty clay loam.
(Op) Oldham and Parnell silty clay loams.
(Ow) Oldham and Parnell silty clay loams, wet.

This is potentially one of the most productive sites in the county. The soils absorb water slowly, but they hold it well for plants.

Where the site is in excellent condition, the vegetation is predominantly big bluestem, prairie cordgrass, indiangrass, slender wheatgrass, Canada wildrye, and switchgrass. The amount of prairie cordgrass, switchgrass, and wildrye varies according to the degree of wetness. Prairie sandreed, western wheatgrass, and needle-and-thread are the chief increasers in areas that are overgrazed.

The estimated average total annual yield of all plants when air dry where this site is in excellent condition is 4,700 pounds per acre in dry years, 5,400 pounds per acre in years of normal rainfall, and 6,200 pounds per acre in wet years.

SALINE LOWLAND RANGE SITE

Only Clayey saline land (Cs) is in this range site. It is in areas that are subirrigated or are subject to overflow. Salts have accumulated on the surface or in the soil material to the extent that the kinds of native plants have been affected. The main area is at the southern end of Long Lake in the west-central part of the county.

Salinity and the high water table make the vegetation on this site spotty. Some areas are bare and are encrusted with salt.

Where this site is in excellent condition, the plant cover consists of salt-tolerant species, such as Nuttall alkaligrass, saltgrass, slender wheatgrass, and alkali cordgrass. In areas that are overgrazed, the main increasers are saltgrass and sedges.

The estimated average total annual yield of all plants when air dry where this site is in excellent condition is 3,000 pounds per acre in dry years, 4,000 pounds per acre in years of normal rainfall, and 5,000 pounds per acre in wet years.

SANDY RANGE SITE

This range site consists of deep to moderately deep, well-drained sandy loams and fine sandy loams. The soils are on stream terraces and lake terraces. The soils in this range site are—

(EfA) Egeland fine sandy loam, 0 to 3 percent slopes.
(EfB) Egeland fine sandy loam, 3 to 9 percent slopes.
(FfA) Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes (Fordville soil only).
(FfB) Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes (Fordville soil only).

These soils take in water readily, but their water-holding capacity is somewhat low. Their subsoil is permeable enough that water moves rapidly through it. A large part of the acreage is in cultivated crops rather than in range.

Where this site is in excellent condition, the vegetation consists of a mixture of tall and mid grasses, principally big bluestem, little bluestem, indiangrass, prairie sandreed, and switchgrass. Needle-and-thread, western wheatgrass, indian ricegrass, blue grama, and hairy grama are the chief increasers in the areas that are overgrazed.

The estimated average total annual yield of all plants when air dry where this site is in excellent condition is 2,300 pounds per acre in dry years, 3,300 pounds per acre in years of normal rainfall, and 4,300 pounds per acre in wet years.

SILTY RANGE SITE

In this range site are medium-textured, moderately well drained or well drained soils that are nearly level to rolling. The soils in this range site are—

(Bc) Brookings silty clay loam.
(Bh) Brookings-Hidewood silty clay loams (Brookings soil only)
(BpD) Buse-Poinsett silt loams, 9 to 15 percent slopes (Poinsett soil only).
(BvD) Buse-Vienna loams, 6 to 15 percent slopes (Vienna soil only).
(Bx) Buse-Vienna-Sioux stony loams (Vienna soil only).
(EsA) Estelline silt loam, 0 to 3 percent slopes.
(EsB) Estelline silt loam, 3 to 6 percent slopes.
(FdA) Fordville silt loam, 0 to 3 percent slopes.
(FdB) Fordville silt loam, 3 to 6 percent slopes.
(FmB) Forman cobbly loam, 3 to 6 percent slopes.
(FmC) Forman cobbly loam, 6 to 9 percent slopes.
(FnA) Forman loam, 0 to 3 percent slopes.
(FnB) Forman loam, 3 to 6 percent slopes.
(FnC) Forman loam, 6 to 9 percent slopes.
(KrB) Kranzburg silty clay loam, 3 to 6 percent slopes.
(Lp) La Prairie silt loam.
(PmA) Poinsett loam, 0 to 3 percent slopes.
(PmB) Poinsett loam, 3 to 7 percent slopes.
(PnB) Poinsett silt loam, 3 to 6 percent slopes.
(PoC) Poinsett-Buse-Forman loams, 6 to 9 percent slopes (Poinsett and Forman soils only).
(PsB) Poinsett-Forman silt loams, 3 to 6 percent slopes.
(PwA) Poinsett-Waubay silty clay loams, 0 to 3 percent slopes.
(VnA) Vienna silt loam, 0 to 3 percent slopes.
(VnB) Vienna silt loam, 3 to 6 percent slopes.
(VnC) Vienna silt loam, 6 to 9 percent slopes.
(Wa) Waubay silty clay loam.
(WfA) Waubay-Forman silty clay loams, 0 to 3 percent slopes.

These soils are permeable and take in water readily. They support a luxuriant growth of grass.

Where this site is in excellent condition, the plant cover consists of a mixture of tall and mid grasses characteristic of true prairie. Big bluestem is predominant in the less sloping areas, and little bluestem is predominant in the steeper areas. Other grasses on this site are indiangrass, switchgrass, tall dropseed, sideoats grama, green needlegrass, and western wheatgrass. Needle-and-thread, blue grama, hairy grama, sand dropseed, and sedges are the main increasers in areas that are overgrazed.

The estimated average total annual yield of all plants when air dry where this site is in excellent condition is 2,300 pounds per acre in dry years, 3,300 pounds per acre in years of normal rainfall, and 4,300 pounds per acre in wet years.

SHALLOW RANGE SITE

In this range site are steep, excessively drained soils that are shallow over glacial till or that are shallow to moderately deep over gravel. These soils are on stream terraces, lake terraces, terrace escarpments, and gravelly ridgetops. The soils in this range site are—

(BmD) Buse loam, 9 to 15 percent slopes.
(BmE) Buse loam, 15 to 35 percent slopes.
(Bo) Buse stony loam.
(BpD) Buse-Poinsett silt loams, 9 to 15 percent slopes (Buse soil only).
(BsD) Buse-Sioux loams, 6 to 15 percent slopes.
(Bu) Buse-Sioux stony loams.
(BvD) Buse-Vienna loams, 6 to 15 percent slopes (Buse soil only).
(Bx) Buse-Vienna-Sioux stony loams (Buse and Sioux soils only).
(FfA) Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes (Renshaw soil only).
(FfB) Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes (Renshaw soil only).
(PoC) Poinsett-Buse-Forman loams, 6 to 9 percent slopes (Buse soil only).
(RsA) Renshaw-Sioux complex, 0 to 3 percent slopes.
(RsB) Renshaw-Sioux complex, 3 to 6 percent slopes.
(Ts) Terrace escarpments.

These soils are droughty and are low in productivity. Many areas are steep or stony.

Where the site is in excellent condition, the vegetation is mainly mid grasses, but the stand is less dense than that on the Silty range site. Little bluestem, western wheatgrass, prairie sandreed, needle-and-thread, and sideoats grama are the principal grasses. Blue grama, hairy grama, sand dropseed, and sedges are the main increasers in areas that are overgrazed.

The estimated average total annual yield of all plants when air dry where this site is in excellent condition is 1,700 pounds per acre in dry years, 2,400 pounds per acre in years of normal rainfall, and 3,100 pounds per acre in wet years.

Use of the Soils for Windbreaks [2]

Early settlers described the Dakotas as a vast, rolling, treeless plain. This plain had only an occasional thicket of cottonwoods or willows by a stream or lake to break the

[2] A. L. Ford and Elmer L. Worthington, woodland conservationlists, Soil Conservation Service, assisted in the preparation of this section.

***Figure 19.*—A well-established field windbreak that protects the soils and crops. It also provides cover for wildlife, holds drifting snow, and adds beauty to the farm.**

monotonous expanse of grass that reached from horizon to horizon. Homesteaders' tree claims and fruit trees the homesteaders carefully tended added only a few spots of shade until the Dust Bowl years of the thirties brought about the windbreak planting program.

The trees that are now in the county are important to farmers and others. Most of these trees have been planted in windbreaks (fig. 19) that protect farmsteads and fields.

Trees and shrubs grow better on some soils than they do on others. Some soils in the county are not suited to trees, but these soils are not extensive. A study of a number of 20-year-old windbreaks has been made to determine the growth in height of the same species of trees and shrubs on different soils of this county. The results of these studies are shown in table 3.

The soils of the county range widely in slope and drainage, and this affects the kinds of trees that are suitable for windbreak plantings. Because the soils differ greatly, not only between farms but also within fields on a farm, a careful study of the soils on a site should be made before any trees are planted. Many kinds of trees are adapted to only a narrow range of soil conditions, and a knowledge of the soils will aid in selecting the best adapted species for the particular site.

The soils of the county are grouped according to their suitability for trees and shrubs, and these groups are discussed in the following pages. For each windbreak suitability group, adapted species of trees and shrubs are listed.

TABLE 3.—*Comparative heights of trees and shrubs 20 years of age on the soils of 4 windbreak groups*

[Absence of a figure indicates the species is not suited to the soils of the group]

Species	Height			
	Group 1	Group 2	Group 3	Group 4 [1]
	Feet	*Feet*	*Feet*	*Feet*
American elm	26	23	18	[2] 24
Caragana	10	8	8	---------
Green ash	20	22	14	[2] 20
Hackberry	[2] 21	20	13	---------
Lilac	[2] 9	8	[2] 7	---------
Ponderosa pine	[2] 20	18	17	---------
Redcedar	15	9	11	---------
Russian-olive	[2] 20	18	14	---------
Siberian elm	34	35	31	---------

[1] Although the comparative height of cottonwood and willow trees is not indicated, cottonwood and willow trees grow well on the soils of group 4.

[2] Estimated heights. All other figures are calculated average heights.

WINDBREAK SUITABILITY GROUP 1

In this group are deep, well-drained, sandy soils that are nonalkaline. These soils are in narrow bands along the eastern edge of the valley of the Big Sioux River. The soils in this group are—

(EfA) Egeland fine sandy loam, 0 to 3 percent slopes.
(EfB) Egeland fine sandy loam, 3 to 9 percent slopes.

All species of trees adapted to the area do well on the soils of this group.

WINDBREAK SUITABILITY GROUP 2

This group consists of deep, medium-textured and moderately fine textured soils that are nonalkaline. These soils are well drained or moderately well drained and are moderately permeable. Most of the soils of the county are in this group. The soils in this group are—

(Bc) Brookings silty clay loam.
(Bh) Brookings-Hidewood silty clay loams (Brookings soil only).
(BmD) Buse loam, 9 to 15 percent slopes
(BmE) Buse loam, 15 to 35 percent slopes.
(BpD) Buse-Poinsett silt loams, 9 to 15 percent slopes.
(BsD) Buse-Sioux loams, 6 to 15 percent slopes (Buse soil only).
(BvD) Buse-Vienna loams, 6 to 15 percent slopes.
(Bx) Buse-Vienna-Sioux stony loams (Vienna soil only).
(EsA) Estelline silt loam, 0 to 3 percent slopes.
(EsB) Estelline silt loam, 3 to 6 percent slopes.
(FmB) Forman cobbly loam, 3 to 6 percent slopes.
(FmC) Forman cobbly loam, 6 to 9 percent slopes.
(FnA) Forman loam, 0 to 3 percent slopes.
(FnB) Forman loam, 3 to 6 percent slopes.
(FnC) Forman loam, 6 to 9 percent slopes.
(KrB) Kranzburg silty clay loam, 3 to 6 percent slopes.
(Lp) La Prairie silt loam.
(Od) Oldham silty clay loam.
(Op) Oldham and Parnell silty clay loams (Oldham soil only).
(Ow) Oldham and Parnell silty clay loams, wet (Oldham soil only).
(PmA) Poinsett loam, 0 to 3 percent slopes.
(PmB) Poinsett loam, 3 to 7 percent slopes.
(PnB) Poinsett silt loam, 3 to 6 percent slopes.
(PoC) Poinsett-Buse-Forman loams, 6 to 9 percent slopes.
(PsB) Poinsett-Forman silt loams, 3 to 6 percent slopes.
(PwA) Poinsett-Waubay silty clay loams, 0 to 3 percent slopes.
(VnA) Vienna silt loam, 0 to 3 percent slopes.
(VnB) Vienna silt loam, 3 to 6 percent slopes.
(VnC) Vienna silt loam, 6 to 9 percent slopes.
(WfA) Waubay-Forman silty clay loams, 0 to 3 percent slopes.
(Wa) Waubay silty clay loam.

Species of trees adapted to the soils of this group are green ash, American elm, Siberian elm, hackberry, redcedar, ponderosa pine, Russian-olive, lilac, and caragana. Cottonwood makes rapid growth but begins to die out at an age of 10 to 15 years. Therefore, this species is not considered permanent enough for use in windbreaks on these soils.

WINDBREAK SUITABILITY GROUP 3

In this group are shallow to moderately deep, droughty soils underlain by coarse sand and gravel. The soils in this group are—

(FdA) Fordville silt loam, 0 to 3 percent slopes.
(FdB) Fordville silt loam, 3 to 6 percent slopes.
(FfA) Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes.
(FfB) Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes.
(RsA) Renshaw-Sioux complex, 0 to 3 percent slopes (Renshaw soil only).
(RsB) Renshaw-Sioux complex, 3 to 6 percent slopes (Renshaw soil only).

The best suited species on these soils are Siberian elm, green ash, redcedar, Russian-olive, and caragana. Ponderosa pine may do well on the less droughty sites.

WINDBREAK SUITABILITY GROUP 4

This group is made up of wet soils in closed depressions. These soils are along streams and bottom lands in the western and northeastern parts of the county. The soils in this group are—

(Bh) Brookings-Hidewood silty clay loams (Hidewood soil only).
(La) Lamoure silty clay loam.
(Lc) Lamoure silty clay loam, channeled.

Selecting adapted species of trees for planting on the soils of this group is difficult because the degree of wetness varies widely in different seasons and in different locations. A detailed study of the individual site should be made before selecting trees. The best trees for wet sites are common cottonwood, Siouxland cottonwood, white willow, golden willow, diamond willow, purple-osier willow, and dogwood.

WINDBREAK SUITABILITY GROUP 5

The soils of this group are too wet, too shallow, or too stony to be suitable for trees, or they contain an excessive amount of salts. The saline soils are in narrow bands around the edges of some lakes and sloughs and along some streams. Small salty spots, about 1 acre or less in size, however, may occur in any site chosen for planting trees. The soils in this group are—

(BsD) Buse-Sioux loams, 6 to 15 percent slopes (Sioux soil only).
(Bo) Buse stony loam.
(Bu) Buse-Sioux stony loams.
(Bx) Buse-Vienna-Sioux stony loams (Buse and Sioux soils only).
(Cs) Clayey saline land.
(Op) Oldham and Parnell silty clay loams (Parnell soil only).
(Ow) Oldham and Parnell silty clay loams, wet (Parnell soil only).
(Ra) Rauville silty clay loam.
(RsA) Renshaw-Sioux complex, 0 to 3 percent slopes (Sioux soil only).
(RsB) Renshaw-Sioux complex, 3 to 6 percent slopes (Sioux soil only).
(Ts) Terrace escarpments.

Use of the Soils for Wildlife [3]

The kinds and numbers of wildlife in any area depend on the kinds of soils and on their use and management. Species of wildlife, such as antelope, bison, and prairie grouse, formerly common in this area, have disappeared because they could not tolerate the change in habitat after the county was settled. Many forms of wildlife, however, did make the transition to changed land use, and some new species, such as pheasant and partridge, found the new farming operations highly compatible with their way of life.

The most common species of game in this county is the pheasant, but the population of pheasant varies greatly throughout the county. This variation is related closely to differences in the soils. The Poinsett, Waubay, and Oldham soils of association 1 in the northwestern and southwestern parts of the county and the Poinsett, Buse, and Parnell soils of association 2 in the west-central part are the main areas for these game birds. The combination of cropland, grassland, and marsh in those areas provides an ideal habitat. The Brookings, Kranzburg, and Vienna soils of association 3 support a moderate population of pheasant. The population potential on that association is limited by the more intensive use of the soils.

Waterfowl are also common throughout the county. Most of their natural habitats are in the western part of the county, mainly on the soils of associations 1 and 2. A narrow strip of Forman, Buse, and Parnell soils of association 4, which extends from north to south through the eastern part of the county, is also a habitat for waterfowl. These three soil associations contain numerous areas and marshes but few, if any, watercourses. They are part of what is termed "the prairie pothole duck factory." All the common species of duck, such as teal, mallard, pintail, spoonbill, and gadwall, nest in this pothole country. The deeper marshes provide nesting areas for redhead and canvasback ducks. In fall they provide excellent hunting for all kinds of waterfowl.

All parts of the county support a limited number of deer. The largest deer population is along the Big Sioux River and on the Estelline, Fordville, and Renshaw soils of association 6. This association follows the general direction of the Big Sioux River and extends from north to south through the center of the county. The planting of trees in farmstead and field windbreaks has extended the areas suitable for deer. Now, deer use all parts of the county to some extent.

Fish of a size and quality suitable for sport fishing are found in Lake Kampeska, Lake Pelican, Punished Womans Lake, and the Big Sioux River. The predominant species are northern pike, walleye, perch, crappie, and bullhead. Periodically, in years when there is a large amount of runoff, fishing is provided in some of the larger marshes and small lakes. The fish from the stocked lakes and the river follow the high water to an otherwise unsuitable habitat.

Other species of wildlife in this county are muskrats, skunks, raccoons, minks, rabbits, doves, and many songbirds.

The potential for increasing the ability of all the soils of the county to support a greater number of wildlife depends on the use of the land. This potential can be reached by applying the needed practices that conserve soil and water and by giving reasonable consideration to wildlife.

[3] By LeRoy A. Shearer, biologist, Soil Conservation Service, Huron, S. Dak.

Engineering Uses of Soils [4]

Since the end of the second World War, engineers have become increasingly interested in soil survey maps. Among the major reasons for this interest are the publication of modern, accurate agricultural soil maps and the increase in highway construction and other engineering projects.

Some soil properties are of special interest to engineers because they affect construction and maintenance of roads, airports, pipelines, foundations for buildings, facilities for water storage, erosion control structures, irrigation and drainage systems, and sewage disposal systems. The properties most important to the engineer are permeability, shear strength, compaction characteristics, shrink-swell characteristics, water-holding capacity, grain size, plasticity, and reaction.

The engineering interpretations reported here can be used for many purposes. It should be emphasized, however, that these interpretations 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 depths of the layers here reported. Even in these 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. Plan soil investigations that may reduce the amount of sampling and testing required for a given project.
2. Make soil and land use studies that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
3. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.
4. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, and utilities.
5. Locate probable sources of sand, gravel, and other material suitable for construction.
6. Correlate performance of engineering structures with soil mapping units and thus develop information that will be useful in designing and maintaining other structures.
7. Determine the suitability of soil mapping units for cross-country movement of vehicles and construction equipment.
8. Develop other preliminary estimates for construction purposes pertinent to the particular area.

Some of the terms used by the soil scientist may be unfamiliar to the engineer, and some words, for example, *clay*, *silt*, and *sand*, may have a special meaning in soil science. These terms, as well as other special terms used in the soil survey report, are defined in the Glossary at the back of this report.

Engineering classification systems

Most highway engineers classify soil material in accordance with the system approved by the American Association of State Highway Officials AASHO (*1*).[5] In this system soil material is classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, consisting of clayey soils that have low strength when wet. These groups are shown in tables 4 and 6. Within each of the principal groups, the relative engineering value of the soil material is indicated by a group index number. These numbers range from 0 for the best material to 20 for the poorest. For the soils tested, the group index number is shown in parentheses, following the soil group symbol in the last column of table 6.

Some engineers prefer to use the Unified soil classification system (*18*). In this system the soils are identified according to their texture and plasticity and are grouped according to their performance as engineering construction material. This system establishes 15 soil groups, which are divided into coarse-grained soils (eight classes), fine-grained soils (six classes), and highly organic soils. The classification of soils that were tested according to this system is given in table 6.

Engineering interpretations of soils

Much of the information in this section is given in tables 4, 5, and 6. In table 4 the soils are briefly described and their physical properties important to engineering are estimated. In table 5 the suitability of the soils for various engineering uses is indicated. Table 6 contains engineering test data obtained from samples taken along proposed highway routes in Codington County.

The estimates in table 4 are based on data obtained by testing similar soils in the county, on data from similar soils in other counties, and on the experience of engineers dealing with these soils as construction material. The data vary considerably because of the variations in the range of properties of the soils.

The depth to bedrock is not given in table 4, but the soils were studied to a maximum depth of 5 feet. In all parts of the county, the depth to bedrock exceeds 5 feet.

The content of salts is also not given, because it is low in all the soils, except Clayey saline land. This land type is moderately saline.

The column that shows permeability in table 4 gives the estimated rate, expressed in inches per hour, at which water moves through a soil that is not compacted. The ratings are based on estimates and on infiltration tests made on soils in South Dakota.

The estimates for available water capacity show the approximate amount of capillary water in the soil that is available to plants after the free water has been drained out of the soil. This is measured in inches per inch of soil material.

The shrink-swell potential is an estimate of the volume change to be expected in the soil material when the con-

[4] This section was prepared under the guidance of the South Dakota Soil Engineering Interpretations Committee, consisting of representatives of the South Dakota Department of Highways, Soil Conservation Service, Bureau of Public Roads, and South Dakota State University. The assistance given by personnel of the South Dakota Department of Highways was performed under a cooperative agreement with the U.S. Department of Commerce, Bureau of Public Roads.

[5] Italic numbers in parentheses refer to Literature Cited, p. 66.

tent of moisture changes. It is expressed in the following terms, which are based on the values for the liquid limit and the plasticity index of the soil:

Shrink-swell potential:

	Liquid limit	*Plasticity index*
Low	30 or less	10 or less.
Moderate	31 to 40	11 to 20.
High	41 to 60	21 to 40.
Very high	More than 60	More than 40.

A range in shrink-swell potential, for example low to moderate, is indicated when the liquid limit shows one rating for shrink-swell potential and the plasticity index shows another rating.

Soils that have a high shrink-swell potential change considerably in volume during the wetting or drying process. Buildings or shallow foundations in soils that have a high shrink-swell potential are likely to shift, and their foundations may crack. Highways on such soils may become rough and unstable unless special precautions are taken.

The depth to the water table, as shown in table 4, varies from season to season and from year to year for any of the specified soils. The information given applies to periods when the amount of rainfall is normal.

The hydrologic soil group for each soil is shown in table 4. These groupings indicate the runoff-producing potential of the soils. The groupings were made by estimating or observing at the end of a long-lasting storm the intake of water of soils that were wet when the storm started, that had swelled after they became wet, and that were bare of vegetation. The hydrologic soil groupings are defined as follows: *A*, Soils that have a high infiltration rate, even when they are saturated; they consist of deep, well-drained to excessively drained sand or gravel, or both; these soils have a high rate of water transmission and low runoff potential. *B*, Soils that have a moderate infiltration rate when saturated; they are moderately deep to deep, moderately well drained or well drained, and moderately fine textured to moderately coarse textured; these soils have a moderate rate of water transmission. *C*, Soils that have a slow infiltration rate when saturated; they contain a layer that impedes the downward movement of water or are moderately fine textured or fine textured and have a slow infiltration rate. These soils have a slow rate of water transmission. *D*, Soils that have a very slow infiltration rate when they are saturated; they are clayey soils that have a high swelling potential, soils that contain a claypan or that have a layer of clay at or near the surface, soils that are shallow over nearly impervious material, or soils that have a permanent high water table. These soils have a very slow rate of water transmission.

In table 5 the suitability ratings of the soils for various engineering uses are given. Also listed are soil features that affect the construction and maintenance of irrigation systems, terraces, and waterways. The interpretations in this table are based on the brief descriptions of the soils and their estimated properties given in table 4 and on the engineering test data given in table 6.

The ratings for road subgrade, as given in table 5, are estimates of the suitability of soil material for the support of a roadway. They are based on the texture of the soils. If other factors remain constant, the soils that are given the higher ratings will be suitable for thinner, less costly pavement. A layer of plastic clay impedes internal drainage and has low stability when wet. Soils that contain such material are given a rating of "poor."

The rating given to show suitability of the soils for road fill is an evaluation of the stability of the soil material if it is used in constructing fills, mainly for highways. This estimate is based on the data given in table 6 and on the assumption that proper practices will be used in constructing the fill. The suitability of the soil material for road fill depends largely on the texture. Highly plastic soil material that has a naturally high content of water is given a rating of "poor."

Suitability for seeding and sodding is an estimate of the effect of texture, fertility, and other characteristics on the ability of the soil to support plants. Information in this column will be helpful to those who wish to grow plants for esthetic purposes, to control erosion, or for other purposes.

Suitability of a soil as a source of sand and gravel indicates the value of that soil for construction material. This rating is only a rough guide to indicate the location of soils where detailed investigations might indicate the presence of desirable construction material.

Susceptibility to frost action is determined by the physiographic position and the physical properties of the soil. The ratings used by the South Dakota Department of Highways are defined as follows: *Slight*—the soil heaves only slightly or not at all when subjected to moisture and freezing; *medium*—the soil heaves to a certain extent (0.1 to 0.2 inch per foot of frost penetration) when it is subjected to moisture and freezing; and *high*—the soil heaves substantially (0.2 inch or more per foot of frost penetration) when it is subjected to moisture and freezing.

Susceptibility to sliding is determined by the kind of soil, its moisture content, and its physiographic position.

Ratings for the suitability of soils for reservoir areas, for embankments, and for features that affect irrigation, terraces, and waterways are estimates of soil properties that might affect the specific practice on construction.

Table 6 summarizes data obtained by the South Dakota Department of Highways as a result of exploring and testing the soils of Codington County. Soil samples were taken along the proposed routes for highways and were tested in laboratories. These data, along with data on the intensity of traffic, precipitation, frost action, depth to the water table, and kind of terrain, help to determine how thick the pavement needs to be to give adequate wheel-load strength.

The location and depth of the soil samples were matched with those of soil mapping units, and the range and mean values of the test results of all samples within each mapping unit were determined. For highway design purposes, samples are taken to represent only major differences in soil texture and color. For this reason, more than one soil horizon may be represented in one engineering soil sample. The major horizons that the engineering samples are believed to represent are indicated in table 6.

Mechanical analysis and tests to determine liquid limit, plasticity index, maximum density, and optimum moisture content were performed according to procedures of the American Association of State Highway Officials (*1*).

TABLE 4.—*Brief description of soils of Codington County,*

Symbol on map	Soil name	Description of soil	Depth from surface	Classification	
				USDA	Unified
			Inches		
Bc	Brookings silty clay loam.	Deep, moderately well drained soil developed in 1 to 5 feet of loess over glacial till.	0 to 13	Silty clay loam	ML-CL
			13 to 29	Silty clay loam	CL
			29 to 60	Clay loam to silty clay loam.	CL
Bh	Brookings-Hidewood silty clay loams (Hidewood soil).	Deep, moderately fine textured, somewhat poorly drained soil in indefinite upland depressions; developed in 1 to 5 feet of loess over glacial till. For estimated properties of the Brookings soil, see Brookings silty clay loam.	0 to 9	Silty clay loam	CL
			9 to 20	Silty clay	CL or CH
			20 to 60	Clay loam	CL or CH
BmD	Buse loam, 9 to 15 percent slopes.	Steep, excessively drained soils developed in glacial till or silty glacial drift. Some areas are stony. For estimated properties of the Poinsett soil, see the Poinsett soils; for estimated properties of the Sioux soils, see the Sioux soils of the Renshaw-Sioux complexes; and for estimated properties of the Vienna soils, see the Vienna soils.	0 to 12	Loam to silt loam	ML-CL
BmE	Buse loam, 15 to 35 percent slopes.		12 to 60	Clay loam to loam	CL
Bo	Buse stony loam.				
BpD	Buse-Poinsett silt loams, 9 to 15 percent slopes (Buse soil).				
BsD	Buse-Sioux loams, 6 to 15 percent slopes (Buse soil).				
Bu	Buse-Sioux stony loams (Buse soil).				
BvD	Buse-Vienna loams, 6 to 15 percent slopes (Buse soil).				
Bx	Buse-Vienna-Sioux stony loams (Buse soil).				
Cs	Clayey saline land.	Deep, poorly drained, moderately saline land type underlain by water-deposited silt and clay in old lakebeds.	(1)	(1)	(1)
EfA	Egeland fine sandy loam, 0 to 3 percent slopes.	Deep, moderately coarse textured, well-drained soils developed in wind-deposited sandy loam and sand over glacial till.	0 to 10	Fine sandy loam to sandy loam.	SM-SC
EfB	Egeland fine sandy loam, 3 to 9 percent slopes.		10 to 31	Fine sandy loam to loamy sand.	SM-SC
			31 to 60	Loamy sand to loam.	SP-SM
EsA	Estelline silt loam, 0 to 3 percent slopes.	Deep, medium-textured, well-drained soils developed in 36 to 60 inches of loess over sand and gravel.	0 to 8	Silt loam	ML-CL
EsB	Estelline silt loam, 3 to 6 percent slopes.		8 to 28	Silty clay loam	ML-CL
			28 to 45	Silt loam to loam	ML-CL
			45 to 60	Fine sand to coarse sand and gravelly sand.	SM-SC
FdA	Fordville silt loam, 0 to 3 percent slopes.	Moderately shallow, medium-textured soils developed in 20 to 36 inches of alluvium over sand and gravel.	0 to 6	Silt loam to loam	ML-CL
FdB	Fordville silt loam, 3 to 6 percent slopes.		6 to 25	Silt loam to loam	CL
			25 to 60	Sand and gravel	GP or SM-SC.
FfA	Fordville-Renshaw fine sandy loams, 0 to 3 percent slopes (Fordville soil).	Moderately shallow, moderately coarse textured soils developed in 20 to 36 inches of sandy alluvium over sand and gravel. For estimated properties of the Renshaw soils, see the Renshaw-Sioux complexes.	0 to 9	Fine sandy loam to sandy loam.	SM or ML
FfB	Fordville-Renshaw fine sandy loams, 3 to 6 percent slopes (Fordville soil).		9 to 23	Sandy loam to loam.	SM or ML
			23 to 60	Sand and gravel	GP to SM

See footnotes at end of table.

S. Dak., and their estimated physical properties

Classification—Con.	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Water table	Hydrologic soil group
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
				Inches per hour	*Inches per inch of soil*	*pH value*			
A-7-6 or A-6.	100	95 to 100	75 to 95	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Moderate to high	Generally below a depth of 4 feet.	B.
A-6 or A-7.	100	95 to 100	75 to 95	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Moderate to high		
A-6	100	95 to 100	65 to 95	0.2 to 0.8	0.14 to 0.21	7.4 to 8.4	Moderate		
A-6	100	95 to 100	75 to 95	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Moderate to high	Generally below a depth of 2 feet.	C.
A-7-6	100	95 to 100	75 to 95	0.05 to 0.2	0.13 to 0.21	6.6 to 7.8	Moderate to high		
A-7-6 or A-6.	100	90 to 100	60 to 90	0.2 to 0.8	0.14 to 0.21	7.4 to 8.4	Moderate to high		
A-6	100	95 to 100	60 to 95	0.8 to 2.5	0.17 to 0.19	6.6 to 7.8	Moderate to high	Below a depth of 5 feet.	B.
A-6	100	95 to 100	60 to 95	0.2 to 2.5	0.14 to 0.21	7.4 to 8.4	Moderate		
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
A-4 or A-2-4.	75 to 100	75 to 100	30 to 50	2.5 to 5.0	0.10 to 0.15	6.0 to 6.5	Low	Below a depth of 5 feet.	A.
A-4 or A-2-4.	75 to 100	75 to 100	15 to 50	2.5 to 10.0	0.06 to 0.15	6.6 to 7.8	Low		
A-3 or A-6.	75 to 100	75 to 100	15 to 80	1.2 to 10.0	0.06 to 0.19	7.4 to 8.4	Low to moderate		
A-7-6 or A-6.	100	95 to 100	60 to 90	0.8 to 0.2	0.17 to 0.19	6.0 to 6.5	Moderate	Below a depth of 5 feet.	B.
A-6 or A-7-6.	100	95 to 100	60 to 95	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Moderate to high		
A-7-6 or A-6.	95 to 100	95 to 100	60 to 95	0.8 to 2.5	0.17 to 0.19	7.4 to 8.4	Moderate		
A-1-b or A-4.	70 to 95	40 to 95	5 to 45	10+	0.03 to 0.06	7.4 to 8.4	Low		
A-7 or A-6.	95 to 100	85 to 100	60 to 95	0.8 to 2.5	0.17 to 0.19	5.8 to 6.5	Low to high	Below a depth of 5 feet.	B.
A-7 or A-6.	95 to 100	95 to 100	60 to 85	0.8 to 2.5	0.17 to 0.19	6.6 to 7.8	Low to moderate		
A-1 or A-4.	25 to 100	15 to 75	5 to 45	10+	0.03 to 0.06	7.4 to 8.5	Low to moderate		
A-2 or A-6.	95 to 100	90 to 100	25 to 55	2.5 to 5.0	0.10 to 0.15	6.0 to 6.5	Low to moderate	Below a depth of 5 feet.	A-B.
A-2 or A-6.	95 to 100	95 to 100	25 to 75	1.2 to 5.0	0.10 to 0.19	6.6 to 7.8	Low to moderate		
A-1 or A-4.	25 to 100	15 to 75	5 to 50	10+	0.03 to 0.06	7.4 to 8.4	Low		

TABLE 4.—*Brief description of soils of Codington County,*

Symbol on map	Soil name	Description of soil	Depth from surface	Classification	
				USDA	Unified
			Inches		
FmB	Forman cobbly loam, 3 to 6 percent slopes.	Deep, medium-textured, well-drained soils developed in moderately fine textured glacial till. A few to many cobbles and stones occur in some areas.	0 to 7	Loam to clay loam	ML or CL
FmC	Forman cobbly loam 6 to 9 percent slopes.		7 to 30	Clay loam	CL
FnA	Forman loam, 0 to 3 percent slopes.		30 to 60	Clay loam to loam	ML or CL
FnB	Forman loam, 3 to 6 percent slopes.				
FnC	Forman loam, 6 to 9 percent slopes.				
KrB	Kranzburg silty clay loam, 3 to 6 percent slopes.	Deep, well-drained soil developed in 15 to 40 inches of silty clay loam loess over glacial till.	0 to 8	Silty clay loam	ML or CL
			8 to 25	Silty clay loam	ML or CL
			25 to 60	Loam to clay loam	ML or CL
La	Lamoure silty clay loam.	Deep, somewhat poorly drained, moderately fine textured soil on bottom lands; developed in alluvial material.	0 to 7	Silty clay loam to silt loam.	ML or MH
Lc	Lamoure silty clay loam, channeled.		7 to 46	Clay loam to silty clay loam.	CL or CH
			46 to 60	Silty clay loam to coarse sand.	SC or CL
Lp	La Prairie silt loam.	Deep, medium-textured, moderately well drained soils in upland swales.	0 to 40	Silt loam or loam to silty clay loam.	ML or CL
			40 to 60	Clay loam	ML or CL
Od	Oldham silty clay loam.	Deep, moderately fine textured, somewhat poorly drained soil in closed depressions and in dry lakebeds; developed in water-deposited silt and clay.	0 to 8	Silty clay loam to silty clay.	CL or CH
			8 to 60	Silty clay	CL or CH
Op	Oldham and Parnell silty clay loams (Parnell soil).	Deep, moderately fine textured, poorly drained soils in closed depressions; developed in water-deposited silt and clay. For estimated properties of the Oldham soils, see Oldham silty clay loam.	0 to 7	Silty clay loam	CL or CH
Ow	Oldham and Parnell silty clay loams, wet (Parnell soil).		7 to 29	Silty clay loam to clay.	CL or CH
			29 to 60	Silty clay loam to clay.	CL or CH
PmA	Poinsett loam, 0 to 3 percent slopes.	Deep, medium-textured, well-drained soils developed in silty glacial drift or stratified, water-deposited silt and sand. For estimated properties of the Buse soil, see the Buse soils; for estimated properties of the Forman soils, see the Forman soils; and for estimated properties of the Waubay soil, see the Waubay soils.	0 to 7	Loam or very fine sandy loam to silty clay loam.	ML or CL
PmB	Poinsett loam, 3 to 7 percent slopes.				
PnB	Poinsett silt loam, 3 to 6 percent slopes.		7 to 22	Silt loam to silty clay loam.	ML or CL
PoC	Poinsett-Buse-Forman loams, 6 to 9 percent slopes (Poinsett soil).		22 to 60	Loam to clay loam	ML or CL
PsB	Poinsett-Forman silt loams, 3 to 6 percent slopes (Poinsett soil).				
PwA	Poinsett-Waubay silty clay loams, 0 to 3 percent slopes (Poinsett soil).				
Ra	Rauville silty clay loam.	Deep, moderately fine textured, poorly drained or very poorly drained soils on bottom lands; developed in alluvium.	0 to 40	Silty clay loam to silty clay.	CL or CH
			40 to 60+	Silty clay loam to sand and gravel.	GC or CL

See footnotes at end of table.

S. Dak., and their estimated physical properties—Continued

Classification—Con.	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Water table	Hydrologic soil group
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
				Inches per hour	*Inches per inch of soil*	*pH value*			
A-7-6	95 to 100	95 to 100	60 to 90	0.2 to 2.5	0.14 to 0.21	6.6 to 7.8	Moderate to high	Below a depth of 5 feet.	B.
A-7-6 or A-6.	95 to 100	90 to 100	70 to 95	0.2 to 0.8	0.14 to 0.21	7.4 to 8.4	Moderate to high		
A-7-6 or A-6.	95 to 100	90 to 100	60 to 90	0.2 to 2.5	0.14 to 0.21	7.4 to 8.4	Moderate		
A-6 or A-7-6.	95 to 100	95 to 100	75 to 95	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Moderate to high	Below a depth of 5 feet.	B.
A-6 or A-7-6.	95 to 100	95 to 100	75 to 95	0.2 to 0.8	0.14 to 0.21	7.4 to 8.4	Moderate to high		
A-6	95 to 100	90 to 100	60 to 95	0.2 to 2.5	0.14 to 0.21	7.4 to 8.5	Moderate to high		
A-7-6	100	100	90 to 100	0.2 to 0.8	0.14 to 0.21	7.4 to 8.4	High	Below a depth of 1 to 4 feet.	C.
A-7-6	100	100	90 to 100	0.2 to 0.8	0.14 to 0.21	7.9 to 9.0	High		
A-1 or A-6.	75 to 100	50 to 100	12 to 90	0.2 to 10.0	0.10 to 0.21	7.9 to 9.0	Low to high		
A-7	100	100	75 to 95	0.2 to 2.5	0.14 to 0.21	6.6 to 7.8	Moderate to high	Below a depth of 3 feet.	B.
A-6 or A-7.	100	95 to 100	60 to 95	0.2 to 0.8	0.14 to 0.21	7.4 to 8.4	Moderate to high		
A-7	100	100	90 to 95	0.05 to 0.8	0.13 to 0.21	6.6 to 7.8	Moderate to high	Below a depth of 2 to 5 feet.	C.
A-7	100	100	90 to 95	0.05 to 0.2	0.13 to 0.21	7.9 to 9.0	Moderate to high		
A-7	100	100	90 to 95	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Moderate to high	Frequently at or above the surface.	C.
A-7	100	100	90 to 95	0.05 to 0.8	0.13 to 0.21	7.4 to 7.8	Moderate to high		
A-7	100	100	90 to 95	0.05 to 0.8	0.13 to 0.21	7.4 to 7.8	Moderate to high		
A-4 or A-7.	95 to 100	95 to 100	60 to 95	0.2 to 3.0	0.13 to 0.21	6.6 to 7.8	Moderate to high	Below a depth of 5 feet.	B.
A-4 or A-7.	95 to 100	95 to 100	60 to 95	0.2 to 2.0	0.14 to 0.21	7.4 to 8.4	Moderate to high		
A-4 or A-7.	95 to 100	90 to 100	60 to 98	0.2 to 1.2	0.14 to 0.21	7.9 to 9.0	Moderate to high		
A-6 or A-7.	95 to 100	95 to 100	90 to 95	0.05 to 0.8	0.13 to 0.21	7.4 to 8.4	Moderate to high	Frequently at or above the surface.	D.
A-2 or A-7.	60 to 100	35 to 95	25 to 95	0.2 to 10.0	0.03 to 0.21	7.4 to 8.4	Low to high		

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TABLE 4.—*Brief description of soils of Codington County,*

Symbol on map	Soil name	Description of soil	Depth from surface	Classification	
				USDA	Unified
			Inches		
RsA	Renshaw-Sioux complex, 0 to 3 percent slopes (Renshaw soil).	Shallow, medium-textured, excessively drained soils developed in 10 to 20 inches of alluvium over sand and gravel. For estimated properties of the Sioux soils, see the Sioux soils of the Renshaw-Sioux complexes.	0 to 7	Fine sandy loam to silt loam.	SM or ML
RsB	Renshaw-Sioux complex, 3 to 6 percent slopes (Renshaw soil).		7 to 15	Sandy loam to loam.	SM or ML
			15 to 60	Sand and gravel	GP or SM
RsA	Renshaw-Sioux complex, 0 to 3 percent slopes (Sioux soil).	Very shallow, excessively drained soils developed in less than 10 inches of alluvium over sand and gravel. For estimated properties of the Renshaw soils, see the Renshaw soils of the Renshaw-Sioux complexes.	0 to 6	Sandy loam to loam.	SM or ML
RsB	Renshaw-Sioux complex, 3 to 6 percent slopes (Sioux soil).		6 to 60	Sand and gravel	GP or SM
Ts	Terrace escarpments.	Rolling to steep, excessively drained land type that is shallow over gravel; on breaks of stream terraces.			
VnA	Vienna silt loam, 0 to 3 percent slopes.	Deep, medium-textured, well-drained soils developed in loam or clay loam glacial till.	0 to 5	Silt loam or loam to silty clay loam.	ML-CL or CL.
VnB	Vienna silt loam, 3 to 6 percent slopes.				
VnC	Vienna silt loam, 6 to 9 percent slopes.		5 to 23	Clay loam to silty clay loam.	ML-CL
			23 to 60	Loam to clay loam	ML-CL or CL.
Wa	Waubay silty clay loam.	Deep, dark, moderately fine textured, moderately well drained soils developed in colluvial and alluvial material or glacial drift. For estimated properties of the Forman soil, see the Forman soils.	0 to 22	Silty clay loam	ML-CL or CL.
WfA	Waubay-Forman silty clay loams, 0 to 3 percent slopes (Waubay soil).		22 to 60	Silty clay loam	ML or CL

[1] Not determined or variable.

The values for dry, loose weight of each sample were obtained by test procedures developed by the South Dakota Department of Highways.

Mechanical analysis, liquid limit, plasticity index, and dry, loose weight were determined for all of the samples tested. Maximum density and optimum moisture content were obtained for some of the samples, generally one or two. These data were obtained by the standard Proctor method.

The test for liquid limit and plastic limit measures the effect of water on the consistence of the soil material. As the moisture content of a soil is increased from a 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 state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is in a plastic condition.

If soil material is compacted at a successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material will increase until the optimum moisture content is reached. After that, the density decreases with an increase in moisture content. The highest dry density obtained in the compaction test is termed the maximum density.

The Unified and AASHO classifications given in table 6 are based on the mean values of the samples. They do not indicate the classification of any one sample, nor do they indicate the range in classification of a specific soil horizon.

Genesis, Classification, and Morphology of Soils

The purpose of this section is to present the outstanding characteristics of the soils of Codington County and to re-

S. Dak., and their estimated physical properties—Continued

Classification—Con.	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential	Water table	Hydrologic soil group
AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)						
				Inches per hour	*Inches per inch of soil*	*pH value*			
A-1 or A-4.	95 to 100	90 to 100	25 to 75	0.8 to 5.0	0.10 to 0.19	6.0 to 6.5	Low	Below a depth of 5 feet.	B.
A-1 or A-4.	90 to 100	60 to 90	25 to 75	1.2 to 5.0	0.10 to 0.19	6.6 to 7.8	Low		
A-1 or A-3.	25 to 80	15 to 60	0 to 15	10+	0.03 to 0.06	7.4 to 8.4	Low		
A-1 or A-4.	90 to 100	85 to 100	25 to 75	1.2 to 5.0	0.10 to 0.19	6.0 to 6.5	Low	Below a depth of 5 feet.	B.
A-1 or A-3.	25 to 75	15 to 50	0 to 25	10+	0.03 to 0.06	7.4 to 8.4	Low		
A-6 or A-7-6.	100	95 to 100	70 to 95	0.2 to 2.5	0.14 to 0.21	6.0 to 6.5	Low to moderate	Below a depth of 5 feet.	B.
A-6 or A-7.	100	90 to 100	60 to 90	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Low to moderate		
A-4 or A-7.	95 to 100	90 to 100	50 to 90	0.2 to 2.5	0.14 to 0.21	7.9 to 9.0	Low to moderate		
A-6 or A-7.	95 to 100	95 to 100	85 to 95	0.2 to 0.8	0.14 to 0.21	6.6 to 7.8	Moderate to high	Below a depth o 4 feet.	B.
A-6 or A-7.	95 to 100	90 to 100	75 to 95	0.2 to 0.8	0.14 to 0.21	7.9 to 9.0	Moderate to high		

late them to the factors of soil formation. The first part of the section deals with the environment of the soils; the second, with the classification of the soils; the third, with the morphology of the soils; and the fourth, with the chemical and physical analyses of selected soils.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by (1) the climate under which the soil material has accumulated and existed since accumulation; (2) the physical and mineralogical composition of the parent material; (3) the relief, or lay of the land; (4) the plant and animal life on and in the soil; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related layers, called horizons. The effects of climate and vegetation are influenced by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into soil. The amount of time may be short or long, but some time is required to form soil horizons. Usually, a long time is required to form distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one, unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Climate

The physical and chemical processes of weathering within the parent material, as well as biologic activity, are influenced by climate. These processes of soil formation

TABLE 5.—*Interpretations of*

Soil series and map symbol [1]	Suitability of soil material for—			Suitability as source of—		Susceptibility to—	
	Road subgrade	Road fill [2]	Seeding and sodding	Sand	Gravel	Frost action	Sliding
Brookings (Bc, Bh)	Poor	Fair	Good	Unsuitable	Unsuitable	Medium	None
Buse (BmD, BmE, Bo, BpD, BsD, Bu, BvD, Bx, PoC).	Fair	Fair	Poor	Unsuitable	Good in localized pockets.	Medium to high.	Slight
Clayey saline land (Cs)	Poor	Poor	Poor	Unsuitable	Unsuitable	High	None
Egeland (EfA, EfB)	Fair to good	Fair to good	Fair	Suitable	Unsuitable	Slight	None
Estelline (EsA, EsB)	Fair	Poor; good below the subsoil.	Good	Suitable	Unsuitable	Medium	Slight
Fordville (FdA, FdB, FfA, FfB).	Fair	Fair to a depth of 2 feet; good below that depth.	Fair	Suitable	Suitable	Medium	Slight
Forman (FmB, FmC, FnA, FnB, FnC, PoC, PsB, WfA).	Fair	Poor to fair	Fair to good	Unsuitable	Unsuitable	Medium	Slight
Hidewood (Bh)	Poor	Poor to fair	Fair	Unsuitable	Unsuitable	High	None
Kranzburg (KrB)	Fair	Fair	Good	Unsuitable	Unsuitable	Medium	Slight
Lamoure (La, Lc)	Poor to fair	Poor to fair	Fair to good	Unsuitable	Unsuitable	Medium to high	None
La Prairie (Lp)	Poor to fair	Poor to fair	Good	Unsuitable	Unsuitable	Medium	None
Oldham (Od, Op, Ow)	Poor	Poor	Fair	Unsuitable	Unsuitable	High	Slight
Parnell (Op, Ow)	Poor	Poor	Fair	Unsuitable	Unsuitable	High	Slight
Poinsett (PmA, PmB, PnB, BpD, PoC, PsB, PwA).	Fair	Fair	Good	Unsuitable	Unsuitable	Medium	Slight
Rauville (Ra)	Poor	Poor to fair	Fair	Unsuitable	Unsuitable	High	None
Renshaw (RsA, RsB, FfA, FfB).	Poor to good	Fair to good	Poor to fair	Suitable	Suitable	Slight	None
Sioux (RsA, RsB, BsD, Bu, Bx).	Fair to good	Good	Poor	Suitable	Suitable	Slight	None
Terrace escarpments (Ts)	Fair to good	Variable; generally good.	Poor	Suitable in localized pockets.	Good in localized pockets.	Slight	Slight
Vienna (VnA, VnB, VnC, Bx, BvD).	Poor to fair	Fair	Good	Unsuitable	Unsuitable	Medium	Slight
Waubay (Wa, WfA, PwA).	Poor	Poor to fair	Good	Unsuitable	Unsuitable	Medium to high.	None

[1] Soil complexes are not listed separately. For their suitability and features, refer to the individual soils of the complexes.

engineering properties of soils

Suitability of soils for farm ponds—		Soil features affecting—		
Reservoir area	Embankment [2]	Irrigation	Terraces	Waterways
Not applicable for low dams; good for dugouts where surface runoff is slow.	Fair	Moderate permeability; needs adequate drainage.	No limitations	No limitations.
Not applicable	Fair	Not applicable	Complex slopes; thin surface layer; stony in places.	Steep slopes; severe hazard of erosion.
Unsuitable; saline	Poor	Slow permeability; saline	Slow permeability; lacks grade.	Lakebeds are saline and vegetation is difficult to establish.
Poor for low dams; good for dugouts where the water table is high.	Fair	Moderately rapid permeability.	Sandy and erodible	Sandy and erodible.
Poor for low dams; good for dugouts where the water table is high.	Poor to fair	Moderate permeability; good subsurface drainage.	No limitations	No limitations.
Poor for low dams; good for dugouts where the water table is high.	Poor to fair	Low water-holding capacity.	Gravel within 20 to 36 inches of the surface.	No limitations.
Not applicable for low dams; good for dugouts where surface runoff is slow.	Poor to fair	Moderate permeability; stones in some places.	Complex slopes in a few areas; stony.	No limitations.
Not applicable for low dams; good for dugouts where surface runoff is slow.	Poor to fair	Slow permeability; needs drainage.	In depressions	Outlets difficult to locate; somewhat wet.
Good for low dams; good for dugouts where surface runoff is slow.	Poor to fair	Moderate permeability	No limitations	No limitations.
Fair for low dams; good for dugouts where the water table is high.	Poor to fair	Moderate permeability; needs drainage in places.	Generally not applicable	On bottom lands; flooded in wet years.
Good for low dams; good for dugouts where surface runoff is slow.	Poor to fair	Needs drainage in places	In swales; wet in places	Somewhat wet in places.
Not applicable for low dams; good for dugouts where surface runoff is slow.	Poor	Slow permeability; needs drainage.	In depressions	Wet; outlets difficult to locate.
Not applicable for low dams; good for dugouts because the water table is frequently high.	Poor	Slow permeability	In depressions; wet	Too wet.
Not applicable for low dams; good for dugouts where surface runoff is slow.	Fair	Moderate permeability	No limitations where slopes are smooth.	No limitations, except on higher slopes.
Fair for low dams; good for dugouts because the water table is frequently high.	Poor	Needs drainage	Too wet and too low	On bottom lands where the water table is high.
Poor for low dams; good for dugouts where the water table is high.	Fair to good	Low water-holding capacity.	Gravel within 10 to 20 inches of the surface.	Gravel within 10 to 20 inches of the surface.
Poor for low dams; good for dugouts where the water table is high.	Fair	Very shallow over gravel	Gravel within 10 inches of the surface.	Shallow over gravel; erodible.
Not applicable	Fair to good	Not applicable	Shallow over gravelly material; steep slopes.	Steep slopes.
Not applicable for low dams; questionable for dugouts.	Poor to fair	Moderate permeability	No limitations	No limitations.
Not applicable for low dams; good for dugouts where the water table is high.	Poor to fair	Moderate permeability; needs drainage in places.	No limitations, except in wet swales.	No limitations.

[2] Refers to stability of the soil material if the soil is used for the purpose indicated.

TABLE 6.—*Engineering test data*[1] *for soil*

[Absence of a figure indicates that the soils

Soils and map symbols	Horizon	Number of samples tested	Mechanical analysis							
			Percentage passing sieve—						Percentage smaller than 5 microns	
			No. 10 (2.0 mm.)		No. 40 (0.42 mm.)		No. 200 (0.074 mm.)			
			Range	Mean	Range	Mean	Range	Mean	Range	Mean
Brookings silty clay loam (Bc).	A	2	99–100	99	92–95	94	71–80	76	11–13	12
	B	3	97–99	98	91–94	92	76–78	77	9–23	16
	C	3	90–96	93	81–87	84	63–69	66	23–26	24
Buse loam (BmD, BmE).	A	2	96–100	98	85–99	92	61–97	79	--------	--------
	AC	2	98–100	99	91–99	95	72–96	84	--------	--------
	C	4	96–98	97	90–92	91	54–71	66	10–25	21
Egeland fine sandy loam (EfA, EfB).	A	2	99	99	78–94	86	37–40	38	4–6	5
	B	1	100	100	95	95	37	37	10	10
	C1	1	78	78	39	39	10	10	3	3
	IIC2	1	100	100	97	97	75	75	40	40
Estelline silt loam (EsA, EsB).	A	14	96–100	98	78–98	90	54–89	73	4–31	19
	B	11	93–100	98	76–99	90	60–96	75	9–26	17
	C	8	98–100	99	91–97	95	73–93	84	9–32	21
	IIC	11	37–98	73	15–85	46	9–70	22	7–18	11
Fordville silt loam (FdA, FdB).	A	10	87–100	95	59–86	78	39–63	52	13–41	19
	B	3	97–99	98	82–89	85	57–62	59	11–23	17
	C	3	52–64	60	30–46	37	13–32	19	6–8	7
Kranzburg silty clay loam (KrB).	A	3	100	100	98–99	98	90–94	92	--------	--------
	B	7	99–100	100	94–100	96	77–95	84	9–11	10
	C1	6	100	100	98–100	99	92–98	96	--------	--------
	C2	4	93–99	95	84–91	88	65–79	73	21–22	22
Parnell silty clay loam (Op, Ow).	A	1	100	100	98	98	87	87	14	14
	B	3	99–100	99	96–99	98	84–92	87	16–17	16
	C	3	98–100	99	97–99	98	95–96	96	24–25	25
Poinsett silt loam (PnB).	A	28	93–100	99	83–99	95	22–96	78	4–18	12
	B	33	90–100	98	80–100	94	20–98	80	8–33	18
	C	24	77–100	95	50–100	88	21–98	75	6–47	20
Sioux loam (RsA, RsB).	A	7	71–79	91	24–79	55	6–43	28	4–13	9
	C	7	43–99	85	25–88	62	8–53	21	1–12	4
Vienna silt loam (VnA, VnB, VnC).	A	4	97–100	98	87–99	91	63–93	75	6–8	7
	B	14	96–100	98	87–99	92	59–93	74	5–15	10
	C	12	92–100	96	75–100	87	47–97	59	5–34	22
Waubay silty clay loam (Wa).	A	1	99	99	97	97	86	86	13	13
	B	2	95–98	96	93–96	94	83	83	14–34	24
	C1	3	98–100	99	92–99	96	70–98	83	23	23

[1] Tests made by the South Dakota Department of Highways.

are most active where the soil material is warm and moist. If the climate is too cold, too wet, or too dry, these processes act slowly.

The climate of Codington County is continental and subhumid. Winters are long and cold, summers are hot, and abrupt changes and wide variations in temperature occur. The average annual precipitation is 20.75 inches, of which 78 percent is received during the growing season of about 137 days.

The influence of climate on the formation of soils in this county is evident. The amount of precipitation has been great enough to leach calcium carbonate to an average depth of 18 to 24 inches in most of the well-drained, gently sloping soils. The combination of temperature, precipitation, and length of the growing season have favored grassland vegetation. The residue from these grasses has produced an abundance of organic matter, which accounts for the dark colors of the surface layer of the soils. Also, strong winds have sorted and shifted the parent material over much of the area.

samples taken along proposed highway routes

were not tested for the indicated property]

Liquid limit		Plasticity index		Dry loose weight		Maximum density		Optimum moisture		Classification	
Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Unified	AASHO
38–45	42	18–19	18	71–73	72	98	98	21	21	ML–CL	A–7–6(12).
38–42	40	17–19	18	71–75	73	105	105	19	19	CL	A–6(11).
31–35	33	15–19	17	77–82	80	112	112	15	15	CL	A–6(9).
42–47	44	14–18	16	60–63	62					ML–CL	A–7–6(11).
41–44	42	18–23	20	61–80	70					CL	A–7–6(12).
29–36	34	10–19	16	79–86	84	103	103	21	21	CL	A–6(9).
28–36	32	4–12	8	77	77					SM–SC	A–4(1).
22	22	5	5	81	81					SM–SC	A–4(0).
22	22	4	4	92	92					SP–SM	A–3(0).
44	44	25	25	79	79					CL	A–7–6(15).
29–44	38	0–19	12	61–78	70	86–109	94	15–27	23	ML–CL	A–6(8).
26–48	35	6–23	13	63–77	70	107–110	108	15–16	16	ML–CL	A–6(9).
29–39	35	7–19	13	68–77	73	106–108	107	16	16	ML–CL	A–6(9).
17–31	21	0–14	4	73–114	99	123	123	12	12	SM–SC	A–1–b(0).
22–49	41	3–21	16	63–83	70	98–116	107	13–19	16	ML–CL	A–7–6(6).
23–35	31	6–16	12	67–81	75	108	108	16	16	CL	A–6(6).
20–31	24	3–15	8	93–108	100					SC	A–2–4(0).
40–48	43	10–13	12	62–63	62					ML	A–7–5(9).
36–46	42	11–20	15	60–75	67					ML–CL	A–7–6(10).
31–41	34	8–19	12	62–78	71					ML–CL	A–6(9).
34–37	35	15–19	17	62–83	74	113	113	17	17	CL	A–6(10).
46	46	14	14	61	61					ML	A–7–5(11).
40–56	48	15–20	17	58–73	65					ML	A–7–5(12).
34–41	38	11–16	14	72–76	74					ML–CL	A–6(10).
19–57	42	2–23	13	56–76	64	94	94	26	26	ML	A–2–6(10).
19–46	35	1–22	12	63–82	71	95–109	102	16–27	21	ML–CL	A–6(9).
21–42	32	1–21	11	60–91	72					CL	A–6(8).
15–47	32	0–15	9	70–97	82	114–117	115	13–14	14	SM–SC	A–2–4(0).
15–38	22	0–19	4	77–120	91	104	104	17	17	SM–SC	A–2–4(0).
39–44	42	11–16	14	63–74	70	85	85	28	28	ML	A–7–6(10).
26–50	41	4–27	16	64–77	71	88–105	98	15–26	21	ML–CL	A–7–6(10).
26–54	35	8–37	17	69–90	82	113–116	114	14–16	15	CL	A–6(8).
46	46	18	18	66	66					ML–CL	A–7–6(12).
41	41	16–20	18	70–71	70					CL	A–7–6(11).
31–42	36	13–18	15	68–74	71					CL	A–6(10).

Parent material

Most of the soils of Codington County formed in material deposited by glaciers, but the parent material has been modified by water or wind in some places. As a result, many soils that have characteristics distinctly different from those of soils developed in glacial material have been produced.

The Vienna, Forman, and Buse soils developed in loamy or somewhat clayey glacial till. They are in areas where the relief is gently sloping to rolling.

The Brookings, Kranzburg, and Hidewood soils developed in silty windblown material, or loess, that covers the glacial till to a depth of 1 to 5 feet in some parts of the county. They are in nearly level or gently sloping areas. The Egeland soils also developed in windblown material, but they developed in sandy instead of in silty material.

The Poinsett and Waubay soils developed in silty glacial drift. They are in undulating to rolling areas in the western part of the county.

Outwash sands and gravel underlie some of the soils.

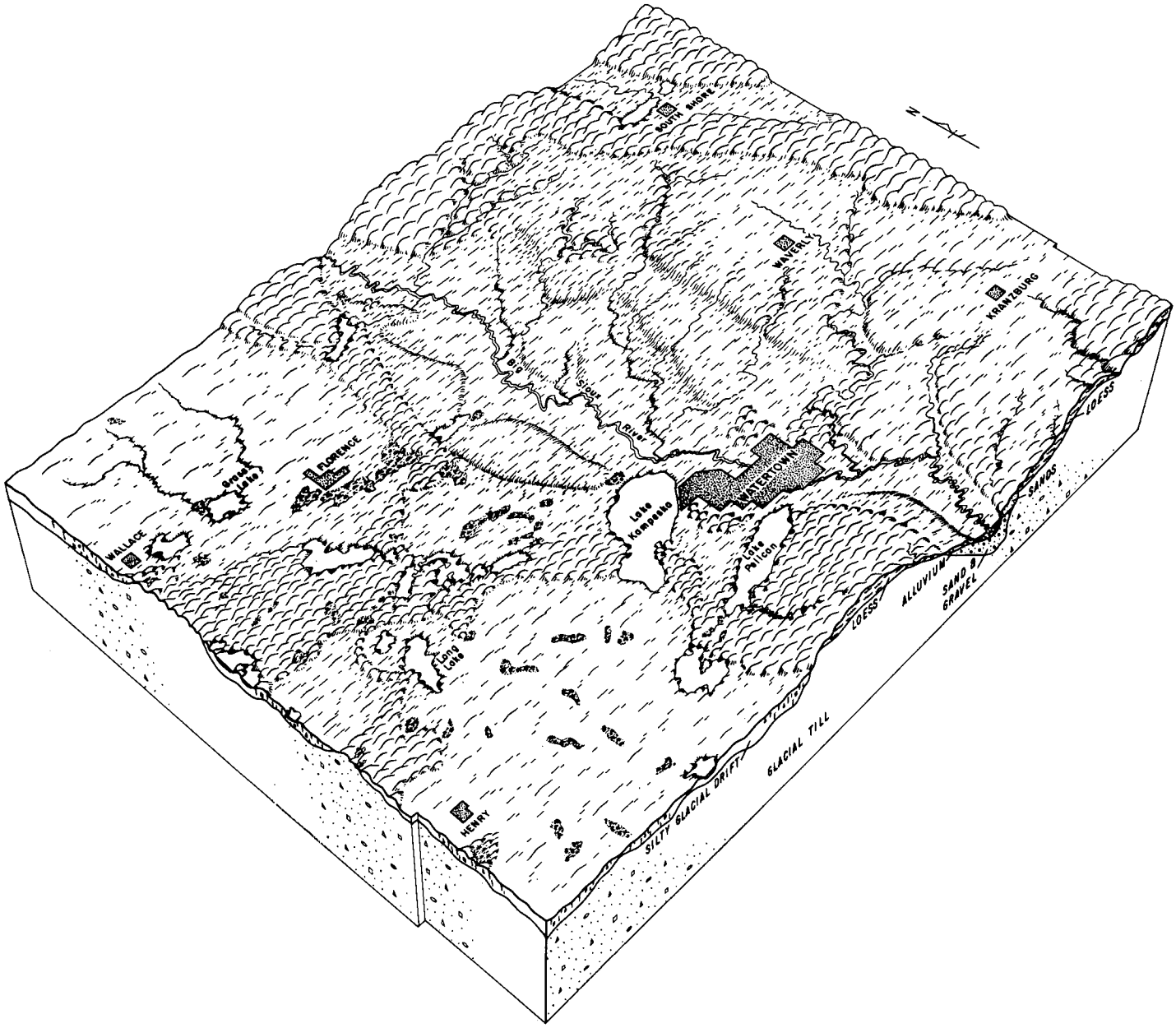

Figure 20.—**Schematic drawing showing the topography of Codington County.**

The Fordville, Renshaw, and Sioux soils developed in alluvial material underlain by outwash sand and gravel. The Estelline soils developed in loess underlain by outwash sand and gravel.

The Lamoure and Rauville soils developed in alluvial material on bottom lands. The Oldham and Parnell soils developed in local alluvium in upland depressions.

Relief

Relief, or topography (fig. 20), influences the formation of soils, chiefly by controlling the movement of water. The effect of relief on the formation of soils is modified, however, by the other four factors of soil formation, especially climate and vegetation.

The influence of relief is evident in the kinds of soils in this county. Where the topography is rolling or hilly, the ridges, knolls, and steep areas are occupied by soils that do not have distinct horizons, such as the Buse soils. The Buse soils have a thin surface layer that rests on relatively unweathered parent material. Runoff is rapid and erosion is active where these soils occur. Vegetation is sparse, partly because the rapid runoff makes the supply of available moisture low. Soils such as the Kranzburg and Vienna developed in nearly level to rolling areas where runoff is slow to medium, infiltration is good, and vegetation is thick. These soils have thick A and B horizons and are leached of lime to a moderate depth. Parnell and Rauville soils, having characteristics associated

with wetness, developed in depressions and on flood plains along streams. They have a thick, dark-colored A horizon and generally have a mottled, grayish-colored subsoil.

Plant and animal life

Plants have been the principal living influence on the formation of soils in this county. Earthworms, bacteria, and other forms of life have also contributed to the development of the soils, but they are of secondary importance. All of these add organic matter to the soil material when they die and decay.

Soils are greatly affected by the kind of vegetation under which they formed. For example, soils developed under prairie grass have a thick, dark-colored surface layer because the roots and tops of the grass decay and are added to the surface layer.

The native vegetation in this county was mainly tall and mid grasses, such as big bluestem, little bluestem, needlegrass, sideoats grama, switchgrass, and dropseed. Trees grew in scattered thickets, around lakes, and on bottom lands.

Time

Soil horizons form slowly, as water moves downward through the soil profile, taking soluble materials and tiny solid particles with it in a process known as leaching. Chemicals in the water react with minerals to weather and change the parent material. Over a long period of time, the leaching and weathering help to develop characteristic horizons, or layers, within the soil profile. As the fine particles are leached and deposited in the subsoil, the grouping of soil aggregates takes place and the structure of the soil is formed.

Some soils, such as those on bottom lands, are young because fresh material is deposited periodically. In those soils not enough time has elapsed for the formation of distinct horizons or structure. Soils on gently sloping uplands are generally older than those on bottom lands. These older soils have well-defined horizons and distinct blocky or prismatic structure in the subsoil.

Classification and Morphology of Soils

Soils are placed in narrowly defined classes for the organization and application of knowledge about their behavior within farms, ranches, or counties. They are placed in broadly defined classes for study and comparison of large areas, such as continents.

Two systems of natural classification of soils are now in general use in the United States. One of these is the 1938 system with later revisions (*2*, *14*). The other, a completely new system, was placed in general use by the Soil Conservation Service at the beginning of 1965 (*12*, *16*).

The 1938 system, with later revisions, consists of six categories. In the highest of these, soils of the whole country have been placed into three orders. The next two categories, the suborder and family, have not been fully developed. As a consequence, they have not been used much. Attention has been centered on the lower categories, the great soil group, the soil series, and the soil type. A further subdivision of the soil type, called the soil phase, has been defined, along with soil type and soil series, in the section "How This Soil Survey Was Made" in the front of this report. In this report the 1938 system with later revisions, is explained more fully than the new system.

The highest category of the 1938 classification system is divided into zonal, intrazonal, and azonal orders (*2*, *14*). The zonal order consists of soils with evident, genetically related horizons that reflect the predominant influence of climate and living organisms in their formation. In the intrazonal order are soils with evident, genetically related horizons that reflect the dominant influence of a local factor of topography or parent material over the effects of climate and living organisms. In the azonal order are soils that lack distinct, genetically related horizons, commonly because of their youth, resistant parent material, or steep topography.

The new system of soil classification recently adopted by the Soil Conservation Service also contains six categories. They are, beginning with the most inclusive, the order, suborder, great group, subgroup, family, and series (*12*). In this new system the criteria used as a basis for classification are observable or measurable soil properties. The properties are so chosen, however, that soils of similar genesis or mode of origin are grouped together.

Table 7 gives the classification of the soil series in Codington County. The first two columns classify the series by orders and great soil groups of the 1938 classification system. The fourth column classifies the series at the subgroup level in the new classification system adopted by the Soil Conservation Service in January 1965. The classification into subgroups is based upon field observations and estimates and on limited laboratory data. Following the table the great soil groups of the 1938 classification system are defined.

CHERNOZEMS

Soils in the Chernozem great soil group have a thick, dark-colored surface horizon rich in organic matter and a subsoil that is lighter colored than the surface horizon. Generally, a zone of calcium carbonate accumulation is in the lower part of the subsoil at a depth of 16 to 39 inches. Chernozems have developed in a subhumid climate under a mixture of tall and mid grasses. In this county the Brookings, Egeland, Estelline, Fordville, Forman, Kranzburg, Poinsett, Renshaw, Vienna, and Waubay soils are in the Chernozem great soil group.

HUMIC GLEY SOILS

Soils in the Humic Gley great soil group are in areas where drainage is poor. They are on bottom lands and in closed depressions. Humic Gley soils have a dark-colored surface layer and a grayish or olive subsoil mottled with yellowish brown. The soils in this county in the Humic Gley great soil group are the Hidewood, Lamoure, Oldham, Parnell, and Rauville. The Hidewood, Lamoure, and Oldham soils developed in areas that have a fluctuating, high water table or that are intermittently flooded. These soils are intergrading toward the Chernozem great soil group.

REGOSOLS

The Regosol great soil group consists of soils that are shallow and developed in thick, unconsolidated material. These soils lack definite genetic horizons. Generally, they have a thin surface horizon that is underlain by unmodified parent material. In this county, however, most of the

TABLE 7.—*Classification of soil series*

Modified 1938 classification system		Soil series—both 1938 and 1965 classifications	1965 classification system
Order	Great soil group		Subgroup
Zonal	Chernozem	Brookings	Cumulic Haploborolls.
		Egeland	Typic Haploborolls.
		Estelline	Cumulic Haploborolls.
		Fordville	Typic Haploborolls.
		Forman	Typic Argiborolls.
		Kranzburg	Typic Haploborolls.
		Poinsett	Typic Haploborolls.
		Renshaw	Typic Haploborolls.
		Vienna	Typic Haploborolls.
		Waubay	Cumulic Haploborolls.
Intrazonal	Humic Gley	Hidewood [1]	Typic Haplaquolls.
		Lamoure [1]	Cumulic Haplaquolls.
		Oldham [1]	Cumulic Haplaquolls.
		Parnell	Cumulic Argiaquolls.
		Rauville	Cumulic Haplaquolls.
Azonal	Regosols	Buse [1]	Entic Haploborolls.
		Sioux	Entic Haploborolls.
	Alluvial	La Prairie [1]	Cumulic Haploborolls.

[1] Intergrading toward Chernozems.

soils classed as Regosols have a thin, weakly defined subsoil. The Buse and Sioux soils are in the Regosol great soil group, but the Buse soils are intergrading toward the Chernozem great soil group. The Buse soils developed in glacial till or silty glacial drift, and the Sioux soils, in sandy and gravelly glacial outwash.

ALLUVIAL SOILS

The Alluvial great soil group consists of soils developed in alluvium that has been recently transported and deposited. The only soils in this great soil group are the La Prairie, and they are intergrading toward the Chernozem great soil group.

Descriptions of the Soil Series

In the following pages the soil series in the county are described in alphabetic order. For each series, a detailed description of a representative profile is given.

Brookings Series

In the Brookings series are deep, moderately fine textured, moderately well drained Chernozems. These soils developed under tall grasses in 18 to 48 inches of silty clay loam loess over loamy glacial till of Iowan and Tazewell age. They are nearly level and are on uplands and in slightly depressed swales in the central and southeastern parts of the county.

The Brookings soils occur with the Kranzburg and Hidewood soils. They developed in material similar to that in which the Kranzburg soils developed, but they are somewhat darker colored and less well drained than those soils. The Brookings soils are better drained and less mottled than the Hidewood soils.

Profile of Brookings silty clay loam on a south-facing slope of 1 percent; in a cultivated field 300 feet south and 100 feet west of the northeast corner of section 1, T. 116 N., R. 52 W.:

Ap—0 to 6 inches, very dark gray (10YR 3/1) light silty clay loam, black (10YR 2/1) when moist; weak to moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A12—6 to 13 inches, very dark gray (10YR 3/1) light silty clay loam, black (10YR 2/1) when moist; weak, coarse and medium, blocky structure; friable; neutral; clear, smooth boundary.

B21—13 to 18 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; moderate to weak, medium, prismatic structure; friable; neutral; clear, smooth boundary.

B22—18 to 25 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak and moderate, medium and coarse, prismatic structure; friable; mildly alkaline; clear, smooth boundary.

B3ca—25 to 29 inches, light olive-brown (2.5Y 5/4) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky; friable; moderately alkaline and calcareous, with a few small segregations of calcium carbonate; clear, smooth boundary.

IIC1ca—29 to 40 inches, pale-yellow (2.5Y 7/4) light clay loam, light olive brown (2.5Y 5/4) when moist; very weak, coarse, prismatic structure to massive; friable; moderately alkaline and calcareous, with common segregations of calcium carbonate; gradual, wavy boundary.

IIC2—40 to 60 inches, pale-yellow (2.5Y 7/4) light clay loam, light olive brown (2.5Y 5/4) when moist; mottled with yellowish red and black in the lower part; massive; friable; moderately alkaline and calcareous with common white segregations of calcium carbonate; gradual, wavy boundary.

The thickness of the loess over glacial till ranges from 18 inches to 48 inches or more. In many places there is a thin layer of gravelly or cobbly material between the loess and the glacial till. Depth to mottling varies slightly because of differences in drainage, but mottling is generally below a depth of 26 inches.

Buse Series

The Buse series consists of well-drained to excessively drained, undulating to steep soils that have weakly defined

horizons. These soils are Regosols but are intergrading toward the Chernozem great soil group. They developed under mixed tall and mid grasses in loamy glacial till or silty glacial drift. These soils are on glacial moraines and on the sides of drainageways throughout the county.

The Buse soils occur with the Forman, Poinsett, Sioux, and Vienna soils. They are steeper and less deep than the Forman, Poinsett, and Vienna soils, and they lack a B2 horizon. In many places the Buse soils are in areas similar to those occupied by the Sioux soils, but the Buse soils are less gravelly than the Sioux.

Profile of Buse loam that has slopes of 12 percent; 1,300 feet west and 128 feet south of the northeast corner of section 7, T. 118 N., R. 55 W.:

A11—0 to 5 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable; mildly alkaline; clear, smooth boundary.

AC—5 to 12 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic to weak, fine, granular structure; friable; moderately alkaline and calcareous; clear, smooth boundary.

C1ca—12 to 17 inches, dark grayish-brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 4/2) when moist; weak to moderate, coarse and medium, prismatic structure; friable when moist and slightly hard when dry; moderately alkaline and calcareous, with common soft segregations of calcium carbonate; clear, smooth boundary.

C2ca—17 to 60 inches, grayish-brown (2.5Y 5/2) clay loam glacial till, dark grayish brown (2.5Y 4/2) when moist; mottled in lower part with light olive brown, red, and reddish brown; structureless; friable when moist and slightly hard when dry; moderately alkaline and calcareous, with common soft segregations of calcium carbonate.

The surface layer ranges from fine sandy loam to clay loam in texture, but a loam texture is most common. The number of stones and pebbles in the upper part of the profile ranges from few to many. In some places the parent material is loam or clay loam glacial till or silty glacial drift, but it is ice-contact, stratified drift in a few places. In some places the AC horizon has characteristics similar to those of a B horizon, but in most places it is a transitional layer between the A and C horizons.

Egeland Series

In the Egeland series are deep, well-drained, moderately coarse textured soils in the Chernozem great soil group. These soils developed under tall grasses in sand deposited by wind or glacial melt water, commonly underlain by glacial till or glacial drift. These soils are nearly level to sloping and are on uplands and terraces along the Big Sioux River and in a small area near South Shore.

The Egeland soils occur with the Poinsett, Fordville, Estelline, and Kranzburg soils. They are coarser textured than those soils, and their underlying material is loamy or silty glacial till or glacial drift rather than gravel like that underlying the Fordville soils.

Profile of Egeland sandy loam that has slopes of 4 percent; in a cultivated field 1,445 feet north and 250 feet west of the southeast corner of section 23, T. 116 N., R. 52 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) sandy loam, black (10YR 2/1) when moist; weak, medium, granular structure; soft when dry, very friable when moist, and nonsticky and nonplastic when wet; neutral; abrupt, smooth boundary.

B21—8 to 11 inches, dark-gray (10YR 4/1) sandy loam, black (10YR 2/1, coarse), very dark brown (10YR 2/2, rubbed) when moist; very weak, medium, subangular blocky structure that breaks to weak, medium, granular; soft when dry, very friable when moist, and slightly sticky and nonplastic when wet; neutral; clear, wavy boundary.

B22—11 to 20 inches, dark grayish-brown (10YR 4/2) heavy sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, coarse, prismatic structure; slightly hard when dry, friable when moist, and slightly sticky and nonplastic when wet; neutral; gradual, wavy boundary.

B3—20 to 24 inches, grayish-brown (10YR 5/2) loamy sand, dark grayish brown (10YR 4/2) when moist; very weak, coarse, prismatic structure; slightly hard when dry, very friable when moist, and nonsticky and nonplastic when wet; neutral; gradual, wavy boundary.

C1—24 to 39 inches, pale-brown (10YR 6/3) loamy sand, dark brown (10YR 4/3) when moist; single grain; loose when dry, very friable when moist, and nonsticky and nonplastic when wet; neutral; clear, wavy boundary.

IIC2—39 to 47 inches, light brownish-gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/4) when moist; contains common, fine, prominent mottles of dark yellowish brown (10YR 4/4) and gray (10YR 6/1), dark yellowish brown (10YR 3/4) and gray (10YR 5/1) when moist; weak, coarse and medium, subangular blocky structure; slightly hard when dry, friable when moist, and slightly sticky and nonplastic when wet; moderately alkaline and calcareous with weak, medium segregations of calcium carbonate; distinct boundary.

IIC3—47 to 60 inches, pale-yellow (2.5Y 7/4) heavy loam glacial till, light olive brown (2.5Y 5/4) when moist; common, fine, prominent mottles of yellowish brown (10YR 5/4) and gray (10YR 6/1); dark yellowish brown (10YR 4/4) and gray (10YR 5/1) when moist; very weak, coarse, subangular blocky structure; hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; moderately alkaline and calcareous, with common, medium segregations of calcium carbonate.

The texture of the surface layer ranges from loamy sand to light loam, but the texture is light loam in only a few places. In nearly level or gently sloping areas, the A horizon is somewhat thicker than that in more sloping areas and the dark color extends downward to the B horizon. The subsoil and the underlying material range from loamy sand to loam in texture. In places thin layers of silt are between the layers of sand. Loamy glacial till or silty glacial drift is typically at a depth of 30 inches or more.

Estelline Series

The soils in the Estelline series are deep, medium-textured, well-drained Chernozems that are nearly level or gently sloping. These soils developed under tall grasses in 36 inches or more of loess over sandy and gravelly outwash. They are on stream terraces and outwash plains near the Big Sioux River in the central part of the county.

The Estelline soils occur with the Egeland, Fordville, and Kranzburg soils. They are finer textured than the Egeland soils and are deeper over gravel than the Fordville soils. The Estelline soils are underlain by sand and gravel, rather than by glacial till like the Kranzburg soils.

Profile of Estelline silt loam that has slopes of 2 percent; in a cultivated field 300 feet north and 290 feet east of the center of section 33, T. 117 N., R. 53 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, medium and fine, granular structure; soft when dry, very friable when moist; slightly acid; abrupt, smooth boundary.

B21—8 to 16 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; continuous coatings, dark gray (10YR 4/1) when dry, on the surfaces of the peds; moderate, coarse and medium, prismatic structure that breaks to moderate, medium, subangular and angular blocky; slightly hard when dry, friable when moist; thin, patchy clay films on the primary surfaces of the peds; slightly acid; clear, smooth boundary.

B22—16 to 21 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; continuous coatings, very dark brown (10YR 2/2) when moist, on the surfaces of the peds; moderate, coarse and medium, prismatic structure that breaks to moderate, medium and fine, subangular and angular blocky; slightly hard when dry, friable when moist; thin, patchy clay films on the surfaces of the peds; neutral; gradual boundary.

B23—21 to 28 inches, light olive-brown (2.5Y 5/3) silty clay loam, olive brown (2.5Y 4/3) when moist; continuous coatings, dark grayish brown (1Y 4/3) when moist, on the surfaces of the peds; moderate, coarse, prismatic structure that breaks to moderate, medium and fine, subangular and angular blocky; slightly hard when dry, firm when moist; thin, continuous clay films on the surfaces of the prisms; neutral; gradual, smooth boundary.

B24—28 to 33 inches, light olive-brown (2.5Y 5/3) silt loam, olive brown (2.5Y 4/3) when moist; continuous coatings, dark grayish brown (2.5Y 4/2) when moist, on the surfaces of the peds; moderate, coarse, prismatic structure that breaks to weak to moderate, medium, subangular and angular blocky; slightly hard when dry, firm when moist; thin, continuous clay films on the surfaces of the prisms; mildly alkaline and noncalcareous; clear, wavy boundary.

B3ca—33 to 37 inches, light yellowish-brown (2.5Y 6/3) silt loam, olive brown (2.5Y 4/3) when moist; weak to moderate, coarse and very coarse, prismatic structure that breaks to weak, coarse and medium, subangular blocky; slightly hard when dry, friable or firm when moist; moderately alkaline and calcareous, with common, soft segregations of calcium carbonate; gradual, wavy boundary.

Cca—37 to 45 inches, light brownish-gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/3) when moist; very weak, coarse, prismatic structure; slightly hard when dry, friable when moist; moderately alkaline and calcareous, with many large, soft segregations of calcium carbonate; gradual, smooth boundary.

IIC—45 to 60 inches, grayish-brown (2.5Y 5/2) gravelly sand; dark grayish brown (2.5Y 4/2) when moist; single grain; loose when dry and moist; moderately alkaline and calcareous.

Generally, the Estelline soils developed in loess over outwash; however, in some areas they developed in loamy alluvium over sandy and gravelly outwash. In small areas the depth to sand and gravel may be less than 36 inches or more than 48 inches.

Fordville Series

The Fordville series is made up of moderately deep, well-drained Chernozems that are nearly level to gently sloping or undulating. These soils developed under tall grasses in 20 to 36 inches of medium-textured to moderately coarse textured alluvium over sandy and gravelly outwash. They are on stream terraces in the central and eastern parts of the county.

The Fordville soils occur with the Estelline, Renshaw, and Egeland soils. They are less deep than the Estelline soils but are deeper over sand and gravel than the Renshaw soils. They developed in alluvium or loess over sand and gravel, rather than in deep windblown sand or in sand underlain by medium-textured glacial drift like the Egeland soils. The soils of the Fordville series are the moderately deep members of the catena composed of Estelline, Fordville, Renshaw, and Sioux soils.

Profile of Fordville silt loam that has slopes of 1 percent; in a cultivated field 165 feet west and 1,200 feet north of the southeast corner of section 18, T. 118 N., R. 52 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; soft when dry, very friable when moist; slightly acid; abrupt, smooth boundary.

B21—6 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular and angular blocky; slightly hard when dry, friable when moist; thin, patchy clay films on the surfaces of the peds; neutral; gradual, smooth boundary.

B22—14 to 18 inches, dark grayish-brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) when moist; continuous coatings, very dark brown (10YR 2.5/1.5) when moist, on the surfaces of the peds; moderate, medium, prismatic structure that breaks to moderate, medium, subangular and angular blocky; slightly hard when dry, friable to firm when moist; thin, patchy clay films on the surfaces of the peds; neutral; gradual, smooth boundary.

B23—18 to 25 inches, light olive-brown (2.5Y 5/3) loam, olive brown (2.5Y 4/3) when moist; continuous very dark gray coatings, dark grayish brown (1Y 3.5/1.5) when moist, on the surfaces of the peds; moderate, medium, prismatic structure that breaks to weak or moderate, medium, subangular and angular blocky; slightly hard when dry, firm when moist; thin, patchy clay films on the surfaces of the peds; neutral; clear, smooth boundary.

B3ca—25 to 30 inches, light olive-brown (2.5Y 5/3) gravelly sandy loam, olive brown (2.5Y 4/3) when moist; continuous coatings, very dark gray to dark gray (2.5Y 3.5/1) when moist, on the surfaces of the peds; weak, medium, prismatic structure; hard when dry, firm when moist; moderately alkaline and calcareous, with common, grayish coatings of lime on the pebbles; clear, wavy boundary.

IIC1ca—30 to 40 inches, light olive-brown (2.5Y 5/3) gravelly coarse sandy loam, olive brown (2.5Y 4/3) when moist; single grain; hard when dry, friable when moist; moderately alkaline and calcareous with common, soft segregations of calcium carbonate and coatings of lime on the pebbles; clear, wavy boundary.

IIC2—40 to 54 inches, light-gray (1Y 7/2) gravelly loamy coarse sand, light olive brown (2.5Y 5/3) when moist; single grain; loose when dry and moist; strongly alkaline and calcareous; clear, wavy boundary.

IIC3—54 to 60 inches, light yellowish-brown (1Y 6/3) gravelly sand, olive brown (2.5Y 4/4) when moist; single grain; loose when dry and moist; strongly alkaline and calcareous.

The texture of the surface layer ranges from sandy loam to silt loam. The depth to gravel ranges from 20 to 36 inches. Where the depth to gravel is between 20 and 24 inches, the zone of calcium carbonate accumulation is in the upper part of the gravelly material, but where the gravel is deeper than 24 inches, the zone of calcium carbonate accumulation is generally in the medium-textured alluvium above the gravelly material. Although these soils are generally well drained, the shallower and more sandy soils are somewhat excessively drained. The texture of the subsoil is loamy or somewhat sandy in some places. In other places the subsoil consists of stratified silt to sand.

Forman Series

In the Forman series are deep, medium-textured, well-drained Chernozems that are nearly level or undulating. These soils developed under tall grasses in moderately fine textured glacial till of Late Wisconsin age. They are on uplands in the northeastern and western parts of the county.

The Forman soils occur with the Poinsett, Buse, La Prairie, and Waubay soils. They developed in loamy glacial till rather than in silty glacial drift like the Poinsett soils. They are more clayey than the Buse soils. The Forman soils are better drained and are lighter colored to a greater depth than the La Prairie and Waubay soils. Their profile is somewhat similar to that of the Vienna soils, but their B horizon is more clayey than that of the Vienna soils.

Profile of Forman loam that has slopes of 2 percent; in a cultivated field 1,800 feet south and 60 feet east of the northwest corner of section 13, T. 118 N., R. 51 W.:

Ap—0 to 4 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; cloddy, but the clods break to weak, fine, granular structure; slightly hard when dry, friable when moist; neutral; abrupt, smooth boundary.

B21t—4 to 10 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; coatings on the surfaces of the peds are very dark brown (10YR 2/2) when moist; moderate, medium, prismatic structure that breaks to moderate, medium and fine, subangular blocky; slightly hard when dry, friable when moist; thin, continuous clay films on all the surfaces of the peds; neutral; gradual, smooth boundary.

B22t—10 to 14 inches, yellowish-brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) when moist; coatings on the surfaces of the peds are dark grayish brown (10YR 4/1.5) to very dark grayish brown (10YR 3/1.5) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, friable to firm when moist; thin, patchy clay films on all the surfaces of the peds; mildly alkaline; clear, smooth boundary.

B23—14 to 18 inches, light yellowish-brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/4) when moist; very few, fine and medium, distinct iron stains that are dark yellowish brown (10YR 4/4) when moist; weak to moderate, medium, prismatic structure that breaks to weak to moderate, medium, subangular blocky; slightly hard when dry, friable to firm when moist; thin, patchy clay films on all the surfaces of the peds; moderately alkaline and calcareous, with coatings of lime on the undersides of the stones and pebbles; clear, smooth boundary.

B3ca—18 to 26 inches, pale-yellow (2.5Y 7/3) clay loam, olive brown (2.5Y 4/4) when moist; very few, fine and medium, distinct, dark yellowish-brown iron stains; weak to moderate, coarse, prismatic structure that breaks to moderate, medium, subangular blocky; slightly hard when dry, friable to firm when moist; thin, patchy clay films on all the surfaces of the peds; moderately alkaline and calcareous with common, medium and large, soft segregations of calcium carbonate; gradual, smooth boundary.

C1ca—26 to 35 inches, pale-yellow (2.5Y 7/3) clay loam, light olive brown (2.5Y 5/5) when moist; few, fine, faint iron stains that are brownish yellow (10YR 6/6) when moist; weak, coarse, prismatic structure that breaks to moderate, medium and fine, subangular and angular blocky; slightly hard when dry, friable or firm when moist; strongly alkaline and calcareous with common, small and medium, soft segregations of calcium carbonate; gradual, smooth boundary.

C2ca—35 to 44 inches, light-gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/4) when moist; few to common, medium, distinct mottles that are dark yellowish brown (10YR 4/4) and brownish yellow (10YR 6/6) when moist; weak, coarse, prismatic structure that breaks to moderate, coarse, subangular and angular blocky; very hard when dry, firm when moist; moderately alkaline and calcareous with a few, small, soft segregations of calcium carbonate; gradual, smooth boundary.

C3ca—44 to 50 inches, olive-yellow (2.5Y 6/5) clay loam, light olive brown (2.5Y 5/5) when moist; few, fine, distinct mottles that are grayish brown (2.5Y 5/2) when moist; few, fine, prominent manganese stains that are black (10YR 2/1) when moist; weak, coarse, prismatic structure that breaks to moderate, medium and fine, subangular and angular blocky; very hard when dry, firm when moist; moderately alkaline and calcareous with common, medium, soft segregations of calcium carbonate; gradual, smooth boundary.

C4ca—50 to 60 inches, olive-yellow (2.5Y 6/5) clay loam, light olive brown (2.5Y 5/5) when moist; common, medium, distinct mottles that are grayish brown (2.5Y 5/2) when moist; few, medium, distinct iron stains that are dark yellowish brown (10YR 4/4) when moist and manganese stains that are black (10YR 2/1) when moist; weak, coarse, prismatic structure that breaks to weak fine blocky; very hard when dry, firm when moist; strongly alkaline and calcareous, with common, small, soft segregations of calcium carbonate.

The texture of the surface layer ranges from loam to silty clay loam. In many places there are pockets of sandy or gravelly material in the glacial till. The number of cobbles and other stones ranges from few to many.

Hidewood Series

In the Hidewood series are deep, moderately fine textured, somewhat poorly drained Humic Gley soils that are intergrading toward the Chernozem great soil group. These soils developed under tall grasses in 30 to 50 inches of loess and local alluvium over glacial till. They are nearly level and are in small, shallow depressions or swales in the central and southeastern parts of the county.

The Hidewood soils occur with the Brookings soils. They have a somewhat finer textured B2 horizon than those soils and are more poorly drained.

Profile of Hidewood silty clay loam that has slopes of 1 percent; 1,300 feet north and 60 feet east of the southwest corner of section 35, T. 117 N., R. 51 W.:

A11—0 to 6 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, medium and fine, granular structure; friable; neutral; clear, smooth boundary.

A12—6 to 9 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure that breaks to weak, medium, granular structure; friable; neutral; clear, smooth boundary.

B21—9 to 14 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; weak, coarse, prismatic structure; friable when moist, slightly hard when dry; mildly alkaline; clear, smooth boundary.

B22g—14 to 20 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; mottled with olive and white; moderate, coarse and medium, prismatic structure; firm when moist, hard when dry; mildly alkaline; contains worm casts that effervesce weakly when acid is added; gradual, wavy boundary.

Cgca—20 to 31 inches, olive (5Y 5/3) clay loam, gray (5Y 5/1) when moist; mottled with strong brown and white; very weak, medium, blocky structure; friable; moderately alkaline and calcareous; gradual, wavy boundary.

IIClgca—31 to 60 inches, olive-yellow (2.5Y 6/6) clay loam glacial till, light olive brown (2.5Y 5/6) when moist; mottled with yellowish red, light brownish gray, and white; structureless; friable when moist, slightly hard when dry; moderately alkaline and calcareous; clear, smooth boundary.

The surface layer is loess or local alluvium in some places. The depth to the underlying glacial till ranges from 30 to 50 inches.

Kranzburg Series

In the Kranzburg series are deep, moderately fine textured, well-drained Chernozems. These soils developed under tall grasses in 15 to 40 inches of loess that rests on glacial till. They have long, smooth, gentle slopes and are on the uplands in the central and southeastern parts of the county.

The Kranzburg soils occur with the Brookings, Vienna, Buse, and La Prairie soils. The Kranzburg soils are better drained and are slightly lighter colored than the Brookings soils. They developed in loess over glacial till, rather than in glacial till like the Vienna soils. The Kranzburg soils are darker colored and have more distinct horizons than the Buse soils. They are lighter colored, have a thinner surface layer, and are better drained than the La Prairie soils.

Profile of Kranzburg silty clay loam that has slopes of 3 percent; in a cultivated field 200 feet east and 95 feet north of the southwest corner of section 29, T. 116 N., R. 52 W.:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown to black (10YR 2/1.5) when moist; weak, fine, granular structure; hard when dry, friable when moist; neutral; abrupt, smooth boundary.

B21—7 to 12 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak and moderate, medium, prismatic structure that breaks to weak or moderate, medium and fine, subangular and angular blocky; slightly hard when dry, friable when moist; thin, continuous clay films on the vertical surfaces of the peds; neutral; gradual, smooth boundary.

B22—12 to 17 inches, light olive-brown (2.5Y 5/3) silty clay loam, moderate olive brown (1Y 3/3) when moist; coatings on the surfaces of the peds are moderate olive brown (1Y 3/2) when moist; moderate, medium, prismatic structure that breaks to weak to moderate, medium and fine, subangular and angular blocky; hard when dry, friable when moist; thin, continuous clay films on all the surfaces of the peds; mildly alkaline; gradual, smooth boundary.

B23—17 to 23 inches, light olive-brown (2.5Y 5/3) silt loam, olive brown (2.5Y 4/3) when moist; weak to moderate, medium, prismatic structure that breaks to weak, medium and fine, subangular and angular blocky; hard when dry, friable when moist; thin, patchy clay films on all the surfaces of the peds; moderately alkaline; clear, smooth boundary.

I–IIB3ca—23 to 28 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/4) when moist; weak to moderate, coarse, prismatic structure that breaks to weak, medium and fine, subangular and angular blocky; slightly hard to hard when dry, friable when moist; thin, patchy clay films on all the surfaces of the peds; moderately alkaline and calcareous, with common, medium, soft segregations of calcium carbonate; discontinuous stone line at a depth of 28 inches; gradual, smooth boundary.

IIC1ca—28 to 40 inches, light yellowish-brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/4) when moist; few, fine, faint iron and manganese stains; weak, coarse and very coarse, prismatic structure; hard when dry, firm when moist; strongly alkaline and calcareous, with common to many, medium, soft segregations of calcium carbonate and coatings of lime on the undersides of stones; gradual, smooth boundary.

IICca—40 to 48 inches, light-gray (2.5Y 7/2) clay loam, light olive brown (2.5Y 5/3) when moist; common, fine and medium, faint, yellowish-brown iron stains and a few, fine, black manganese stains; weak, coarse or very coarse, prismatic structure; very hard when dry, firm when moist; strongly alkaline and calcareous, with common, small and medium, soft segregations of calcium carbonate and coatings of lime on the undersides of stones; gradual, smooth boundary.

IIC3ca—48 to 60 inches, pale-yellow (2.5Y 7/3) clay loam, light olive brown (2.5Y 5/4) when moist; common, fine and medium, distinct, yellowish-brown iron stains; weak, coarse or very coarse, prismatic structure; very hard when dry, firm when moist; strongly alkaline and calcareous, with few, soft, segregations of calcium carbonate.

The thickness of the loess over glacial till ranges from 15 to 40 inches. In places a thin layer of cobbly or gravelly material lies between the loess and the glacial till.

Lamoure Series

The Lamoure series is made up of deep, moderately fine textured, somewhat poorly drained Humic Gley soils that are intergrading toward the Chernozem great soil group. These soils developed under tall grasses in alluvium. They are nearly level and are on flood plains.

The Lamoure soils occur with the Rauville and Fordville soils. They developed in material similar to that in which the Rauville soils developed, but they are better drained than those soils. The Lamoure soils are less well drained than the Fordville soils and are darker colored and generally deeper over sand and gravel than those soils.

Profile of Lamoure silty clay loam that has slopes of 1 percent; in a cultivated field 2,600 feet west and 100 feet north of the southeast corner of section 33, T. 119 N., R. 52 W., Sisseton Whoreton Indian Reservation:

Ap—0 to 7 inches, very dark gray (10YR 3/0.5) silty clay loam, black (10YR 2/1) when moist; cloddy and clods breaks to weak, fine, crumb structure; hard when dry, friable when moist; moderately alkaline and calcareous; abrupt, smooth boundary.

AC—7 to 11 inches, dark-gray (2.5Y 4/0.5) silty clay loam, black (10YR 2/1) when moist; very weak, coarse and medium, prismatic structure that breaks to weak, fine, subangular blocky; hard when dry, friable when moist; moderately alkaline and calcareous; clear, smooth boundary.

C1gca—11 to 15 inches, dark-gray (2.5Y 4/1) silty clay loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure that breaks to weak, medium and thick, platy; hard when dry, friable when moist; moderately alkaline and calcareous, with common very fine flecks of segregated lime; gradual, smooth boundary.

C2gca—15 to 21 inches, gray (2.5Y 5/1) silty clay loam, black (1Y 2/1) when moist; weak, coarse, prismatic structure that breaks to weak, medium and thick, platy; slightly hard when dry, friable when moist; moderately alkaline and calcareous, with common very fine flecks of segregated lime; clear, smooth boundary.

C3gca—21 to 27 inches, gray (2.5Y 5/1) silty clay loam, very dark gray (1Y 3/1) when moist; weak, coarse, prismatic structure that breaks to weak, medium and thick, platy; slightly hard, when dry, friable when moist; moderately alkaline and calcareous; clear, smooth boundary.

C4gca—27 to 38 inches, gray (2.5Y 5/1) silty clay loam, very dark gray (2.5Y 3/1) when moist; weak, coarse, prismatic structure that breaks to weak, thick, platy; slightly hard when dry, friable when moist; moderately alkaline and calcareous; gradual, smooth boundary.

C5gca—38 to 46 inches, dark-gray (2.5Y 4/1) silt loam, very dark gray (2.5Y 3/1) when moist; weak, coarse, prismatic structure that breaks to weak, thick, platy; slightly hard when dry, friable when moist; few faint iron stains; moderately alkaline and calcareous; clear, smooth boundary.

IIC6g—46 to 52 inches, gray (2.5Y 5/1) loam, very dark gray (2.5Y 3/1) when moist; weak, coarse, prismatic structure that breaks to weak, thick, platy; slightly hard when dry, friable when moist; few faint iron stains; moderately alkaline and calcareous; clear, smooth boundary.

IIIC7—52 to 60 inches, multicolored gravelly sand; basic color light brownish gray (2.5Y 6/2), dark grayish brown (2.5Y 4/2) when moist; single grain; loose; moderately alkaline and calcareous.

The texture of the surface layer ranges from silt loam to silty clay loam. In places sand and gravel are at a depth of slightly less than 36 inches. In many areas of these soils, the water table is within 36 inches of the surface during part of the growing season.

La Prairie Series

In the La Prairie series are deep, dark-colored, moderately well drained Alluvial soils that are intergrading toward the Chernozem great soil group. These soils developed under tall grasses in local alluvium. They are nearly level and occur as narrow bands in upland swales, along drainageways, and on colluvial toe slopes throughout the county.

The La Prairie soils occur with the Forman, Kranzburg, Poinsett, and Vienna soils of the uplands. They are darker colored, have a thicker A horizon, and are less well drained than those soils.

Profile of La Prairie silt loam that has slopes of 2 percent; in a cultivated field 500 feet west and 150 feet north of the southeast corner of section 2, T. 116 N., R. 52 W.:

A1p—0 to 5 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A12—5 to 23 inches, very dark gray (10YR 3/1) heavy silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable; neutral; gradual, smooth boundary.

A13—23 to 42 inches, very dark gray (10YR 3/1) heavy silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable; neutral; gradual, smooth boundary.

C1—42 to 54 inches, faintly mottled olive-brown (2.5Y 4/4) and light olive-brown (2.5Y 5/4) clay loam, very dark grayish brown (2.5 Y 3/2) and dark grayish brown (2.5Y 4/2) when moist; common distinct iron stains; structureless; friable; mildly alkaline; a cobbly layer or a stone line is the lower boundary.

IICca—54 to 60 inches, faintly mottled light yellowish-brown (2.5Y 6/4) and light olive-brown (2.5Y 5/4) clay loam, light olive brown (2.5Y 5/4 to 5/6) when moist; prominently mottled with white and yellowish red; structureless; friable; moderately alkaline and calcareous.

The texture of the surface layer ranges from loam to silty clay loam. The thickness of this dark-colored surface layer ranges from 24 to 60 inches.

Oldham Series

In the Oldham series are deep, dark-colored, nearly level, slowly permeable soils that are moderately well drained or somewhat poorly drained. These are Humic Gley soils that are intergrading toward the Chernozem great soil group. They developed under tall grasses in colluvial and alluvial material in closed upland depressions. They are in the western and northeastern parts of the county. These soils have calcium carbonate near the surface and generally have mottling in the lower part of the B2 horizon.

The Oldham soils occur with the Poinsett, Waubay, and Parnell soils. They are darker colored to a greater depth and are finer textured and less well drained than the Poinsett soils. They are more poorly drained than the Waubay soils, and they are in closed depressions rather than in upland swales like those soils. The Oldham soils are better drained than the Parnell soils.

Profile of Oldham silty clay loam that has slopes of 1 percent; in a cultivated field 1,800 feet east and 90 feet south of the northwest corner of section 22, T. 116 N., R. 54 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

B21—8 to 15 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; weak, medium, prismatic structure that breaks to moderate, medium, subangular blocky; friable when moist, slightly hard when dry; mildly alkaline; clear, wavy boundary.

B22gca—15 to 22 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; a few, small, reddish-brown stains; weak, coarse, prismatic structure that breaks to moderate, medium, blocky; friable when moist, slightly hard when dry; strongly alkaline and calcareous, with few, small, soft segregations of calcium carbonate; clear, wavy boundary.

B23gca—22 to 27 inches, olive-gray (5Y 5/2) silty clay, olive (5Y 4/3) when moist; mottled dark reddish brown and yellowish red; moderate, coarse, prismatic structure that breaks to moderate, medium, blocky structure; firm when moist, hard when dry; strongly alkaline and calcareous, with common, large, soft segregations of calcium carbonate; clear, wavy boundary.

B3gca—27 to 32 inches, light olive-gray (5Y 6/2) silty clay, olive (5Y 4/3) when moist; mottled with dark olive gray; weak, medium, blocky structure; firm when moist, hard when dry; strongly alkaline and calcareous, with common, large, soft segregations of calcium carbonate; clear, wavy boundary.

C1gca—32 to 36 inches, pale-olive (5Y 6/3) silty clay, olive (5Y 4/3) when moist; mottled light olive gray, dark olive gray, and black; very weak, medium, blocky structure; friable when moist, slightly hard when dry; moderately alkaline and calcareous, with common, large, soft segregations of calcium carbonate; clear, wavy boundary.

C2g—36 to 60 inches, light-gray (5Y 7/2) silty clay, olive gray (5Y 5/2) when moist; mottled with yellowish red, dark reddish brown, and black; structureless; moderately alkaline and calcareous, with common, small, soft segregations of calcium carbonate.

The texture of the surface layer ranges from silty clay loam to silty clay.

Parnell Series

The Parnell series consists of deep, dark-colored, moderately fine textured, poorly drained or very poorly drained Humic Gley soils. These soils developed in local

alluvium. They are in closed depressions in the western and northeastern parts of the county.

The Parnell soils occur with the Oldham soils, but they are more poorly drained than those soils. They also support more tall grasses, such as reed canarygrass, that are more palatable to livestock than the reeds, sedges, and cattails that grow in permanent marshes and intermittent lakes.

Profile of Parnell silty clay loam that has slopes of 1 percent; 250 feet east and 100 feet south of the northwest corner of section 23, T. 119 N., R. 55 W.:

A11—0 to 3 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable; mildly alkaline and calcareous; clear, smooth boundary.

A12—3 to 7 inches, very dark gray (10YR 3/1) silty clay loam, black (N 2/0) when moist; weak, medium, subangular blocky structure that breaks to moderate, fine, granular structure; firm when moist, hard when dry; moderately alkaline and calcareous; clear, smooth boundary.

B21g—7 to 18 inches, very dark gray (10YR 3/1) silty clay loam; black (5Y 2/1) when moist; weak, coarse, blocky structure; firm when moist, hard when dry; strongly alkaline and calcareous; clear, wavy boundary.

B22g—18 to 29 inches, dark-gray (N 4/0) silty clay loam, black (N 2/0) when moist; weak blocky structure or structureless; firm when moist, hard when dry; strongly alkaline and calcareous; clear, wavy boundary.

C1g—29 to 39 inches, dark-gray (5Y 4/1) silty clay loam, black (10YR 2/1) when moist; structureless; friable when moist, hard when dry; strongly alkaline and calcareous; clear, smooth boundary.

C2g—39 to 45 inches, light olive-gray (5Y 6/2) silty clay loam, olive gray (5Y 5/2) when moist; mottled pale yellow; structureless and stratified; friable; moderately alkaline and calcareous; clear, smooth boundary.

C3g—45 to 60 inches, light-gray (5Y 7/2) silty clay loam, olive gray (5Y 5/2) when moist; mottled with pale yellow, olive, and white; structureless and stratified; friable; moderately alkaline and calcareous.

The texture of the surface layer ranges from silty clay loam to clay. In many places a thin layer of peaty or mucky, partly decomposed organic material is on the surface of these soils. The parent material is stratified in many places.

Poinsett Series

In the Poinsett series are deep, medium-textured, well-drained Chernozems. These soils developed under tall grasses in silty and loamy glacial drift. They are nearly level to undulating and are on uplands in the western and northeastern parts of the county.

The Poinsett soils occur with the Forman, Buse, La Prairie, Waubay, Oldham, and Egeland soils. They developed in loamy or silty glacial drift, rather than in clay loam glacial till like the Forman soils. They have well-defined B2 horizons that are lacking in the Buse soils, and they are less sloping than the Buse soils. The Poinsett soils are better drained than the La Prairie, Waubay, and Oldham soils. They are finer textured than the Egeland soils.

Profile of Poinsett silt loam that has slopes of 2 percent; in a cultivated field 700 feet north and 100 feet east of the southwest corner of section 18, T. 119 N., R. 54 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; black (10YR 2/1) when moist; weak, fine, granular structure; soft or slightly hard when dry, friable when moist; mildly alkaline and noncalcareous; abrupt, smooth boundary.

AB—7 to 10 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; weak to moderate, medium, prismatic structure that breaks to weak to moderate, medium, subangular blocky; slightly hard when dry, friable when moist; mildly alkaline and noncalcareous; gradual, smooth boundary.

B21—10 to 15 inches, grayish-brown (2.5Y 5/2) silty clay loam, very dark gray (2.5Y 3/1) when moist; coatings on the surfaces of the peds are very dark gray (10YR 3/1) when moist; moderate, coarse and medium, prismatic structure that breaks to weak and moderate, medium, and fine, subangular blocky; slightly hard when dry, friable when moist; thin, patchy clay films on all the surfaces of the peds; moderately alkaline and noncalcareous; gradual, smooth boundary.

B22—15 to 22 inches, grayish-brown (2.5Y 5/2) light silty clay loam, dark grayish brown (2.5Y 4/2) when moist; patchy coatings on the surfaces of the peds, very dark gray (2.5Y 3/1) when moist; moderate, coarse and medium, prismatic structure that breaks to moderate, medium and fine, subangular blocky; slightly hard when dry, friable when moist; thin, patchy clay films on all the surfaces of the peds; moderately alkaline and noncalcareous; clear, wavy boundary.

B3ca—22 to 27 inches, pale-yellow (5Y 7/3) light silty clay loam, olive (5Y 5/3) when moist; few, fine, prominent iron stains that are dark brown (7.5YR 4/4) when moist; weak to moderate, coarse, prismatic structure that breaks to very weak, medium and coarse, blocky; soft or slightly hard when dry, friable when moist; moderately alkaline and calcareous, with few, small, soft segregations of calcium carbonate; gradual, smooth boundary.

C1ca—27 to 36 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/3) when moist; common, fine, faint, yellowish-brown iron stains and very few, fine, black manganese stains; weak to moderate, coarse, prismatic structure that breaks to weak, medium and coarse, blocky; soft to slightly hard when dry, friable when moist; strongly alkaline and calcareous, with common, medium, soft segregations of calcium carbonate; clear, smooth boundary.

C2ca—36 to 44 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/4) when moist; common, fine, distinct, yellowish-brown iron stains and few, fine, black manganese stains; weak, very coarse, prismatic structure that breaks to weak, medium and coarse, blocky; soft or slightly hard when dry, friable when moist; strongly alkaline and calcareous, with few, medium, soft segregations of calcium carbonate; clear, smooth boundary.

C3ca—44 to 56 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/4) when moist; few, fine, faint, gray mottles; common, fine, distinct iron stains that are yellowish brown (10YR 5/8) when moist; few, fine, black manganese stains; weak, very coarse, prismatic structure; soft or slightly hard when dry, very friable when moist; moderately alkaline and calcareous, with few, medium, soft segregations of calcium carbonate; clear, smooth boundary.

C4—56 to 65 inches, light-gray (5Y 7/1) silt loam, gray (5Y 6/1) when moist; common, medium, distinct, yellowish-brown iron stains and few, fine, black manganese stains; weak, very coarse, prismatic structure; soft or slightly hard when dry, very friable when moist; moderately alkaline and calcareous; few pipestem iron concretions.

The texture of the surface layer ranges from very fine sandy loam to silty clay loam. In places glacial till is at a depth of 15 to 48 inches. The depth to the zone of calcium carbonate accumulation ranges from 12 to 36 inches. Most areas of these soils are free of stones, but there are a few pebbles and stones in places. In many places the substratum is stratified silt, sand, and clay.

Rauville Series

In the Rauville series are deep, moderately fine textured Humic Gley soils. These soils are very poorly drained; the water table is at or near the surface during much of the year. These soils developed under tall grasses in alluvium on bottom lands. They are along the Big Sioux River and its major tributaries in the central and eastern parts of the county.

The Rauville soils occur with the Lamoure soils. They are more poorly drained than those soils.

Profile of Rauville silty clay loam that has slopes of 1 percent; 1,800 feet south and 175 feet west of the northeast corner of section 14, T. 117 N., R. 53 W.:

A1—0 to 8 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; mottled with dark reddish brown; weak, very thick, platy or blocky structure; friable; moderately alkaline and calcareous; clear, smooth boundary.

ACg—8 to 15 inches, gray (5Y 5/1) silty clay, black (10YR 2/1) when moist; weak, very thick, platy structure that breaks to weak, very coarse, blocky structure; friable when moist, sticky when wet; moderately alkaline and calcareous; gradual, wavy boundary.

C1g—15 to 34 inches, gray (5Y 4/1) silty clay, black (10YR 2/1) when moist; mottled with yellowish brown and dark reddish brown; structureless; friable when moist, sticky when wet; moderately alkaline and calcareous; gradual, wavy boundary.

C2g—34 to 60 inches, dark-gray (5Y 4/1) silty clay, black (10YR 2/1) when moist; structureless; friable; mildly alkaline and calcareous; gradual, wavy boundary.

IIC3g—60 inches +, black stratified sand; mildly alkaline and calcareous.

In many places a thin layer of peaty or mucky, partly decomposed organic material is on the surface of these soils. Also, in many places the substratum contains lenses of sand and gravel between a depth of 30 and 60 inches.

Renshaw Series

The Renshaw series consists of somewhat excessively drained Chernozems that are shallow over gravelly material. These soils developed in 10 to 20 inches of loamy to sandy alluvium that rests on gravelly outwash. They are nearly level or gently undulating and are on stream terraces and outwash plains throughout the county.

The Renshaw soils occur with the Estelline, Fordville, and Sioux soils. They are shallower over gravel than the Estelline and Fordville soils and have a thicker solum than the Sioux soils.

Profile of Renshaw loam that has slopes of 1 percent; in a cultivated field 1,500 feet west and 100 feet north of the southeast corner of section 35, T. 118 N., R. 53 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) light loam, black (10YR 2/1) when moist; weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

B21—7 to 11 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, coarse and medium, prismatic structure; friable; neutral; clear, smooth boundary.

B22—11 to 15 inches, dark-brown (10YR 3/3) loam, very dark gray (10YR 3/1) when moist; weak or moderate, prismatic structure that breaks to weak, medium, blocky; friable; neutral; clear, wavy boundary with some tonguing.

B3—15 to 18 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure; friable; neutral; clear, smooth boundary.

IIC1ca—18 to 22 inches, dark grayish-brown (10YR 4/2) and light yellowish-brown (10YR 6/4) mixed sand and gravel, very dark grayish brown (10YR 3/2) and yellowish brown (10YR 5/4) when moist; mottled with light gray; single grain; loose; moderately alkaline and calcareous, with lime coatings on the pebbles; clear, smooth boundary.

IIC2—22 to 60 inches, multicolored brown, yellowish-brown, and grayish-brown sand and gravel; single grain; loose; moderately alkaline and calcareous.

The texture of the surface layer ranges from fine sandy loam to loam. The depth to sand and gravel ranges from 10 to 20 inches.

Sioux Series

In the Sioux series are excessively drained Regosols that are very shallow over gravelly material. These soils developed in 10 inches or less of loamy or sandy alluvium over gravelly outwash. In some places they are nearly level to undulating and are on stream terraces and outwash plains. In other places they are rolling to steep and are on the tops of ridges of glacial moraines throughout the county.

The Sioux soils occur with the Renshaw soils on stream terraces and outwash plains and with the Buse and Vienna soils on uplands. They are shallower over gravel than the Renshaw soils, and they have more excessive drainage than the Renshaw, Vienna, and Buse soils. The Sioux soils are coarser textured than the Vienna and Buse soils.

Profile of Sioux loam that has slopes of 2 percent; 500 feet east and 100 feet north of the center of section 3, T. 119 N., R. 52 W., Sisseton Whoreton Indian Reservation:

Ap—0 to 6 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

AC—6 to 8 inches, very dark grayish-brown (10YR 3/2) gravelly sandy loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure or single grain; very friable and soft; neutral; clear, smooth boundary.

IIC1ca—8 to 20 inches, brown (10YR 5/3) sand and gravel, dark brown (10YR 4/3) when moist; single grain; loose; moderately alkaline and calcareous; contains a few to common, soft masses of lime and coatings on the pebbles; gradual, wavy boundary.

IIC2—20 to 60 inches, light-gray (10YR 7/2) and pale-brown (10YR 6/3) mixed sand and gravel, light olive brown (2.5Y 5/4) when moist; single grain; loose; moderately alkaline and calcareous.

The texture of the surface layer ranges from sandy loam to loam. The depth to gravel ranges from 5 to 10 inches. Some areas of these soils are stony.

Vienna Series

The Vienna series consists of deep, medium-textured, well-drained Chernozems. These soils developed under tall grasses in loamy glacial till. They have a few cobbles and other stones in the profile and on the surface. These soils are nearly level to sloping and are on uplands in the central and southeastern parts of the county. The slopes are long and smooth.

The Vienna soils occur with the Brookings, La Prairie, Buse, Sioux, and Kranzburg soils. They are coarser textured and better drained than the Brookings soils and have a thicker A horizon and are better drained than the La Prairie soils. They have a thicker A horizon and a thicker solum than the Buse and Sioux soils. The profile of the Vienna soils is similar to that of the Kranzburg soils, ex-

cept that it is coarser textured. Also, the Vienna soils developed in glacial till rather than in a moderately thick layer of loess over glacial till like the Kranzburg soils. The profile of the Vienna soils is similar to that of the Forman soils in the western and northeastern parts of the county, but the B and C horizons are less clayey than those of Forman soils.

Profile of Vienna silt loam that has slopes of 2 percent; in a cultivated field 2,000 feet north and 155 feet west of the southeast corner of section 14, T. 118 N., R. 52 W.:

Ap—0 to 5 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, fine, granular structure and cloddy; soft when dry, friable when moist; slightly acid; clear, smooth boundary.

B1—5 to 12 inches, very dark gray (10YR 3/1) loam; black (10YR 2/1) when moist; weak to moderate, coarse and medium, prismatic structure; slightly hard when dry, friable when moist; thin, patchy clay films on all the surfaces of the peds; slightly acid; gradual, smooth boundary

B21—12 to 18 inches grayish-brown (1Y 5/2) light clay loam, olive brown (2.5Y 4/3) when moist; patchy coatings, black to very dark gray (10YR 2.5/1) when moist, on the surfaces of the peds; moderate, coarse and medium, prismatic structure; slightly hard when dry, friable when moist; thin, patchy clay films on all the surfaces of the peds; neutral; clear, smooth boundary.

B22—18 to 23 inches, light olive-brown (2.5Y 5/4) light clay loam, olive brown (2.5Y 4/4) when moist; patchy coatings, very dark gray (2.5Y 3/1) when moist, on the surfaces of the peds; moderate, medium and coarse, prismatic structure; slightly hard or hard when dry, friable or firm when moist; thin, patchy clay films on the surfaces of the peds; mildly alkaline; clear, smooth boundary.

B2ca—23 to 27 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/5) when moist; patchy coatings, olive brown (2.5Y 4/3) when moist, on the surfaces of the peds; moderate, medium and coarse, prismatic structure; hard when dry, firm when moist; thin, patchy clay films on all the surfaces of the peds; moderately alkaline and calcareous, with common, medium, soft segregations of calcium carbonate; gradual, smooth boundary.

C1ca—27 to 37 inches, pale-yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/5) when moist; patchy light brownish-gray (2.5Y 6/2) coatings on the surfaces of the peds; weak, coarse, prismatic structure; hard when dry, firm when moist; moderately alkaline and calcareous, with common, medium, soft segregations of calcium carbonate; clear, smooth boundary.

C2ca—37 to 45 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/5) when moist; few, fine, prominent iron stains that are dark reddish brown (2.5YR 3/4) when moist; weak, coarse and very coarse, prismatic structure; very hard when dry, firm when moist; moderately alkaline and calcareous, with few to common soft threads and seams of segregated calcium carbonate; gradual, smooth boundary.

C3ca—45 to 53 inches, light yellowish-brown (2.5Y 6/3) loam, light olive brown (2.5Y 5/5) when moist; few, fine, prominent iron stains that are dark reddish brown (2.5YR 3/4) when moist; weak, very coarse, prismatic structure; very hard when dry, firm when moist; strongly alkaline and calcareous, with few soft threads and seams of segregated calcium carbonate; clear, smooth boundary.

C4ca—53 to 60 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/5) when moist; common, medium, distinct iron stains that are light olive brown (2.5Y 5/6) when moist; weak, very coarse, prismatic structure; very hard when dry, firm when moist; strongly alkaline and calcareous, with a few soft threads and seams of segregated calcium carbonate.

The texture of the surface layer ranges from loam to silty clay loam. In places the glacial till is capped by a mantle of silty material, generally less than 15 inches in thickness. The texture of the glacial till ranges from loam to light clay loam.

Waubay Series

In the Waubay series are deep, dark-colored, moderately well drained Chernozems. These soils developed under tall grasses in silty glacial drift and colluvial and alluvial deposits. They are on upland flats and in slightly depressed swales in the western and northeastern parts of the county.

The Waubay soils occur with the Poinsett, Forman, and Oldham soils. They are darker colored to a greater depth and are less well drained than the Poinsett and Forman soils. They are better drained than the Oldham soils.

Profile of Waubay silty clay loam that has slopes of 2 percent; in a cultivated field 1,300 feet north and 90 feet east of the southwest corner of section 34, T. 117 N., R. 54 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

B21—7 to 12 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, coarse, prismatic structure that breaks to moderate, fine, granular structure; friable when moist, slightly hard when dry; neutral; contains a few, small, white flecks of calcium carbonate; clear, smooth boundary.

B22—12 to 22 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, coarse and medium, prismatic structure that breaks to moderate, medium, blocky; firm when moist, slightly hard when dry; mildly alkaline and noncalcareous, but contains a few, small, white segregations of calcium carbonate; clear, wavy boundary.

B3ca—22 to 27 inches, pale-olive and gray (5Y 6/3 and 5/1) silty clay loam, olive (5Y 5/3) and dark gray (5Y 4/1) when moist; moderate, medium, prismatic structure that breaks to moderate, medium, blocky; friable when moist, slightly hard when dry; moderately alkaline and calcareous; few to common small segregations of calcium carbonate; clear, wavy boundary.

C1—27 to 46 inches, light-gray (5Y 7/1) and pale-olive (5Y 6/3) silty clay loam, olive (5Y 5/3) and dark gray (5Y 4/1) when moist; mottled with reddish brown and black; weak, medium and coarse, prismatic structure; friable, moderately alkaline and calcareous; clear, smooth boundary.

C2—46 to 60 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 5/1) when moist; mottled with reddish brown, yellowish red, and black; structureless; friable; moderately alkaline and calcareous.

The texture of the surface layer ranges from silt loam to silty clay loam. In some places the underlying material is silty glacial drift or glacial till. In others it is material washed down from the adjacent slopes.

Mechanical and Chemical Analyses [6]

Data obtained by mechanical and chemical analyses of selected soils in Codington County are given in table 8. Profiles of the selected soils are described in the section

[6] Profiles described by GEORGE BUNTLEY, assistant professor of agronomy, South Dakota Agricultural Experiment Station.

"Genesis, Classification, and Morphology of Soils." The data in this table are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful for estimating available water capacity, the extent of wind erosion, fertility, tilth, and other properties that affect soil management.

Field and laboratory methods

All samples used to obtain the data in table 8 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 of an inch in diameter. Estimates of the fraction of the sample consisting of particles larger than three-fourths of an inch were made during the sampling. If necessary, the sample was sieved after it was dried and rock fragments larger than three-fourths of an inch in diameter were discarded. Then the material made up of particles less than three-fourths of an inch was rolled, crushed, and sieved by hand to remove rock fragments larger than 2 millimeters in diameter. The amount of material larger than 2 millimeters, but smaller than three-fourths of an inch in diameter, is recorded on the data sheets and in table 8 as the percentage greater than 2 millimeters. This percentage is calculated from the total weight of the particles smaller than three-fourths of an inch in diameter.

The percentage given for the two fractions that consist of particles larger than three-fourths of an inch in diameter and of particles between 2 millimeters and three-fourths of an inch in diameter is somewhat arbitrary. The accuracy of the data depends on the severity of the preparative treatment, which may vary with the objectives of the study. But it can be said that the two fractions contain relatively unaltered rock fragments that are larger than 2 millimeters in diameter and that they do not contain slakable clods of earthy material. Unless otherwise noted, all laboratory analyses were made on ovendry material that passed a 2-millimeter sieve.

Standard methods of the Soil Survey Laboratory were used to obtain most of the data in table 8. Determinations of clay content were made by the pipette method (*5, 6, 8*). The reaction of the saturated paste was measured with a glass electrode. Organic carbon was determined by wet combustion, using a modification of the Walkley-Black method (*9*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples treated with concentrated hydrochloric acid. The cation-exchange capacity was determined by direct distillation of absorbed ammonia (*9*).

To determine the extractable calcium and magnesium, calcium was separated as calcium oxalate, and magnesium, as magnesium ammonium phosphate (*9*). Extractable hydrogen was determined by the triethanolamine method. Extractable potassium was determined on original extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*11*). Soluble potassium was determined on the saturation extract with a flame spectrophotometer. The base saturation is the percentage of bases computed by using the cation-exchange capacity, as measured by distillation.

Surface Geology and Physiography [7]

All of South Dakota east of the Missouri River has been glaciated. The glacial residue (glacial drift) that resulted covered sedimentary strata of Tertiary and Cretaceous age. This glacial drift is the parent material of the soils in the eastern part of South Dakota, and it is also responsible for the present-day topography of that area. The general topography in the eastern part of South Dakota is dominated by two plateau-like highlands, the Coteau du Missouri and the Coteau des Prairies, which are separated by the lowlands of the James River (*3*). Codington County is located in the approximate center of the Coteau des Prairies at an elevation of 1,700 to 2,000 feet above sea level.

The first ice sheet that covered the eastern part of South Dakota was the Nebraskan, and it was followed by the Kansan, Illinoian, and Wisconsin ice sheets (*13, 15*). The Wisconsin ice sheet had four separate advances, which were, from the oldest to the youngest, the Iowan, Tazewell, Cary, and Mankato. These ice sheets deposited drift that consisted of clay, silt, sand, gravel, and boulders that had been reworked from bedrock and older surficial deposits. In this county the drift is approximately 500 feet thick over bedrock.

Glacial drift may be of three types—till, outwash, and glacial lake deposits. Till is the most abundant and consists of a mixture of unsorted and unstratified material. In some places this material consists of boulders, but the size may be as small as particles of clay. The till was produced by the abrasion of the ice sheet against the land surface, and it was deposited in ground moraines or in end moraines.

Extensive areas of outwash also occur in this county. These are beds of stratified silt, sand, and gravel that have been rewashed from the drift and deposited by the melt water of streams that flowed from the ice sheets. These beds are important sources of gravel for roads and for other construction purposes. Also, they are storage reservoirs for ground water. Most of the outwash in this county is believed to be of Cary age; however, small patches of Tazewell (?) outwash have been identified.

Glacial lake deposits are the least abundant of the glacial materials in this county. These deposits consist of stratified silt, sand, and clay deposited by streams as they flowed into ponded areas held behind temporary glacial dams (*15*). Glacial lake deposits occur around many of the lakes and sloughs within the areas of Cary drift. Strand lines that are rimmed in many places with ice-rafted boulders are above the present shoreline of these lakes.

Many of the soils of this county formed in loess that overlies the drift. The loess consists of silt, clay, and a few particles of sand. It was derived mainly from outwash and was deposited by wind.

Some of the soils, such as the Rauville, Lamoure, and Parnell, formed in alluvium. This material is made up of silt, sand, and clay that has been deposited by streams and has been reworked from bedrock and older surficial

[7] JOHN A. WILSON, geologist, Soil Conservation Service, assisted in the preparation of this section.

TABLE 8.—*Analytical data*

[Analyses made at Soil Survey Laboratory, Soil Conservation Service,

Soil	Horizon	Depth	Particle-size distribution (in millimeters)							
			Very coarse sand (2.0 to 1.0 mm.)	Coarse sand (1.0 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (<0.002 mm.)	Coarse fragments (>2.0 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Egeland fine sandy loam.										
Location: Sec. 23, T. 116 N., R. 52 W.; 900 ft. W. and 925 ft. S. of center of the section.	Ap	0–9	3.4	29.6	24.4	14.2	2.6	17.0	8.8	--------
Survey No. S58SD-15-1-(1-9).	B21	9–14	1.9	23.1	23.5	14.7	2.8	22.6	11.4	--------
Laboratory No. 9452–9460.	B22	14.21	2.0	26.2	29.3	19.1	2.7	12.8	7.9	--------
	B31	21–26	2.1	28.3	29.7	19.1	2.8	11.5	6.5	--------
	B32	26–32	.7	16.6	21.0	15.0	5.4	29.5	11.8	--------
	IIC1ca	32–38	1.8	7.0	7.0	8.8	7.7	51.0	16.7	(1)
	IIC2ca	38–44	4.6	8.3	8.0	15.4	8.8	33.6	21.3	8.9
	IIC3ca	44–49	3.4	6.5	6.5	12.8	8.3	37.6	24.9	8.0
	IIC4ca	49–60+	3.7	6.8	6.3	12.0	8.0	38.8	24.4	15.6
Estelline silt loam:										
Location: Sec. 33, T. 117 N., R. 53 W.; 300 ft. N. and 290 ft. E. of the center of the section.	Ap	0–8	1.2	3.4	3.0	2.8	3.2	60.1	26.3	--------
Survey No. S58SD-15-5-(1-8).	B21	8–16	.5	2.2	2.0	1.6	2.9	62.2	28.6	--------
Laboratory No. 9486–9493.	B22	16–21	.1	.6	.6	.6	3.1	65.9	29.1	--------
	B23	21–28	.3	.7	.7	.8	4.4	66.0	27.1	--------
	B24	28–33	.1	.3	.4	.5	5.9	69.3	23.5	--------
	B3ca	33–37	.1	.6	.5	.5	6.7	70.9	20.8	--------
	Cca	37–45	4.7	5.6	5.3	5.7	5.9	55.0	17.8	10.3
	IIC	45–60+	13.4	29.5	35.0	13.8	.6	3.5	4.2	29.0
Location: Sec. 36, T. 117 N., R. 53 W.; 580 ft. E. and 765 ft. N. of SW. corner.	Ap	0–8	.7	2.1	2.3	2.8	3.1	63.1	25.9	--------
Survey No. S58SD-15-8-(1-8).	B21	8–15	.5	1.7	2.0	2.1	2.9	63.0	27.8	(1)
Laboratory No. 9510–9517.	B22	15–21	.2	1.3	1.5	1.6	2.8	64.8	27.8	--------
	B23	21–28	.2	.7	1.0	1.2	3.7	65.1	28.1	--------
	B24	28–33	.1	.7	.9	1.0	5.0	66.9	25.4	--------
	B3ca	33–39	.4	.9	1.1	1.2	5.8	69.5	21.1	(1)
	Cca	39–49	3.9	7.4	9.0	15.7	10.7	36.5	16.8	5.9
	IIC	49–60+	4.9	18.7	29.5	33.1	4.7	5.3	3.8	10.1
Fordville silt loam:										
Location: Sec. 18, T. 118 N., R. 52 W.; 165 ft. W. and 1,200 ft. N. of SW. corner.	Ap	0–6	2.4	5.1	4.6	5.9	3.8	53.8	24.4	--------
Survey No. S58SD-15-3-(1-8).	B21	6–14	1.8	4.7	3.6	4.6	3.5	56.4	25.4	(1)
Laboratory No. 9470–9477.	B22	14–18	2.8	4.9	3.7	4.6	3.9	56.9	23.2	(1)
	B23	18–25	4.1	6.9	5.9	9.7	6.6	46.9	19.9	3.9
	B3ca	25–30	12.7	12.0	10.3	17.4	10.2	25.0	12.4	31.1
	IICca	30–40	18.4	17.7	12.9	14.9	7.6	19.6	8.9	19.8
	IIC1	40–54	18.3	23.8	15.5	23.3	2.6	12.4	4.1	32.7
	IIC2	54–60	11.2	20.6	16.0	32.6	9.5	7.2	2.9	32.5
Location: Sec. 29, T. 118 N., R. 52W.; 155 ft. N. and 220 ft. W. of center of the section.	Ap	0–7	1.5	4.3	3.6	4.4	3.6	58.2	24.4	(1)
Survey No. S58SD-15-7-(1-9).	B21	7–13	1.7	3.2	2.6	3.3	3.3	59.5	26.4	(1)
Laboratory No. 9501–9509.	B22	13–18	.8	2.4	2.1	2.7	3.5	62.4	26.1	1.3
	B23	18–23	.3	1.0	.9	1.4	4.7	66.3	25.4	--------
	B3ca	23–28	2.0	2.8	2.3	3.7	7.7	62.1	19.4	4.3
	IIC1ca	28–33	4.6	10.8	10.0	16.0	10.2	33.8	14.6	7.2
	IIC2ca	33–38	7.6	13.0	14.4	26.9	11.6	15.1	11.4	29.3
	IIICca	38–49	23.0	37.7	14.6	9.3	4.1	7.5	3.8	49.7
	IIIC	49–60	39.6	29.3	13.3	6.7	1.6	7.4	2.1	78.2

See footnote at end of table.

for selected soil profiles

Lincoln, Nebr. Dashes indicate values not determined or do not apply]

pH	Organic carbon	Calcium carbonate equivalent	Moisture held at tension of 15 atmospheres	Cation-exchange capacity (NH_4OAc)	Extractable cations (meq./100 gr.)				Base saturation (NH_4Ac)	Calcium-magnesium ratio
					Ca	Mg	H	K		
				Meq./100 gr.					*Percent*	
6.3	1.25	----------	4.4	10.2	7.0	1.8	3.2	0.4	90	3.9
6.3	.77	----------	5.0	10.1	6.9	2.3	2.4	.3	94	3.0
6.5	.34	<1	3.2	6.8	4.6	1.5	1.6	.2	93	3.1
6.7	.19	<1	2.7	5.8	4.0	1.4	1.2	.2	96	2.8
7.1	.32	<1	5.0	9.9	8.0	2.9	1.2	.2	112	2.8
7.9	.33	15	6.5	11.8	----------	----------	----------	.3	----------	----------
8.0	.20	22	7.4	10.3	----------	----------	----------	.3	----------	----------
8.1	.13	22	9.2	12.0	----------	----------	----------	.3	----------	----------
8.2	.09	25	9.2	11.3	----------	----------	----------	.3	----------	----------
6.1	4.08	----------	13.5	27.4	19.3	6.1	7.8	.7	96	3.2
6.4	2.09	----------	12.4	23.6	16.5	6.7	6.6	.5	101	2.5
6.7	1.06	<1	12.0	23.2	15.5	8.4	4.5	.4	105	1.8
7.0	.73	<1	11.0	21.8	14.1	8.6	5.3	.5	107	1.6
7.6	.54	2	9.8	18.4	----------	8.5	1.6	.4	----------	----------
7.9	.33	11	8.8	16.1	----------	----------	----------	.4	----------	----------
8.0	.25	16	7.5	12.0	----------	----------	----------	.3	----------	----------
8.4	.03	9	3.9	4.6	----------	----------	----------	.1	----------	----------
6.0	4.24	----------	13.5	28.8	19.7	5.4	10.7	.5	89	3.6
6.6	2.11	<1	12.8	25.6	17.5	6.4	6.2	.5	96	2.7
6.8	1.19	<1	12.0	24.0	15.7	7.4	4.5	.5	99	2.1
7.1	.71	<1	11.6	22.7	15.1	8.0	3.3	.5	104	1.9
7.5	.59	<1	10.9	20.9	15.0	8.2	2.0	.5	114	1.8
7.9	.36	15	8.9	16.5	----------	----------	----------	.4	----------	----------
8.0	.18	12	6.9	12.2	----------	----------	----------	.3	----------	----------
8.5	.01	9	1.9	2.9	----------	----------	----------	.1	----------	----------
6.2	3.99	----------	13.3	28.7	20.9	5.4	8.2	.4	93	3.9
6.6	1.64	<1	11.3	24.5	17.6	5.6	4.9	.4	97	3.1
6.8	1.23	<1	10.1	21.5	16.1	5.6	3.7	.4	103	2.9
7.0	.69	<1	8.2	17.1	12.4	4.8	2.4	.3	103	2.6
8.0	.43	12	5.1	9.0	----------	----------	----------	.2	----------	----------
8.2	.10	18	3.1	6.0	----------	----------	----------	.2	----------	----------
8.5	.01	20	2.5	3.1	----------	----------	----------	.1	----------	----------
8.5	.01	19	2.3	2.8	----------	----------	----------	.1	----------	----------
5.9	3.46	----------	12.3	25.7	18.1	4.9	9.0	.4	91	3.7
6.5	1.67	<1	11.9	24.0	17.0	5.9	5.3	.4	98	2.9
6.8	1.36	<1	11.0	23.8	16.9	6.9	3.7	.4	102	2.4
7.5	.97	1	11.0	21.7	----------	7.8	1.6	.4	----------	----------
7.9	.51	16	8.0	15.4	----------	----------	----------	.3	----------	----------
8.1	.24	16	5.3	9.8	----------	----------	----------	.3	----------	----------
8.2	.16	11	4.0	7.5	----------	----------	----------	.2	----------	----------
8.6	.06	20	1.4	2.3	----------	----------	----------	.1	----------	----------
8.5	.04	20	1.4	2.3	----------	----------	----------	.1	----------	----------

TABLE 8.—*Analytical data for*

Soil	Horizon	Depth	Particle-size distribution (in millimeters): Very coarse sand (2.0 to 1.0 mm.)	Coarse sand (1.0 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (<0.002 mm.)	Coarse fragments (>2.0 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Forman loam:										
Location: Sec. 13, T. 118 N., R. 51 W.; 1,800 ft. S. and 60 ft. E. of the NW. corner.	Ap	0–4	2.7	6.1	6.3	9.9	5.2	43.7	26.1	2.0
Survey No. S57SD-15-10-(1-9).	B21t	4–10	2.5	3.6	4.6	7.2	5.5	45.0	31.6	(1)
Laboratory No. 6076–6084.	B22t	10–14	2.6	4.8	5.7	10.2	7.5	37.0	32.2	3.9
	B23	14–18	5.1	4.8	4.9	8.5	6.9	39.1	30.7	6.4
	B3ca	18–26	3.9	4.8	4.5	8.0	6.6	40.0	32.2	5.7
	C1ca	26–35	2.5	4.0	3.7	7.7	7.8	44.4	29.9	(1)
	C2ca	35–44	3.4	4.0	4.2	7.3	6.8	43.7	30.6	7.9
	C3ca	44–50	4.6	4.4	4.5	7.9	6.5	42.8	29.3	5.7
	C4ca	50–60	3.8	4.3	4.3	7.3	6.4	43.9	30.9	4.9
Location: Sec. 26, T. 118 N., R. 51 W.; 280 ft. S. and 60 ft. W. of the NE. corner.	Ap	0–7	2.3	5.4	5.3	7.3	4.7	47.3	27.7	2.0
Survey No. S57SD-15-3-(1-8).	B21	7–10½	2.1	4.3	4.3	7.2	4.7	47.1	30.3	1.9
Laboratory No. 6015–6022.	B22t	10½–17	2.8	5.8	6.3	10.3	6.8	34.5	33.5	2.9
	B2ca	17–23	3.4	5.1	4.9	8.5	7.3	40.0	30.8	6.4
	B3ca	23–30	5.2	5.9	5.4	9.3	8.1	32.3	33.8	5.9
	C1ca	30–38	4.5	6.1	6.0	10.8	8.8	38.9	24.9	1.8
	C2ca	38–45	4.8	5.9	5.6	9.7	8.2	39.3	26.5	6.3
	C3ca	45–60+	5.0	6.4	5.8	9.6	8.1	38.6	26.5	6.8
Kranzburg silty clay loam:										
Location: Sec. 29, T. 116 N., R. 52 W.; 200 ft. E. and 95 ft. N. of the SW. corner.	Ap	0–7	.4	1.5	2.0	4.1	3.8	60.0	28.2	(1)
Survey No. S57SD-15-1-(1-8).	B21	7–12	.1	.4	.4	1.2	2.8	63.9	31.2	--------
Laboratory No. 5997–6004.	B22	12–17	.1	.3	.4	.7	4.6	65.6	28.3	(1)
	B23	17–23	.1	.9	1.7	6.0	6.0	66.6	24.1	(1)
	I-IIB3ca	23–28	3.0	5.6	6.2	10.2	7.4	47.7	19.9	6.0
	IIC1ca	28–40	3.1	5.0	5.3	8.9	6.7	41.9	29.1	4.4
	IIC2ca	40–48	3.4	4.2	4.3	8.1	7.2	43.0	29.8	4.5
	IIC3ca	48–60+	5.0	4.2	4.0	7.3	6.9	43.7	28.9	5.3
Location: Sec. 8, T. 119 N., R. 52 W., Sisseton Whoreton Indian Reservation; 800 ft. N. and 115 ft. W. of the SE. corner.	Ap	0–8	.4	.9	1.2	1.9	4.4	62.8	28.4	(1)
Survey No. S57SD-15-4-(1-8).	B21	8–11	--------	.3	.5	.8	3.8	64.8	29.8	(1)
Laboratory No. 6023–6030.	B22	11–19	--------	.1	.1	.2	5.1	64.6	29.9	(1)
	B23	19–25	--------	.1	.3	7.1	7.1	67.5	24.9	--------
	B3ca	25–32	--------	.2	.4	.7	7.2	71.8	19.7	--------
	I-IICca	32–36	2.5	4.6	4.6	6.5	7.9	54.1	19.8	5.7
	IIC1ca	36–47	3.2	7.8	9.5	13.8	6.8	36.8	22.1	4.7
	IIC2ca	47–60+	4.8	6.2	6.1	9.3	6.0	40.5	27.1	4.7
Lamoure silty clay loam:										
Location: Sec. 9, T. 116 N., R. 52 W.; 175 ft. S. and 50 ft. E. of the NW. corner.	Ap	0–6	.9	3.5	3.5	5.2	7.3	50.6	29.0	(1)
Survey No. S57SD-15-2-(1-10).	AC	6–11	.9	3.5	3.3	4.5	6.4	50.2	31.2	(1)
Laboratory No. 6005–6014.	C1gca	11–17	1.8	4.8	4.2	6.0	5.3	49.3	28.6	.9
	C2gca	17–22	1.7	5.8	5.0	6.7	4.3	44.0	32.5	(1)
	C3gca	22–30	1.9	5.7	5.6	7.5	4.3	39.7	35.3	.8
	C4gca	30–35	3.8	9.5	8.9	10.5	4.2	33.9	29.2	1.6
	C5ca	35–40	4.6	12.2	10.5	12.0	4.2	33.2	23.3	1.7
	IIC6	40–46	7.5	16.1	16.5	21.2	6.6	20.9	11.2	6.5
	IIIC7	46–57	17.3	23.1	21.2	19.7	5.9	7.9	4.9	19.0
	IIIC8	57–65	20.8	25.1	20.9	20.7	4.6	5.0	2.9	20.2
Location: Sec. 33, T. 119N., R. 52 W., Sisseton Whoreton Indian Reservation; 2,600 ft. W. and 100 ft. N. of the SE. corner.	Ap	0–7	1.8	1.6	1.8	3.2	5.1	54.7	31.8	(1)
Survey No. S57SD-15-5-(1-9).	AC	7–11	.4	1.9	1.5	3.1	4.5	58.2	30.4	(1)
Laboratory No. 6031–6039.	C1gca	11–15	.1	.9	1.1	2.3	4.0	57.1	34.5	(1)
	C2gca	15–21	.2	.6	1.1	2.6	4.9	56.3	34.3	(1)
	C3gca	21–27	.7	1.0	1.4	3.7	5.3	54.4	33.5	(1)
	C4gca	27–38	.8	1.5	1.4	2.6	5.1	57.1	31.5	.6
	C5gca	38–46	2.6	3.3	2.8	4.1	7.2	53.4	26.6	(1)
	IIC6g	46–52	11.6	11.7	8.6	9.7	6.4	33.3	18.7	4.1
	IIIC7	52–60	15.9	21.9	22.4	15.9	3.4	14.5	6.0	31.1

See footnote at end of table.

selected soil profiles—Continued

pH	Organic carbon	Calcium carbonate equivalent	Moisture held at tension of 15 atmospheres	Cation-exchange capacity (NH_40Ac)	Extractable cations (meq./100 gr.)				Base saturation (NH_4Ac)	Calcium-magnesium ratio
					Ca	Mg	H	K		
				Meq./100 gr.					*Percent*	
6.9	3.64	----------	12.7	29.3	21.1	7.2	5.0	0.5	98	2.9
6.9	1.57	----------	11.7	24.3	15.8	6.9	3.8	.3	95	2.3
7.7	.98	4	10.9	20.8	----------	----------	----------	.3	----------	----------
8.1	.53	24	9.3	14.8	----------	----------	----------	.2	----------	----------
8.3	.30	29	9.8	13.1	----------	----------	----------	.2	----------	----------
8.5	.14	28	11.2	13.3	----------	----------	----------	.2	----------	----------
8.4	.10	25	11.8	13.8	----------	----------	----------	.2	----------	----------
8.4	.10	26	11.7	13.9	----------	----------	----------	.2	----------	----------
8.5	.07	23	12.0	14.0	----------	----------	----------	.2	----------	----------
6.4	2.92	----------	12.4	27.0	18.2	5.2	7.2	.3	88	3.5
6.9	1.34	----------	12.2	23.6	16.1	5.8	5.5	.2	94	2.8
7.7	.81	1	11.1	20.2	----------	----------	----------	.2	----------	----------
8.2	.47	26	9.1	14.4	----------	----------	----------	.2	----------	----------
8.4	.28	33	9.7	13.6	----------	----------	----------	.2	----------	----------
8.4	.10	30	8.5	11.9	----------	----------	----------	.1	----------	----------
8.4	.07	26	9.5	12.0	----------	----------	----------	.2	----------	----------
8.4	.05	26	10.3	12.6	----------	----------	----------	.2	----------	----------
6.6	2.76	----------	12.5	27.2	18.1	6.6	6.7	.6	93	2.7
7.1	1.34	----------	12.7	25.6	15.9	8.3	4.2	.3	96	1.9
7.4	.85	----------	11.9	23.9	15.1	9.0	2.5	.2	100	1.7
7.9	.67	3	10.1	20.2	----------	9.0	1.7	.2	----------	----------
8.2	.30	16	7.4	12.6	----------	----------	----------	.1	----------	----------
8.5	.13	24	9.7	13.5	----------	----------	----------	.2	----------	----------
8.5	.07	27	10.7	13.2	----------	----------	----------	.2	----------	----------
8.5	.05	26	10.9	13.5	----------	----------	----------	.2	----------	----------
6.9	3.41	----------	13.6	30.6	21.0	7.2	5.5	.7	94	2.9
7.1	1.74	----------	13.0	25.7	16.1	8.5	4.2	.3	97	1.9
7.4	.84	----------	12.5	24.5	14.4	11.3	2.9	.3	100	1.3
7.9	.59	4	10.4	20.4	----------	11.0	1.2	.3	----------	----------
8.3	.30	17	8.1	14.9	----------	----------	----------	.2	----------	----------
8.5	.22	15	7.9	14.1	----------	----------	----------	.2	----------	----------
8.7	.01	16	7.7	12.1	----------	----------	----------	.2	----------	----------
8.7	.08	17	9.7	14.2	----------	----------	----------	.2	----------	----------
7.9	4.54	2	17.2	35.4	----------	----------	----------	.4	----------	----------
8.0	3.93	6	18.2	33.8	----------	----------	----------	.3	----------	----------
8.2	2.85	9	16.6	28.9	----------	----------	----------	.3	----------	----------
8.5	1.58	15	14.3	22.5	----------	----------	----------	.2	----------	----------
8.5	.99	21	13.7	16.5	----------	----------	----------	.1	----------	----------
8.4	.66	16	10.3	13.4	----------	----------	----------	.1	----------	----------
8.2	.59	12	8.7	13.7	----------	----------	----------	.1	----------	----------
8.3	.23	4	4.6	8.6	----------	----------	----------	.1	----------	----------
8.6	.06	14	2.3	3.9	----------	----------	----------	.1	----------	----------
8.5	.01	13	2.0	2.9	----------	----------	----------	.1	----------	----------
8.0	4.57	11	18.5	36.6	----------	----------	----------	.3	----------	----------
8.1	3.24	22	18.2	31.7	----------	----------	----------	.2	----------	----------
8.2	2.55	23	17.7	39.4	----------	----------	----------	.2	----------	----------
8.4	1.82	25	15.4	25.2	----------	----------	----------	.2	----------	----------
8.4	1.57	30	14.6	22.9	----------	----------	----------	.2	----------	----------
8.3	.82	28	13.2	21.1	----------	----------	----------	.2	----------	----------
8.2	.59	19	11.8	20.0	----------	----------	----------	.2	----------	----------
8.2	.34	11	8.3	15.5	----------	----------	----------	.2	----------	----------
8.4	.06	11	3.2	5.7	----------	----------	----------	.1	----------	----------

TABLE 8.—*Analytical data for*

Soil	Horizon	Depth	Particle-size distribution (in millimeters)							
			Very coarse sand (2.0 to 1.0 mm.)	Coarse sand (1.0 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (<0.002 mm.)	Coarse fragments (>2.0 mm.)
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Poinsett silt loam:										
Location: Sec. 18, T. 119 N., R. 54 W.; 700 ft. N. and 100 ft. E. of the SW. corner.	Ap	0–7	0.3	0.8	1.1	2.2	5.7	63.3	26.6	(1)
	AB	7–10	.3	.3	.4	1.0	4.4	64.0	29.6	--------
	B21	10–15	--------	.2	.2	.5	3.6	65.5	30.0	(1)
	B22	15–22	.2	.3	.3	.7	4.1	68.5	25.9	--------
Survey No. S57SD–15–7–(1–9).	B3ca	22–27	.2	.2	.2	.4	3.6	70.0	25.4	--------
Laboratory No. 6049–6057.	C1ca	27–36	.1	.3	.2	.6	4.3	70.4	24.1	(1)
	C2ca	36–44	.5	.3	.2	.8	5.4	70.8	22.0	--------
	C3ca	44–56	.6	.4	.2	.6	7.7	69.8	20.7	--------
	C4	56–65	--------	.2	.3	.6	7.6	71.8	19.5	--------
Location: Sec. 32, T. 116 N., R. 55 W.; 750 ft. W. and 95 ft. S. of the NE. corner.	Ap	0–6	.2	.8	1.6	5.3	8.4	56.9	26.8	--------
	AB	6–13	.1	.5	.7	2.7	9.1	57.9	29.0	(1)
	B21	13–17	--------	.2	.4	1.8	12.6	55.5	29.5	--------
	B22	17–24	--------	.2	.2	1.2	8.8	58.5	31.1	(1)
Survey No. S57SD–15–6–(1–9).	B3ca	24–33	--------	.1	.2	2.1	16.0	60.9	20.7	--------
Laboratory No. 6040–6048.	C1ca	33–41	--------	.1	.2	1.1	9.9	64.5	24.2	--------
	C2	41–45	--------	.1	.1	.3	2.9	64.4	32.2	--------
	C3	45–53	.2	.4	.2	.6	5.6	66.0	27.0	--------
	C4	53–62	.3	.3	.2	.6	6.3	63.7	28.6	--------
Vienna silt loam:										
Location: Sec. 14, T. 118 N., R. 52 W.; 2,000 ft. N. and 155 ft. W. of the SE. corner.	Ap	0–5	1.4	3.0	3.9	6.5	2.6	55.6	27.0	--------
	B1	5–12	.8	4.4	4.5	6.4	4.3	51.6	28.0	(1)
	B21	12–18	1.4	4.5	4.7	7.1	4.8	46.9	30.6	(1)
Survey No. S57SD–15–9–(1–9).	B22	18–23	4.5	6.7	6.8	12.0	7.9	30.4	31.7	1.8
	B2ca	23–27	3.5	5.0	5.4	13.5	9.1	38.5	25.0	6.1
Laboratory No. 6067–6075.	C1ca	27–37	3.0	4.4	5.0	13.1	9.1	39.3	26.1	5.6
	C2ca	37–45	3.0	5.4	5.5	13.1	8.9	38.5	25.6	4.7
	C3ca	45–53	3.3	4.7	4.8	12.6	9.0	39.4	26.2	5.6
	C4ca	53–60	5.4	5.1	5.0	12.3	8.9	41.2	22.1	7.4
Location: Sec. 36, T. 118 N., R. 52 W.; 2,600 ft. E. and 140 ft. S. of the NW. corner.	Ap	0–6	1.6	5.1	5.2	8.1	3.9	49.5	26.6	(1)
	B1	6–10	1.1	4.0	4.4	6.2	3.4	52.4	28.5	(1)
	B21	10–15	1.1	3.6	4.7	6.8	4.1	52.7	27.0	.9
Survey No. S57SD–15–8–(1–9).	B22	15–19	4.8	8.7	10.9	17.7	6.6	29.7	21.6	2.4
	B2ca1	19–24	6.3	7.3	6.3	11.4	7.5	35.1	26.1	7.4
Laboratory No. 6058–6066.	B2ca2	24–31	6.5	5.5	5.1	9.0	7.1	37.6	29.2	5.6
	C1ca	31–36	7.8	5.7	5.1	9.2	7.1	37.9	27.2	6.8
	C2	36–44	8.8	6.4	5.2	8.9	7.4	37.0	26.3	6.3
	C3	44–60	11.2	5.8	4.8	9.1	7.4	36.9	24.8	6.6

[1] Trace.

deposits. The alluvium is mainly on the nearly level bottom lands of the Big Sioux River and its tributaries where drainage is poor.

Climate [8]

Codington County has a continental climate. This type of climate is characterized by large seasonal and daily fluctuations in temperature; generally, only a small amount of precipitation is received in winter, and marginal to adequate rainfall for crops is received during the growing season. Although numerous small lakes occur throughout the county, these bodies of waters are not large enough to affect the climate. Also, differences in elevation have had only a relatively minor effect on the climate because the total difference in elevation is only about 350 feet.

Table 9 gives more detailed information about the temperature and precipitation in this county. For the most part, the information given in the table is based on records kept over the period from 1898 to 1962 at Watertown, in the south-central part of the county. The average temperature and precipitation at Watertown are considered representative for the rest of the county; the average temperature varies only 1 or 2 degrees, plus or minus, and the average annual precipitation varies only 1 or 2 inches, plus or minus, from that in the other parts of the county.

Temperature.—Occasionally there are marked differences between the temperatures recorded in this county on consecutive days. Differences between the temperatures recorded in summer and those recorded in winter are also

[8] By WALTER SPUHLER, State climatologist, U.S. Weather Bureau, Brookings, S. Dak.

selected soil profiles—Continued

pH	Organic carbon	Calcium carbonate equivalent	Moisture held at tension of 15 atmospheres	Cation-exchange capacity (NH_4OAc)	Extractable cations (meq./100 gr.)				Base saturation (NH_4Ac)	Calcium-magnesium ratio
					Ca	Mg	H	K		
				Meq./100 gr.					*Percent*	
7. 6	3. 68	----------	14. 3	30. 1	24. 9	8. 1	2. 5	1. 1	100	3. 1
7. 7	2. 63	----------	14. 2	27. 6	20. 5	9. 2	2. 5	. 7	100	2. 2
7. 9	1. 32	----------	12. 9	25. 1	14. 3	11. 6	2. 1	. 4	100	1. 2
8. 1	. 85	1	11. 7	21. 5	----------	12. 0	. 4	. 3	----------	----------
8. 4	. 46	21	9. 2	15. 7	----------	----------	----------	. 2	----------	----------
8. 5	. 32	20	9. 0	15. 5	----------	----------	----------	. 2	----------	----------
8. 5	. 22	19	9. 4	15. 7	----------	----------	----------	. 2	----------	----------
8. 3	. 18	18	9. 5	14. 7	----------	----------	----------	. 2	----------	----------
8. 1	. 15	15	9. 1	14. 3	----------	----------	----------	. 3	----------	----------
6. 8	3. 79	----------	14. 8	32. 1	23. 3	6. 4	5. 0	2. 3	100	3. 6
7. 2	3. 17	----------	14. 7	30. 3	23. 1	6. 6	3. 8	1. 2	100	3. 5
7. 4	1. 32	----------	12. 9	25. 5	----------	----------	----------	. 5	----------	----------
7. 7	. 87	1	12. 4	23. 3	----------	----------	----------	. 4	----------	----------
8. 3	. 38	18	8. 0	13. 1	----------	----------	----------	. 3	----------	----------
8. 4	. 26	10	10. 0	14. 3	----------	----------	----------	. 2	----------	----------
8. 4	. 24	13	12. 8	16. 8	----------	----------	----------	. 3	----------	----------
8. 5	. 21	10	12. 3	15. 9	----------	----------	----------	. 2	----------	----------
8. 5	. 18	19	13. 2	17. 5	----------	----------	----------	. 3	----------	----------
6. 1	5. 94	----------	17. 8	33. 6	21. 8	6. 3	10. 5	. 9	86	3. 5
6. 5	3. 40	----------	13. 4	28. 1	18. 7	7. 0	7. 1	. 3	93	2. 7
6. 8	1. 12	----------	10. 9	22. 4	14. 0	8. 0	3. 8	. 2	100	1. 8
7. 4	. 80	1	9. 8	19. 0	----------	8. 2	2. 9	. 2	----------	----------
8. 1	. 42	29	7. 5	12. 5	----------	----------	----------	. 1	----------	----------
8. 4	. 20	31	8. 0	11. 0	----------	----------	----------	. 1	----------	----------
8. 4	. 11	27	8. 6	10. 5	----------	----------	----------	. 1	----------	----------
8. 5	. 10	28	9. 3	11. 0	----------	----------	----------	. 1	----------	----------
8. 5	. 07	26	8. 2	9. 9	----------	----------	----------	. 1	----------	----------
6. 4	3. 73	----------	13. 9	27. 9	18. 1	7. 0	7. 1	. 8	93	2. 6
7. 0	1. 92	----------	12. 8	26. 1	16. 7	8. 2	4. 2	. 3	97	2. 0
7. 3	1. 11	----------	10. 6	22. 6	14. 2	8. 8	2. 9	. 2	100	1. 6
7. 8	. 66	4	7. 5	14. 7	----------	----------	----------	. 2	----------	----------
8. 3	. 40	27	7. 4	12. 2	----------	----------	----------	. 1	----------	----------
8. 5	. 28	31	8. 9	12. 8	----------	----------	----------	. 1	----------	----------
8. 5	. 14	32	8. 8	11. 3	----------	----------	----------	. 1	----------	----------
8. 6	. 07	28	9. 3	11. 2	----------	----------	----------	. 1	----------	----------
8. 6	. 07	28	9. 9	11. 2	----------	----------	----------	. 1	----------	----------

great. In some years, for example, the temperature has risen higher than 100° in summer and has dropped lower than 30° below zero in winter. A reading of 100° or higher may be expected in this county about 2 years out of 3 in July and about 1 year out of 4 in June and August.

A temperature of 90° or higher occurs, on the average, about 17 days per year but has occurred as often as 53 days in 1 year or as seldom as only 1 day in 1 year. A reading of 30° below zero or lower may be expected in January and February about 1 year in 3. A temperature of 20° below zero or lower may be expected each year about three times in January, twice in February, and once in December. A minimum temperature of zero or lower can be expected, on the average, about 42 times per year, but this minimum temperature may occur as often as 71 times per year and as few as 10 times per year. The temperature may fail to climb above zero during the day about six times per year. Table 10 shows the probabilities of receiving freezing temperatures after a given date in spring and before a given date in fall.

Figure 21 gives the average weekly temperatures recorded at Watertown. The temperatures shown in figure 21 are based on records kept from 1896 to 1954. (*10*).

Precipitation.—The average annual precipitation is 20.75 inches at Watertown, and about 78 percent of this amount falls during the growing season of April to September. Thunderstorms are the main source of rainfall during the growing season. They range widely in intensity and in the amount of rain received. About once a year, a 1-inch rain may be expected to occur in 1 hour, and once in 25 years a 2½-inch rain may be expected to occur in 1 hour (*4*). Once a year 2 inches of rain may be expected during a 24-hour period, and once in 25 years a 5-inch rain may be expected during a 24-hour period.

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TABLE 9.—*Temperature and precipitation*

[Prepared by W. F. Lytle, South Dakota State University, using punchcards and digital computer, from records kept at Watertown, S. Dak. All data are for the period from 1898 to 1962, except that for snow cover, which is for the period from 1930 to 1962]

Month	Temperature				Precipitation						Average number of days with—	
	Average daily maximum	Average daily minimum	7 years in 10 will have— Average maximum temperature equal to or higher than—	7 years in 10 will have— Average minimum temperature equal to or lower than—	Average total	Maximum total	Minimum total	3 years in 10 will have— More than—	3 years in 10 will have— Less than—	Average total snowfall	Snowfall of 1 inch or more	Snow cover of 1 inch or more
	° F.	° F.	° F.	° F.	Inches	Inches	Inches	Inches	Inches	Inches		
January	21.1	−0.6	23.8	−3.0	0.51	1.87	0.02	0.20	0.60	5.2	2.0	22.0
February	25.1	−4.0	27.8	.2	.56	2.28	.01	.27	.69	5.5	1.6	16.5
March	38.0	17.5	41.1	15.2	.88	3.16	.05	.44	1.12	5.7	2.0	10.3
April	55.1	31.2	57.8	29.5	1.98	5.16	.17	1.28	2.65	2.3	.7	1.2
May	67.5	42.7	69.2	40.8	2.89	8.75	.39	1.83	3.49	.1	.1	.1
June	76.6	52.9	78.4	51.2	3.72	8.99	.33	2.55	4.61	0	0	0
July	83.3	57.7	85.6	56.0	2.79	7.77	.46	1.74	3.38	0	0	0
August	81.9	55.9	84.7	54.7	2.80	7.67	.39	1.71	3.34	0	0	0
September	71.8	46.0	74.1	44.2	2.04	7.22	.12	1.20	1.49	0	0	0
October	59.2	34.4	62.1	33.3	1.31	4.53	.03	.73	1.75	.4	.2	.2
November	40.3	20.1	43.7	17.9	.76	2.97	0	.38	.97	3.5	1.2	5.5
December	26.5	7.2	23.8	4.9	.51	3.36	.02	.26	.73	4.5	1.8	12.1
Year	53.9	31.7	----------	----------	20.75	29.12	11.83	18.04	23.30	27.2	6.5	67.9

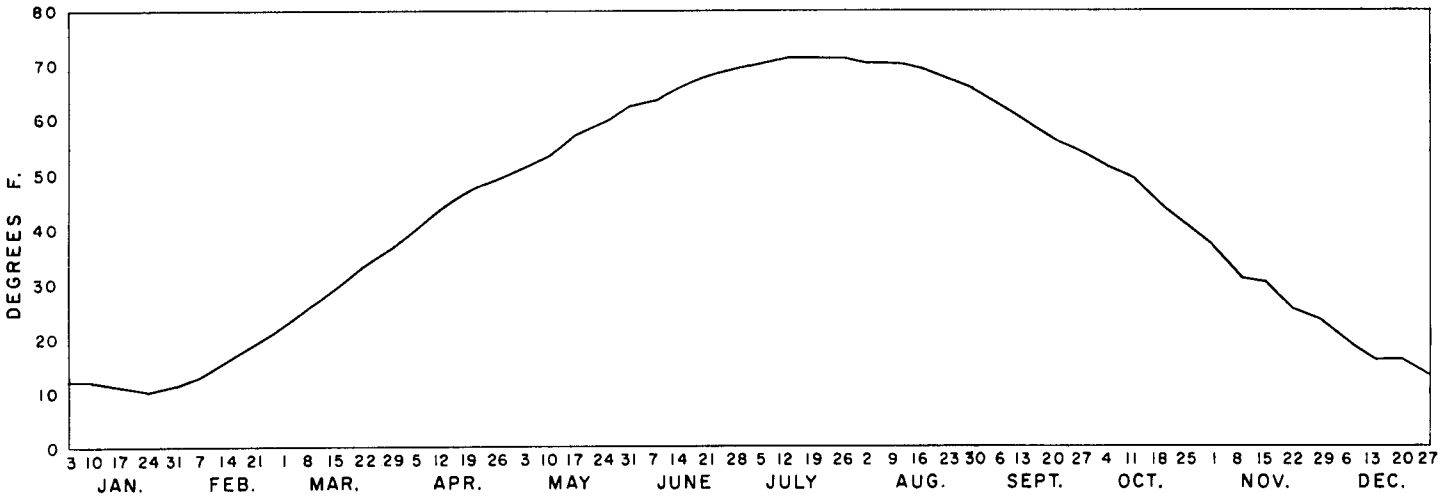

***Figure 21.*—Average weekly temperatures at Watertown based on records kept from 1898 to 1954.**

In March the chance of receiving 1 inch of precipitation at Watertown during a 1-week period is less than 7 percent, but this percentage generally increases through April and May into mid-June. In mid-June there is more than a 35 percent chance of receiving 1 inch of precipitation per week. The chance of receiving an inch of precipitation in a week generally decreases after June and reaches a yearly minimum in winter. Similar seasonal trends are evident in the percent chance of receiving other given amounts of measurable precipitation in a 1-week period, as well as in a 2- or 3-week period (*17*).

An important factor in the production of crops in this county is the fact that a high temperature is likely to occur at the same time that little or no precipitation has been received for a week or more. When this occurs, the moisture in the upper layers of the soil is soon exhausted. As a rule, for 1 to 2 weeks each year, the average temperature is 85° or higher and the total precipitation for the same period is only 0.10 inch or less. On only three occasions in the 66 years of record, however, did these conditions last for 2 consecutive weeks.

Snowfall and snow cover are important because the snow protects crops seeded in fall. A heavy snowfall, however, may hinder farm activities in winter. The average amount of snowfall received each year at Watertown is about 21 inches, but as much as 45 inches or as little as 5 inches is

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall*

[Prepared by W. F. Lytle, South Dakota State University, using punchcards and digital computer. Based on data recorded at Watertown, S. Dak., from 1898 to 1962]

Probability	Dates for given probability and temperature					
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower	36° F. or lower
Spring:						
1 year in 10, later than	April 19	May 3	May 12	May 22	June 7	June 13
2 years in 10, later than	April 13	April 27	May 3	May 15	May 29	June 9
5 years in 10, later than	April 2	April 14	April 25	May 4	May 18	May 28
Fall:						
1 year in 10, earlier than	October 12	October 7	September 22	September 17	September 10	August 28
2 years in 10, earlier than	October 20	October 11	September 28	September 22	September 13	September 3
5 years in 10, earlier than	November 2	October 24	October 11	October 2	September 23	September 14

received in some years. On about 68 days each year, 1 inch or more of snow covers the ground. On as many as 92 days in a year, snow has covered the ground to a depth of 1 inch or more. In some years, however, there has been only 1 day in which the ground was covered by snow to a depth of 1 inch or more. Strong winds usually accompany the snowstorms. As a result, open fields that are nearly bare of snow are common, while the snow piles up in drifts in and near sheltered areas.

Other factors of climate.—Hail and damaging winds may damage or destroy crops in this county. Hail may be expected on an average of about 11 times in 10 years, and the maximum occurrence in any year is about 5 times. In about 1 year in 2, no hail may be expected. Therefore, when hail does occur, it is likely to fall more than once in a year.

Winds of 50 miles per hour are likely to accompany thunderstorms at least once a year. In winter, northwesterly winds are prevalent and the average speed of the wind is 12 to 13 miles per hour. In summer, southerly winds are prevalent and the average speed of the wind is 10 to 11 miles per hour. Tornadoes rarely touch down in this county.

Sunshine is an important factor in the production of crops. During the growing season, an average of about 65 percent of the possible amount of sunshine can be expected in this county. July has the highest percentage of possible sunshine, or about 75 percent. In winter the percentage of possible sunshine is the lowest; in February less than 50 percent of the possible amount is received.

The amount of moisture evaporated from large pans indicates the amount of water lost by soils and crops through evaporation. The average annual amount of evaporation lost from a class A pan in this county is about 46 inches. The average amount that evaporates during the period of May through October is about 38 inches (7).

Additional Facts About the County

In this section the history and development of the county are briefly discussed and information is given about the agriculture. The figures for population were taken from reports of the U.S. Bureau of the Census.

Codington County was created by an act of the Dakota Territorial Legislature in 1877 and was formed from parts of Grant, Hamlin, and Clark Counties. The following year Kampeska City, later renamed Watertown, became the county seat.

The county was settled rapidly, and soon most of the wild prairie became cultivated farmland. By 1880 the population was 2,156. It continued to grow rapidly and had reached 16,549 in 1910. After 1910 the population increased at a slower rate. In 1960 the population was 20,220.

Agriculture has always been the main enterprise in this county. According to the U.S. Census of Agriculture, there were 1,058 farms in the county in 1959. A total of 415,574 acres was in farms; this acreage makes up about 94 percent of the total land area in the county. The average size of farms in 1959 was approximately 404 acres. Owners or part owners operate many of the farms, but tenants operate about 23 percent.

About 15 percent of the income derived from the sale of farm products is derived from the sale of field crops. Table 11 shows the acreage of the principal crops in stated years.

TABLE 11.—*Acreage of the principal crops in stated years* [1]

Crops	Acres harvested	
	1964	1946–55
Corn for all purposes	41, 400	36, 400
Wheat for all purposes	24, 100	50, 100
Oats	61, 100	68, 100
Barley	5, 500	22, 100
Rye	4, 000	4, 900
Soybeans	1, 100	[2] 2, 800
Flaxseed	48, 300	56, 400
Potatoes	770	[2] 2, 000
Hay for all purposes:		
Alfalfa	27, 400	16, 600
Wild	14, 900	27, 600

[1] Crop summary from reports of the South Dakota Crop and Livestock Reporting Service, Sioux Falls, S. Dak.
[2] 1951–55 average.

In 1959 nearly 85 percent of the total agricultural income was from the sale of livestock and livestock products. The number of cattle varies from year to year, but cattle are an important source of income in this county. A total of 33,087 head was reported in the county in 1959. Of these, 5,838 were milk cows.

The number of hogs also varies greatly from year to year. A total of 15,497 was reported in the county in 1959, but a high of 29,400 head was estimated in 1931, and a low of 4,800 head was estimated in 1935. The numbers of hogs vary greatly because the production of hogs can be quickly increased or decreased to keep pace with changes in marketing conditions and in the supply of grain for feed.

The number of horses and mules has steadily declined for a number of years. Only 421 were reported in the county in 1959.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Catena. A sequence, or "chain," of soils on a landscape, developed from one kind of parent material but having different characteristics because of differences in relief and drainage.

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. (See also Texture, soil.)

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

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; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Cropland. Land regularly used for crops, except forest crops. Cropland includes rotation pasture, cultivated summer fallow, or other land ordinarily used for crops but temporarily idle.

Genesis, soil. The manner in which a soil originated, with special reference to the processes responsible for the development of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Green-manure crop. Any crop grown and plowed under for the purpose of improving a soil, especially by adding organic matter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. It may be limited either by the infiltration capacity of the soil or by the rate at which water is applied to the surface soil.

Lacustrine deposit (geology). Material deposited in lake water and exposed by lowering of the water level or elevation of the land.

Loam. Soil having approximately equal amounts of sand, silt, and clay. (See also Texture, soil.)

Loess. A deposit of fine-grained windblown material consisting dominantly of silt-sized particles.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil, and carbon, hydrogen, and oxygen obtained largely from the air and water, are plant nutrients.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Permeability. 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.*

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay. (See also Texture, soil.)

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay. (See also Texture, soil.)

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in a mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms that have 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 adhere together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportions of fine particles, are as follows: 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." (See also Clay, Loam, Sand, and Silt.)

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

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