SOIL SURVEY

Sargent County North Dakota

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

Series 1958, No. 28

Issued January 1964

HOW TO USE THE SOIL SURVEY REPORT

THIS SURVEY of Sargent County, North Dakota, will serve several groups of readers. It will help farmers in planning the kind of management that will protect and improve their soils and provide good yields; assist engineers in selecting sites for roads, buildings, ponds, and other structures; help county planning or development boards to decide on future development of the area; and add to our knowledge of soil science.

Locating Soils

Use the *index to map sheets* at the back of this report to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When you find the correct sheet of the large map, you will see that boundaries of the soils are outlined, and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they occur on the map. The symbol is inside the area if there is enough room; otherwise it is outside the area and a pointer shows where the symbol belongs.

Suppose, for example, an area located on the map has the symbol FoB. The legend for the detailed soil map shows that this symbol identifies Forman-Aastad loams, undulating. These soils and all others mapped in the county are described in the section "Descriptions of the Soils."

Finding Information

Some readers will be more interested in one part of the report than another, for the report has special sections for different groups, as well as sections that may be of value to all.

Farmers and those who work with farmers can learn about the soils in the section "Descriptions of the Soils" and then turn to the section "Use and Management of Soils." In this way, they first identify the soils on their farm and then learn how these soils can be managed and what yields can be expected. The "Guide to Mapping Units and Capability Units" at the back of the report will simplify use of the map and report. This guide lists, in alphabetic order according to map symbols, each soil and land type mapped in the county, and the page where each of these is described. It also lists, for each soil and land type, the capability unit and the page where it is described.

Engineers will want to refer to the subsection "Use of Soils for Engineering," which evaluates the soil characteristics that affect engineering.

Scientists and others who are interested will find information about how the soils were formed and how they are classified by reading the section "Formation and Classification of Soils."

Biologists and others interested in wildlife will find information about fish and wild game in the subsection "Management of Soils for Wildlife."

Students, teachers, and other readers will find information about soils and their management in various parts of the report, depending on their particular interest. Those not familiar with the county may want to refer to the section "General Soil Map," which describes broad areas of soils. They may also want to refer to "General Nature of the County" for information about climate, physiography, and drainage. That section also summarizes briefly the early history of the county and gives some statistics on agriculture.

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The Sargent County Soil Conservation District and the Wild Rice Soil Conservation District arrange for farmers to receive technical help from the Soil Conservation Service in planning good use and conservation of the soils on their farms. This survey furnishes some of the facts needed for this technical help.

The fieldwork for this survey was completed in 1958. Unless noted otherwise, all statements refer to conditions at the time of the survey.

Cover picture: Aerial view of Forman-Aastad loams, undulating; Sargent County Soil Conservation District headquarters and tree plantings in foreground.

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SOIL SURVEY OF SARGENT COUNTY, NORTH DAKOTA

BY WESLEY M. LARSEN, HOLLIS OMODT,[1] ELDON EVANSON, DONALD KERL, AND LORN DUNNIGAN, SOIL SCIENTISTS, SOIL CONSERVATION SERVICE

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

General Nature of the County

SARGENT COUNTY is in the southeastern part of North Dakota (fig. 1). The county extends 36 miles from east to west and 24 miles from north to south, and it has an area of approximately 855 square miles. Forman, the county seat, is in the geographic center.

About 95 percent of the land area of Sargent County is farmed, and about three-fourths of this is cropland on which small grains, corn, flax, millet, and alfalfa are grown. The rest of the farmland is used mostly for pasture. The sale of grain and of livestock provides most of the farm income.

Early History

In the spring of 1879, a survey party led by E. H. Antwerp entered what is now Sargent County in the Sisseton Hills area and found no white settlers there. Some settlers did come in that summer, however, and many more came during the next 2 years. The first settlers staked claims in the eastern part of the county, many of them along the Wild Rice River. Much of the county was surveyed in 1882. By that year, many settlers had staked claims on unsurveyed land and were holding their land under squatters rights. These first settlers usually built sod shacks that had roofs and doors of lumber. They generally broke land near their shacks. The survey party was instructed to note the squatters' names and the land improvements.

[1] Mr. Omodt is now soil scientist, North Dakota Agricultural Experiment Station.

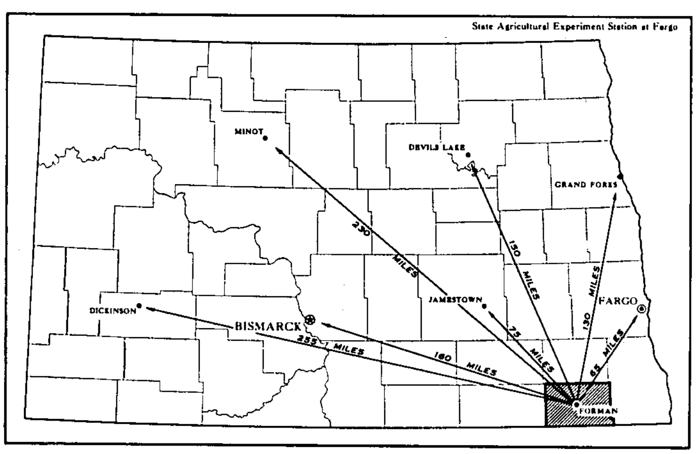


Figure 1.—Location of Sargent County in North Dakota.

In 1883 the Territorial Legislature of Dakota created Sargent County out of the southern half of Ransom County. It was named in honor of H. E. Sargent, the Superintendent of the Northern Pacific Railroad, to acknowledge his interest in developing the Red River Valley.

On July 16, 1883, Governor Ordway appointed the first county commissioners, who designated Milnor as the temporary county seat. In the following year the first county election was held, and Forman was named the county seat.

The Northern Pacific Railroad extended to Milnor in 1882, and was completed across the county by 1886. During this period, the Minneapolis, St. Paul, and Sault Ste. Marie Railroad was also completed.

Climate

Temperature and rainfall vary widely in Sargent County. Table 1 shows average monthly, seasonal, and annual temperatures and precipitation at the weather station in Forman.

Seasonal temperatures range from an average of 7.6° F. in January to an average of 70.1° in July. The lowest temperature ever recorded was −45°, and the highest was 110°. The difference between the average summer and winter temperatures is 56.2°. The average annual temperature is 41.5°.

Although daytime temperatures are usually high in summer, the weather is reasonably comfortable because the air is dry. The lowest daily temperature is seldom above 70°, and nights are usually cool.

During winter the daily temperature fluctuates greatly. Early morning is usually the coldest time, but the day warms up considerably when the sun shines.

The average date of the last killing frost in the spring is May 21, and the earliest killing frost in the fall is September 21. Thus, the county has an average growing season of about 123 days. The latest killing frost on record was on July 7, and the earliest was on August 10.

TABLE 1.—*Temperature and precipitation at Forman, Sargent County, North Dakota*

[Elevation, 1,249 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1936)	Wettest year (1916)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
January	7.6	57	−45	0.45	0.29	1.62	5.2
February	11.9	64	−43	.50	.53	.10	6.4
March	26.0	84	−34	.80	.60	1.15	5.5
April	44.0	99	−5	2.01	1.18	3.05	2.7
May	55.7	99	18	2.95	1.14	5.16	.5
June	65.0	102	24	3.60	.93	6.78	0
July	70.1	110	28	2.88	.51	10.10	0
August	68.2	105	29	2.75	.45	4.09	0
September	59.5	101	11	2.07	2.03	2.59	.4
October	46.0	97	−6	1.35	.15	.05	1.1
November	28.6	82	−28	.57	.64	.07	3.8
December	15.3	64	−36	.56	.61	.75	5.1
Year	41.5	110	−45	20.49	9.06	35.51	30.7

[1] Average temperature based on a 64-year record through 1955; highest temperature, on a 42-year record; and lowest temperature, on a 40-year record, through 1952.

[2] Average precipitation based on a 64-year record through 1955; wettest and driest years based on a 61-year record in the period 1892–1955; snowfall based on a 20-year record through 1952.

Most of the precipitation in Sargent County falls during the growing season, almost half of it in May, June, and July. June, the wettest month, has an average annual rainfall of 3.60 inches. During summer, most precipitation comes from thunderclouds, which produce heavy rainfalls in short periods over small areas.

When the moisture supply is adequate during the growing season, the soils of Sargent County produce good crop yields. Crop yields are often determined by the amount of rain that falls in critical periods. Thus, the timeliness of rainfall is more important than total annual precipitation.

Because the temperature and rainfall vary widely, only a few kinds of crops can grow. The best suited crops are Durum wheat, hard red spring wheat, oats, barley, flax, and rye. Corn is grown for cash or for feed. About one-third of the corn in the county is cut for silage or for green fodder, or is grazed off. Occasionally the frost-free period is so short that corn does not fully mature, and the crop is cut for silage, is grazed off, or is picked and sold locally as feed grain.

Weather variations also directly influence the amount of soil lost by wind and water erosion. Most of the wind erosion takes place during winter when there is little or no snow cover and early in the spring before growing plants are established.

Sheet erosion accounts for most of the soil lost through water erosion, but little or no soil is lost during long, general rains. The erosion occurs mostly during short, hard rainstorms or hailstorms. Except in small local areas that are repeatedly hit by hard rainstorms, sheet erosion is not serious. Summer-fallowed fields are most susceptible to sheet erosion because they are bare in summer.

Agriculture

The statistics in this subsection are from reports published by the United States Bureau of the Census.

In 1959 there were 1,003 farms in Sargent County, compared to 1,168 farms in 1954. The average-sized farm in 1959 was 512.8 acres, or a little larger than that in 1954. Of the total number of farm operators in 1959, 406 were full owners, 411 were part owners, 185 were tenants, and 1 was a manager.

About 75 percent of the farmland in the county is suitable for crops. Farmland not suitable for crops is mostly wet, steep, stony, or susceptible to wind erosion and is best suited to permanent pasture. In 1959 there were 324 cash-grain farms, 345 livestock farms, 163 general farms, 36 dairy farms, 15 poultry farms, and 120 farms of miscellaneous types. Most of the cash-grain farms are on the well-drained, productive soils, whereas the livestock farms are on soils that produce low yields of crops or are not suited to cultivation.

Farming operations fluctuate more on general farms than on other kinds of farms. On general farms the income is from cash grain and livestock, and farmers vary their number of acres in crops and the number of cattle according to the price outlook. Between 1954 and 1959, the number of cash-grain farms decreased about 37 percent, the number of general farms decreased about 45 percent, and the number of livestock farms increased about 24 percent.

Table 2 gives the acreage of principal crops in the county in 1954 and 1959. Table 3 lists the number of livestock on farms and the number sold in 1954 and 1959.

TABLE 2.—*Acreage of principal crops in 1954 and 1959*

Crops	1954	1959
Corn for all purposes	41,222	42,128
Durum wheat harvested	35,374	11,689
Other spring wheat harvested	44,343	48,470
Oats harvested	62,296	56,977
Barley harvested	41,879	43,909
Flaxseed harvested	35,033	23,291
Proso millet harvested	15,388	17,503
Rye harvested	8,856	9,212
Soybeans harvested for beans	392	5,466
Hay crops, total	81,583	65,041

TABLE 3.—*Number of livestock on farms and number sold in 1954 and 1959*

Livestock	Number on farms		Number sold	
	1954	1959	1954	1959
Cattle and calves	33,926	31,564	11,907	15,744
Hogs and pigs	23,334	27,335	20,452	33,588
Sheep and lambs	20,350	24,012	11,242	12,473
Chickens over 4 months old	182,649	137,369	75,956	76,578

Native Woodland

Native timber in Sargent County occupies only about 3,000 acres and is mostly on the bottom lands of the Wild Rice River. Common native trees are American elm, ash, boxelder, cottonwood, bur oak, and basswood. Only a small part of this timber is cut and used for lumber.

Physiography, Relief, and Drainage

Sargent County was glaciated by the late Wisconsin ice sheet, which determined its physiography. A glacial till plain occupies about 65 percent of the county, and two glacial-lake areas occupy the rest. The topography of the county ranges from nearly level to hilly. Although the county slopes gradually from southwest to northeast, the drainage system is not well defined.

The relief of the till plain was formed as the ice melted and is much the same today as it was when the glacier left it. The plain consists of three areas of morainic hills and of extensive areas in the central and western parts of the county that are dotted by depressions and potholes (fig. 2). The depressions and potholes range from one to more than 40 acres in size, but three-fourths of them are less than 5 acres. They receive as runoff all precipitation in the area except that absorbed by the soil or drained by the Wild Rice River and its tributaries. In this area dotted by potholes, relief ranges from 2 to 25 feet.

The three areas of morainic hills on the glacial till plain range from 50 to 200 feet in height. They are the Sisseton Hills, the Dead Colt Hills, and an area consisting of the Sand Hills and a glacial moraine. The Sisseton Hills, which are the largest in the county, rise abruptly from the till plain in the southeastern part of the county. They form a distinct line of bluffs that can be seen for many miles from the north. The Sisseton Hills consist of several single ranges with intervening draws and valleys that run in a southeast-northwest direction and drain northward into the Wild Rice River.

The Dead Colt Hills (fig. 2), in the north-central part of the county, are a single range of glacial till hills. These hills rise abruptly from the till plain on the east, but they slope gradually to the plain on the west.

The Sand Hills and the glacial moraine are near the southern part of the western boundary of the county. The sand on the Sand Hills was blown by the wind from that part of glacial Lake Dakota west of the hills. In the northern part of the Sand Hills, glacial till is exposed in some places.

The two glacial lakes in the county were glacial Lake Agassiz, in the northeastern part, and glacial Lake Dakota, in the western part. The area covered by glacial Lake Agassiz is part of the Red River Valley. This area consists of soils developed in moderately well drained deposits of silt and clay. Some parts of the Lake Agassiz area are so nearly level that surface drainage is restricted. A distinct beach line of the lake runs in a northwest-southeast direction through the town of Milnor.

The glacial Lake Dakota area consists mainly of soils developed in sandy material. It includes, however, soils

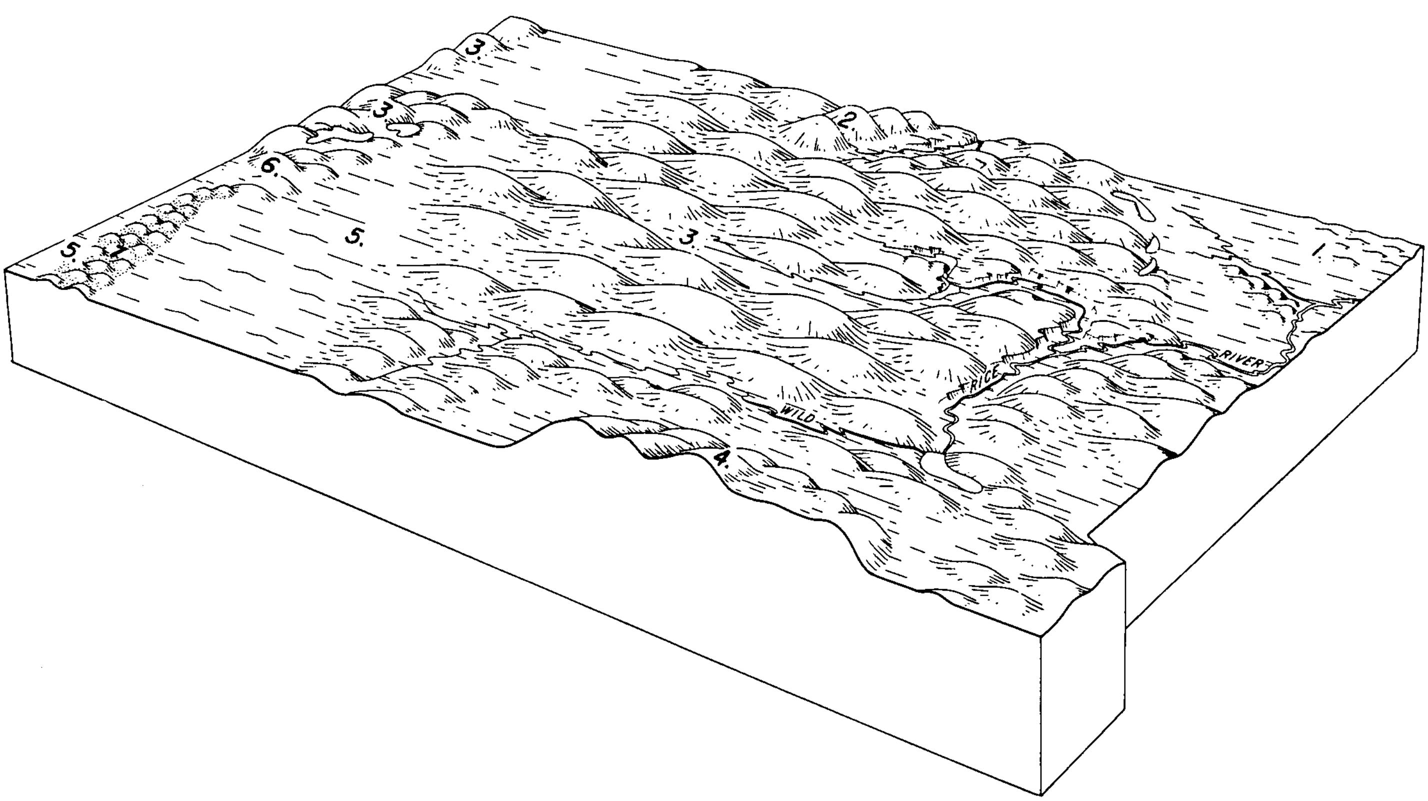


Figure 2.—**Physiographic features of Sargent County: (1) glacial Lake Agassiz; (2) Dead Colt Hills; (3) glacial till plain; (4) Sisseton Hills; (5) glacial Lake Dakota; (6) glacial moraine; (7) Sand Hills.**

in glacial deposits of silt and clay and soils in loam underlain by sand, gravel, or both. In this generally level to rolling area are large sloughs and swales. The drainage pattern is not well developed, and a high water table underlies much of the area.

How Soils Are Named, Mapped, and Classified

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

The scientists 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 other facts about the soils. They dug or bored 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 to the rock material that has not been changed much by soil-forming processes.

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 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. Aastad and Barnes, 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 natural characteristics.

Many soil series contain soils that are alike except for texture of their surface layer. According to this difference 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. Aastad clay loam and Aastad loam are two soil types in the Aastad 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 soil phases. The name of a soil phase indicates a feature that affects management. For example, Hecla fine sandy loam, nearly level, is one of three phases of Hecla fine sandy loam.

After a fairly detailed guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. For their base map, they used aerial photos, because these show woodlands, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The soil map in the back of this report was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning 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 other soils 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, this mixture of soils is shown as one mapping unit and is called a soil complex. Ordinarily, a soil complex is named for the major soils in it, for example, Barnes-Buse loams, rolling.

In many counties there are areas to be shown that are so rocky, so shallow, or so wet that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Artesian ponds or Fresh water marsh, and are called land types rather than soils.

Only part of the soil survey was done when the scientists had named and described the soil series and mapping units, and had shown the location of the mapping units on the soil map. The mass of detailed information they had recorded then needed to be presented in different ways for different groups of people, among them farmers, managers of rangelands, and engineers.

To do this efficiently, the scientists consulted persons in other fields of work and jointly prepared with them groupings that would be of practical value to people who manage soils. Such groupings are the capability classes, subclasses, and units, designed to help farmers manage crops and pasture; range sites, for those who manage large tracts of native and tame grass; and the classifications used by engineers who build highways or structures to conserve soil and water.

General Soil Map

After studying the soils in a locality and the way they are arranged, a soil scientist can make a general map that shows the main patterns of soils, called soil associations. Such a map is the colored general soil map in the back of this report. Each association, as a rule, contains a few major soils and several minor soils in a pattern that is characteristic, although not strictly uniform.

The soils within any one association are likely to differ greatly from each other in many properties: for example, slope, depth, stoniness, or natural drainage. Thus, the general soil map does not show the kind of soil at any particular place, but patterns of soils, in each of which there are several different kinds of soils.

The soil association is named for the major soil series in it, but, as already noted, soils of other series may also be present. The major soils of one association may also be present in another association, but in a different pattern.

The general map showing patterns of soils is useful to people who want a general idea of the soils, who want to compare different parts of a county, or who want to know the possible location of good-sized areas suitable for a certain kind of farming or other land use. The twelve soil associations in Sargent County are described in the following pages.

1. Exline-Aberdeen association: Solodized soils in old, clayey lake sediments

This soil association is nearly level and consists of soils that are often ponded because they have restricted surface runoff and internal drainage. These soils formed in clayey sediments of glacial lakes. Locally the soils are called sour, or "alkali." The association amounts to about 1 percent of the county and is in the northeastern corner.

The Exline soils are the most extensive in this association. They have a thin surface layer that is underlain by a clayey, very slowly permeable subsoil of columnar structure. In the lower part of the subsoil, salts are visible. The Aberdeen soils have a thicker surface layer than the Exline soils, and a more permeable subsoil.

Also in this association are Dimmick soils and a small acreage of Bearden soils. The Dimmick soils are in very slight depressions. They are moderately wet, clayey soils that, unlike the Exline and Aberdeen soils, do not contain visible salts or have a columnar subsoil. The Bearden soils contain much lime.

The soils of this association are so nearly level that topography has not caused differences that are easy to see. Both the Exline and Aberdeen soils have a dark surface layer. In cultivated fields, however, the Exline soils are much cloddier than the Aberdeen because the columnar subsoil has been mixed with the thin surface layer by plowing. The Aberdeen soils are so deep that these layers have not been mixed.

Salts and wetness prevent cultivation throughout much of this association. Yields generally are low. Most of the acreage is used for hay.

2. Gardena-Overly association: Well-drained soils in old, silty and clayey lake sediments

This soil association is in nearly level and slightly depressional areas. It consists of soils formed in silty and clayey sediments deposited in old glacial lakes. The association occupies 2 or 3 percent of the county and is in the northeastern part.

Dominant in this association are the Gardena and Overly soils. They are deep, dark, moderately well drained, and fertile. Also in the association are Tetonka, Bearden, and Glyndon soils, all of which are not so well drained as the Gardena and Overly soils. The Tetonka soils are mainly in small depressions. The Beardon and Glyndon soils, which are rich in lime, are in small areas and are intricately associated with the Gardena and Overly soils but are lower on the landscape.

The soils in this association are among the best in the county for farming, and nearly all of their acreage is cultivated. The main crops are small grains, alfalfa, and corn. The soils can be farmed intensively if simple practices are followed to protect them from erosion and to keep them productive.

3. Forman-Aastad association: Well drained and moderately well drained, nearly level and undulating soils in loamy glacial till; prismatic-blocky subsoil

This soil association occupies the nearly level and undulating glacial till plain. Scattered through the plain are many enclosed depressions and potholes, which generally are less than 5 acres in size. Figure 3 is a typical view of cultivated fields in this soil association. This association covers about 60 percent of the county.

The Forman and Aastad soils are the most extensive in this association. They formed in glacial till and are deep, dark, and fertile. The Forman soils are well drained, and the Aastad are moderately well drained. The Aastad soils have a thicker surface soil than the Forman.

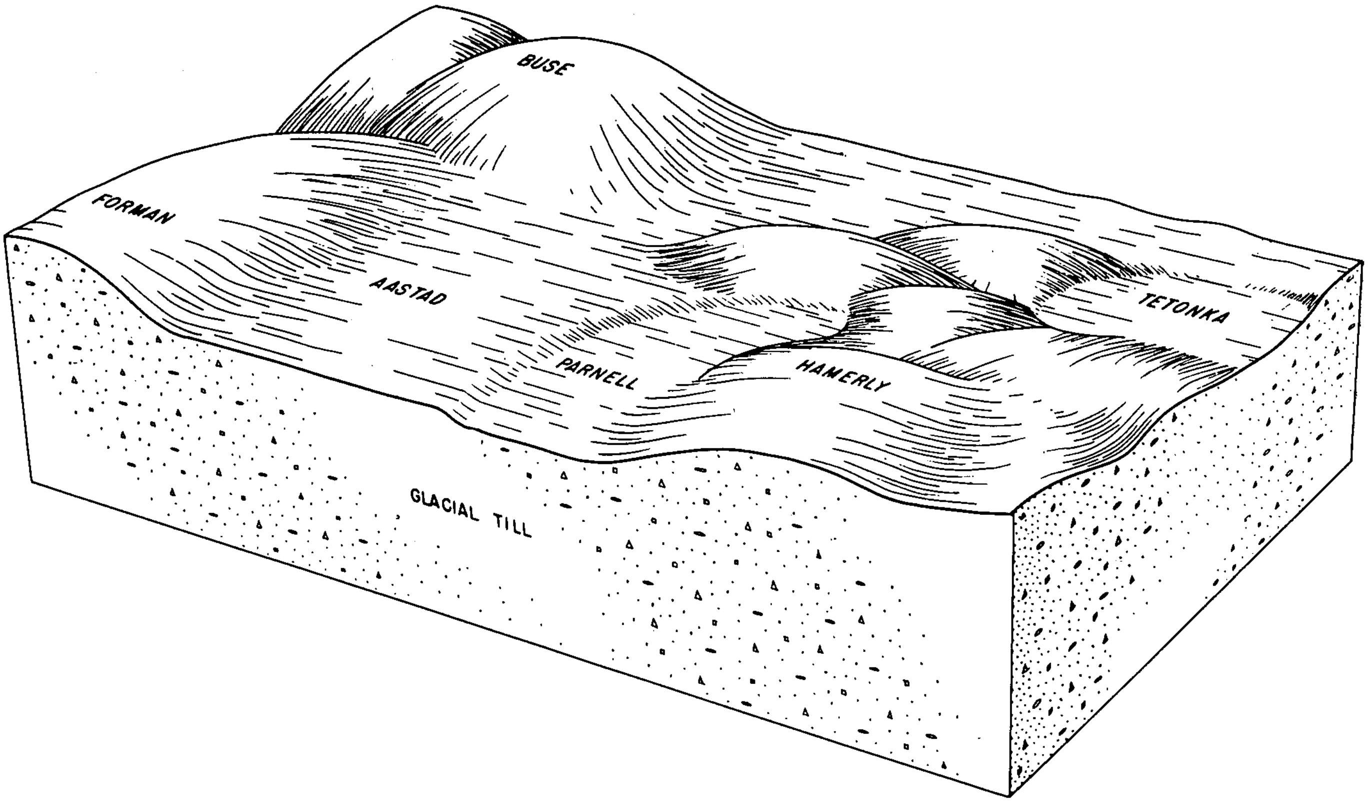
Other soils in this association are the Buse, Hamerly, Tetonka, Parnell, Cresbard, La Prairie, Lamoure, and Zell. Figure 4 (top) shows the position of the major soils and some of the minor soils.

The well-drained Forman soils are the most extensive soils in undulating areas. In these areas the Buse soils are on the tops of knolls, the Forman soils are on the upper parts of slopes, and the Aastad soils are on the lower parts of slopes. The depressions in undulating areas are deeper than those in the nearly level areas and are occupied by Parnell soils (fig. 5).

The Aastad soils are the most extensive soils in the nearly level and very gently undulating areas. In these areas the Tetonka soils occupy the shallow depressions, which are numerous in some places. Between the depressions are distinct, light-colored spots of Hamerly soils. The Hamerly soils contain much free lime. The Cresbard soils are in slightly convex areas. They are moderately deep and have a dark surface layer and a slowly permeable subsoil.

La Prairie soils and Lamoure soils are on the bottom land along the Wild Rice River. La Prairie soils are moderately well drained, and the Lamoure soils are poorly drained. On the breaks along the Wild Rice River are the silty Zell soils, which also occur along unnamed streams.

Figure 3.—Cultivated fields in the Forman-Aastad soil association.



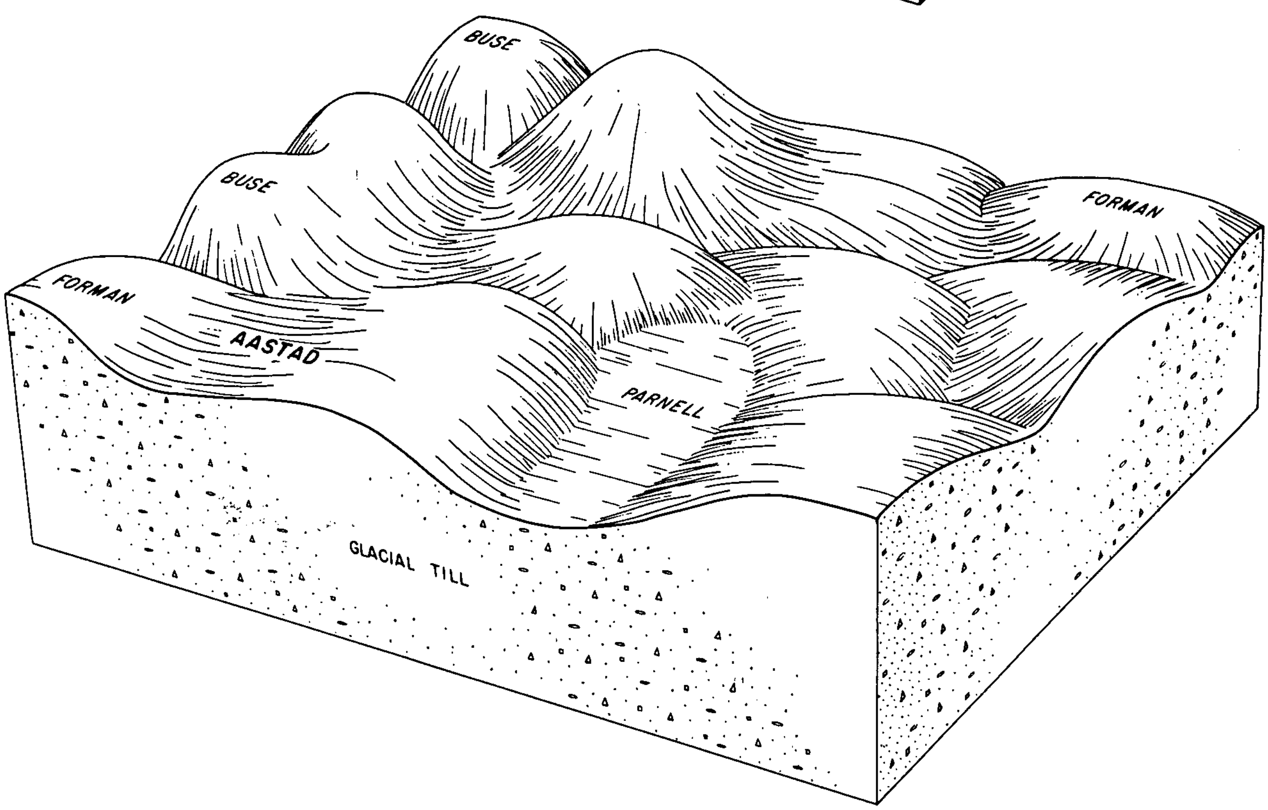


Figure 4.—Top, major soils and some minor soils in the undulating Forman-Aastad soil association; *bottom,* rolling landscape in the Forman-Buse soil association.

Figure 5.—**Parnell soils in depressions.**

The soils on the till plains are farmed extensively and are in small grains, corn, alfalfa, and tame pasture. In wet periods seeding of the soils in the shallow depressions is delayed. In the deeper depressions the soils generally are too wet for cultivation and are used for hay, pasture, or wildlife. Where stream channeling has not made cultivation impractical, La Prairie soils are used for crops. The Lamoure and Zell soils are mainly in pasture or hay.

4. Hecla-Renshaw association: Well-drained sandy and loamy soils underlain by gravel and sand

This soil association is an old beach of glacial Lake Agassiz. It consists of well-drained loamy and sandy soils, and of wet, loamy and clayey soils in depressions and ponded areas. A chain of small lakes on the southwestern boundary of this association separates it from the glacial till plain. The association covers between 3 and 4 percent of the county and is in the northeastern part.

The Hecla and Renshaw soils are the most extensive soils in this association. These soils are well drained. The Hecla soils are generally deep, dark, and sandy; but some areas are moderately shallow and are underlain by loamy and silty material. The Renshaw soils are moderately deep and are underlain by gravel.

Other soils in this association are the Sioux, Gardena, Glyndon, Maddock, Borup, Colvin, Perella, Stirum, and Arveson. The Sioux soils have a thin, loamy or sandy surface layer that is underlain by gravel. The Gardena soils are deep and silty and are closely associated with the Glyndon soils, which are high in content of lime. The Maddock soils are moderately shallow and have a sandy surface layer that is underlain by loamy or silty material.

The Borup, Colvin, Perella, Stirum, and Arveson soils are moderately wet or wet. They are wet when the water table is high or when water seeps in from higher soils. Small areas of Colvin and Perella soils contain salts in amounts large enough to injure plants.

Farms in this association are diversified, and the farmers depend on the sale of grain and livestock for income. On the deep, well-drained soils, the farmers plant grain for sale or for feed. They use the wet soils and the shallow soils for pasture and hay. Because there is not enough acreage suited to grain, few farmers depend on this crop alone for income.

5. Hegne-Fargo association: Poorly drained and somewhat poorly drained soils in old, clayey lake sediments

The association is nearly level and consists of soils formed in clay deposits of the glacial lakes. It amounts to less than 1 percent of the county and is in the southeastern part.

The Hegne and the Fargo soils are the most extensive soils in the association. Also included are the Overly and Dimmick soils. The Fargo soils consist of deep, slowly permeable clay and are less permeable than the silty Overly soils. Hegne soils are somewhat poorly drained and are high in free lime. The Dimmick soils occur in wet, slightly depressed areas.

Except for a few areas of Dimmick soils, all areas of the soils in this association are cultivated. The soils generally are plowed in the fall, for they do not dry out early enough to be plowed in spring. They compact and puddle if cultivated when wet.

Small grains and alfalfa are the main crops. Because of their high moisture-holding capacity, the soils in this association produce better yields in dry seasons than do most other soils in the county.

6. Overly-Fargo association: Moderately well drained to poorly drained soils in old, silty and clayey lake sediments

This soil association is nearly level and consists of soils formed in silt and clay deposits of glacial lakes. The association occupies about 3 percent of Sargent County and is in the southern part.

This association is made up of large areas of Overly and Fargo soils and of smaller areas of Colvin, Borup, Glyndon, and Hegne soils. These soils have better surface drainage than the soils in the Hegne-Fargo association. The Fargo soils have a deep, black clay surface layer. The surface layer in the Overly soils is also deep and black, but it contains more silt and less clay than Fargo soils and has better internal drainage. The Colvin and Borup soils are in shallow depressions. Glyndon and Hegne soils are moderately well drained, are high in content of free lime, and have conspicuous light-gray spots in cultivated fields.

Nearly all the acreage of these soils is used for small grains, alfalfa, corn, and soybeans. Because of their high moisture-holding capacity, the soils in this association produce better yields in dry periods than most other soils in the county.

7. Forman-Buse association: Well-drained to excessively drained, undulating and rolling soils in loamy glacial till

This soil association, known locally as the Sisseton Hills, is part of a moraine (glacial deposit) that extends from South Dakota into Sargent County and forms a semicircle. It is in the southeastern part of the county. The northern edge of the moraine is a bluff that rises abruptly off the till plain and can be seen for many miles. Many draws in the hills drain northward into the Wild Rice River.

The Forman and Buse soils are the main soils in this association, but the Aastad, Tetonka, and Parnell also occur. (See figure 4, bottom.) The Forman soils are deep and dark colored. They are on the upper parts of slopes below the Buse soils and have a thicker surface layer than those soils. The Buse soils are on hilltops and knolls. On the lower parts of all slopes are the Aastad soils, which have a thicker surface layer than the Forman soils. The Tetonka and Parnell soils are in enclosed depressions or potholes.

About 35 percent of this association is cultivated, mainly the gentler slopes. Because the soils are susceptible to water erosion, slopes of more than 10 percent are generally in native grasses and are used for pasture and hay.

8. Barnes-Svea association: Well-drained, undulating soils in loamy glacial till; prismatic-blocky subsoil

This soil association is on the glacial till plain in the northwestern part of the county. It occupies between 4 and 5 percent of the total county area.

The landscape of this association is similar to that shown in figure 4 for the Forman-Aastad association. However, the Barnes soils, instead of Forman soils, occupy the upper parts of slopes, and the Svea soils, instead of Aastad soils, occupy the lower parts. Differences in subsoil characteristics distinguish the Barnes-Svea association from the Forman-Aastad association, which is also on the glacial till plain. The subsoil in the Barnes and the Svea soils contains less clay and is weaker in structure than that in the Forman and the Aastad soils.

Some of the minor soils in the Barnes-Svea association are the Buse, Parnell, Hamerly, and Tetonka.

The soils in this association are farmed extensively. Small grains, corn, and alfalfa are the main crops and are grown in the less sloping areas. Slopes of more than 10 percent are used mainly for pasture.

9. Gardena-Spottswood-Wessington association: Well-drained loamy soils underlain by sands and gravel

This association consists mainly of nearly level, well-drained soils that formed in glacial outwash, but there are many areas of low, poorly drained soils in fresh-water marshes. This association covers about 8 percent of the county and is in the northwestern part.

The most extensive soils in the association are the Gardena, the Spottswood, and the Wessington soils.[2] All these soils have a dark loam surface layer. The Gardena soil is underlain by loamy sand, fine sand, and silt, and the Spottswood and Wessington soils are underlain by coarse sand and gravel. The depth to the sand and gravel is 30 inches or more in the Spottswood soils and is less than 30 inches in Wessington soils.

Also in this association are the Hecla and Maddock soils, which are sandy, and the Borup, Stirum, and Arveson soils, which are wet because of a high water table. Many areas of the wet soils are 25 to 100 acres in size. The Maddock soils are moderately shallow and are underlain by glacial till.

The well-drained soils in this association are planted to small grains, corn, and alfalfa. Because of their low moisture-holding capacity, these well-drained soils produce lower yields in dry seasons than soils formed in glacial till and are more susceptible to wind erosion. Most areas of the wet soils are used for pasture and hay. Those that are cultivated are planted to flax, millet, or other fast-maturing crops.

[2] After this report and map had been prepared for publication, the soils called Wessington were classified with soils of the Fordville series. Similar soils will be called Fordville in other publications.

10. Gardena-Glyndon association: Moderately well drained soils in old, silty lake sediments

This association consists of deep, nearly level soils that formed in silty deposits of glacial lake material. They occupy between 4 and 5 percent of the county and are in two areas in the western part.

The Gardena soils are the most extensive soils in this association. They are deep, dark, moderately well drained, and fertile. The Gardena soils are in slightly lower positions than the Glyndon soils, which are high in lime. Also in this association are the Borup, Perella, Tetonka, Overly, and Hecla soils. The Borup, Perella, and Tetonka soils are in shallow depressions, and the areas of Overly and Hecla soils are small. The Overly soils are similar to the Gardena soils but contain more clay. The Hecla soils are sandy.

Like the Gardena-Overly association, in the northeastern part of the county, this association includes some of the best soils in the county for farming. These soils are used intensively for small grains, alfalfa, and corn.

11. Valentine association: Sandy soils in a choppy area where differences in elevation are 20 to 40 feet

The fine sands of this association are in choppy relief, in which the hills are 20 to 40 feet high. The association makes up about 1 percent of the county and is in the southwestern part. Small spots of glacial till are exposed.

Most areas of the Valentine soils in this association are about 40 feet higher than areas of the lowest soils. Hecla soils are in small areas of low, choppy relief. The top layer of the Valentine soils is dark colored because it is stained by organic matter. It is about 1 or 2 inches thick. Light-colored fine sand extends from the top layer to a depth of 5 feet or more from the surface. The Hecla soils have a dark-colored surface layer that is 5 to 10 inches thick.

This association is in native grass and is used for pasture.

12. Valentine-Hecla association: Sandy soils in a choppy area where differences in elevation are generally less than 10 feet

The soils in this association formed in sandy material in areas of choppy relief. The differences in elevation range from 3 to 10 feet. In some areas accelerated erosion has caused the choppy relief.

The surface layer of the soils in this association is fine sand or loamy fine sand and is dark colored to a depth ranging from 5 to 20 inches or more. It is underlain by fine sand. In only a few places is the loamy fine sand surface layer more than 20 inches thick. Where the relief is more than 5 feet, the surface layer generally is dark to a depth of 5 inches, but in other areas it is fine sand or loamy fine sand underlain by lighter colored fine sand. Where the relief is less than 5 feet, the surface layer is dark to a depth of 10 to 20 inches and is generally loamy fine sand underlain by fine sand at a depth of about 10 inches.

The Valentine and Hecla soils are the most extensive soils in this association. They occur together in a complex pattern. The Valentine soils are excessively drained and have a thin surface layer of fine sand or loamy fine sand. The surface layer of the Hecla soils is loamy fine sand and is thicker than that in the Valentine soils. Some areas of Hecla soils are nearly level.

Arveson and Gannett soils also occur in this association. The Arveson soils are in many of the large depressions and are high in lime. The very poorly drained Gannett soils are in the numerous small depressions where the relief is strongest.

Most of the farm income in this soil association is from the sale of livestock. Farmers grow corn, oats, and alfalfa on the more nearly level areas and use the rest of the association for pasture and hay.

Descriptions of the Soils

This section describes, in nontechnical language, the soil series (groups of soils) and single soils (mapping units) of Sargent County. The acreage and proportionate extent of each mapping unit are given in table 4.

The procedure in this section is first to describe the soil series, and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the section "How Soils Are Named, Mapped, and Classified," not all mapping units are members of a soil series. Artesian ponds and Fresh water marsh are miscellaneous land types and do not belong to a soil series but, nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and the range site in which the mapping unit has been placed. The page on which each capability unit is described can be found readily by referring to the "Guide to Mapping Units and Capability Units" at the back of the report.

TABLE 4.—*Approximate acreage and proportionate extent of the soils*

Map symbol	Soil name	Area	Extent
		Acres	*Percent*
Aa	Aastad clay loam	9, 252	1. 7
Ab	Aastad loam	123, 324	22. 5
Ac	Aastad-Cresbard loams	412	. 1
Ad	Aberdeen silt loam	310	. 1
Ae	Aberdeen-Exline silty clay loams	865	. 2
Am	Artesian ponds	112	(1)
An	Arveson fine sandy loam	4, 622	. 8
BbC	Barnes-Buse loams, rolling	1, 254	. 2
BbC2	Barnes-Buse loams, rolling, eroded	556	. 1
Bc	Barnes-Buse stony loams	272	(1)
BdB	Barnes-Svea loams, undulating	8, 865	1. 6
BdB2	Barnes-Svea loams, undulating, eroded	104	(1)
Bf	Bearden silty clay loam	1, 446	. 3
Bk	Bearden-Tetonka silt loams	157	(1)
Br	Borup, Colvin, and Perella soils	9, 208	1. 7
BvD	Buse-Barnes loams, strongly rolling	12, 942	2. 4
BvD2	Buse-Barnes loams, strongly rolling, eroded	1, 944	. 4
Cp	Colvin and Perella soils, saline	842	. 2
Dc	Dimmick clay	161	(1)
Dm	Dimmick clay, basins	316	. 1
Dv	Divide loam	58	(1)
EcA	Eckman silt loam, nearly level	136	(1)
EcB	Eckman silt loam, undulating	3, 634	. 7
EmB	Eckman and Maddock loams, undulating	510	. 1
EmC	Eckman and Maddock loams, rolling	94	(1)
Ex	Exline complex	1, 954	. 4
Fc	Fargo clay	3, 638	. 7
FoB	Forman-Aastad loams, undulating	118, 615	21. 7
FoB2	Forman-Aastad loams, undulating, eroded	9, 620	1. 8
Fs	Forman-Aastad stony loams	126	(1)
FvC	Forman-Buse loams, rolling	5, 169	. 9
FvC2	Forman-Buse loams, rolling, eroded	8, 929	1. 6
Fw	Fresh water marsh	4, 504	. 8
Ga	Gannett loamy fine sand	198	(1)
GgA	Gardena-Glyndon loams, sandy substratum, nearly level	5, 742	1. 0
GmA	Gardena-Glyndon silt loams, nearly level	41, 630	7. 6
GoA	Glyndon loam, sandy substratum, nearly level	3, 263	. 6
GsA	Glyndon silt loam, nearly level	7, 959	1. 5
Ha	Hamar fine sandy loam	3, 028	. 6
Hb	Hamerly complex	4, 216	. 8
Hf	Hamerly-Aastad loams	3, 514	. 6
Hh	Hamerly-Svea loams	616	. 1
Hkx	Hecla fine sand	2, 169	. 4
HlAx	Hecla fine sandy loam, nearly level	13, 193	2. 4
HlBx	Hecla fine sandy loam, undulating	256	(1)
HmA	Hecla fine sandy loam, moderately shallow, nearly level	4, 286	. 8
HnAx	Hecla loamy fine sand, nearly level	21, 532	3. 9
HoA	Hecla loamy fine sand, moderately shallow, nearly level	734	. 1
Hwx	Hecla-Maddock loamy fine sands	1, 378	. 3
Hz	Hegne clay	1, 707	. 3
Hfa	Hegne-Fargo clays	552	. 1
La	Lamoure silty clay loam	2, 780	. 5
Lf	La Prairie and Fairdale soils	357	. 1
Lp	La Prairie silt loam	1, 820	. 3
MdBx	Maddock loamy fine sand, undulating	908	. 2
MdC	Maddock loamy fine sand, rolling	737	. 1
MkAx	Maddock fine sandy loam, moderately shallow, nearly level	996	. 2
MkBx	Maddock fine sandy loam, moderately shallow, undulating	1, 272	. 2
MkCx	Maddock fine sandy loam, moderately shallow, rolling	224	(1)
OaA	Overly silt loam, nearly level	812	. 1
OcB	Overly silty clay loam, undulating	717	. 1
Os	Overly-Aasted silt loams	5, 541	1. 0
OvC	Overly and Barnes silt loams, rolling	446	. 1
OyA	Overly-Bearden silty clay loams, nearly level	12, 720	2. 3
Pa	Parnell soils	17, 280	3. 2
Pe	Perella silty clay loam	1, 058	. 2
Ra	Rauville soils	891	. 2
RhA	Renshaw loam, nearly level	1, 383	. 3
RhB	Renshaw loam, undulating	252	(1)
Ro	Renshaw and Sioux soils	655	. 1
SpA	Spottswood-Wessington loams, nearly level	2, 258	. 4
St	Stirum and Arveson loams	9, 723	1. 8
Sv	Svea loam	5, 833	1. 1
Tk	Tetonka silt loam	798	. 1
Tp	Tetonka and Parnell soils	6, 767	1. 2
Un	Ulen fine sandy loam, moderately shallow	5, 178	. 9
VaD	Valentine fine sand, hilly	1, 892	. 3
VhC	Valentine-Hecla fine sands, hummocky	10, 890	2. 0
ZmC	Zell silt loam, rolling	510	. 1
ZmD	Zell silt loam, hilly	64	(1)
	Intermittent lakes	2, 514	. 5
	Total land area	547, 200	100. 0

[1] Less than 0.1 percent.

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

Aastad Series

The Aastad series consists of deep, moderately well drained soils that have a loamy subsoil. These dark, fertile soils formed in nearly level glacial till under a cover of tall grass. They are the most extensive soils in Sargent County and are mainly in the central part.

The surface layer is black or very dark gray loam to clay loam of fine granular or crumb structure. Generally, this layer is about 8 inches thick, but the range is from 6 to 12 inches. It is hard when dry, friable when moist, and easily tilled. This layer contains a large amount of organic matter.

The loamy subsoil is very dark gray to very dark grayish brown, and tongues of the dark surface soil extend down into it, as shown in figure 6. The prisms in the subsoil break into medium-sized blocks. All faces of the prisms and blocks are covered by continuous, distinct clay films. The subsoil is hard when dry and firm when moist. In many places, it is limy in the lower part.

The parent material is limy glacial till. Lime has accumulated in a light-colored zone, directly under the subsoil, at a depth of 14 to 22 inches. Below this lime zone, the parent material is light brownish gray to light olive brown and is very hard when dry and friable when moist. Nests of gypsum crystals are common in the parent material at a depth of 3½ to 5 feet.

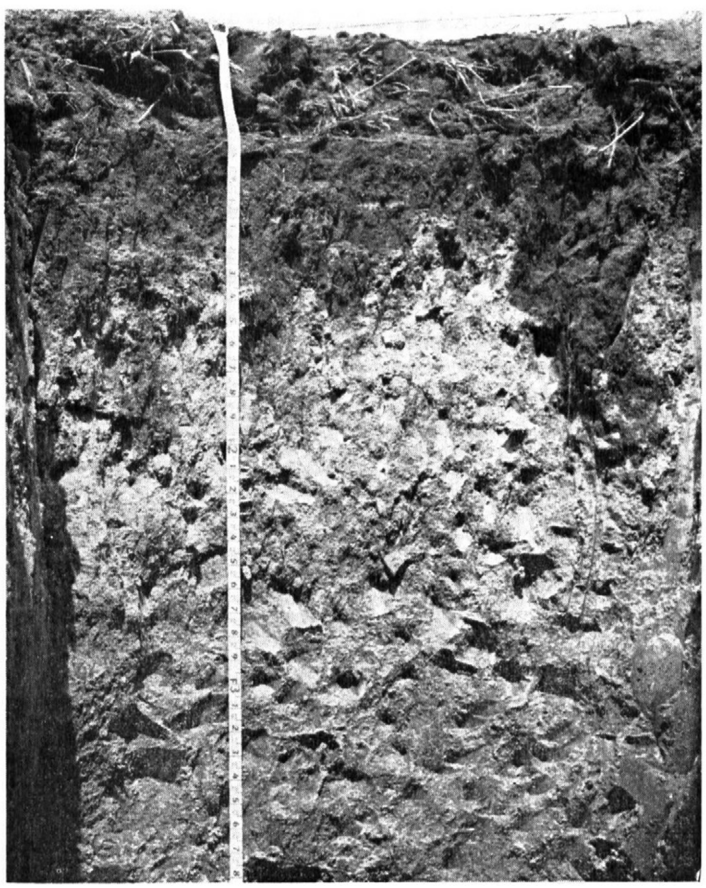


Figure 6.—**A profile of Aastad soil, showing on the right side a tongue of dark surface soil that extends down into the light-colored lime zone.**

Figure 7.—**Aastad loam about 2 miles south and one-fourth mile east of Forman.**

The Aastad soils occur with Forman soils but are in a lower position and have a thicker surface layer and a darker subsoil. Their subsoil has stronger structure and contains more clay than that of the Svea soils. The clay on the prisms in the Svea soils occurs in patches.

Aastad clay loam (Aa) (0 to 3 percent slopes).—This deep soil has a dark, thick surface layer that contains a large amount of organic matter. The surface layer absorbs most of the rainfall, holds a large amount of moisture, and resists wind and water erosion. In Sargent County this soil is mostly in areas northeast of Stirum and north of Gwinner. Areas of Hamerly, Tetonka, and Parnell soils make up about 10 percent of the total area of this mapping unit.

Nearly all of this soil is cultivated. Although it is well suited to small grains, corn, alfalfa, and tame grasses, it is used mainly for small grains, especially wheat. Yields are good except in years when rainfall is less than normal. (Capability unit IIc-6; Silty range site)

Aastad loam (Ab) (0 to 3 percent slopes).—This is the most extensive soil in the county, and it occurs mainly in the central part. It is nearly level, as shown in figure 7, and is on glacial till. Its surface layer contains less clay, but this soil is otherwise similar to Aastad clay loam. Both soils resist wind and water erosion. They are suited to the same crops, require the same management, and produce about the same yields. As much as 10 percent of any area of this mapping unit may consist of Hamerly, Tetonka, and Parnell soils.

Aastad loam is used for crops and pasture. The pasture is generally overgrazed and does not produce as much forage as it could under improved management. (Capability unit IIc–6; Silty range site)

Aastad-Cresbard loams (Ac) (0 to 3 percent slopes).—Aastad loam and Cresbard loam are mapped together because many spots of Cresbard loam occur with the Aastad loam and are too small to map separately. These soils are on nearly level glacial till. The Cresbard series is described later in this report.

Cresbard loam has a dark surface layer. Its subsoil is a dense claypan with prismatic structure. Cresbard loam is droughty because its subsoil is slowly permeable to water. Only a few roots penetrate into the subsoil, and these go down along the faces of the prisms.

All of this mapping unit is used for small grains, corn, and alfalfa. The droughty Cresbard spots are conspicuous in grain fields because the grain is short. Because of the droughty spots, Aastad-Cresbard loams are less productive than Aastad loam. The permeability of the Cresbard soil can be increased by using legumes or other crops that send their roots into the subsoil. (Capability unit IIIs–P; Pan Spots range site)

Aberdeen Series

In the Aberdeen series are nearly level soils that have a dark surface layer and a claypan subsoil. These soils are on the flats of glacial Lake Agassiz in the northeastern part of the county.

The surface layer is silt loam or silty clay loam that is black when moist. It is generally about 7 inches thick, but the range is from 6 to 12 inches. This layer is friable, is free of lime, and has a fine, granular or crumb structure.

Underlying the surface layer is a leached layer, about 4 inches thick. The leached layer is generally light gray to dark gray but, when moist, varies between very dark gray and white. The blocks or prisms of its structure break down into plates.

The clayey subsoil has a medium to strong, prismatic or columnar structure. The prisms or columns of the structure break down readily into strong, medium and fine blocks. The subsoil is very slowly permeable to water and to plant roots. The few plant roots that penetrate the subsoil go down along the faces of the prisms or columns.

The parent material of Aberdeen soils is silty or clayey. It generally has a distinct lime zone directly under the subsoil. This lime zone contains gypsum crystals and other visible salts. At about 2½ feet from the surface, stratified silt, fine sand, and clay materials are common.

Aberdeen soils occur with Exline soils but have a thicker surface layer and weaker structure in the subsoil.

Aberdeen silt loam (Ad) (0 to 3 percent slopes).—This soil is in the glacial Lake Agassiz area along with the Gardena soils and Colvin and Perella soils, saline. Inclusions of Gardena soils make up as much as 10 percent of the area mapped as Aberdeen silt loam.

Where it occurs with Gardena soils, this soil is in many small, round areas. In cultivated fields it is conspicuous next to the black Gardena soils because its surface layer is dark gray as a result of mixing with the underlying gray, leached layer. A very slowly permeable subsoil makes this soil droughty.

In fields with Gardena soils, Aberdeen silt loam is used for small grains, corn, and alfalfa. Yields are generally low because the soil is droughty, but they are fair if light rains are frequent enough to keep the surface soil moist. Where this soil is next to the poorly drained Colvin and Perella soils, it is used for pasture and hay. (Capability unit IIIs–P; Pan Spots range site)

Aberdeen-Exline silty clay loams (Ae) (0 to 3 percent slopes).—These soils have a very slowly permeable claypan subsoil. They are in glacial Lake Agassiz, in the northeastern part of the county, and are in such an intricate pattern that it is impractical to map them separately.

The subsoil of these soils has a very strong, columnar structure. In cultivated fields the Exline soil is easy to distinguish because its surface is very cloddy. Plowing has brought up clods from the strong columns in the subsoil and has mixed them into the thin surface layer. A description of the Exline series is given later in this report.

The soils of this mapping unit are used mainly for hay, but some areas are in small grains and alfalfa. Yields are low. (Capability unit IIIs–P; Pan Spots range site)

Artesian Ponds

Artesian ponds are formed when the water from artesian wells overflows from stock-water tanks and drains into depressions or potholes. Although it is suitable for livestock, the water contains salts that are toxic to plants.

Artesian ponds (Am).—Artesian ponds are depressions or potholes that receive overflow from stock-water tanks, which are filled by a continuous flow of water from artesian wells. Most of the ponds are near farmsteads. Parnell and Tetonka soils are in the depressions. Because the water contains salts that are toxic to plants, these ponds have no vegetation. (Capability unit VIIIs–1)

Arveson Series

The Arveson series consists of deep, dark, calcareous soils that are poorly drained. These soils are in glacial Lake Dakota, which is in the southwestern part of the county. They occupy slight depressions or low broad swales and have formed in loamy fine sand to fine sand. A high water table keeps Arveson soils wet most of the time.

These soils have a very friable, dark-gray to black surface layer that is limy and about 10 inches thick. It ranges from light loam to fine sandy loam and has a fine granular structure.

Directly under the surface layer is a light-gray to gray zone in which the largest amount of the lime has accumulated. Except for its lighter color and higher content of lime, this zone is similar to the surface soil. It is between the surface soil and the parent material. In many areas there are two zones of lime accumulation within a depth of about 4 feet.

The parent material is also limy. It is light-gray to light olive-gray loamy fine sand to fine sand mottled with brownish yellow and yellowish brown.

Arveson soils are more poorly drained than Ulen soils and are sandier than Borup soils.

Arveson fine sandy loam (An) (0 to 1 percent slopes).—This soil is in depressions or swales. It is in the sandy areas of glacial Lake Dakota, in the western part of the county, and is near Milnor in the northeastern part.

Most of this soil occurs with Valentine-Hecla fine sands, hummocky, and is used for pasture or hay. Some of this pasture or hay is native grasses, mainly switchgrass, Indiangrass, and big bluestem. A small part of this soil occurs with Hecla and Ulen soils on nearly level slopes and is used for corn, oats, flax, and other crops. Yields are good because the soil is kept moist most of the time by a high water table. (Capability unit IIIwe-3; Subirrigated range site)

Barnes Series

The Barnes series consists of deep, dark, fertile soils on undulating to rolling glacial till in the western part of the county. These soils are well drained.

The surface layer is black or very dark gray loam that is generally about 6 inches thick but ranges from 5 to 8 inches in thickness. It contains a large amount of organic matter. It is granular in structure, friable when moist, and easily tilled.

The dark gray or very dark gray subsoil has tongues extending into it from the darker surface layer. The subsoil is generally friable when moist. It has a moderate and strong, prismatic structure, but the structural prisms break into weak blocks. The subsoil contains little or no more clay than the surface layer. Only patches of clay film are on the prism faces of the subsoil. These soils contain less clay and have weaker prisms in the subsoil than the Forman soils, which have continuous clay films on all faces of prisms and blocks.

The Barnes soils occur with Svea soils but are higher on the slopes, are better drained, and have a slightly thinner surface layer.

Barnes-Buse loams, rolling (BbC) (6 to 9 percent slopes).—Barnes loam and Buse loam are mapped as one unit in the western part of the county because they occur together in such a complex pattern that it is impractical to map them separately. The Barnes soil is on slopes and is more extensive than the Buse soil. The Buse soil is on hilltops. It has a thinner surface layer than the Barnes soil. The Buse series is described later in this report.

Most areas of these soils are used for small grains, alfalfa, and tame grasses. Corn does not produce enough cover early in the season to protect the soil against water erosion, and subsequent cultivation increases the erosion hazard.

Because slopes are short and broken, contour cropping is not practiced. Yields are fair when the rainfall is adequate, but they are lower than on Barnes-Svea loams, undulating, because more water is lost in runoff. Practices that help control water erosion are stubble mulching, stripcropping, using grasses and legumes in the cropping system, and tilling the fields across slopes where possible. (Capability unit IIIe-6; Silty range site)

Barnes-Buse loams, rolling, eroded (BbC2) (6 to 9 percent slopes).—These soils were mapped together because they occur in such a complex pattern that it is impractical to map them separately. They are in the western part of the county.

Many hilltops are light colored because water and wind have removed the surface soil. Water caused most of the erosion. Intense rains or hail washed the soil from bare, summer-fallowed or fall-plowed fields. Wind removed some of the soil in winter when the hilltops were unprotected by snow and in spring before vegetation was established on fall-plowed or fallowed land.

These eroded soils are used for the same crops as Barnes-Buse loams, rolling, and about the same mangement is required to control further erosion. Crop yields are lower, however, because the eroded hilltops have low fertility. (Capability unit IIIe-6; Silty range site)

Barnes-Buse stony loams (Bc) (3 to 9 percent slopes).—These soils occur together in such a complex pattern that they were mapped as one unit. The soil material of these soils is like that of Barnes-Buse loams, rolling, but so many stones are in these stony loams that they cannot be cultivated. Removal of the stones is not practical. Some areas slope as much as 15 percent.

In Sargent County these soils are inextensive and, generally, are in small areas. They are in native grasses, which are grazed if these soils occur with other soils in pastures. Barnes-Buse stony loams are left idle if they are with soils used for hay or cultivated crops. (Capability unit VIs-Si; Silty range site)

Barnes-Svea loams, undulating (BdB) (3 to 6 percent slopes).—These soils occur together in such a complex pattern in the western part of the county that it is impractical to map them separately. They are on undulating glacial till. The Barnes soil is more extensive than the Svea soil and is higher on slopes. The soils in this mapping unit differ from those in Forman-Aastad loams, undulating, by having a lower clay content and weaker structure in the subsoil. As much as 10 percent of Barnes-Svea loams, undulating, is made up of Hamerly, Tetonka, and Parnell soils. The Svea series is described later in this report.

These soils are well suited to small grains, alfalfa, and tame grasses. Crop yields are good except when rainfall is less than normal.

Water erosion is the main hazard. If these soils are cultivated but not protected, slight to moderate water erosion is likely. Moderate erosion is likely on fields planted to corn. Corn does not produce enough cover in early stages of growth to protect the soil, and subsequent cultivation increases the erosion hazard. These soils resist wind erosion. (Capability unit IIe-6; Silty range site)

Barnes-Svea loams, undulating, eroded (BdB2) (2 to 5 percent slopes).—These soils occur together in such a complex pattern that they were mapped as one unit. They differ from Barnes-Svea loams, undulating, only by being moderately eroded. Some of the hilltops in areas of these soils are light colored where the surface soil has been removed. This removal was mostly by intense rain or hail falling on summer-fallowed land. Some soil has been removed by wind in winter when little or no snow covered the soil, and from fall-plowed or fallowed land early in spring before vegetative cover was established.

These soils are used for small grains, alfalfa, and tame grasses. Because of the eroded hilltops, yields are lower than those on the Barnes-Svea loams, undulating. Stubble mulching, field windbreaks, and stripcropping help to control erosion. (Capability unit IIe–6; Silty range site)

Bearden Series

This series consists of moderately well drained to imperfectly drained, limy soils. These soils formed in silty and clayey material that was deposited by water. They are in three widely separated areas in this county: (1) glacial Lake Agassiz in the northeastern corner, (2) glacial Lake Dakota in the southwestern part, and (3) an area below the Sisseton Hills in the southeastern part.

The surface layer is generally about 8 inches thick, but the range is from 6 to 15 inches. It is black and friable when moist, dark gray when dry, and slightly sticky and plastic when wet. This layer contains a large amount of organic matter and is limy in most places.

A light-colored lime zone is in the parent material; it is directly under the surface layer in areas where that layer is more than 10 inches thick. Where the surface layer is less than 10 inches thick, a dark-gray layer is between the surface layer and the parent material. Except in color, the dark-gray layer resembles the surface layer. The dark-gray layer, in turn, is underlain by pale-yellow to light yellowish-brown parent material that contains a white zone of lime accumulation.

The parent material is silty or clayey, is friable when moist, and has a fine, granular structure. It is generally light yellowish brown to brownish yellow, mottled with gray and light brownish gray. Many wide tongues of the black material extend from the surface soil deep down into the lime zone of the parent material.

The Bearden soils occur with the Overly soils and the Tetonka soils. They are not so well drained as the Overly soils but are better drained than the Tetonka soils. They are better drained than the Borup soils and formed in more clayey material.

Bearden soils are widespread in the county, but their total acreage is small. They are easily worked and highly productive. Most of their small acreage is cultivated.

Bearden silty clay loam (Bf) (0 to 3 percent slopes).—This nearly level soil is mainly in the northeastern part of the county. Cultivated fields show light-gray spots in those places where the lime zone is near the surface, and plowing has mixed some of the lime with the surface layer. Overly and Tetonka soils may make up as much as 10 percent of the total area of this soil.

This soil is well suited to small grains, corn, alfalfa, and tame grasses. Yields are good for periods of several years. Even if this soil is not protected, the hazard of wind erosion is only slight. But wind erosion is more likely on this soil than on Overly-Bearden silty clay loams, nearly level. (Capability unit IIe–4L; Silty range site)

Bearden-Tetonka silt loams (Bk) (0 to 3 percent slopes).—Bearden silt loam and Tetonka silt loam were mapped together in the northeastern part of the county because the Tetonka soil occupies many small, shallow depressions and is impractical to map separately. The Bearden soil is dominant. Much of its surface is light colored because the lime zone is near the surface and plowing has mixed part of the lime with the surface layer. The Tetonka series is described later in this report.

All the acreage of these soils is in small grains, corn, and alfalfa. Yields are good. In some years seeding is delayed until the small depressions dry out. (Capability unit IIe–4L; Silty range site)

Borup Series

The Borup series consists of poorly drained soils that contain large amounts of lime and occur in swales or depressions on glacial lake plains. These soils are in glacial Lake Agassiz in the northeastern part of Sargent County and in glacial Lake Dakota in the southwestern part.

The black surface layer generally is about 8 inches thick, but the range is from 6 to 12 inches. This layer is generally limy and has a fine, granular structure. It is friable when moist and is slightly sticky and slightly plastic when wet.

Directly under the surface layer is a gray layer that is the zone of maximum lime accumulation. It commonly contains large, white, soft masses of segregated lime. This lime layer is friable when moist; it is slightly sticky and slightly plastic when wet. The parent material of the Borup soils is limy and moderately sandy to silty.

Borup soils generally are silty to a depth of 5 feet, but in many places the silty material extends to a depth of about 3 feet and is underlain by sandy material.

Borup soils are more poorly drained than the Bearden soils and formed in less clayey material. They formed in less clayey material than did the Colvin soils and have a more prominent lime zone than the poorly drained Perella soils.

Borup, Colvin, and Perella soils (Br) (0 to 3 percent slopes).—These soils were mapped together because they are similar in drainage, in suitability for use, and in management requirements. They are in depressions and low swales of the glacial lake plains in the northeastern and western parts of the county. They are kept wet much of the time by a high water table or by frequent ponding. The Colvin series and the Perella series are described later in this report.

These soils are used mostly for pasture or hay. Because moisture is excessive, the pasture and hay is mainly tall, coarse grasses. Some areas are cultivated and produce average yields of flax, millet, or other late seeded crops.

The high water table and lack of drainage outlets generally prohibit artificial drainage on these soils; but some areas that were ponded have been drained, and they produce average yields of small grains. (Capability unit IIw–4L; Subirrigated range site)

Buse Series

In the Buse series are excessively drained soils on hilltops and crests of slopes in glacial till landscape. They are most extensive in the western part of the county and in the Sisseton Hills in the southeastern part. In the Sisseton Hills, the Buse soils occur with the Forman soils, and in the western part of the county, they occur with the Barnes soils.

The loam surface layer is about 4 inches thick, but the range is from 2 to 6 inches. It is black when moist and dark gray when dry. The structure is granular. In most cultivated areas, the surface layer is limy because the parent material has been mixed with it by plowing.

Generally, a limy transitional zone is between the surface layer and the parent material. This transitional zone has a weak, coarse, prismatic structure but is not a distinct layer. In some places, however, there is no transitional zone, and the surface layer is directly underlain by a weak zone of lime accumulation in the parent material. The parent material is limy glacial till that is friable and light olive brown when moist.

Buse-Barnes loams, strongly rolling (BvD) (10 to 25 percent slopes).—These soils are on glacial till. Strongly rolling areas of Buse loam and Barnes loam were mapped together on short, broken slopes because they are in such a complex pattern that it is impractical to map them separately. The Buse soil is on hilltops and upper slopes, and the Barnes soil is on lower slopes.

These soils are used mainly for pasture and hay. The pasture is generally overgrazed and is not so productive as it would be if management were improved. A large acreage is in native grass, mainly little bluestem, prairie dropseed, green needlegrass, side-oats grama, prairie cordgrass, and switchgrass.

Because of the erosion hazard, these soils are not suited to cultivation. Small grains and alfalfa are grown in some areas, but these areas produce lower yields than do other soils on glacial till because so much rainfall runs off their steep slopes. (Capability unit VIe–Si; Silty range site)

Buse-Barnes loams, strongly rolling, eroded (BvD2) (9 to 15 percent slopes).—These soils are mapped as one unit because they occur together in such a complex pattern that they cannot be mapped separately. They are moderately eroded but, otherwise, are like Barnes-Buse loams, strongly rolling. Many hilltops are light colored where water and wind have removed the surface soil. Water caused most of the erosion when intense rains or hail fell on bare land. Wind blew away some soil when it was not protected by snow in winter and by vegetation early in spring. These soils are droughty because they lose much rainfall in runoff from the steep slopes.

These soils are used for small grains and alfalfa. Yields are low because the soils are droughty, and the eroded areas are low in fertility. These soils are probably better suited to permanent pasture or hay than to small grains and alfalfa. (Capability unit VIe–Si; Silty range site)

Colvin Series

The Colvin series consists of poorly drained, limy soils that formed in clayey materials. These soils are in shallow depressions and low swales in glacial lake plains.

The black surface layer is about 8 inches thick, but the range is from 6 to 14 inches. This surface layer has fine, granular structure and generally is limy. It is friable when moist and slightly sticky and slightly plastic when wet.

A prominent, gray or white layer of accumulated lime underlies the surface layer. This lime zone is separated from the surface layer by a boundary that is generally clear but is gradual in some places. In many areas the boundary is irregular or broken, for the lime has accumulated in large, soft, white masses that are surrounded by olive-colored parent material or by black material extending from the surface soil. The parent material is limy and clayey.

Colvin soils are similar to Bearden soils but are more poorly drained. They have about the same drainage as the Borup and Perella soils. But Colvin soils formed in more clayey material than the Borup soils and have a more distinct zone of lime accumulation than the Perella soils.

A high water table keeps the Colvin soils wet much of the time. Most of the acreage is used for pasture or hay, but a few drained areas are used for small grains.

Colvin and Perella soils, saline (Cp) (0 to 1 percent slopes).—Saline areas of Colvin soils and of Perella soils were mapped together as one unit because they occupy about the same positions, have about the same drainage, are suitable for the same uses, and require the same management. These soils are mainly southeast of Milnor.

These soils are often ponded or are wet because the water table is high. They are moderately salty to strongly salty. Most of the acreage is in pasture consisting of tall coarse grasses and saltgrass. A small acreage is cultivated and is best suited to alfalfa, flax, barley, rye, and other plants tolerant of salt. (Capability unit IIIws–4L; Saline Lowland range site)

Cresbard Series

The Cresbard series consists of moderately well drained soils that have a thick surface layer and a claypan. These soils are in many small, nearly round areas in a complex pattern with the Aastad soils.

The loam or silt loam surface layer generally is about 8 inches thick, but the range is from 7 to 11 inches. It is black when moist. This layer is very friable, is free of lime, and has a fine, granular structure.

A gray to dark-gray, leached layer underlies the surface layer. This leached layer ranges from 3 to 6 inches in thickness but generally is about 5 inches thick. It has a medium blocky structure. The blocks of this structure break readily into medium plates. The leached layer is abruptly underlain by a claypan, which has a medium prismatic structure. The prisms are not very durable and break down into strong, medium and fine blocks. This claypan is very slowly permeable to roots and water. Most of the roots that penetrate the claypan go down along the faces of prisms.

Limy glacial till parent material underlies the claypan. This limy material is of loam or clay loam texture. In its upper part many gypsum crystals and a few other salts are visible.

The Cresbard soils resemble the Aberdeen soils but have formed in glacial till, whereas the Aberdeen soils formed in glacial lake deposits. The Cresbard soils differ from the Aastad soils in having a leached layer and a claypan. The claypan is more strongly developed than the subsoil layers of Aastad soils and is more slowly permeable.

Dimmick Series

The Dimmick series consists of very poorly drained soils that formed in clayey material. These soils occur in flat, wet depressions and old stream channels in the eastern part of Sargent County.

The surface layer is silty clay loam to clay and is limy in some places. It generally is about 7 inches thick, but the range is from 6 to 12 inches. The surface layer has fine, granular structure. It is very firm when moist, sticky and plastic when wet, and black when moist or dry. Although some areas have a lime zone, most areas are limy without a prominent lime zone.

The subsoil is dark olive gray when moist and has moderate, medium and coarse prisms that break into fine and very fine blocks. It is very hard when dry, very firm when moist, and sticky and plastic when wet.

The parent material is clay that ranges from olive to very dark gray when moist. It is very hard when dry, very firm when moist, and very sticky and very plastic when wet. Generally the parent material is limy.

Dimmick soils are similar to Hegne soils but are more poorly drained.

Dimmick clay (Dc) (0 to 1 percent slopes).—This deep, clayey soil occurs in depressions of the glacial lake basin. It is in the eastern part of the county. Because internal drainage is very slow, water remains on the surface for long periods after heavy rains. Artificial drainage is generally not feasible, because the surrounding area is so nearly level that there is no outlet for excess water. This soil is too wet to be cultivated. The vegetation is mainly sedges and some bulrushes. (Capability unit Vw–WL; Wetlands range site)

Dimmick clay, basins (Dm) (0 to 1 percent slopes).—Many areas of this soil have a prominent lime zone, but some areas are limy to a depth of 5 feet and do not have a lime zone. This soil occurs with Dimmick clay but is more limy than that soil and, because of a high water table, is wetter.

Like Dimmick clay, this soil is too wet to be cultivated and generally is not suitable for artificial drainage. The vegetation is mainly sedges, which are sometimes cut for hay. (Capability unit Vw–WL; Wetlands range site)

Divide Series

The Divide series consists of moderately well drained to imperfectly drained, limy soils. These soils are in shallow depressions or on terraces that receive seepage water from higher land. They have formed in loamy material underlain by loose, gravelly or sandy material.

The surface layer of this soil is sandy loam to clay loam and is 6 to 16 inches thick. This layer is black when moist. It is free of lime in some places and, in other places, contains light-gray mottles of accumulated lime. The surface layer has a gradual or clear, irregular boundary that separates it from a lime zone.

The light-colored lime zone is prominent. It generally overlies gravelly material, which is only slightly limy. In some places, however, the lime zone extends into the upper part of the gravelly material.

Divide loam (Dv) (0 to 3 percent slopes).—This soil is the least extensive one in the county and occurs in the eastern part. It is limy at the surface and gravelly below the surface layer. Free water usually is at a depth of 3½ to 5 feet. This indicates that, under the gravelly materials, fine-textured materials hold the water table at its existing level.

About half of this soil is cultivated, and half is in native grasses used for hay. Low yields of corn and small grains are produced on the cultivated part because the high water table causes excess moisture. (Capability unit IIIs–4L; Subirrigated range site)

Eckman Series

In the Eckman series are deep, dark, well-drained soils that formed in silty material. They are in glacial Lake Agassiz in the northeastern part of the county and in glacial Lake Dakota in the western part.

The silt loam surface layer generally is about 7 inches thick, but the range is from 6 to 10 inches. This layer has fine granular structure and is black or very dark gray when moist. It is free of lime, very friable, and easily worked.

The subsoil is silt loam that is friable and very dark grayish brown to yellowish brown when moist. It has weak to moderate, coarse, prismatic structure.

Lime has accumulated in a distinct zone directly under the subsoil. This zone is light yellowish brown when moist, and it contains much white. Under the lime zone, the parent material is light olive brown when moist. It is silty in most places but, at a depth below 3 feet, it may be silt loam, loam, or very fine sandy loam. The percentage of fine sand, very fine sand, and silt is high, but the percentage of coarse sand is low.

Eckman soils are better drained than Gardena soils but formed in the same kind of parent material. Eckman soils are similar to the Barnes soils but formed in silty, water-deposited material, whereas Barnes soils formed in loamy glacial till.

Eckman silt loam, nearly level (EcA) (0 to 3 percent slopes).—This deep, dark-colored, fertile soil has a thick surface layer with a fine, granular structure. The silt loam subsoil has moderate, prismatic structure. This soil contains a large amount of organic matter, absorbs rainfall readily, and resists wind and water erosion. It is easily tilled.

In Sargent County this soil is near the southern boundary west of Havana. Its total area is cultivated. It is well suited to small grains, corn, alfalfa, and tame grasses. Wheat and barley are the main crops. Yields are high except when there is not enough rain. (Capability unit IIc–6; Silty range site)

Eckman silt loam, undulating (EcB) (3 to 6 percent slopes).—Most of this soil is on the breaks along the Wild Rice River. On the upper slopes it has a thinner surface layer than Eckman silt loam, nearly level.

Most of this deep, productive soil is used for small grains and alfalfa. Yields are high except in years when rainfall is less than average. Corn is not suitable; it does not produce enough cover in the early stages to protect the soil from erosion. Necessary cultivation of the crop increases the hazard of erosion.

Although erosion has been slight, it is the main hazard if this soil is cultivated. Erosion can be controlled, however, by stubble mulching, stripcropping, using grasses and legumes in the crop rotation, and working the soil across slopes where that can be done. (Capability unit IIe–6; Silty range site)

Eckman and Maddock loams, undulating (EmB) (3 to 6 percent slopes).—Both soils in this mapping unit are deep; are rapidly permeable to roots, air, and moisture; and are easily tilled. They are in the northwestern part of the county and are so intermingled that they have been mapped as one unit. Their loamy surface layer is underlain by sandy material at a varying depth. The depth to the sandy material is 20 inches or more in the more extensive Eckman soil, but is less in the Maddock soil.

These soils are well suited to small grains, corn, alfalfa, grasses, and trees, but they may be damaged by wind erosion if they are cultivated. Because their surface layer contains more sand than that of Eckman silt loam, nearly level, these soils are more susceptible to erosion. Wind erosion can be controlled, however, by stubble mulching, stripcropping, and planting trees for windbreaks in fields. Yields of crops generally are fair except when there is not enough rain. Yields vary from place to place according to the depth to the underlying sandy material, which has low moisture-holding capacity. (Capability unit IIe-5; Silty range site)

Eckman and Maddock loams, rolling (EmC) (6 to 9 percent slopes).—These soils are in the northwestern part of the county where Eckman and Maddock loams are so intricately mixed that it is not practical to map them separately. In most areas the soils are loamy from the surface to a depth of 20 inches or more; the underlying material is sandy.

About half of this mapping unit is used for production of small grains, corn, alfalfa, and tame grasses. The rest is adjacent to soils on greater slopes and is used for pasture.

The soils of this mapping unit are susceptible to wind and water erosion when cultivated. Stripcropping, stubble mulching, and spring plowing will help to control erosion. Crop yields are slightly lower than on Eckman and Maddock loams, undulating, because more rainfall runs off. (Capability unit IIIe-5; Silty range site)

Exline Series

The soils in the Exline series have a thin surface layer and a claypan subsoil that has a columnar structure. These soils are in the northeastern corner of the county.

The surface layer generally is 4 inches thick, but the range is from 2 to 5 inches. This layer is free of lime. When moist, it is friable and black to very dark gray; when wet, it is sticky and plastic.

A light-gray leached layer, 2 inches thick or less, abruptly underlies the surface layer in most places. The structure of the leached layer breaks down into medium and fine plates. In some places this layer is indicated only by a light-gray color on the rounded tops of the subsoil columns.

Underlying the leached layer is a clay subsoil that has a columnar structure. The strong medium columns have rounded tops. The columns are generally very durable, either moist or dry, but in some places they separate into weak or moderate, angular blocks. Gypsum crystals and other salts are visible in the lower part of the subsoil.

The upper part of the parent material also contains visible salts and is limy and clayey. Generally, strata of silt, clay, and sand are at a depth greater than 2 feet, but in some places the profile is clayey to a depth of more than 5 feet.

Exline complex (Ex) (0 to 1 percent slopes).—This complex consists mostly of Exline soils, but with these soils are areas of Aberdeen and Bearden soils that are too small to map separately. The Aberdeen and Bearden soils make up about 15 percent of the complex. The soils in Exline complex are nearly level and have a claypan. They are in the northeastern corner of the county.

The surface layer is silty clay loam to loam that is black when dry and has a granular structure. This layer is 3 to 6 inches thick. It is thickest and has a silty clay loam surface layer in small depressions, which cover about 5 percent of the complex.

The subsoil is a clay loam with strong, columnar structure. The columns have light-gray, rounded tops. The subsoil is very slowly permeable to water and is not penetrated by many plant roots. The few plant roots that do penetrate the subsoil go down along the faces of the columns. Because of the slow internal and external drainage, water ponds after heavy rains.

The parent material is limy, is clayey, and contains visible salts. It is underlain by limy, sandy material at a depth of 2 to 5 feet.

These soils are used mainly for hay, but some of the acreage is in small grains and alfalfa. Cultivated fields are cloddy because part of the claypan has been mixed with the surface layer by plowing. Because these soils are droughty, average yields over long periods are low. Yields are fair when frequent rains keep the thin surface layer moist. (Capability unit VIs-SL; Saline Lowland range site)

Fairdale Series

The Fairdale series consists of moderately well drained soils in silty alluvium. These soils are mainly on the bottom lands of the Wild Rice River, but small areas are also in old abandoned stream channels, mostly in the eastern part of the county.

The surface layer is about 3 inches thick and is very dark gray or very dark brown when moist. It has a fine, granular structure, is free of lime, and is very friable.

Stratified, light- and dark-colored material underlies the thin surface layer and extends to a depth of about 5 feet. The strata are generally silt loam, fine sandy loam, and silty clay loam; but silt loam is most plentiful. In a few places fine sand occurs in the stratified material. The stratified material is limy in many areas. It is common to find the surface soil of one or more buried soils in the profile.

In Sargent County the Fairdale soils occur closely with La Prairie soils and have been mapped with them. Fairdale and La Prairie soils are in the same kind of alluvial material, but the Fairdale soils have a thinner surface layer and a lighter color. The Fairdale soils are better drained than the Lamoure soils.

Fargo Series

The Fargo series consists of deep, dark, poorly drained soils that formed in water-deposited clay material. Generally, these soils are not limy at the surface but are limy within a depth of 2 feet. They are in the eastern part of Sargent County.

The surface layer is about 7 inches thick, but the range is from 5 to 10 inches. This layer is black when either moist or dry. It is very hard when dry, firm when moist, and very sticky and very plastic when wet. The structure is moderate to strong and granular or blocky. The tilth is cloddy. In some areas a few glacial stones are in the soil and on the surface.

The subsoil is olive gray when moist. Black tongues extend into it from the surface layer. Like the surface layer, the subsoil is hard when dry, firm when moist, and very sticky and very plastic when wet. It is moderately limy.

The limy parent material is olive-gray clay with mottles of yellow and brown. The mottles range from few to many.

Fargo soils occur with the Hegne soils. They formed in the same kind of material but do not have a prominent lime zone. The Fargo soils are similar to the Parnell soils but formed in more clayey material. They are better drained than Dimmick soils.

Fargo clay (Fc) (0 to 6 percent slopes).—This deep, dark, poorly drained soil is in the eastern part of the county. Included with this mapping unit are Hegne soils, which make up as much as 10 percent of each area mapped.

Water is generally excessive on this clay soil, for runoff and internal drainage are slow. Artificial drains, however, have improved some areas.

The soil requires fall plowing because it does not dry early enough in the spring to be plowed or to allow preparing a seedbed for small grains. If it is worked when wet, this soil puddles and its granular structure is destroyed. When it dries, the soil is hard and cloddy. More power is required to pull a plow in this clayey soil than in most other soils in the county.

Wind erosion is likely in cultivated fields. In fall-plowed fields, the soil slakes, and sand-sized granules or crumbs are left on the surface. In the winter when there is little or no snow cover, wind blows the sand-sized particles into depressions, drains, fence rows, and tree belts. Wind erosion may not seriously damage the soil, but it clogs surface drains.

All of this soil is cultivated. It is used mainly for small grains and alfalfa, but some fields are in corn and soybeans.

Because this soil holds much moisture, average yields are good for long periods. In dry seasons, yields are higher than on most other soils in the county. (Capability unit IIwe-4; Clayey range site)

Forman Series

The Forman series consists of deep, well-drained soils that have a clayey subsoil. They are on undulating glacial till, mainly in the central part of the county.

The surface soil is black or very dark gray and loamy. It generally is about 7 inches thick, but the range is from 5 to 9 inches. This layer is slightly hard when dry, is very friable when moist, and is easily worked. Tongues of the black surface layer extend into the subsoil, which is grayish brown.

The subsoil has a prismatic structure; the prisms break down into blocks. Distinct clay films are on the faces of the prisms and blocks. The subsoil contains more clay than the surface layer. Roots easily penetrate the subsoil. In some places the lower part of the subsoil is limy.

The parent material is also limy, and most of the accumulated lime is in the upper part. The depth to the lime zone ranges from 12 to 20 inches. The parent material is light yellowish-brown glacial till that is hard when dry and friable or firm when moist. Nests of gypsum crystals are present.

Forman soils contain more clay in the subsoil than the Barnes soils and have stronger prisms and blocks. Forman soils are higher, are better drained, and have a thinner surface layer than the Aastad soils.

Forman-Aastad loams, undulating (FoB) (3 to 6 percent slopes).—Forman loam and Aastad loam have been mapped together because they occur together in such a complex pattern that it is impractical to map them separately. The Forman soil is more extensive and better drained than the Aastad soil and is higher on the landscape (see figure 4, p. 6). As much as 15 percent of this complex consists of the Hamerly, Tetonka, and Parnell soils.

Water erosion is the main hazard on these soils, but it is only slight to moderate, even in unprotected areas. Moderate erosion is likely in cornfields because the corn does not adequately protect the soil in summer against short, intense rains. The soils resist wind erosion.

These soils are deep, dark, and fertile. They are well suited to small grains, alfalfa, and grasses. Yields are good except when there is not enough rain. (Capability unit IIe-6; Silty range site)

Forman-Aastad loams, undulating, eroded (FoB2) (3 to 6 percent slopes).—These soils occur together in such a complex pattern that it is impractical to map them separately. They are similar to Forman-Aastad loams, undulating, but are moderately eroded and light colored where the surface soil has been removed from hilltops. Most of the erosion is caused by water when intense rain or hail falls on summer-fallowed land. Wind blows away some of the surface soil in winter when there is little or no snow cover, and early in spring before vegetation is established.

These soils are well suited to small grains, alfalfa, and grasses. Corn does not produce enough cover in early stages to protect the soil from further erosion. Yields of all crops are slightly lower than those on the Forman-Aastad loams, undulating, because eroded areas are more numerous. (Capability unit IIe-6; Silty range site)

Forman-Aastad stony loams (Fs) (2 to 6 percent slopes).—These soils are in small areas and occur together in such a complex pattern that it is impractical to map them separately. They are too stony to be cultivated. Otherwise, they are like Forman-Aastad loams, undulating. Removing the stones is not practical. These soils are in native grass. The small patches that occur in cultivated fields are left idle. (Capability unit VIs-Si; Silty range site)

Forman-Buse loams, rolling (FvC) (6 to 9 percent slopes).—These soils are mapped together because they occur in such a complex pattern that it is impractical to map them separately. They are deep, dark-colored soils on glacial till. The Buse soil is on hilltops and is excessively drained. It has a thinner surface layer than the Forman soil, which is on slopes. As much as 10 percent of this mapping unit consists of Aastad, Hamerly, Tetonka, and Parnell soils.

Most of the acreage is in small grains and alfalfa. The remainder is used for pasture and hay. Corn is not suited, for it does not produce enough cover in the early stages to protect the soils from water erosion. Because these soils are steeper and lose more water in runoff than the

Forman-Aastad loams, undulating, they produce slightly lower yields. The pasture is generally overgrazed and does not produce so much forage as it would under improved management.

Erosion has not seriously damaged these soils but is always a hazard on cultivated fields. Stubble mulching, stripcropping, and using grass or legumes in the rotation will help to control erosion. (Capability unit IIIe–6; Silty range site)

Forman-Buse loams, rolling, eroded (FvC2) (6 to 9 percent slopes).—These soils are mapped together because they occur in such a complex pattern that it is impractical to map them separately. They are similar to Forman-Buse loams, rolling, but are moderately eroded and light colored on hilltops where the surface soil has been removed.

Water erosion is the main hazard. Intense rain or hail washes the soil from the fallowed fields. Wind removes some soil in winter when there is little or no snow cover, and early in spring before vegetation is established on fall-plowed or fallowed fields.

These soils are used for small grains, alfalfa, and grasses. Because of the many eroded areas, yields are lower on these soils than on the Forman-Buse loams, rolling.

Stubble mulching, stripcropping, and using grass and legumes in the cropping system will help to control erosion. (Capability unit IIIe–6; Silty range site)

Fresh Water Marshes

Fresh water marshes are in depressions and swales in the glacial lake plains. They are of no agricultural value but are important as wildlife areas.

Fresh water marsh (Fw) (0 to 1 percent slopes).—These marshes of the glacial lake plains are covered by a high water table most of the time. The vegetation consists mainly of bulrushes and some sedges. Although these areas are of no agricultural value, they are important as wildlife areas. (Capability unit VIIIw–1)

Gannett Series

The Gannett series consists of deep, dark, very poorly drained soils that formed in sandy material. These soils are in depressions or swales and are wet most of the time because their water table is high. They occur in glacial Lake Dakota in the western part of the county, where they are associated with the Hecla and Valentine soils.

The sandy surface layer generally is about 10 inches thick, but the range is from 8 to 14 inches. This layer is black to very dark gray when moist and is free of lime. A gradual boundary separates the surface layer from the parent material.

The parent material is gray or olive-gray fine sand. It is mottled with many dark yellowish-brown to reddish-brown mottles. Because of poor drainage, the mottles extend from the upper part of the parent material through the rest of the profile. The parent material is free of lime to a depth of 3 to 5 feet and is only mildly limy below that depth.

Gannett loamy fine sand (Ga) (0 to 1 percent slopes).—This sandy soil occurs with the Valentine and Hecla soils in the wet depressions of glacial Lake Dakota in the western part of the county.

The dark surface layer is deep and is free of lime. It is wet much of the time because the water table is high.

The vegetation consists of sedges and of switchgrass, Indiangrass, northern reedgrass, big bluestem, and other native grasses. The sedges are more plentiful than the grasses in the wetter depressions. This soil is used for pasture and hay. Because of the good water supply, forage is abundant. (Capability unit IIIwe–2; Subirrigated range site)

Gardena Series

The Gardena series consists of deep soils that are moderately well drained and contain a large amount of organic matter. These dark soils have formed in silty, water-deposited material in the glacial lake areas of the county.

The surface layer generally is about 10 inches thick, but the range is from 8 to 15 inches. This layer is black when moist and dark gray when dry. It has a fine, granular structure, is very friable, and is easily worked.

The subsoil has a weak, prismatic structure. The prisms break down to weak, subangular blocks and then to fine granules. The subsoil is friable and contains little or no more clay than does the surface layer.

A lime zone underlies the subsoil. In some places this zone is dark gray and is not clearly defined, but in other places it is light gray and prominent.

The parent material below the lime zone is pale yellow when dry and is light yellow when moist. This material ranges from silt loam to fine sand. Because the percentage of silt and very fine sand is high in this material, it feels very smooth or floury when rubbed between the fingers.

Gardena soils have a profile similar to that of the Svea soils. However, the Gardena soils feel smooth because they are silty, whereas the Svea soils, which formed in glacial till loam, are gritty. The Gardena soils are better drained than Glyndon soils and are not limy at the surface.

Gardena-Glyndon loams, sandy substratum, nearly level (GgA) (0 to 3 percent slopes).—Gardena and Glyndon soils occur together in such a complex pattern that they have been mapped as one unit. They are in the glacial lake areas of the county. The Gardena soil is more extensive, is slightly higher, and is better drained than the Glyndon soil. The Glyndon soil is limy at the surface, but the Gardena soil is not. The Glyndon series is described later in this report.

These soils are sandier than Gardena-Glyndon silt loams, nearly level, and are more susceptible to wind erosion. The loamy material extends from the surface to a depth of 1½ to 3½ feet and is directly underlain by sandy material. The surface of the Glyndon soil is spotted with gray where the lime zone has been mixed with the plow layer. These soils are easily tilled.

Small grains, corn, alfalfa, and grasses are well suited to these soils. Most of the acreage is in wheat, corn, and alfalfa. Yields are good in areas where the loamy material is at least 2½ feet thick; but where this material is 2 feet thick or less, yields are lower because the underlying sandy material has a low moisture-holding capacity.

These soils have not been seriously damaged by erosion, but wind erosion is likely in cultivated fields. Stubble mulching, stripcropping, spring plowing, and planting trees for windbreaks will help to control wind erosion. (Capability unit IIe–5; Silty range site)

Gardena-Glyndon silt loams, nearly level (GmA) (0 to 3 percent slopes).—These soils are extensive, but they occur together in such a complex pattern that they have been mapped as one unit. They are south of Delamere, near Straubville, and east of Brampton. The Gardena soil is more extensive than the Glyndon soil.

These deep, fertile soils are among the best in the county for farming. They are easy to work and are resistant to wind and water erosion.

All areas of these soils are in small grains, corn, alfalfa, and grasses. Wheat, corn, barley, and alfalfa are the main crops. Yields are as high as any in the county and are good except when there is not enough rain. (Capability unit IIc–6; Silty range site)

Glyndon Series

The Glyndon series consists of deep, moderately well drained soils that are limy at the surface and have a distinct lime zone below the surface layer. These soils have formed in loamy or silty material. They are in nearly level areas in the northeastern and western parts of the county.

The surface layer is dark grayish-brown loam or silt loam that ranges from 6 to 10 inches in thickness. In most places it is 8 inches thick. It is limy, very friable when moist, and easy to work. There is a gradual transition from the surface layer to a lighter colored layer where lime has accumulated.

The lime zone varies in color and prominence, depending on the content of lime and of moisture. In moist soil the color ranges from dark gray to nearly white as the content of lime increases. A few salts are visible in this zone. The content of lime decreases gradually with increasing depth.

The parent material is generally pale yellow when dry and light yellowish brown when moist. It is silty to sandy and is moderately limy. In some places the Glyndon soils are silty to a depth greater than 5 feet and in others they are loamy or silty to a depth of 2 feet and sandy below.

Glyndon soils are lower and more poorly drained than Gardena soils and are limy at the surface. Glyndon soils have profiles similar to those of Bearden soils but formed in a less clayey material.

Glyndon loam, sandy substratum, nearly level (GoA) (0 to 3 percent slopes).—This dark, loamy soil, underlain by sandy material, occurs in the northeastern and western parts of the county. As much as 10 percent of the area of the mapping unit may consist of Gardena, Arveson, and Stirum soils.

The surface layer is black to light gray when moist. It is gray where the lime zone is near the surface and has been mixed with the surface layer by plowing.

Nearly all of this soil is used to produce small grains, corn, alfalfa, and grasses. Yields of these crops vary and depend on the thickness of the loam. Yields are good if the loam is 2½ feet thick, but if it is thinner than 2½ feet, yields are lower because the underlying sandy material has a very low moisture-holding capacity.

Erosion has not seriously damaged this soil, but wind erosion is always a hazard in cultivated fields. This soil is sandier and more susceptible to wind erosion than Glyndon silt loam, nearly level. Stubble mulching, spring plowing, stripcropping, and field windbreaks help to control wind erosion. (Capability unit IIe–4L; Silty range site)

Glyndon silt loam, nearly level (GsA) (0 to 3 percent slopes).—This deep soil is moderately well drained to imperfectly drained and is silty to a depth greater than 4 feet. It is high in lime. As much as 10 percent of its area may consist of Gardena soil.

In cultivated fields, the color of the surface layer varies, depending on the depth to the lime zone. The surface layer is dark gray where the lime zone is near the surface and has been mixed with the surface layer by plowing. This lime zone may contain a few visible accumulations of salts.

Because this soil is easily tilled and is productive, all of it is in small grains, corn, alfalfa, and grasses. Yields vary and depend on the depth to the lime zone and the content of salts. Yields are lowest where the lime zone is near the surface. Average yields in a long period are only fair. (Capability unit IIe–4L; Silty range site)

Hamar Series

Soils of the Hamar series are deep, dark colored, and imperfectly drained. They have formed in sandy material and are in shallow depressions or swales in the northeastern and western parts of the county.

The fine sandy loam surface layer ranges from 7 to 15 inches in thickness. The weak, subangular blocks in the structure of this layer break down into fine granules. The surface layer is very friable and is easy to work. It is slightly limy in some places. This layer is black when moist and dark gray when dry. The dark color at the surface grades gradually to a lighter color just above the parent material.

The light-colored, sandy parent material is mottled with brown or reddish brown. The mottles are caused by restricted drainage, and they increase in number with increasing depth. The parent material ranges from fine sandy loam to fine sand. Hamar soils are generally limy below a depth of 30 inches, but not above that depth. They have a distinct lime zone in only a few places.

Hamar soils differ from the Ulen soils by having sandier parent material and by not having a prominent lime zone. They are more poorly drained than the Hecla soils.

Hamar fine sandy loam (Ha) (0 to 3 percent slopes).—This deep, imperfectly drained to poorly drained soil is in shallow depressions. It occurs mainly in the sandy part of glacial Lake Dakota in the southwestern part of the county, but a few acres are in the northeastern part. A high water table keeps the soil moist much of the time.

Most of this soil occurs with the Valentine-Hecla fine sands, hummocky. The two soils are in native grasses, mainly switchgrass, Indiangrass, and big bluestem, which are used for pasture and hay.

Some areas of this soil occur with the nearly level areas of Hecla soils and are cultivated. Small grains, corn, alfalfa, and grasses are suited to these areas, but wetness may delay seeding in the spring. Average yields of crops can be expected from this soil.

This soil has not been damaged by erosion, but it is susceptible to blowing if the surface is dry and bare. Spring plowing and stubble mulching help to control wind erosion. (Capability unit IIIwe–3; Sandy range site)

Hamerly Series

Soils of the Hamerly series are moderately well drained, are high in lime, and have a thin to moderately thick surface layer. These dark soils have formed in limy glacial till. They occur as irregular rings on the nearly level, convex slopes that enclose depressions.

The loamy surface layer ranges from 5 to 12 inches in thickness but generally is about 7 inches thick. It is black when moist and commonly contains light-colored specks of lime. This layer has a medium, granular structure; is friable when moist; and is easily worked.

In most places, lime has accumulated directly under the surface layer in a zone that is light brownish gray when moist and white when dry. In some places, however, there is a dark-gray transitional layer between the black surface layer and the white lime zone. The parent material is friable when moist.

The Hamerly soils have a profile similar to that of the Bearden soils, but the Hamerly soils are in glacial till whereas the Bearden soils are in clayey sediments of the glacial lakes.

Hamerly complex (Hb) (0 to 3 percent slopes).—This complex consists mostly of Hamerly soil, but as much as 25 percent of it is Aastad, Tetonka, and Parnell soils. All of these soils occur together in such an intricate pattern that they have been mapped as one unit. These soils are on nearly level glacial till in the central part of the county. They are high in lime.

The surface layer of these soils is loam, silt loam, or clay loam. In cultivated fields many light-gray or white spots are conspicuous in the surrounding dark-gray soil. These light spots cover more than 20 percent of the surface. They occur where the limy material is near the surface and has been mixed with the surface layer by plowing.

Most areas of these soils are in small grains, corn, alfalfa, or grasses. Yields are fair. They are lower than yields from Aastad loam or Aastad clay loam because along with the lime in most places are small amounts of salts that are toxic to plants.

Crops best suited to these moderately salty soils are flax, barley, rye, sweetclover, and alfalfa. Some areas are in grass, mainly big bluestem, which is used for pasture and hay.

Erosion has not seriously damaged these soils, but wind erosion is likely in cultivated fields. The lime causes the soils to slake to sand-sized particles, which blow away easily. The Hamerly soil contains more lime than the Aastad soil and is therefore more susceptible to wind erosion. Stubble mulching, field windbreaks, and stripcropping help to control erosion. (Capability unit IIe–4L; Silty range site)

Hamerly-Aastad loams (Hf) (0 to 3 percent slopes).—Hamerly loam and Aastad loam occur together in such a complex pattern that they have been mapped as one unit. About 5 percent of the area of this mapping unit is Tetonka and Parnell soils. The nearly level soils in this mapping unit are on glacial till in the central part of the county.

This complex is similar to the Hamerly complex, but the light spots cover only 5 to 20 percent of the area. In cultivated fields, the light-colored spots are the Hamerly soil where the lime zone has been mixed with the surface layer by plowing.

Most of the acreage of this complex is used for small grains, corn, alfalfa, and grasses. Yields are slightly higher than those on Hamerly complex because the depth to the lime zone is greater.

Wind erosion is likely in cultivated fields, but even if these soils are not protected, damage probably will be only slight. Stripcropping, stubble mulching, and field windbreaks help to control wind erosion. (Capability unit IIe–4L; Silty range site)

Hamerly-Svea loams (Hh) (0 to 3 percent slopes).—Hamerly loam and Svea loam occur together in such a complex pattern that they have been mapped as one unit. These soils are somewhat similar to Hamerly-Aastad loams, but the subsoil of Svea loam contains less clay than that of Aastad loam.

Nearly all of Hamerly-Svea loams is used for small grains, corn, alfalfa, and grasses. Yields are fair. Although wind erosion is a hazard in cultivated fields, stripcropping, stubble mulching, and field windbreaks help protect these soils. (Capability unit IIe–4L; Silty range site)

Hecla Series

Soils of the Hecla series are deep and moderately well drained. They are dark soils that formed in sandy material on the nearly level and undulating landscape in the northeastern and western parts of the county. Hecla soils are extensive in Sargent County and are agriculturally important.

The surface layer is fine sandy loam to fine sand. It is black or dark gray when moist. This layer is generally about 14 inches thick, but the range is from 10 to 20 inches. The surface layer grades gradually from finer material at the surface to coarser material in the lower part.

Sandy parent material underlies the surface layer. This material is single grained and is yellowish brown when moist.

The content of lime in Hecla soils varies widely. In some places these soils are free of lime to a depth of more than 5 feet, and in other places they are slightly limy at the surface. Though they are not strongly limy above a depth of 15 inches, in some places they are strongly limy below that depth.

The Hecla soils have a thicker surface layer than the Maddock soils. They are better drained than the Hamar soils and are sandier than the Emden soils, which are in adjacent counties.

Hecla fine sand (Hkx) (0 to 6 percent slopes).—This very sandy, nearly level to undulating soil is in the southwestern part of the county.

The dark surface layer is from 10 to 20 inches thick and is underlain by a light-colored fine sand. Because the moisture-holding capacity is low, this soil is droughty and very susceptible to wind erosion.

Most of the acreage is in native grass, mainly needlegrass, prairie sandreed, threadleaf sedge, little bluestem, and leadplant. Controlled grazing will help to maintain good forage and an adequate cover.

A few acres are in corn and oats, but yields are low on this droughty soil. (Capability unit VIe-Sa; Sands range site)

Hecla fine sandy loam, nearly level (HlAx) (0 to 3 percent slopes).—This deep, dark, fertile soil is one of the most extensive soils in the county to have formed in sandy material on nearly level slopes. It is in the northeastern and western parts of the county.

The surface layer is very friable, is high in organic matter, and is very easily tilled. This soil, however, has a low moisture-holding capacity.

Most of this soil is cultivated and used for locally grown crops, mainly oats, corn, and alfalfa. Yields are fair but, because of droughtiness, are lower than those on soils formed in nearly level glacial till.

Although damage from erosion generally has been slight to moderate, this soil is susceptible to severe wind erosion if cultivated and not protected. Erosion can be controlled by stubble mulching, stripcropping, spring plowing, planting trees for field windbreaks, and using grasses and legumes in the cropping system. Generally, more than one of these practices will be required.

The areas that are in pasture are seeded to crested wheatgrass, bromegrass, slender wheatgrass, Russian wildrye, green stipagrass, or other tame grasses. (Capability unit IIIe-3; Sandy range site)

Hecla fine sandy loam, undulating (HlBx) (3 to 6 percent slopes).—Small, scattered spots of this soil are in sandy areas of the county. The slopes are steeper than those of Hecla fine sandy loam, nearly level, and the surface layer is slightly thinner. Consequently, this undulating soil is droughtier and more susceptible to wind erosion.

Most of this soil is used for pasture or hay. A few acres are in small grains, corn, and alfalfa. (Capability unit IIIe-3; Sandy range site)

Hecla fine sandy loam, moderately shallow, nearly level (HmA) (0 to 3 percent slopes).—This dark, sandy soil is underlain by silty material. It is on the eastern edge of glacial Lake Dakota in the southwestern part of the county.

The surface layer of this soil is like that of Hecla fine sandy loam, nearly level, but is underlain by silty material instead of sandy material. The depth to the silty material ranges between 1½ and 4 feet.

Most of this soil is cultivated. Suitable crops are small grains, corn, alfalfa, and grasses. Although yields are only fair, they are higher than those on Hecla fine sandy loam, nearly level, because the underlying silty material holds more water. Yields vary according to the depth to the silty material. They decrease as the depth to the silty material increases.

This soil is highly susceptible to wind erosion if cultivated and not protected. Stripcropping, field windbreaks, stubble mulching, and spring plowing help to protect the soil against erosion. (Capability unit IIIe-3M; Sandy range site)

Hecla loamy fine sand, nearly level (HnAx) (0 to 3 percent slopes).—In Sargent County this deep, very sandy, dark soil is the most extensive soil that has formed in sandy material in a nearly level landscape. It is mainly in glacial Lake Dakota in the western part of the county.

The surface layer is fertile and contains a large amount of organic matter, but the soil is rapidly permeable, holds little moisture, and is highly susceptible to wind erosion.

This soil is used for crops and pasture. Much of the acreage is in oats, barley, corn, alfalfa, and other feed crops because livestock is the main source of income in areas where this soil occurs.

Yields are fair when rainfall is adequate, but they are low in dry seasons because the soil is droughty. Wind erosion is the main hazard in cultivated areas, where damage has been slight to moderate. Erosion can be controlled by stripcropping, stubble mulching, spring plowing, planting trees for field windbreaks, and using legumes and grasses in the cropping system. Two or more of these practices are required for successful management.

The extensive pastures are in native and tame grasses. Some of the native grasses are green needlegrass, prairie sandreed, threadleaf sedge, sand dropseed, little bluestem, and leadplant. Some of the tame grasses are Russian wildrye, green stipagrass, slender wheatgrass, and bromegrass. Drought-resistant grasses provide the best forage on this soil and produce good yields under good management. (Capability unit IVe-2; Sands range site)

Hecla loamy fine sand, moderately shallow, nearly level (HoA) (0 to 3 percent slopes).—This very sandy soil is underlain by silty material. Most of the acreage is near the eastern edge of glacial Lake Dakota in the southwestern part of the county, but a few acres are in the northeastern part.

This soil is shallower to silty material than Hecla loamy fine sand, nearly level, but is otherwise similar to that soil. The silty material in the moderately shallow soil is 1½ to 4 feet from the surface.

This soil is in field crops, hay, and pasture. The main crops are corn, oats, and alfalfa. Yields vary according to the depth to the silty material. They are lower as the depth to the silty material increases because the sandy layer has low moisture-holding capacity. Yields are higher than those on Hecla loamy fine sand, nearly level, because the underlying silty material is near the surface and, consequently, more moisture is available. (Capability unit IVe-2M; Sands range site)

Hecla-Maddock loamy fine sands (Hwx) (3 to 9 percent slopes).—Hecla loamy fine sand and Maddock loamy fine sand occur together in such a complex pattern that they have been mapped as one unit. These soils are deep and very sandy. The Maddock soil is higher than the Hecla soil and is more excessively drained.

These soils are rapidly permeable, are low in moisture-holding capacity, and are highly susceptible to wind erosion. Consequently, most areas are in pasture or hay. The soils produce a fair amount of forage under good management. Some of the acreage is in corn, oats, and alfalfa, but yields are generally low because the soils are droughty.

Wind erosion has caused slight to moderate damage, mainly in cultivated areas. Stripcropping, stubble mulching, spring plowing, and planting trees for field windbreaks will protect the soils against erosion. (Capability unit IVe-2; Sands range site)

Hegne Series

Soils of the Hegne series are poorly drained and are high in lime. They have formed in clay sediments in nearly flat areas where both internal and external drainage are very slow.

The surface layer is limy and about 10 inches thick, but the range is from 6 to 12 inches. This soil is granular silty clay loam to clay. It is hard when dry, firm when moist, and sticky when wet. Although the surface layer is black when moist or dry, light-gray spots occur where the lime zone is at a depth of 6 to 8 inches and has been mixed with the surface layer by plowing.

A distinct, light-colored lime zone lies directly under the surface layer in some places. In other places, however, the lime zone and surface layer are separated by a dark-gray transitional layer that is high in lime. Tongues of the black surface layer extend down through the lime zone. This zone has a very fine to medium, blocky structure. A gradual lower boundary separates the lime zone and the parent material.

The olive-gray parent material is clayey and has blocky structure. This material is very hard when dry, firm when moist, and very sticky when wet.

Hegne soils have the same profile characteristics as Bearden soils but have formed in more clayey material. They differ from the Fargo soils by having a distinct lime zone that is nearer the surface.

Hegne clay (Hz) (0 to 1 percent slopes).—This soil is in nearly level areas in the northeastern and southeastern parts of the county. It is high in lime. The surface layer is black in undisturbed areas, but in cultivated fields it is gray of varying shades. The gray color varies because different amounts of lime have been mixed with the black surface layer by plowing.

Excess surface water and wind erosion are the main hazards in cultivating Hegne clay. Water ponds on the surface because this soil is slowly permeable and nearly flat. Working the soil when it is wet destroys the granular structure and causes puddling. The soil then dries out hard and cloddy. Fall-plowed fields are highly susceptible to wind erosion because the soil slakes down, leaving sand-sized particles on the surface. These particles blow away readily in winter when there is little snow, or early in spring before a cover has been established.

All of this soil is in small grains, corn, alfalfa, and some soybeans. Even in dry years yields are good, for the soil holds a large amount of moisture. (Capability unit IIwe-4L; Clayey range site)

Hegne-Fargo clays (Hfa) (0 to 1 percent slopes).—The Hegne clay and Fargo clay in this mapping unit occur in such a complex pattern that it is impractical to map them separately. These soils are high in clay content and have very slow internal and external drainage. The Hegne soil is generally conspicuous in cultivated fields because its surface is gray and contrasts with the black surface of the Fargo soil.

All of the acreage is used for small grains, corn, alfalfa, and some soybeans. Yields are consistent from year to year. Because these soils have high moisture-holding capacity, they are more productive in dry years than most other soils in the county. (Capability unit IIwe-4L; Clayey range site)

Lamoure Series

The Lamoure series consists of deep, dark, poorly drained soils formed on silty and clayey bottom lands, mainly along the Wild Rice River. Some small areas are in old stream channels in the central and eastern parts of the county.

The black surface layer is silt loam to silty clay loam, 10 to 20 inches thick. It is limy at the surface or within 6 inches of the surface. This layer has granular or crumb structure and is very friable. It is kept moist by a high water table.

A gradual boundary separates the surface layer from the parent material, which contains more lime than the surface layer. The parent material is silty or clayey and is gray, light gray, yellow, and olive. In some places, strata of fine sand to silty clay loam occur below a depth of 3½ feet.

Lamoure soils have a thicker surface layer than the Rauville soils and are better drained. They are more poorly drained than the La Prairie soils and contain more lime.

Lamoure silty clay loam (La) (0 to 3 percent slopes).—This deep, poorly drained soil is on the bottom lands of the Wild Rice River and is in small channels of old streams in the central and eastern parts of Sargent County. The dark surface layer is silt loam to silty clay loam. The soil is wet much of the time because the water table is high and there is occasional flooding.

This soil generally is too wet to be cultivated, but because moisture is plentiful, large amounts of native grasses are produced. The main native grasses are big bluestem, switchgrass, and Indiangrass. (Capability unit IIw-4L; Subirrigated range site)

La Prairie Series

The La Prairie series consists of deep, dark silty soils on bottom lands of rivers and small streams. These soils are mainly along the Wild Rice River.

The surface layer, about 8 inches thick, is free of lime and is black or very dark gray when moist. It has a fine, granular structure, is very friable, and therefore is easily tilled.

Underlying the surface layer is a lighter colored, mildly limy layer that extends to a depth of 18 to 26 inches. This layer is very dark gray when moist and dark gray when dry. In some places it has a slightly higher clay content than the surface layer.

A zone of accumulated lime underlies the mildly limy layer and extends to a depth of 3 feet. This zone is strongly calcareous and is light brownish gray when dry. It is generally underlain by strata of light-colored silty clay loam, sandy loam, sandy clay loam, and silt loam. Commonly the surface layer of a buried soil is in the profile of La Prairie soils.

La Prairie soils are darker than Fairdale soils and have a thicker surface layer. They are better drained than the Lamoure soils.

La Prairie and Fairdale soils (Lf) (0 to 3 percent slopes).—These La Prairie and Fairdale soils are so intermingled that they have been mapped together. They occur mainly in old abandoned stream channels in the eastern part of the county. The soils are on narrow stream bottoms and on steep, narrow breaks that rise as much as 10 feet to the adjoining upland.

These soils are deep, but their dark surface layer may be thin or thick. They are silty and are readily permeable to roots, air, and moisture.

Because farm machinery cannot cross many of the old channels, these soils are not cultivated. They are in native grass that is grazed or left idle. (Capability unit VIe-Si; Silty range site.)

La Prairie silt loam (Lp) (0 to 3 percent slopes).—This is a deep, dark soil that contains a large amount of organic matter and occurs mainly on the narrow bottom lands of the Wild Rice River.

The thick, silty surface layer has a fine, granular structure, is easy to work, and is resistant to wind and water erosion. The soil is readily permeable to roots, air, and moisture.

About half of this soil is cultivated, and the rest is so cut up by old channels that it is not suited to crops and is mostly in pasture. The main crops in the cultivated areas are small grains, corn, alfalfa, and tame grasses. Yields are good except when there is not enough moisture. Because this soil is in small areas, it is farmed with adjoining soils on uplands. (Capability unit IIc-6; Silty range site)

Maddock Series

The Maddock series consists of well-drained to excessively drained soils on nearly level to rolling slopes. These soils are in sandy material that was deposited by wind or water and in many places has been reworked by wind. The soils are highly susceptible to wind erosion.

The surface layer ranges from 6 to 18 inches in thickness. It is black to very dark gray when moist, is rapidly permeable to moisture, and is free of lime. This layer is separated from the parent material by a gradual or an abrupt boundary.

The parent material is lighter in color than the surface layer. It is sandy to a depth that ranges from 30 inches to 5 feet. In Sargent County glacial till or silty to clayey, water-deposited material is generally at a depth below 30 inches. The parent material is generally limy below 30 inches.

Maddock soils are higher and better drained than Hecla soils, which do not have loamy or clayey material below a depth of 30 inches.

Maddock fine sandy loam, moderately shallow, nearly level (MkAx) (0 to 3 percent slopes).—This sandy soil has a surface layer that is 6 to 12 inches thick and is black when moist. Underlying it is a light-colored, sandy layer, which is 10 to 20 inches thick over limy glacial till. This soil is in the northeastern and southwestern parts of the county.

Although the soil is easily tilled, severe wind erosion is likely if the soil is cultivated and not protected. Most areas are in small grains, corn, alfalfa, and grasses. Yields are fair. Wind erosion can be controlled by stubble mulching, stripcropping, planting trees for field windbreaks, and using grasses and legumes in the cropping system. (Capability unit IIIe-3M; Sandy range site)

Maddock fine sandy loam, moderately shallow, undulating (MKBx) (3 to 6 percent slopes).—This undulating soil differs from Maddock fine sandy loam, moderately shallow, nearly level, only by having stronger slopes and a slightly thinner surface layer. Like the nearly level soil, it is in the northeastern and southwestern parts of the county.

Most of this undulating soil is in pasture or hay and produces fair yields. The cultivated areas are used for the same crops as those of the nearly level soil and produce about the same yields. (Capability unit IIIe-3M; Sandy range site)

Maddock fine sandy loam, moderately shallow, rolling (MkCx) (6 to 9 percent slopes).—This rolling soil has stronger slopes than Maddock fine sandy loam, moderately shallow, nearly level, and greater variation in the depth to the underlying glacial till. It is in the western part of the county.

Most of this soil is tilled and is in oats, barley, and alfalfa. Yields are low because the surface layer is thin and much rainfall is lost in runoff.

This soil has not been adequately protected and, consequently, has been moderately damaged by wind erosion. Erosion can be controlled by stubble mulching, spring plowing, adding manure, and using grasses and legumes in the cropping system. (Capability unit IVe-3M; Sandy range site)

Maddock loamy fine sand, undulating (MdBx) (3 to 6 percent slopes).—This very sandy soil generally has a thin, dark surface layer that is underlain by a light-colored, very sandy layer over loamy glacial till. The depth to the glacial till ranges from 1½ to more than 5 feet within short distances. This soil is in the western part of the county.

If it is cultivated or overgrazed, the soil is highly susceptible to wind erosion. Also, it is droughty where the depth to the glacial till is more than 24 inches.

About half of this soil is tilled, and the rest is in native grasses. Corn, oats, and alfalfa are the main crops. Yields are low because this soil is droughty and erosion has removed much of the surface layer in many places. The cultivated areas have been moderately damaged by wind erosion. Erosion can be controlled by stubble mulching, adding manure, spring plowing, planting trees for field windbreaks, and using grasses and legumes in the cropping system. The pasture is mainly green needlegrass, prairie sandreed, threadleaf sedge, little bluestem, and leadplant. (Capability unit IVe-2M; Sands range site)

Maddock loamy fine sand, rolling (MdC) (6 to 15 percent slopes).—This soil is similar to Maddock loamy fine sand, undulating, but is on stronger slopes. Like the undulating soil, it is in the western part of the county and ranges from 1½ to more than 5 feet in depth to glacial till.

All this soil is in pasture of native plants, mainly green needlegrass, sand dropseed, prairie sandreed, threadleaf sedge, needle-and-thread, and leadplant. Because this soil is highly susceptible to wind erosion, the pasture should not be overgrazed. (Capability unit VIe-Sa; Sands range site)

Overly Series

Soils of the Overly series are deep, fertile, and moderately well drained. These dark soils have formed in silty to clayey materials that were deposited by water. They occur in glacial Lake Agassiz in the northeastern part of the county and in glacial Lake Dakota near Straubville, in the western part.

The surface layer is silt loam to silty clay loam, 6 to 14 inches thick. This layer has a granular structure, is friable when moist, and is easy to work. It is free of lime.

The dark subsoil has a weak to moderate, prismatic structure. The prisms break down into fine and very fine blocks. This layer contains little, if any, more clay than the surface layer.

In the upper part of the parent material is a distinct, light-gray lime zone that is underlain by moderately limy, silty or clayey material. This material is brownish gray or yellowish brown when moist and is mottled brown, white, and light gray. In some places layers of silt loam alternate with silty clay loam below a depth of 3 feet.

Overly soils differ from the Gardena soils by being developed in more clayey material. They are better drained than the Bearden soils and are deeper to the lime zone.

Overly silt loam, nearly level (OaA) (0 to 3 percent slopes).—This deep, silty, moderately well drained soil occurs in a nearly level area near Straubville. The silt loam surface layer is underlain by a silty clay loam subsoil, and that, in turn, by silty clay loam parent material.

This is one of the best soils in the county. It is fertile, holds a large amount of moisture, resists erosion, and is easy to work. All of it is in small grains, corn, and alfalfa; wheat and corn are the main crops. Yields are high except when there is not enough rain. (Capability unit IIc–6; Silty range site)

Overly silty clay loam, undulating (OcB) (3 to 6 percent slopes).—This deep, dark soil is in small areas on the breaks along the Wild Rice River. It differs from Overly silt loam, nearly level, by having stronger slopes and a finer textured surface layer.

All of this soil is cultivated, and most of it is in small grains, mainly wheat. Yields are high except when there is not enough rain. (Capability unit IIe–6; Silty range site)

Overly-Aastad silt loams (Os) (0 to 3 percent slopes).—Overly silt loam and Aastad silt loam occur together in such a complex pattern that they have been mapped as one unit.

These deep, moderately well drained soils occur mainly in a belt on the eastern edge of glacial Lake Dakota in the western part of the county. A small acreage is in the southeastern part of the county.

These soils resist wind and water erosion and are highly productive. All the acreage is cultivated and used for small grains, corn, and alfalfa. Crop yields are high except when there is not enough rain. (Capability unit IIc–6; Silty range site)

Overly and Barnes silt loams, rolling (OvC) (6 to 9 percent slopes).—These Overly and Barnes soils occur together in a complex pattern and have been mapped as one unit. They are near the western edge of glacial Lake Dakota in the western part of the county.

These soils are used mainly for pasture or hay. They are generally overgrazed and do not produce as much forage as they would under good management. Cultivated areas produce good yields. (Capability unit IIIe–6; Silty range site.

Overly-Bearden silty clay loams, nearly level (OyA) (0 to 3 percent slopes).—These Overly and Bearden soils are so intermingled that they have been mapped as one unit. They are extensive near Milnor in the northeastern part of the county, but a few acres are also in the southeastern and western parts.

These soils are deep, fertile, and resistant to wind erosion. The Bearden soil is conspicuous in cultivated fields because it has a gray surface that contrasts with the black surface of the Overly soil. The gray occurs where the lime zone has been mixed with the surface layer by plowing.

All of the acreage is used for small grains, corn, alfalfa, and grasses. Yields from these soils are among the highest in the county. (Capability unit IIc–6; Silty range site)

Parnell Series

The Parnell series consists of poorly drained and very poorly drained soils in closed depressions of the glacial till plain, mainly in the central part of the county. These soils formed in glacial till or in local alluvium consisting of clayey, water-deposited materials that washed from higher surrounding soils. Runoff from the higher soils ponds on the Parnell soils and keeps them wet much of the time.

The surface layer is black loam to clay loam that is very high in organic matter and, in many places, is covered by a thin mat of plant remains. This layer is 8 to 11 inches thick. It is generally free of lime.

The subsoil is firm and very dark gray when moist and is very sticky and very plastic when wet. It has a strong, angular blocky structure.

The subsoil generally is underlain by a light-gray zone of accumulated lime in the upper part of the parent material. Under the lime zone, the parent material is olive gray when moist and contains iron concretions that are strong brown in color. Although this soil generally is free of lime to a depth of 3 feet, in some places lime is at or near the surface and there is no distinct, light-colored lime zone.

Parnell soils are in deeper and wetter depressions than are the Tetonka soils.

Parnell soils (Pa) (0 to 1 percent slopes).—These poorly drained and very poorly drained soils occur in depressions and potholes of the glacial till plain, mainly in the central part of the county. These depressions are kept wet by runoff from higher surrounding soils. Much of the runoff comes from snowmelt early in spring while the soils are still frozen. In the summer, especially if the surrounding soils are bare, there is much runoff when rains are short and intense.

Parnell soils are generally too wet to cultivate. In dry years some of the drier depressions occasionally can be seeded to flax, millet, or other late crops, but most of them are used for hay. Drained areas produce good yields of small grains, corn, and alfalfa. Most of the depressions, however, are ponded early in spring. Marsh grasses, sedges, and bulrushes are the main vegetation. The depressions make good breeding places for ducks and also protect other wildlife.

In nearly flat areas it may be possible to dig shallow ditches that connect two or more potholes and thus drain the excess water into one pothole. The cost will determine whether digging these ditches is practical. (Where drainage is feasible, capability unit IIIw-4; Overflow range site; where drainage is not feasible, capability unit Vw-WL; Wetland range site)

Perella Series

In the Perella series are deep, dark soils that are high in organic matter and are imperfectly drained to poorly drained. These soils lie in shallow depressions or on low flats in the northeastern and southwestern parts of the county.

The surface layer is silt loam to silty clay loam that ranges from 6 to 12 inches in thickness but is generally about 8 inches thick. This layer is granular in structure, is black and friable when moist, and is easy to work. The surface layer is separated from the subsoil by a boundary that is gradual in some places and abrupt in others. Tongues of the dark surface layer extend into the subsoil to a depth of 24 inches.

The subsoil contains little, if any, more clay than the surface layer and is very dark grayish brown or dark gray when moist. It has a weak, prismatic or a fine and very fine, blocky structure.

A lime zone, which is brownish gray to olive gray when moist, is in the upper part of the parent material. Below the lime zone, the parent material is moderately limy and silty or clayey. In some places sandy to clayey material is at a depth of almost 5 feet.

Perella soils are in less clayey material than are the Fargo soils and are more poorly drained than the Overly soils.

Perella silty clay loam (Pe) (0 to 1 percent slopes).—This deep, dark, poorly drained soil is in shallow depressions in flats of the glacial lake plains in the northeastern and western parts of the county. The soil is fertile and is high in organic matter. It is ponded for short periods.

All the acreage is in small grains, corn, and alfalfa. In some years this soil dries out slower than surrounding higher soils and is seeded a week or two later. This soil produces good yields. In dry years yields are better than those on the Overly or Gardena soils because the moisture supply is better. (Capability unit IIw-6; Overflow range site)

Rauville Series

The Rauville series consists of very poorly drained, silty or clayey soils on bottom land. These soils are mainly along the Wild Rice River and in old channels of smaller streams in the central and eastern parts of the county. A high water table keeps these soils wet all of the time, and occasionally they are flooded.

The black surface layer is 10 to 18 inches thick, is granular in structure, and is generally limy. In some places, however, the soil is free of lime to a depth of 5 feet. The surface layer is underlain by very dark-gray or grayish-brown, clayey parent material. This material has a weak, prismatic structure, and the prisms break down into medium and fine, subangular blocks. Below the parent material are strata of sandy, silty, clayey, and gravelly material.

Rauville soils (Ra) (0 to 1 percent slopes).—These inextensive soils are silty or clayey and are very poorly drained. They occur mainly in very wet sites on the bottoms of the Wild Rice River and in old, small stream channels in the central and eastern parts of the county. They are in wetter sites than are Lamoure soils and are more poorly drained.

Rauville soils are too wet to farm. Sedges and reeds are about the only plants that grow on these soils. (Capability unit Vw-WL; Wetlands range site)

Renshaw Series

The Renshaw series consists of dark, well-drained soils that formed in loamy material underlain by gravel and sand. These soils are on slopes of 0 to 9 percent in the northeastern part of Sargent County.

The surface layer is loam or sandy loam that is thin to moderately thick. It is black when moist and has a fine, granular or crumb structure. This layer is sandier than the surface layer of soils formed in glacial till and, therefore, is more susceptible to wind erosion. A clear boundary separates the surface layer from the subsoil.

The subsoil is very dark grayish brown when moist. It has a weak to moderate, prismatic structure. Underlying the subsoil, at a depth of 16 to 36 inches, are strata of gravelly or sandy material that are limy in the upper part. This material is coarse sand, gravel, or mixed sand and gravel.

Renshaw soils are similar to the Wessington soils but have a thinner mantle of loamy material over the gravel and sand. They are better drained than the Spottswood soils.

Renshaw loam, nearly level (RhA) (0 to 3 percent slopes).—This moderately deep, loamy, droughty soil is southeast of Milnor in the northeastern part of the county. As much as 10 percent of any area consists of the more shallow, less developed Sioux soils.

This soil has a black, loamy surface layer that is underlain by sand and gravel at a depth of 16 to 36 inches. The surface layer is sandier than that of the Aastad or Forman soils and, therefore, is more susceptible to blowing. This soil is moderately susceptible to blowing if it is cultivated. It is droughty because of the underlying sand and gravel.

Nearly all of this soil is used for small grains, corn, and alfalfa. Yields vary according to the depth to the gravel or sand. If this depth is 30 inches or more, yields are fair; if it is less than 20 inches, yields are low.

This soil will be slightly or moderately damaged by wind erosion if it is cultivated but not protected. Erosion can be controlled by stubble mulching, stripcropping, spring plowing, and planting trees for field windbreaks. (Capability unit IIIs-5; Silty range site)

Renshaw loam, undulating (RhB) (3 to 6 percent slopes).—This soil occurs with Renshaw loam, nearly level, but varies much more in thickness of the loamy material over gravel or sand.

Most of this soil is in pasture or hay. Some of it is in small grains, corn, or alfalfa. Yields are low because the soil is droughty. (Capability unit IIIs-5; Silty range site)

Renshaw and Sioux soils (Ro) (0 to 9 percent slopes).—These soils generally have a surface layer of loam, but it is sandy loam in some places. The depth to sand or gravel ranges from 6 to 26 inches and varies greatly within short distances. The Sioux soils differ from the Renshaw soils by having a thinner mantle of loamy material over sand or gravel. Slopes range from 0 to 9 percent, but the dominant range is from 3 to 9 percent.

These soils supply most of the gravel for roads in the county. They are too droughty for crops but can be used for pasture or hay. Native plants that are common on these soils are blue grama, green needlegrass, threadleaf sedge, curlycup gumweed, and buckbrush. (Capability unit VIs-SW; Shallow range site)

Sioux Series

The Sioux series consists of shallow, dark-colored soils that are underlain at a depth of 18 inches or less by sand or gravel. The dark-colored surface layer of loam is 3 to 6 inches thick. Beneath it is lighter colored gravelly loam, then the stratified sand and gravel. Segregated lime is generally present in the upper part of the gravel or sand.

Sioux soils in this county were mapped only in an undifferentiated unit of Renshaw and Sioux soils. Sioux soils differ from the Renshaw soils in not having a B horizon.

Spottswood Series

Soils of the Spottswood series are moderately well drained and loamy. They have formed over shaly gravel or shaly sand that contains 10 to 25 percent shale and other soft rock material.

The surface layer is dark loam to sandy loam that is very friable and easy to work. It has a fine, granular or crumb structure. These soils are moderately susceptible to wind erosion.

The dark subsoil has a weak, coarse to medium, prismatic structure. The subsoil is separated from the shaly gravel or shaly sand by an abrupt or a gradual boundary. The gradual boundary is gravelly loam.

A lime zone generally is in the upper part of the gravel or sand; but in some places the lime zone is in the loamy material, and in other places the soil, to a depth of 5 feet, does not contain lime.

Spottswood soils contain more shale in the gravel or sand than do the Renshaw soils.

Spottswood-Wessington loams, nearly level (SpA) (0 to 3 percent slopes).—Spottswood loam and Wessington loam were mapped together because the thickness of their loamy surface layer over gravel and sand varies so much that it is impractical to map them separately. This layer is 16 to 36 inches thick. Spottswood soils and Wessington soils are similar, except that the Wessington soil has a thinner mantle of loam over the sand or gravel. Both of these soils are moderately deep and occur together in the northwestern part of the county.

The loamy surface layer of these soils is easy to work, and much of the acreage is cultivated. Small grains, particularly oats, are grown, as well as corn and alfalfa. Yields vary according to the depth to the gravel or sand. They are low where this depth is less than 20 inches and are fair where the depth is 30 inches or more. Yields are good in years when rainfall is above average.

These soils will be slightly or moderately damaged by wind erosion if they are not protected. Because they are sandier than the Barnes and Svea soils, they are more susceptible to wind erosion. Erosion can be controlled by stripcropping, stubble mulching, spring plowing, planting trees for field windbreaks, and using grasses and legumes in the cropping system. (Capability unit IIIs-5; Silty range site)

Stirum Series

The Stirum series consists of poorly drained, alkali soils formed in sandy material. They are in depressions of low, level areas in the southwestern and northeastern parts of the county.

The thin to moderately thick surface layer is black or very dark gray and is very friable when moist. It is slightly sticky and plastic when wet. This layer has a fine, crumb structure.

The subsoil has a coarse, prismatic or columnar structure and distinct clay films on the faces of the prisms or columns. In some places the prisms or columns are not prominent and are within 2 inches of the surface. The subsoil is olive gray when moist and is high in lime. It is friable to firm when moist and sticky and plastic when wet.

A dark-gray, indistinct lime zone underlies the subsoil. The lime zone is sticky and plastic when wet and contains many light-gray concretions of lime.

Sandy material underlies the lime zone. When moist, this sandy material is olive gray with many brown, reddish-brown, and black mottles. It contains a large amount of lime.

Stirum soils occur closely with the Arveson soils, which do not have columns or prisms with clay films on them and which are not plastic when wet.

Stirum and Arveson loams (St) (0 to 3 percent slopes).—Stirum loam and Arveson loam make up this mapping unit. These soils occur close together in low, broad flats in the western part of the county and are wet much of the time because the water table is high. The Stirum soil is more extensive than the Arveson soil. The Arveson series has been described earlier in this report.

The black loam surface layer ranges from 3 to 8 inches in thickness. Salts are generally visible within 12 inches of the surface. In roadcuts, and other exposed areas, the surface particles of the Stirum soil flow together when wet and form a smooth surface, which seals over and is extremely hard and cementlike when it dries.

A large acreage of these soils was broken out of virgin sod and farmed for short periods. But the soil was too wet to cultivate, and most of the acreage was returned to tame and native grasses, which are used for pasture and hay. Some of the grasses and other plants are coarse sedges, big bluestem, foxtail barley, bromegrass, quackgrass, scouring-rush, prairie cordgrass, and Kentucky bluegrass.

The better drained areas of these soils are cultivated. These areas dry out slowly and are seeded late in the spring. Because they are moderately tolerant of salts, flax, barley, and alfalfa are commonly grown. Yields, however, are only fair, even in the most favorable years when light rains are frequent. (Capability unit IIIsw-5; Subirrigated range site)

Svea Series

In the Svea series are deep, moderately well drained soils that formed in glacial till. These dark soils are nearly level to undulating and occur in the northwestern part of the county.

The surface layer, 8 to 16 inches thick, is black when moist and very dark gray when dry. This layer is granular in structure. It is easily tilled and generally is free of lime.

The subsoil is slightly hard when dry and friable to firm when moist. It has a moderate, medium, prismatic structure. The prisms break into weak, subangular blocks. Patches of clay films are common on the faces of the prisms.

Underlying the subsoil, in the upper part of the parent material, is a distinct light-colored lime zone. The material in the lime zone has a weak, coarse, prismatic structure. It is soft when dry and friable when moist. This zone is from 15 to 36 inches from the surface.

The parent material below the lime zone is olive brown to yellowish brown when moist. It is moderately limy and contains many light-gray and strong-brown mottles.

Svea soils occur with Barnes soils but have a thicker surface layer and a darker subsoil. They are less clayey than the Aastad soils, which have continuous, distinct clay films on all prism faces.

Svea loam (Sv) (0 to 3 percent slopes).—This deep, fertile soil is in the northwestern part of the county. Dominant slopes are less than 3 percent. Barnes, Hamerly, and Tetonka soils make up as much as 10 percent of any area of this soil shown on the map.

This soil resists wind and water erosion, absorbs most of the rainfall, and has good moisture-holding capacity. It is easily tilled.

Nearly all of this soil is cultivated. It is used for corn, for small grains, particularly wheat, and for alfalfa and tame grasses. Yields are consistently good for long periods. (Capability unit IIc-6; Silty range site)

Tetonka Series

The Tetonka series consists of imperfectly drained to poorly drained, dark soils in shallow, moderately wet depressions of the glacial till plain and the glacial lake plain. These soils are more common on the glacial till plain.

The black surface layer generally is about 8 inches thick, but the range is from 6 to 12 inches. This layer is free of lime, is friable when moist, and is granular in structure. It is easy to work.

A very dark gray or dark gray leached layer underlies the surface layer and is 3 to 8 inches thick. Lime, gypsum, and other soluble salts have been leached from this layer and deposited in lower layers. The leached layer has a platy structure.

The structure of the subsoil is prismatic, and the prisms break into plates or blocks. The subsoil is very firm when moist and very sticky and very plastic when wet.

The Tetonka soils are in shallow depressions and are drier than the Parnell soils, which do not have a gray, leached layer.

Tetonka silt loam (Tk) (0 to 1 percent slopes).—This soil is in shallow, closed depressions in the glacial Lake Agassiz basin in the northeastern part of the county and the glacial Lake Dakota area in the western part of the county. It occurs with the Gardena and Glyndon soils.

Although this soil is ponded for short periods, it is seldom wet long enough to prevent cultivation. Most of the water is runoff from higher soils. After winters with heavy snow, seeding is delayed because the melting snow produces excess water.

Small grains, corn, alfalfa, and tame grasses are grown, and yields generally are good. In dry years yields are higher on this soil than on the surrounding soils because this soil has more available moisture.

In some areas ditches have been dug to connect two or more depressions and thus to drain the excess water into one depression. This drainage is not feasible if the drains have to be deep and the cost of construction is great. (Capability unit IIw-6; Overflow range site)

Tetonka and Parnell soils (Tp) (0 to 1 percent slopes).—Tetonka soils and Parnell soils make up this mapping unit. They occur in shallow, closed depressions in the glacial till plain and are mainly in the central part of the county. The soils are on glacial till or are in clayey material that washed into the depressions from surrounding, higher soils.

Runoff from higher soils keeps these soils moderately wet, but they are used for small grains, corn, alfalfa, and tame grasses. Because of wetness, these soils frequently are seeded 2 weeks later than surrounding soils. Yields are good. They are better in dry years than yields on surrounding soils because more moisture is available to plants.

In many nearly level areas the excess water in two or more depressions is drained into one by digging shallow ditches. This kind of drainage is not feasible if the drains have to be deep and their construction is therefore expensive. Seeding is not delayed early in spring if the potholes are drained. (Capability unit IIw-6; Overflow range site)

Ulen Series

The soils of the Ulen series are deep, are moderately well drained or imperfectly drained, and are high in lime. They have formed in sandy material that is underlain by glacial till or water-deposited silt and clay.

The black surface layer is 6 to 15 inches thick. It is granular in structure and easy to work. This layer has an abrupt or gradual boundary separating it from a distinct gray layer in which lime has accumulated.

The moderately limy parent material is very sandy and single grained. This material is grayish brown to light olive brown when moist. In some areas Ulen soils are sandy to a depth of 5 feet, and in other areas the underlying glacial till or water-deposited silt and clay is at a depth of more than 30 inches.

The lime in the Ulen soils is nearer the surface than that in the Hamar soils. The Ulen soils have formed in sandier material than have the Glyndon soils.

Ulen fine sandy loam, moderately shallow (Un) (0 to 2 percent slopes).—This moderately well drained to imperfectly drained soil is in sandy material that is underlain by glacial till or water-deposited silty and clayey material. The soil is near the eastern edge of glacial Lake Dakota in the western part of the county; it is also in the northeastern part of the county. The finer textured material under the sandy material is at a depth of 2 to 4 feet.

Most of this soil is in small grains, corn, alfalfa, and tame grasses. Yields generally are good.

If this soil is cultivated, wind erosion is the main hazard, and severe erosion is likely in unprotected fields. Erosion can be controlled by stripcropping, stubble mulching, spring plowing, and planting trees for field windbreaks. (Capability unit IIIe-3M; Sandy range site)

Valentine Series

The soils of the Valentine series are excessively drained and consist of very sandy material under a sparse cover of native grass. These soils consist of fine sand to a depth of 5 feet. To a depth of 1 to 6 inches they are black to dark grayish brown when moist, and below that depth are grayish brown to light grayish brown.

These soils are of little value for crops and are mainly in native grasses used for pasture or hay.

Valentine fine sand, hilly (VaD) (6 to 25 percent slopes).—This very sandy soil is in the southwestern part of the county on hilly terrain that has a difference in elevation of about 40 feet. Loose fine sand extends from the surface to a depth of about 5 feet. It is black when moist and very dark when dry to a depth of 1 or 2 inches, and below that depth it is dark grayish brown when moist and grayish brown when dry.

This soil is in native pasture consisting mainly of green needlegrass, blue grama, prairie sandreed, sun sedge, Indiangrass, and buckbrush. The soil is very susceptible to blowing and will be damaged by wind erosion if overgrazed. (Capability unit VIIe-CS; Choppy Sands range site)

Valentine-Hecla fine sands, hummocky (VhC) (0 to 6 percent slopes).—Hummocky areas of Valentine fine sand and Hecla fine sand are so intermingled that they have been mapped as one unit. These soils are deep and very sandy. They formed when wind blew the soil material into hummocks, which are 3 to 10 feet high. These soils are extensive and are in the southwestern part of the county. The Valentine soil occupies about 50 percent of the area, the Hecla soil 35 percent, and Gannett and Arveson soils about 15 percent.

The dark, sandy surface material ranges from 5 to 20 inches in thickness and is underlain by lighter colored sandy material.

Wind erosion is the greatest hazard on these soils, especially if they are overgrazed. They are in native pasture consisting mainly of prairie sandreed, little bluestem, Indiangrass, switchgrass, big bluestem, sun sedge, and Kentucky bluegrass. (Capability unit VIe-Sa; Sands range site)

Wessington Series [3]

The Wessington series consists of dark-colored, nearly level loamy soils that are underlain at 30 to 40 inches by gravel or sand containing 10 to 25 percent shale and other soft rock. In this county they make up part of the complex of Spottswood-Wessington loams, nearly level.

Zell Series

The soils of the Zell series are excessively drained and have formed in silty material. Their dark surface layer ranges from 2 to 6 inches in thickness. It has a very fine, granular structure and is generally limy and very friable. This layer is black when moist. It is underlain by a weak zone of accumulated lime, and that, in turn, by water-deposited silty parent material that is pale yellow to yellowish brown.

Zell silt loam, rolling (ZmC) (6 to 9 percent slopes).—This soil is on slope breaks along the Wild Rice River. Most of it is in pasture, but some is in small grains and alfalfa. In cultivated fields, the crests of the breaks are light colored where some of the parent material has been mixed with the thin surface layer by plowing. Because some rainfall is lost in runoff and the soil is eroded in spots, it produces average yields. (Capability unit IIIe-6; Silty range site)

Zell silt loam, hilly (ZmD) (9 to 20 percent slopes).—This inextensive soil is in small areas on breaks along the Wild Rice River and is used for pasture. (Capability unit VIe-Si; Silty range site)

Use and Management of Soils

This section discusses the use and management of soils for crops, for range and tame pasture, for windbreaks, for wildlife, and for engineering uses.

Use and Management of Soils for Crops

All cultivated soils require general practices of good management that conserve soil and moisture, maintain fertility and organic matter, and improve tilth. Some soils are eroded, or are poorly drained, or have other limitations that require additional practices to make them suitable for crops and pasture. If soils that have about the same uses and require about the same management are grouped together, management can be specified for groups of soils rather than for single soils.

In this subsection general practices of management are first discussed. Then a system of capability grouping is described; the soils of the county are placed in capability units, or management groups; and the uses and management of these groups of soils are discussed. A part of this subsection is a table of estimated yields that tells how much of a specified crop each soil in the county can be expected to produce under two levels of management.

[3] After this report and map had been prepared for publication, the soils called Wessington were classified with soils of the Fordville series. Similar soils will be called Fordville in other publications.

General practices of management

Discussed in the following pages are (1) controlling erosion, (2) artificial drainage, (3) cropping systems, (4) maintaining organic matter, (5) applying commercial fertilizer, and (6) summer fallowing.

CONTROLLING EROSION

Loss of soil through wind and water erosion is serious in Sargent County. Wind erosion is the main problem on sandy and clayey soils. The sandy Hecla soils and the clayey Fargo soils, for example, are susceptible to severe wind erosion if they are cultivated. In winter the clayey soils tend to slake down and leave on the surface sand-sized particles that are easily blown away if the soil is not protected by snow or vegetation.

Water erosion is the main problem in cultivating loamy and silty soils with slopes of more than 3 percent. Most water erosion occurs during storms when intense rain or hail strikes summer-fallowed soil or other bare soil.

Common practices that control erosion are planting trees in windbreaks, stubble mulching, spring plowing, stripcropping, and maintaining grassed waterways. On some soils one practice is enough to control erosion, but on others, a combination of several practices may be needed.

Field windbreaks.—Field windbreaks are strips or belts of trees and shrubs that are planted as barriers against prevailing winds to protect cultivated fields from wind erosion. Trees are grown in Sargent County only for windbreaks, and their management is discussed in the subsection "Management of Windbreaks."

Stripcropping.—This is the practice of growing crops in strips at angles to the direction of prevailing winds. Since the prevailing winds in Sargent County are from the northwest, the strips generally run in a north-south or east-west direction. Because slopes are short and irregular, tilling the strips on the contour generally is not practical in Sargent County. In a conventional stripcropping pattern, strips of crops that resist erosion are alternated with strips of corn or other cultivated crops, or with strips of summer-fallowed soil. The strips that resist erosion generally are in small grains, in standing crop residue, or in grass or alfalfa. If stripcropping is used without a supporting practice on the kinds of soils listed, use strips of widths that do not exceed the following:

Soils	*Width of strips in rods*
Fine sandy loams and sandy loams	2
Clay loams and clays that contain more than 35 percent clay; very fine sandy loams, loams, silt loams, and clay loams that are calcareous and contain less than 35 percent clay	5
Very fine sandy loams, loams, and silt loams that are noncalcareous and contain less than 20 percent clay	15
Loams, silt loams, and clay loams that are noncalcareous and contain 20 to 35 percent clay	20

Strips alone are not effective on loamy sands and loamy fine sands.

Spring plowing.—Spring plowing provides maximum cover on a soil from after harvesting until seeding and is very effective in controlling wind erosion. This practice is applied mainly to sandy soils such as the Hecla, Maddock, and Ulen soils. The stubble remains undisturbed between harvest time and seeding time the following spring. Then the soils are plowed, packed, and seeded, all in one operation. This is done by a tractor pulling a moldboard plow, a packer, and a pony press drill. Sometimes the packer is not used.

Figure 8.—**A stubble-mulched field.**

Spring plowing, however, is not practical on clayey soils or on some soils formed in glacial till. These soils seldom dry out early enough to be plowed in the spring, and they are generally plowed in the fall. Examples of soils not suited to spring plowing are the loams, clay loams, and clays in the Aastad, Forman, Fargo, Hegne, Overly, and Bearden series.

Stubble mulching.—This is the management of plant residue so that as much of it as possible is left on the surface from the time of harvesting until the next crop is seeded. Stubble mulching is effective in controlling wind erosion, especially on sandy soils. Figure 8 shows a field that has been stubble mulched shortly after it was combined. The best implements for stubble mulching are sweep cultivators, disk plows, and wide-blade cultivators. The amount of residue required to control wind erosion depends on the texture of the surface soil. If stubble mulching is the only practice used to control wind erosion, the following approximate amounts of tilled (nearly flat) residue should be evenly distributed and anchored to the surface of soils of various texture.

	Pounds of air-dry plant residue per acre
Loamy sands and loamy fine sands	1,750 or more
Fine sandy loams, sandy loams, clay loams, and clays that contain more than 35 percent clay; and very fine sandy loams, loams, silt loams, and clay loams that are calcareous and contain less than 35 percent clay	1,250
Very fine sandy loams, loams, and silt loams that are noncalcareous and contain less than 20 percent clay; and loams, silt loams, and clay loams that are noncalcareous and contain 20 to 35 percent clay	750

Grassed waterways.—Areas through which excess water flows at high speed should be protected by a vegetative cover. Figure 9 shows an artificial drain seeded to perennial grasses to prevent running water from cutting in the drain. The grass in this waterway is cut for hay.

Figure 9.—Artificial drain seeded to perennial grasses.

Waterways that require seeding to grasses are mainly in undulating and rolling glacial till areas. The Forman, Buse, and Aastad soils in the Sisseton Hills are examples of soils that should be drained by grassed waterways. Many of the artificial drains carry small volumes of slow-moving water and are not grassed. Such drains are constructed so they can be crossed with farm machinery and can be cropped the same as the rest of the field.

ARTIFICIAL DRAINAGE

Wet soils are drained artifically if they can be used for crops and drainage is practical. Artificial drainage is most commonly applied to Tetonka and Parnell soils in the many shallow depressions of the glacial till plain. Water runs off the surrounding soils into these closed depressions, which have no natural outlet. Although some of these depressions dry out enough to be tilled in early spring with surrounding soils, many of the depressions have to be tilled later, and some of them cannot be tilled at all. Thus, they cause inconvenience and extra work, as well as some loss of production.

Many of the shallow depressions can be drained artificially by digging ditches and combining the water from two or more depressions into one. These drains must be back-sloped so that they can be crossed by farm machinery. The cost of the drains determines whether artificial drainage is practical.

CROPPING SYSTEMS

A good cropping system (1) aids in maintaining an adequate supply of nitrogen and organic matter in the soil, (2) increases the yields and improves the quality of crops, (3) aids in controlling weeds, insects, and diseases, (4) keeps the soil in good physical condition, and (5) makes the most efficient use of labor, machinery, and other resources.

A cropping system should be planned for a long period, but the system does not have to be inflexible. Substituting one small grain for another or making other substitutions will not defeat the purpose of the system.

To aid in planning a cropping system, crops have been classified as soil building, soil conserving, and soil depleting. Soil-building crops actually produce a temporary increase in organic matter and nitrogen. Legumes and legume-grass mixtures are soil building. Soil-conserving crops, such as small grains, legumes, and grasses, protect the soil from erosion and maintain nitrogen and organic matter at a reasonably high level. Corn and other clean-cultivated crops deplete the soil of nutrients and organic matter and expose the soil to erosion. Nevertheless, cultivating these soil-depleting crops helps to control weeds.

On soils that are suited to clean-cultivated crops, the cropping system should be balanced between soil-building, soil-conserving, and soil-depleting crops.

MAINTAINING ORGANIC MATTER

Organic matter, which is decomposed plant material and animal matter, is essential to the tilth and fertility of soil. Organic matter (1) improves soil structure by holding soil particles together, (2) increases the water-holding capacity of soil, (3) improves the permeability of soil to air, roots, and water, and (4) increases resistance of soil to erosion. Organic matter supplies some plant nutrients, stores plant nutrients, and is a source of food for micro-organisms, which circulate nutrients in the soil.

The amount of organic matter that should be maintained in a soil depends on the kind of soil and on the kind of crop grown. Organic matter is decreasing in soils under cultivation, but the loss can be offset by adding barnyard manure, by turning under crop residue or green-manure crops, and by including legumes or grass-legume mixtures in the cropping system.

APPLYING COMMERCIAL FERTILIZERS

In Sargent County commercial fertilizers are used to a very limited extent, although their use has about doubled in the past few years. Only a few farmers fertilize all of their crops, and many are using commercial fertilizers on a trial basis. Farmers are reluctant to use commercial fertilizers because, in years when the moisture supply is good, the soils produce good yields without fertilizer. Moisture supply affects crop production in Sargent County more than anything else.

In 1953, the North Dakota State University of Agriculture and Applied Science at Fargo established a soil-testing service. The main purpose of this service was to determine the soils deficient in phosphorus. The university has also conducted many fertilizer trials, some of them in Sargent County.

The results of these tests and trials indicate that most soils in North Dakota are deficient in phosphorus. Fallowed soils require a straight phosphate fertilizer, which should be applied by drill or planter attachments. The tests also indicated that deficiency of nitrogen limits yields on nonfallowed soils. Nitrogen applied to soils that are in native or tame grasses will produce large increases in yields.

Information about fertilizers and soil testing can be obtained from the county agent, the local office of the Soil Conservation Service, or the Soils Department of the North Dakota State University at Fargo.

SUMMER FALLOWING

Fallowing is the practice of leaving soil idle for one cropping season and cultivating it as many times as is necessary to keep it free of weeds and to save moisture. For good results from summer fallowing, the tillage should begin before the weeds get much of a start (before June 1). Field cultivators with narrow shovels or wide sweeps are generally used, but the kinds of implements used have little effect on the amount of moisture conserved or on the amount of yield obtained the following season. Fallowing conserves about 20 percent of the moisture that falls during the fallow season.

Sometimes corn is grown in the crop rotation as a substitute for summer fallowing. Although less moisture is conserved when corn is grown than when the soil is summer fallowed, yields of the crop that follows corn are only slightly lower.

Sandy soils and loamy soils underlain by sand and gravel are not summer fallowed. Because these soils have low moisture-holding capacity, moisture is not conserved by summer fallowing. Furthermore, fallowing exposes the soils to wind erosion.

Capability grouping

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

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. Eight capability classes are in the broadest grouping and 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 including Sargent County, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no erosion hazard but have other limitations that limit their use largely to pasture, range, woodland, or wildlife habitats.

Within the subclasses are the capability units, which are groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping of soils for making many statements about their management. Capability units are generally identified by numbers assigned locally, for example, IIe-5 or IIIe-3. These numbers are not consecutive in Sargent County, because not all of the capability units used in North Dakota apply to the soils in Sargent County.

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Soils are classified in capability classes, subclasses, and units according to their degree and kind of permanent limitations. Not considered in this classification are major projects of land forming or reclamation that would change the slope, depth, or other characteristics of the soil.

In Sargent County, the capability units in Classes V and VI have limitations that prohibit cultivation. These limitations are indicated by the unit symbol and are described in the discussion of each unit. Also given in the discussion of each unit is the range site classification of the soils, because the soils in these units are used mainly for range.

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. (None of the soils in Sargent County are in Class I, because even on the best soils the climatic limitation is too great.)

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

- Subclass IIc. Soils that have moderate climatic limitations of a short growing season and little moisture.
  - Capability unit IIc-6.—Deep, dark, nearly level loamy soils with a surface layer that is 20 to 35 percent clay.
- Subclass IIe. Soils subject to moderate wind and water erosion.
  - Capability unit IIe-4L.—Deep, moderately well drained, nearly level soils that are loamy or silty and high in lime.
  - Capability unit IIe-5.—Deep, dark soils that have a loamy surface layer underlain by sandy material.
  - Capability unit IIe-6.—Deep, well-drained, dark soils that are loamy and silty, undulating, and slightly to moderately eroded.
- Subclass IIw. Soils that have moderate limitations because of excess water.
  - Capability unit IIw-4L.—Deep, silty and clayey soils that are high in lime and are moderately wet because the water table is temporarily high.
  - Capability unit IIw-6.—Deep, dark, loamy and clayey soils in shallow, closed depressions that receive runoff from higher soils.
  - Capability unit IIwe-4.—Deep, dark clay soil that has restricted internal and external drainage.
  - Capability unit IIwe-4L.—Deep, clay soils that are high in lime and have restricted internal and external drainage.

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

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

Capability unit IIIe-3.—Deep, sandy, dark soils on nearly level to undulating slopes.

Capability unit IIIe-3M.—Moderately deep, dark soils that are nearly level to undulating and have a moderately sandy surface layer underlain by loamy glacial till or water-deposited silty to clayey material.

Capability unit IIIe-5.—Deep, rolling soils that have a thick, dark, loamy surface layer underlain by sandy material.

Capability unit IIIe-6.—Deep, well-drained, dark soils that are loamy and silty and are on rolling slopes.

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

Capability unit IIIs-4L.—Moderately deep, nearly level, loamy soil that is imperfectly drained, is high in lime, and is underlain by a gravel substratum.

Capability unit IIIs-5.—Moderately deep, loamy soils that are nearly level to undulating and are underlain by a sand or gravel substratum.

Capability unit IIIs-P.—Moderately deep, loamy and silty soils that have a claypan subsoil and are droughty.

Capability unit IIIsw-5.—Deep, poorly drained, salty soils that are high in lime and have a black, loamy surface layer and a sandy substratum.

Subclass IIIw. Soils that have severe limitations because of excess water.

Capability unit IIIw-4.—Deep, poorly drained, silty and clayey soils that occur in depressions on the glacial till plain and are ponded by runoff from higher soils.

Capability unit IIIwe-2.—Deep, very sandy, dark soil that occurs in depressions and is wet because of a high water table.

Capability unit IIIwe-3.—Deep, sandy, dark soils that are wet because of a high water table and are limy in some places.

Capability unit IIIws-4L.—Deep, poorly drained, salty soils that are high in lime and are wet because of a high water table.

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-2.—Deep, well-drained, dark soils that are very sandy, are nearly level to rolling, and are slightly to moderately eroded.

Capability unit IVe-2M.—Dark, well-drained, undulating soils that are very sandy and are underlain by loamy or silty substrata.

Capability unit IVe-3M.—Dark, well-drained sandy soil that is rolling and hilly, is slightly to moderately eroded, and is underlain by a loamy or silty substratum.

Class V. Soils that have little or no erosion hazard, but have other limitations, impractical to remove, that restrict their use largely to pasture, range, woodland, or wildlife food and cover.

Subclass Vw. Soils that are too wet for cultivation, and drainage or protection is not feasible.

Capability unit Vw-WL.—Deep, poorly drained, dark, silty and clayey soils on wet bottom lands and in depressions of the glacial lake plains.

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

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

Capability unit VIe-Sa.—Deep, very sandy soils that are slightly to severely eroded and are nearly level, rolling, and hummocky.

Capability unit VIe-Si.—Deep, loamy and silty soils, slightly to moderately eroded, on very hilly terrain, and silty soils on channeled bottom land.

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

Capability unit VIs-Si.—Deep, dark soils that are in glacial till and are too stony for cultivation.

Capability unit VIs-SL.—Silty and clayey soils that are nearly level, are salty, and have a claypan subsoil.

Capability unit VIs-SW.—Shallow, droughty, loamy soils underlain by gravel that is less than 18 inches from the surface.

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

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

Capability unit VIIe-CS.—Soil that is very severely limited, chifly by risk of erosion if protective cover is not maintained.

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

Subclass VIIIs. Soils that have little potential value for production of plants.

Capability unit VIIIs-1.—Soils that receive overflow from artesian wells and contain salts toxic to plants.

Subclass VIIIw. Extremely wet or marshy land.

Capability unit VIIIw-1.—Fresh water marsh.

Management of soils by capability units

In this subsection, each capability unit is described and the soils in it are listed. Suggestions are given on how to use and manage the soils in each unit. As stated in the explanation of capability grouping, a capability unit consists of soils that are suited to the same crops, require similar management, and produce about the same yields.

CAPABILITY UNIT IIc-6

The soils of this group are deep, dark, nearly level, and loamy. The clay content of the surface layer is 20 to 35 percent. The soils are—

Aastad clay loam.
Aastad loam.
Eckman silt loam, nearly level.
Gardena-Glyndon silt loams, nearly level.
La Prairie silt loam.
Overly silt loam, nearly level.
Overly-Aastad silt loams.
Overly-Bearden silty clay loams, nearly level.
Svea loam.

These soils are easily tilled and are readily permeable to roots, air, and moisture. They are well supplied with organic matter and most plant nutrients. Crops respond to nitrogen and phosphate, which should be applied in amounts determined by annual soil tests. The soils resist wind and water erosion. Crop growth is limited mainly by the short growing season and lack of enough moisture.

Spring wheat is usually the most profitable crop, but corn, barley, oats, flax, millet, alfalfa, and bromegrass and other tame and native grasses are also grown.

Summer fallowing is commonly practiced to conserve moisture and to control weeds that are not easily killed by a chemical spray. Instead of summer fallowing, corn is often grown the season after small grain. Cultivating the corn helps to control weeds.

These soils are commonly fall plowed and left rough through winter to catch snow and control erosion. Tree windbreaks are also effective in controlling snow and soil blowing.

CAPABILITY UNIT IIe-4L

This unit consists of deep, moderately well drained, nearly level soils that are loamy or silty and are high in lime. The soils are—

Bearden silty clay loam.
Bearden-Tetonka silt loams.
Glyndon loam, sandy substratum, nearly level.
Glyndon silt loam, nearly level.
Hamerly complex.
Hamerly-Aastad loams.
Hamerly-Svea loams.

These soils are easily tilled and are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. The soils respond to nitrogen and phosphate, which should be applied in amounts determined by annual soil tests.

These soils are limy at the surface and have a prominent, light-gray zone of lime under the surface layer. The surface layer ranges from black to various shades of gray, the shade depending on the depth to the lime zone. If the lime zone is near the surface, some of the lime is mixed with the black surface layer through tillage. This mixing gives the plow layer a gray color.

Lime is brought to the surface in these soils when the water table rises temporarily. After the water table falls, the water evaporates and leaves lime in the surface layer. Summer fallowing is not a suitable practice on these soils, because it increases the accumulation of lime at the surface. The lime in the surface layer causes the soil granules or crumbs to break into sand-sized particles. Then the soils are more susceptible to wind erosion than loamy or silty soils that are not limy at the surface.

The soils in this capability unit are fall plowed and left rough through winter to prevent the soil from drifting. Field windbreaks, stubble mulching, and stripcropping will control wind erosion.

Although these soils are suited to all crops grown in the area, spring wheat is the most profitable. Other suitable crops are barley, oats, corn, flax, millet, and bromegrass and other tame grasses.

CAPABILITY UNIT IIe-5

In this unit are deep, dark soils that have a loamy surface layer underlain by sandy material. They are—

Eckman and Maddock loams, undulating.
Gardena-Glyndon loams, sandy substratum, nearly level.

In most places, the loamy surface layer is 20 inches or more thick. These soils are easy to till and are readily permeable to roots, air, and moisture. They respond to nitrogen and phosphate, but the amounts of these applied should be determined by soil tests.

The soils in this unit are susceptible to wind erosion if they are not protected. They are slightly droughty because the sandy material under the loamy surface has a low moisture-holding capacity. Summer fallowing does not conserve much moisture. It leaves the soil bare and increases the hazard of wind erosion. Although corn uses much moisture, it is often grown because cultivating the crop eradicates weeds that are not easily killed by chemical sprays. Generally the soils are spring plowed.

Trees grow well on these soils and are often planted in belts as field windbreaks to control erosion. Stubble mulching and stripcropping combined generally control erosion without the use of field windbreaks.

These soils are suited to all crops grown locally but are used mainly for spring wheat and corn. Other crops grown are oats, barley, flax, millet, alfalfa, and bromegrass and other tame grasses.

CAPABILITY UNIT IIe-6

This unit consists of deep, well-drained, dark soils that are loamy and silty, undulating, and slightly to moderately eroded. They are—

Barnes-Svea loams, undulating.
Barnes-Svea loams, undulating, eroded.
Eckman silt loam, undulating.
Forman-Aastad loams, undulating.
Forman-Aastad loams, undulating, eroded.
Overly silty clay loam, undulating.

These soils are easily tilled and are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients, except on hilltops where much of the surface soil has been removed by erosion. The soils respond to nitrogen and phosphate fertilizers. Annual soil tests are needed to determine the kinds and amounts of fertilizer required.

The main hazard in cultivating these soils is erosion by water, especially sheet erosion, which occurs when intense rain or hail strikes summer-fallowed fields or other bare areas. Some of the rain is lost in runoff, which washes the soil from hilltops and upper slopes down to lower slopes and depressions. Wind also removes some of the soil from bare fields in winter when there is little or no snow cover and early in spring before vegetation is established.

Because these soils are on short, irregular slopes, contour tillage is impractical. The soils are fall plowed and are left rough through the winter to catch snow and control erosion. Stubble mulching, stripcropping, and planting trees in field windbreaks also help to conserve moisture and control erosion.

Wheat, barley, oats, flax, and millet are the main crops on these soils, but they are well suited to other local crops, including alfalfa, bromegrass, and other tame grasses. Corn is grown less frequently on these undulating soils than on more nearly level soils because it does not provide enough protection against water erosion, and the trenches formed by cultivation increase the erosion hazard.

CAPABILITY UNIT IIw-4L

In this capability unit are deep, silty and clayey soils that are high in lime and are moderately wet because the water table is high part of the time. The soils are—

Borup, Colvin, and Perella soils.
Lamoure silty clay loam.

These soils occur in shallow depressions or on low, broad flats of the glacial lake plains and on low, wet bottom lands. The soils are easily tilled and are readily permeable to roots but are not permeable to air when the water table is high.

Excess water, on the surface and in the soil, is the main problem in cultivated areas. The soils are ponded by surface water after heavy rains have raised the water table. In some areas, however, drainage has been improved by digging ditches.

Wind erosion is also a hazard on these soils. When their surface is dry, the lime deflocculates, or breaks down, the soil granules into sand-sized particles that blow easily. Stubble mulching, stripcropping, and planting trees in field windbreaks are good erosion control practices.

These soils are too wet in the spring for early tillage. They are generally tilled in the fall. Some farmers plow these soils, but most farmers till them with a cultivator or disk harrow so that much trash is left on the surface and erosion is controlled.

All local crops are grown on these soils. They are best suited to rye, barley, flax, alfalfa, and sweetclover. Corn and flax are often grown, however, because the soils are too wet in the spring for crops that require early tillage. Trees that can be planted in windbreaks are ash, cottonwood, American elm, willow, Russian-olive, pine, spruce, Caragana, and other species adapted to wet sites.

Some areas of these soils are in tame pasture, commonly bromegrass mixed with alfalfa. Yields of forage are good because the moisture supply is abundant.

CAPABILITY UNIT IIw-6

In this capability unit are deep, dark, loamy and clayey soils in shallow, closed depressions that receive runoff from higher soils. These soils are—

Perella silty clay loam.
Tetonka silt loam.
Tetonka and Parnell soils.

Tetonka and Parnell soils, which are the most extensive in this capability unit, are on the glacial till plain. Perella silty clay loam and Tetonka silt loam are on the glacial lake plains.

All these soils contain a large amount of organic matter and a good supply of plant nutrients. The soils are readily permeable to roots, but their permeability to air and moisture varies according to the texture of the subsoil and the substratum. When dry, these soils are easily tilled and resist erosion.

Excess water that ponds on the surface is the main problem in cultivating these soils. They receive this water in runoff from higher soils when snow melts while the ground is still frozen and when intense rains or hail falls on bare, summer-fallowed fields. These wet soils complicate farming because they generally do not dry out early enough to be tilled and seeded with surrounding higher soils and have to be seeded from 1 to 3 weeks later.

These soils are artificially drained in some places. Since natural outlets are few, ditches are dug to drain the water from two or more depressions into a deeper depression. These ditches are backsloped so that farm machinery can cross them and to allow them to be farmed with the rest of the area. Cost determines whether ditches are dug or not.

All local crops grow well on these soils. Because they receive more moisture, they produce better yields in dry years than the surrounding, higher soils.

CAPABILITY UNIT IIwe-4

Fargo clay is the only soil in this capability unit. This deep clay is dark and has restricted internal and external drainage.

This soil contains a large supply of organic matter and plant nutrients. It is very clayey and, therefore, is slowly permeable to moisture, but it has a high water-holding capacity and is permeable to roots. Adding phosphate increases the yields on all fields of this soil. Adding nitrogen increases yields on all fields except those that are summer fallowed. Annual soil tests are needed to determine the kinds and amounts of fertilizer required.

Wetness and wind erosion are the main problems of management. The slowly permeable clay restricts internal drainage, and surface water drains slowly from this nearly flat soil. Consequently, water ponds on the surface for short periods after heavy rains. Permeability and soil structure can be improved, however, by seeding sweetclover or alfalfa. Surface drainage can be improved by digging ditches where they are practical.

If this soil is tilled when it is wet, it puddles, loses its granular or crumb structure, and dries out cloddy and hard. In spring if the soil is bare, it crusts when it dries rapidly after a heavy rain. Although the crust does not harm most plants, flax breaks through it with difficulty, and the stand may be poor.

Summer fallowing, a common practice, is used mainly to eradicate weeds that are not easily killed by chemicals. Because this practice increases the hazard of wind erosion, summer-fallowed fields are often seeded to a cover crop in fall.

Fall plowing also is common, and it also increases the hazard of wind erosion. After the soil is plowed, it slakes into sand-sized particles. These particles are blown away in winter when there is not enough snow to protect the soil, and in the spring before vegetation is established. This wind erosion does not damage the soil seriously, but the blown soil clogs surface drains and collects along fence lines and in tree belts. Planting a cover crop, stripcropping, stubble mulching, and planting trees in windbreaks will help control wind erosion.

The main crops on this soil are spring wheat, barley, and flax. Spring wheat is the most profitable crop. Other crops well suited to the soil are alfalfa, sweetclover, and tame grasses, especially bromegrass. Corn and soybeans are grown, but not extensively.

CAPABILITY UNIT IIwe-4L

In this capability unit are deep, clay soils that are high in lime and have restricted internal and external drainage. The soils are—

Hegne clay.
Hegne-Fargo clays.

These soils are generally limy at the surface and have a distinct, light-gray lime zone under a darker surface layer. When dry, the surface layer ranges from black to various shades of gray, depending on the depth to the lime zone. Where the lime zone is close to the surface, the surface layer is gray because lime has been mixed with it by plowing. These soils contain more lime than the soil in capability unit IIwe-4 and, therefore, require more phosphate fertilizer. The lime ties up some of the phosphorus in the soils and makes it unavailable to plants.

Wetness and wind erosion are the main problems of management. Water ponds on the surface because the soils are slowly permeable and nearly flat. If they are tilled when wet, they dry out cloddy and hard. In the spring after heavy rains, a crust often forms on the surface, but this damages only flax. Sweetclover improves permeability and soil structure, and surface drains, where practical, improve external drainage.

These soils are plowed in the fall and are, therefore, susceptible to wind erosion unless they are protected by snow or vegetation. Summer fallowing, a common practice, also exposes the soils to wind erosion. Planting a cover crop, stripcropping, stubble mulching, and planting trees in windbreaks will help to control wind erosion.

The main crops grown on these soils are barley, flax, and spring wheat. Spring wheat is the most profitable. Other crops that grow well are alfalfa, sweetclover, and tame grasses.

CAPABILITY UNIT IIIe-3

The soils in this capability unit are deep, sandy, and dark and are nearly level to undulating. They are—

Hecla fine sandy loam, nearly level.
Hecla fine sandy loam, undulating.

These soils are easily tilled and are readily permeable to roots, air, and moisture. They are well supplied with organic matter and plant nutrients. Adding nitrogen, however, increases the yields of all crops except alfalfa, which does not need nitrogen. Adding phosphate increases the yields of all crops. Annual soil tests are needed to determine the kinds and amounts of fertilizer required.

These soils are moderately droughty and, if not protected, are susceptible to wind erosion. They can be protected from wind erosion by stubble mulching, stripcropping, and planting trees in windbreaks. Summer fallowing is seldom practiced. These soils generally are not plowed in fall but are plowed, packed, and seeded in one operation in spring so that they are not stirred and exposed to wind in winter.

These soils produce moderately high yields of spring wheat and corn, which are the main crops. Other crops grown are oats, barley, rye, flax, alfalfa, and bromegrass, as well as other tame and native grasses. Rye is often grown in winter as a cover crop. Although these soils are suited to trees, the trees are not grown for timber. They are planted in belts to protect fields or in windbreaks to protect farmsteads.

CAPABILITY UNIT IIIe-3M

In this capability unit are moderately deep, dark soils that are nearly level and undulating. They have a moderately sandy surface layer underlain by loamy glacial till or water-deposited silty to clayey material. The soils are—

Hecla fine sandy loam, moderately shallow, nearly level.
Maddock fine sandy loam, moderately shallow, nearly level.
Maddock fine sandy loam, moderately shallow, undulating.
Ulen fine sandy loam, moderately shallow.

These soils differ from those in capability unit IIIe-3 only by having loamy to clayey material under the sandy surface layer. This finer textured material is 16 to 36 inches from the surface. The soils are used and managed in about the same way as the soils in capability unit IIIe-3 but are generally less droughty because the fine-textured material of the substratum holds more moisture.

The soils are easily tilled, are permeable, and are well supplied with organic matter. Although the soils are fertile, they respond to additions of nitrogen and phosphate.

Wind erosion is a hazard if the soils are not protected. They are, therefore, plowed and seeded in the spring and are seldom summer fallowed. Other practices that control wind erosion are stubble mulching, stripcropping, and planting trees in field windbreaks.

Spring wheat and corn are the main crops, and yields are good. Other crops grown are oats, barley, rye, flax, alfalfa, and tame grasses, especially bromegrass. Trees are well suited to these soils.

CAPABILITY UNIT IIIe-5

Eckman and Maddock loams, rolling, are the only soils in this capability unit. They are deep and have a dark, loamy surface layer, 16 to 36 inches thick, underlain by sandy material.

These soils are well supplied with organic matter and plant nutrients and are readily permeable to roots, air, and moisture. They are moderately droughty because the underlying sandy material holds only a medium amount of moisture and because some moisture is lost in runoff from the moderate slopes.

Wind and water erosion are hazards in cultivated areas, but because of slopes, water erosion is the main problem. Although some areas of these soils are fall plowed, spring plowing is the general practice and is desirable because it leaves the fields protected by stubble during the winter. Summer fallowing is not a common practice. Because these soils hold only a medium amount of moisture, summer fallowing conserves only a little moisture and leaves the soils exposed to wind and water erosion. Stripcropping, planting trees in field windbreaks, and stubble mulching will help to control erosion.

All local crops are grown on these soils. The main crops are wheat, oats, barley, alfalfa, and tame grasses, especially bromegrass.

If there is enough moisture, adding phosphate increases yields of all crops. Adding nitrogen increases the yields of all crops except alfalfa, which does not require nitrogen fertilizer. Annual soil tests are needed to determine the kinds and amounts of fertilizer required.

CAPABILITY UNIT IIIe-6

This capability unit consists of deep, well-drained, dark, loamy and silty soils on rolling slopes. The soils are—

Barnes-Buse loams, rolling.
Barnes-Buse loams, rolling, eroded.
Forman-Buse loams, rolling.
Forman-Buse loams, rolling, eroded.
Overly and Barnes silt loams, rolling.
Zell silt loam, rolling.

These soils are easily tilled and are readily permeable to roots, air, and moisture. They are well supplied with organic matter, except on hilltops where much of the surface layer has been lost by erosion. Additions of nitrogen and phosphate generally bring higher yields of crops, but annual soil tests are needed to determine the amount and kind of fertilizer required.

Water erosion is the main problem in cultivating these soils. The soil is washed from hilltops and upper slopes when intense rains or hailstorms strike bare soil in summer-fallowed fields or other areas. Wind removes some of the soil in winter when there is not enough snow to protect it, and in spring before growing plants are established.

These soils are fall plowed and left rough through winter to catch snow, which provides moisture and protects against erosion. Other practices that control erosion are stubble mulching, stripcropping, and planting trees in windbreaks. Contour tillage is impractical because these soils are on short, irregular slopes.

Spring wheat is the main crop. Other crops grown on these soils are oats, barley, millet, flax, and alfalfa. Although yields are about average, they are low on hilltops where moisture and the surface soil are lost through runoff. Not much corn is grown. It does not provide enough cover to protect the soil against erosion, and cultivation of the crop increases the erosion hazard.

Some areas of these soils are in pastures of tame and native grasses. Bromegrass is one of the tame grasses. The areas in native grasses occur with soils on steeper slopes and have never been cultivated. The main native grasses are little bluestem, prairie dropseed, green needlegrass, and side-oats grama.

CAPABILITY UNIT IIIs-4L

Divide loam is the only soil in this capability unit. This soil is moderately deep, nearly level, and imperfectly drained. It is high in lime and is underlain by a gravel substratum.

This soil is loamy to a depth of 16 to 36 inches. It is well supplied with organic matter and plant nutrients and is readily permeable to roots, air, and moisture. A high water table keeps it moderately wet.

About half the acreage of this soil is used with surrounding drier soils for corn, alfalfa, wheat, barley, flax, and other cultivated crops. Excess water from the high water table is the main hazard, and artificial drainage is not practical. This soil is not summer fallowed. It is generally plowed and seeded in the spring 1 to 3 weeks later than the surrounding soils.

The remaining acreage is used for hay and is in native grasses consisting of big bluestem, little bluestem, prairie cordgrass, and switchgrass. Yields are good because the supply of moisture is abundant.

CAPABILITY UNIT IIIs-5

The soils in this capability unit are moderately deep and loamy, are nearly level to undulating, and are underlain by sand or gravel substratum. The soils are—

Renshaw loam, nearly level.
Renshaw loam, undulating.
Spottswood-Wessington loams, nearly level.

These soils are easily tilled, are well supplied with organic matter and plant nutrients, and are readily permeable to roots, air, and moisture. Because of the sand or gravel substratum, they are moderately droughty and are susceptible to wind erosion. Except in very dry years, additions of nitrogen and phosphate will increase yields. Annual soil tests are needed to determine the amounts and kinds of fertilizer required.

As a precaution against wind erosion, these soils generally are not summer fallowed. They are usually plowed in the spring because fall plowing leaves the surface exposed to the wind during the winter. But farmers do not plow these soils every year. In some years, instead of plowing, farmers till the soils with field cultivators and disk harrows so that trash is left on the surface to control wind erosion. Other practices that help to control wind erosion are stripcropping and planting trees in field windbreaks.

All local crops are grown on these soils, but wheat, corn, and oats are the main crops. Other crops are barley, millet, flax, rye, alfalfa, and native and tame grasses, especially bromegrass. Rye is often grown as a cover crop. Trees are planted, not for wood products, but for windbreaks to control erosion and protect farmsteads.

CAPABILITY UNIT IIIs-P

In this capability unit are moderately deep, loamy and silty soils that have a claypan subsoil and are droughty. They are —

Aastad-Cresbard loams.
Aberdeen silt loam.
Aberdeen-Exline silty clay loams.

Except for the Exline soil, these soils are easily tilled and their surface layer is readily permeable to roots, air, and moisture. The dense clay subsoil, however, has a strong, prismatic or columnar structure and is very slowly permeable. Consequently, water ponds on the surface for short periods after rains. The few roots that penetrate the subsoil go down along the faces of the prisms or columns; but the permeability can be improved by growing alfalfa, which has long, penetrating roots. Salts are at the base of the subsoil in most places.

These soils are plowed in fall and are left rough through winter to catch moisture from snow. They are seldom summer fallowed because this practice saves little or no moisture.

Corn, spring wheat, and barley are the main crops. Other crops are oats, flax, alfalfa, and tame grasses, especially bromegrass. Yields are best when frequent rains keep the surface soil moist. Alfalfa is commonly grown to improve the permeability of the subsoil. Although trees do not grow well, some trees are planted for farmstead windbreaks.

CAPABILITY UNIT IIIsw-5

Stirum and Arveson loams are the only soils in this capability unit. These soils are deep, poorly drained, salty, and high in lime. They have a black, loamy surface layer and a sandy substratum.

These soils contain a large amount of organic matter. They are generally limy at the surface and, in some areas, are very limy below the surface layer. Salts are visible immediately below the surface layer in some places. The Stirum soil has a high content of sodium, which causes granules or crumbs in the surface soil to slake down to very fine particles. These particles then settle and make a smooth surface that becomes extremely hard when it is dry.

Water generally ponds on these soils after heavy rains, and even after the surface dries, the water table remains high. Artificial drainage is not feasible in the low, broad, flat area where these soils occur.

Most areas of these soils are in wetland sedges, prairie cordgrass, western wheatgrass, switchgrass, big bluestem, and other native plants that are used for hay or pasture. Wetland sedges and prairie cordgrass are much more palatable when they are young than when they mature.

Small areas of these soils are tilled. These areas are easily tilled, but spring plowing and seeding are delayed until the soils dry out. Fall-plowed fields are often seeded to rye for a cover crop. The best-suited crops are rye, flax, barley, alfalfa, and bromegrass.

CAPABILITY UNIT IIIw-4

Parnell soils that are feasible to drain are the only soils in this capability unit. Those Parnell soils that are not feasible to drain are in capability unit Vw-WL. In capability unit IIIw-4 are deep, poorly drained, silty and clayey soils in depressions of the glacial till plain. These soils are ponded by runoff from higher soils.

Parnell soils contain a large amount of plant nutrients and organic matter. In some places they are covered by as much as 1 inch of matted plant material. They are readily permeable to roots but are slowly permeable to air and moisture.

These fertile soils produce good yields in areas that can be cultivated, but most areas are too wet to cultivate because they are closed depressions that receive runoff from higher soils in the spring. After a winter with little snow, some of the shallow depressions dry up early enough to be farmed with other soils, but water stands in the deeper depressions until midsummer.

It may be feasible to drain these soils by channeling the water from shallow depressions into deeper ones, but the drains should be constructed so they can be crossed by farm machinery. The cost of construction determines whether this is practical.

If these soils are drained, they are suited to all local crops. The main crops are wheat, barley, corn, oats, alfalfa, and bromegrass and other tame grasses. Flax or millet are generally seeded in areas that do not require drainage.

Untilled areas of Parnell soils are in native grasses that are often cut for hay. The main hay crops are slough sedge, prairie cordgrass, rivergrass, and bulrushes. The bulrushes are in the wetter parts and are surrounded by an outer fringe of switchgrass, big bluestem, Indiangrass, and little bluestem. If the grasses are not cut for hay, good food and shelter for ducks and other wildlife are provided. The depressions that contain water in spring and summer are good places for ducks to breed.

CAPABILITY UNIT IIIwe-2

Gannett loamy fine sand is the only soil in this capability unit. This soil is deep, very sandy, and dark. It lies in depressions of hummocky terrain and is kept wet by a high water table.

Because of the good moisture supply and high content of organic matter, this soil produces large amounts of forage consisting of wetland sedges, switchgrass, northern reedgrass, Indiangrass, some big bluestem, and other native grasses.

Where drainage is feasible, this soil is suited to cultivated crops.

CAPABILITY UNIT IIIwe-3

The soils in this capability unit are deep, sandy, and dark. They are kept wet by a high water table, and they are limy in some places. The soils are—

Arveson fine sandy loam.
Hamar fine sandy loam.

These soils are easily tilled and are readily permeable to roots, air, and moisture. Although they are well supplied with organic matter and plant nutrients, they produce increased yields if fertilizers are added. Additions of phosphate increase the yields of all crops, and additions of nitrogen increase yields of all crops except alfalfa. Annual soil tests are needed to determine the kinds and amounts of fertilizer required.

Generally, these soils are not plowed in fall, because stubble is needed on the surface to help control wind erosion in winter. The soils are usually plowed, packed, and seeded in one operation in the spring. Sometimes they are fall plowed and then seeded to rye, which makes a good cover crop for the winter. Because their moisture supply is ample, these soils are not summer fallowed. Summer fallowing would leave them dry, bare, and susceptible to wind erosion. Wind erosion can be controlled by stripcropping, stubble mulching, and planting trees in field windbreaks.

These soils are suited to all local crops, mainly corn, flax, oats, alfalfa, bromegrass, and other tame grasses. Other crops grown are barley, rye, and wheat. These soils are also suited to trees, which are grown in field and farmstead windbreaks rather than for wood products. The soils are not tilled in areas where they occur with very sandy, droughty soils but are kept in native grasses and are used for pasture or hay.

CAPABILITY UNIT IIIws-4L

Colvin and Perella soils, saline, are the only soils in this capability unit. These salty soils are deep, poorly drained, and high in lime. They are kept wet by a high water table.

These soils contain a large amount of organic matter. They also contain salt, which restricts the penetration of roots and limits the kinds of plants that grow.

The vegetation consists mainly of native grasses that are used for pasture or hay, but the presence of some tame grass indicates that some areas were farmed at one time. The main grasses on these soils are inland saltgrass, quackgrass, Kentucky bluegrass, prairie cordgrass, foxtail barley, and big bluestem. The pastures have been overgrazed and are in poor condition. Overgrazing increases foxtail barley, inland saltgrass, and other undesirable grasses. Grazing should not be permitted until June 1, and about one-fourth of the plant growth should be left in the fall.

Some of these pastures could be improved if they were broken up and reseeded to alfalfa, bromegrass, slender wheatgrass, tall wheatgrass, meadow fescue, or other tame grasses adapted to these soils.

CAPABILITY UNIT IVe-2

In this capability unit are deep, dark, well-drained, very sandy soils that are nearly level to rolling and slightly to moderately eroded. They are—

Hecla loamy fine sand, nearly level.
Hecla-Maddock loamy fine sands.

Hecla loamy fine sand, nearly level, amounts to about 90 percent of the total area of soils in this capability unit.

These soils are easily penetrated by roots and are rapidly permeable to air and moisture. Because their moisture-holding capacity is low, they are droughty and are highly susceptible to wind erosion. These soils generally are well supplied with organic matter and plant nutrients, but they respond to additions of nitrogen and phosphate if the moisture supply is adequate. Annual soil tests are needed to determine the kinds and amounts of fertilizer required.

Wind erosion is the main hazard in cultivated areas. Because of this hazard, the soils are not summer fallowed. Generally, they are plowed, packed, and seeded in one operation in the spring. If they are plowed in the fall, they generally are seeded to rye, which provides a good cover to control wind erosion. Occasionally, these soils are tilled in the fall with a one-way disk plow or field cultivator. This operation leaves plant residues on the surface to protect the soil from wind erosion. Other practices that control erosion are stripcropping and planting trees in windbreaks. Two or more of the practices described should be combined for successful control of erosion on these soils.

Livestock provides most of the income obtained from these soils. Most of the corn, oats, and alfalfa is not sold but is used for feed. Some barley and flax are also grown. The tame pastures generally are a mixture of alfalfa and bromegrass. Some pastures are in native plants, mainly little bluestem, big bluestem, Indiangrass, and sun sedge.

These soils are well suited to trees, which are planted extensively for field and farmstead windbreaks rather than for wood products.

CAPABILITY UNIT IVe-2M

The soils in this capability unit are dark, well drained, and undulating. They are very sandy and are underlain by loamy or silty substrata. The soils are—

Hecla loamy fine sand, moderately shallow, nearly level.
Maddock loamy fine sand, undulating.

These soils are well supplied with organic matter and are readily permeable to roots, air, and moisture. They are highly susceptible to wind erosion, but are less droughty than the soils in capability unit IVe-2. If their moisture supply is adequate, they respond to additions of nitrogen and phosphate. Annual soil tests are needed to determine the kinds and amounts of fertilizer required.

These soils are used and managed in the same way as soils in capability unit IVe-2 but produce slightly higher yields of crops or forage than those soils because they are less droughty.

CAPABILITY UNIT IVe-3M

Maddock fine sandy loam, moderately shallow, rolling, is the only soil in this capability unit. This soil is dark, well drained, and sandy. It is rolling and hilly, is slightly to moderately eroded, and is underlain by loamy and silty substrata.

This soil loses some moisture in runoff and holds only a medium amount. Consequently, it is droughty and susceptible to wind and water erosion.

About half of this soil is used for crops, and the other half is in native grasses, mainly big bluestem, switchgrass, Indiangrass, little bluestem, prairie sandreed, and Kentucky bluegrass.

CAPABILITY UNIT Vw-WL

In this capability unit are deep, dark, poorly drained, silty and clayey soils on wet bottom lands and in depressions of the glacial lake plains. The soils are—

Dimmick clay.
Dimmick clay, basins.
Rauville soils.

Areas of Parnell soils not feasible to drain are also included in this capability unit.

The soils in this capability unit contain a good supply of organic matter and plant nutrients. The movement of air through these soils is restricted by excess water, either in or on the soil.

The Rauville soils occur on wet bottom lands along streams or rivers, and the Dimmick soils are in shallow depressions of the glacial lake plains. Dimmick clay is wet because water ponds on the surface, but the Rauville soils and Dimmick clay, basins, are wet because of a high water table.

All of these soils are too wet to cultivate, and drainage is not feasible. Vegetation, consisting mainly of wetland sedges and bulrushes, is used mostly for pasture, but some of it is cut for hay. The soils are in the Wetlands range site.

CAPABILITY UNIT VIe-Sa

This capability unit consists of deep, very sandy soils that are slightly to severely eroded, nearly level, rolling, and hummocky. The soils are—

Hecla fine sand.
Maddock loamy fine sand, rolling.
Valentine-Hecla fine sands, hummocky.

These soils are generally dark colored to a depth of 10 to 20 inches because organic matter has accumulated in them. They are readily penetrated by roots and are rapidly permeable to air and moisture. They hold little moisture, however, and because they are very droughty, they are susceptible to wind erosion if they are not protected.

The Maddock soil is on smoother slopes than Valentine-Hecla soils, and is less droughty. It is also less droughty than Hecla fine sand. The Maddock soil has a loamy or silty substratum at depths less than 5 feet from the surface.

In some areas accelerated erosion has caused the hummocky relief of the Valentine-Hecla soils, but in most areas the soils are not eroded. Only a few areas have blowouts caused by severe wind erosion. In the Valentine-Hecla soils, it is common to find dark surface layers of buried soils.

Although the soils in this unit differ from each other, they are used and managed in about the same way. Some areas were tilled a number of years ago but were too droughty and erodible for crops. The soils are now in native grasses and are used as range or for hay. The main native grasses are sand bluestem, Prairie sandreed, Canada wild rye, sun sedge, little bluestem, big bluestem, and Indiangrass. Kentucky bluegrass is common in areas that were once farmed.

These soils are in the Sands range site. Overgrazing favors the spread of less desirable grasses and other plants and increases the hazard of wind erosion.

CAPABILITY UNIT VIe-Si

In this capability unit are deep, loamy and silty soils that are rolling or hilly and slightly to moderately eroded, and silty soils on channeled bottom land. The soils are—

Buse-Barnes loams, strongly rolling.
Buse-Barnes loams, strongly rolling, eroded.
La Prairie and Fairdale soils.
Zell silt loam, hilly.

Except for La Prairie and Fairdale soils, the soils in this group have a thin, dark surface layer and are too steep, droughty, and susceptible to water erosion for use as cropland. Because the surface layer is thin, the soils lack organic matter and plant nutrients. Much of the moisture is lost in runoff. Although the La Prairie and Fairdale soils, which are on bottom lands, have a moderately thick surface layer and are well supplied with organic matter and plant nutrients, they are so cut up by old channels that they cannot be cultivated.

Buse-Barnes loams, strongly rolling, eroded, are now farmed or have once been farmed, and on hilltops much of their surface soil has been removed by water erosion. They are used mainly for wheat, barley, oats, and alfalfa, and for bromegrass and other tame grasses. Yields are low on these infertile, droughty soils. Very little corn is grown because it does not protect the soil from erosion. The rest of the soils in this unit are in native grasses and are used for pasture or hay. The main grasses are needlegrass, side-oats grama, western wheatgrass, needle-and-thread, and blue grama. Many of the pastures are quite brushy. Overgrazing favors the spread of less palatable grasses and other plants, and it reduces protection and increases runoff. These soils are in the Silty range site.

CAPABILITY UNIT VIs-Si

This capability unit consists of soils in glacial till that are deep and dark but are too stony for cultivation. They are—

Barnes-Buse stony loams.
Forman-Aastad stony loams.

These soils have a thin to thick, dark surface layer. They are well supplied with organic matter and plant nutrients and are readily permeable to roots, air, and moisture. Removal of the stones is not economical.

All of these soils are used for native grasses. Some very small areas surrounded by cropland are left idle, but most areas are used for pasture. Because many stones are on the surface in most places, mowing hay is not possible. The main native grasses are green needlegrass, side-oats grama, western wheatgrass, needle-and-thread, and blue grama. These soils are in the Silty range site.

CAPABILITY UNIT VIs-SL

The soils in the Exline complex are the only soils in this capability unit. They are silty and clayey, nearly level, salty soils that have a claypan subsoil.

These soils have a thin to moderately thick surface layer over the claypan subsoil. The subsoil is columnar in structure, is nearly impermeable to roots, air, and moisture, and has visible salts at its lower boundary. Consequently, the soils are difficult to till and are droughty.

Some areas of these soils are cultivated. These areas are plowed in the fall because they do not dry out soon enough in the spring for early seeding. Wheat, barley, flax, and soybeans are the main crops. Yields are low because the soils are droughty and salty. Trees grow poorly on these soils, but a few have been planted for farmstead windbreaks.

Most areas of these soils are in native and tame grasses, which are used for hay and pasture. The main grasses are inland saltgrass, western wheatgrass, Kentucky bluegrass, and dryland sedge. Bromegrass and alfalfa are commonly seeded for tame hay or pasture. These soils are in the Saline Lowland range site.

CAPABILITY UNIT VIs-SW

Renshaw and Sioux soils are the only soils in this capability unit. They are shallow, droughty, loamy soils underlain by gravel at less than 18 inches from the surface.

The dark, loamy surface layer is well supplied with organic matter. Because of the gravel substratum, however, these soils are very droughty and are moderately susceptible to wind erosion.

Some areas are used for crops, mainly corn, oats, and alfalfa, but yields are low because of the droughtiness. Although trees grow poorly on these soils, a few are planted for farmstead protection.

Most areas of these soils are in native and tame pastures. Bromegrass and alfalfa are generally seeded for tame hay or pasture. Native forage plants include needle-and-thread, western wheatgrass, blue grama, and threadleaf sedge. Kentucky bluegrass is also prevalent. These soils are in the Shallow range site.

CAPABILITY UNIT VIIe-CS

Valentine fine sand, hilly, is the only soil in this capability unit. It is a deep, very sandy soil on hills about 40 feet high. The surface layer is stained dark by organic matter to a depth of 2 inches, and the rest of the profile is light-colored fine sand. This very rapidly permeable soil holds little moisture, is very droughty, and if not protected, is highly susceptible to wind erosion.

This soil produces a sparse growth of sand bluestem, prairie sandreed, Canada wildrye, sun sedge, and other native plants. Overgrazing causes severe wind erosion. This soil is in the Choppy Sands range site.

CAPABILITY UNIT VIIIs-1

This capability unit consists only of Artesian ponds, which are soils that receive overflow from artesian wells. The soils in and around these ponds are too salty for most plants and have no agricultural value. Artesian ponds, however, provide food and cover for ducks and other wildlife.

CAPABILITY UNIT VIIIw-1

This capability unit consists entirely of Fresh water marsh, which is covered by water most of the time. Except in dry years when it may be dry much of the summer, Fresh water marsh is dry for only a short period late in summer. The plants that grow are mainly bulrushes and some wetland sedges. Fresh water marsh has no agricultural value, but it provides food and cover for ducks and other wildlife.

Estimated yields of crops

Table 5 lists estimated acre yields of the principal crops grown in Sargent County under two levels of management. In columns A are estimated average yields per acre that can be obtained by using prevailing management. In columns B are estimates of yields that could be obtained under improved management.

Under the prevailing management, a cropping system generally consists of 2 or 3 years of small grains, 1 year of corn or summer fallow, and a limited use of grasses and legumes. This management provides few if any erosion control practices, no commercial fertilizer, and only limited use of chemicals to control weeds. The improved management provides more effective control of erosion than is normally practiced, more use of grasses and legumes in the cropping system, and regular applications of commercial fertilizer and of chemical weed spray.

The estimates of yields are based on records kept by farmers who cooperate with the North Dakota State University of Agriculture and Applied Science, and on interviews with farmers, farm managers, and others who know the capabilities of soils in Sargent County.

TABLE 5.—*Estimated average acre yields of the principal crops under prevailing and improved management*

[In columns A are yields under prevailing management; in columns B are yields that could be obtained under improved management. Absence of yield indicates the soil is not suited to the crop]

Map symbol	Soil	Wheat		Barley		Oats		Corn		Millet		Alfalfa	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
Aa	Aastad clay loam	20	26	30	36	40	50	30	40	30	40	1. 6	1. 8
Ab	Aastad loam	20	26	30	38	40	50	30	40	30	40	1. 6	1. 8
Ac	Aastad-Cresbard loams	16	20	25	30	32	38	20	25	20	30	1. 2	1. 4
Ad	Aberdeen silt loam	12	14	15	20	25	30	18	24	20	25	1. 2	1. 4
Ae	Aberdeen-Exline silty clay loams	12	14	15	20	25	30	18	24	20	25	1. 2	1. 4
Am	Artesian ponds	----	----	----	----	----	----	----	----	----	----	----	----
An	Arveson fine sandy loam	----	----	----	----	30	40	20	25	25	30	1. 0	1. 2
BbC	Barnes-Buse loams, rolling	15	18	20	25	30	38	----	----	25	32	1. 2	1. 4
BbC2	Barnes-Buse loams, rolling, eroded	13	16	18	23	28	33	----	----	22	30	1. 0	1. 2
Bc	Barnes-Buse stony loams	----	----	----	----	----	----	----	----	----	----	----	----
BdB	Barnes-Svea loams, undulating	18	24	25	35	35	45	25	40	25	40	1. 5	1. 8
BdB2	Barnes-Svea loams, undulating, eroded	17	22	23	30	32	42	22	35	25	40	1. 4	1. 7
Bf	Bearden silty clay loam	15	18	20	25	30	38	18	23	25	30	1. 2	1. 4
Bk	Bearden-Tetonka silt loams	13	16	18	23	28	33	16	20	22	30	1. 0	1. 2
Br	Borup, Colvin, and Perella soils	12	14	18	22	30	35	16	20	20	25	1. 0	1. 1
BvD	Buse-Barnes loams, strongly rolling	----	----	----	----	----	----	----	----	----	----	----	----
BvD2	Buse-Barnes loams, strongly rolling, eroded	8	12	14	18	20	25	----	----	15	20	. 7	. 8
Cp	Colvin and Perella soils, saline	----	----	----	----	----	----	----	----	----	----	----	----
Dc	Dimmick clay	----	----	----	----	----	----	----	----	----	----	----	----
Dm	Dimmick clay, basins	----	----	----	----	----	----	----	----	----	----	----	----
Dv	Divide loam	12	14	18	22	30	35	16	20	20	25	1. 0	1. 1
EcA	Eckman silt loam, nearly level	22	28	32	40	45	55	40	50	35	45	1. 75	2. 0
EcB	Eckman silt loam, undulating	22	26	32	38	45	52	40	50	35	45	1. 75	2. 0
EmB	Eckman and Maddock loams, undulating	16	20	23	28	32	40	25	40	25	38	1. 6	1. 8
EmC	Eckman and Maddock loams, rolling	14	18	20	25	28	36	22	36	22	32	1. 0	1. 2
Ex	Exline complex	6	7	11	13	15	18	10	15	12	15	. 7	. 8
Fc	Fargo clay	22	26	32	38	45	52	40	50	35	45	1. 75	2. 0
FoB	Forman-Aastad loams, undulating	20	24	30	36	40	50	30	40	30	40	1. 6	1. 8
FoB2	Forman-Aastad loams, undulating, eroded	18	22	27	32	35	45	27	40	27	40	1. 5	1. 8
Fs	Forman-Aastad stony loams	----	----	----	----	----	----	----	----	----	----	----	----

TABLE 5.—*Estimated average acre yields of the principal crops under prevailing and improved management*.—Con.

[In columns A are yields under prevailing management; in columns B are yields that could be obtained under improved management. Absence of yield indicates the soil is not suited to the crop]

Map symbol	Soil	Wheat		Barley		Oats		Corn		Millet		Alfalfa	
		A	B	A	B	A	B	A	B	A	B	A	B
		Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*
FvC	Forman-Buse loams, rolling	16	20	22	27	32	40	20	27	27	35	1.2	1.4
FvC2	Forman-Buse loams, rolling, eroded	14	18	20	25	30	38	18	25	25	32	1.0	1.2
Fw	Fresh water marsh	----	----	----	----	----	----	----	----	----	----	----	----
Ga	Gannett loamy fine sand	----	----	----	----	----	----	----	----	----	----	----	----
GgA	Gardena-Glyndon loams, sandy substratum, nearly level	18	24	25	32	35	45	30	40	30	40	1.6	1.8
GmA	Gardena-Glyndon silt loams, nearly level	22	28	32	40	45	55	40	50	35	45	1.75	2.0
GoA	Glyndon loam, sandy substratum, nearly level	13	17	18	23	28	33	18	22	20	25	1.0	1.2
GsA	Glyndon silt loam, nearly level	15	20	20	25	30	38	20	25	25	32	1.2	1.4
Ha	Hamar fine sandy loam	12	16	18	22	30	35	30	36	22	26	1.2	1.4
Hb	Hamerly complex	16	20	25	30	32	38	20	25	20	30	1.2	1.4
Hf	Hamerly-Aastad loams	18	22	27	34	35	40	25	30	25	35	1.4	1.6
Hh	Hamerly-Svea loams	18	22	27	34	35	40	25	30	25	35	1.4	1.6
Hkx	Hecla fine sand	----	----	----	----	----	----	----	----	----	----	----	----
HlAx	Hecla fine sandy loam, nearly level	12	16	18	22	28	35	30	36	22	26	1.6	1.8
HlBx	Hecla fine sandy loam, undulating	12	14	18	22	28	35	30	36	22	26	1.6	1.8
HmA	Hecla fine sandy loam, moderately shallow, nearly level	14	18	20	28	30	40	20	28	25	35	1.6	1.8
HnAx	Hecla loamy fine sand, nearly level	10	12	16	20	25	30	18	22	18	22	1.2	1.4
HoA	Hecla loamy fine sand, moderately shallow, nearly level	----	----	----	----	25	30	16	20	----	----	1.4	1.6
Hwx	Hecla-Maddock loamy fine sands	8	10	14	18	20	25	12	18	15	20	1.0	1.2
Hz	Hegne clay	15	18	20	25	30	35	20	25	25	30	1.2	1.4
Hfa	Hegne-Fargo clays	20	24	30	36	40	50	30	40	30	40	1.6	1.8
La	Lamoure silty clay loam	----	----	----	----	----	----	----	----	----	----	----	----
Lf	La Prairie and Fairdale soils	----	----	----	----	----	----	----	----	----	----	----	----
Lp	La Prairie silt loam	22	28	32	40	45	55	40	50	35	45	1.75	2.0
MdBx	Maddock loamy fine sand, undulating	----	----	----	----	25	30	18	22	----	----	1.0	1.2
MdC	Maddock loamy fine sand, rolling	----	----	----	----	----	----	----	----	----	----	----	----
MkAx	Maddock fine sandy loam, moderately shallow, nearly level	14	18	20	30	30	40	20	30	25	35	1.2	1.4
MkBx	Maddock fine sandy loam, moderately shallow, undulating	14	18	20	30	30	40	20	30	25	35	1.2	1.4
MkCx	Maddock fine sandy loam, moderately shallow, rolling	8	12	14	18	20	25	12	18	15	20	.8	.9
OaA	Overly silt loam, nearly level	22	28	32	40	45	55	40	50	35	45	1.75	2.0
OcB	Overly silty clay loam, undulating	22	28	32	40	45	55	40	50	35	45	1.75	2.0
Os	Overly-Aastad silt loams	20	24	30	36	40	50	30	40	30	40	1.6	1.8
OvC	Overly and Barnes silt loams, rolling	20	26	30	38	40	50	30	40	30	40	1.6	1.8
OyA	Overly-Bearden silty clay loams, nearly level	22	28	32	40	45	55	40	50	35	45	1.75	2.0
Pa	Parnell soils	----	----	----	----	----	----	----	----	----	----	----	----
Pe	Perella silty clay loam	20	26	30	40	40	50	30	40	25	35	1.5	1.7
Ra	Rauville soils	----	----	----	----	----	----	----	----	----	----	----	----
RhA	Renshaw loam, nearly level	8	12	14	18	20	25	12	18	15	20	.8	.9
RhB	Renshaw loam, undulating	8	12	14	18	20	25	12	18	15	20	.8	.9
Ro	Renshaw and Sioux soils	----	----	----	----	----	----	----	----	----	----	----	----
SpA	Spottswood-Wessington loams, nearly level	8	12	14	18	20	25	12	18	15	20	.8	.9
St	Stirum and Arveson loams	----	----	----	----	----	----	----	----	----	----	----	----
Sv	Svea loam	18	24	25	35	35	45	25	35	25	35	1.5	1.8
Tk	Tetonka silt loam	13	16	18	22	28	33	16	20	22	30	1.0	1.2
Tp	Tetonka and Parnell soils	14	18	20	30	30	40	20	30	25	35	1.2	1.4
Un	Ulen fine sandy loam, moderately shallow	18	22	25	30	35	45	30	40	30	40	1.6	1.8
VaD	Valentine fine sand, hilly	----	----	----	----	----	----	----	----	----	----	----	----
VhC	Valentine-Hecla fine sands, hummocky	----	----	----	----	----	----	----	----	----	----	----	----
ZmC	Zell silt loam, rolling	16	20	22	27	32	40	20	27	27	35	1.2	1.4
ZmD	Zell silt loam, hilly	----	----	----	----	----	----	----	----	----	----	----	----

Management of Range and Tame Pasture

Although most of the agricultural land in Sargent County is used for crops, some pasture is intermingled with the cultivated fields, and a small part of the county is unbroken range. In this subsection the soils of the county are listed in their range sites, the range in the county is described, and the management of range and of tame pasture is discussed.

Range sites and range condition

A range site is an area of land that, because of its climate, soil, and topography, will support a certain climax vegetation. The climax vegetation is the native plant cover that maintains and reproduces itself as long as the environment remains unchanged. If the natural balance between the vegetation and its environment is upset by overgrazing, burning, or trampling, some plants die out and are replaced by those that are less palatable than the original plants, or are shorter and less productive.

The condition of a range is determined by comparing the kind and amount of present vegetation with the climax vegetation. If 76 to 100 percent of the present vegetation is the same as the climax vegetation, the range is in excellent condition. If 51 to 75 percent is the same as the climax vegetation, the range is in good condition. A range is in fair condition if 26 to 50 percent of the vegetation is the same as the climax vegetation. If the percentage is less than 25 percent, the range is in poor condition.

In the following list, the soils of Sargent County are grouped according to range site, even though most of the soils are cultivated.

SILTY RANGE SITE

Aa Aastad clay loam.
Ab Aastad loam.
BbC Barnes-Buse loams, rolling.
BbC2 Barnes-Buse loams, rolling, eroded.
Bc Barnes-Buse stony loams.
BdB Barnes-Svea loams, undulating.
BdB2 Barnes-Svea loams, undulating, eroded.
Bf Bearden silty clay loam.
Bk Bearden-Tetonka silt loams.
BvD Buse-Barnes loams, strongly rolling.
BvD2 Buse-Barnes loams, strongly rolling, eroded.
EcA Eckman silt loam, nearly level.
EcB Eckman silt loam, undulating.
EmB Eckman and Maddock loams, undulating.
EmC Eckman and Maddock loams, rolling.
FoB Forman-Aastad loams, undulating.
FoB2 Forman-Aastad loams, undulating, eroded.
Fs Forman-Aastad stony loams.
FvC Forman-Buse loams, rolling.
FvC2 Forman-Buse loams, rolling, eroded.
GgA Gardena-Glyndon loams, sandy substratum, nearly level.
GmA Gardena-Glyndon silt loams, nearly level.
GoA Glyndon loam, sandy substratum, nearly level.
GsA Glyndon silt loam, nearly level.
Hb Hamerly complex.
Hf Hamerly-Aastad loams.
Hh Hamerly-Svea loams.
Lf La Prairie and Fairdale soils.
Lp La Prairie silt loam.
OaA Overly silt loam, nearly level.
OcB Overly silty clay loam, undulating.
Os Overly-Aastad silt loams.
OvC Overly and Barnes silt loams, rolling.
OyA Overly-Bearden silty clay loams, nearly level.
RhA Renshaw loam, nearly level.
RhB Renshaw loam, undulating.
SpA Spottswood-Wessington loams, nearly level.
Sv Svea loam.
ZmC Zell silt loam, rolling.
ZmD Zell silt loam, hilly.

PAN SPOTS RANGE SITE

Ac Aastad-Cresbard loams.
Ad Aberdeen silt loam.
Ae Aberdeen-Exline silty clay loams.

SUBIRRIGATED RANGE SITE

An Arveson fine sandy loam.
Br Borup, Colvin, and Perella soils.
Dv Divide loam.
Ga Gannett loamy find sand.
La Lamoure silty clay loam.
St Stirum and Arveson loams.

SALINE LOWLAND RANGE SITE

Cp Colvin and Perella soils, saline.
Ex Exline complex.

WETLANDS RANGE SITE

Dc Dimmick clay.
Dm Dimmick clay, basins.
Pa Parnell soils.
Ra Rauville soils.

CLAYEY RANGE SITE

Fc Fargo clay.
Hz Hegne clay.
Hfa Hegne-Fargo clays.

SANDY RANGE SITE

Ha Hamar fine sandy loam.
HlAx Hecla fine sandy loam, nearly level.
HlBx Hecla fine sandy loam, undulating.
HmA Hecla fine sandy loam, moderately shallow, nearly level.
MkAx Maddock fine sandy loam, moderately shallow, nearly level.
MkBx Maddock fine sandy loam, moderately shallow, undulating.
MkCx Maddock fine sandy loam, moderately shallow, rolling.
Un Ulen fine sandy loam, moderately shallow.

SANDS RANGE SITE

Hkx Hecla fine sand.
HnAx Hecla loamy fine sand, nearly level.
HoA Hecla loamy fine sand, moderately shallow, nearly level.
Hwx Hecla-Maddock loamy fine sands.
MdBx Maddock loamy fine sand, undulating.
MdC Maddock loamy fine sand, rolling.
VhC Valentine-Hecla fine sands, hummocky.

OVERFLOW RANGE SITE

Pe Perella silty clay loam.
Tk Tetonka silt loam.
Tp Tetonka and Parnell soils.

SHALLOW RANGE SITE

Ro Renshaw and Sioux soils.

CHOPPY SANDS RANGE SITE

VaD Valentine fine sand, hilly.

Range in Sargent County

In Sargent County, the acreage of range in native grass is small if compared to the acreage of all agricultural land. All areas in the county have been cultivated except those where slope, stones, wetness, or hazard of erosion have prevented cultivation. Some sandy areas that were once farmed now support only native grasses because these areas are too droughty or susceptible to erosion to support crops.

Most of the range in native grass is in three main areas of the county and can be located on the general soil map at the back of this report. These areas are (1) in the Forman-Buse and the Valentine soil associations; (2) in that part of the Valentine-Hecla soil association in Brampton and Southwest townships; and (3) in that part of the Barnes-Svea soil association extending from the Minneapolis, St. Paul and Sault Ste. Marie Railroad to the Valentine soil association. Other areas of native grasses are small and are scattered throughout the county, mainly on poorly drained soils. The grasses on poorly drained soils are cut for hay.

In the Forman-Buse and the Barnes-Svea associations, growing cash grain and raising livestock are both important enterprises. The range in native grass is in small areas of loamy soil and is intermingled with cultivated fields. Most of this range is grazed in summer, but some of it is used for hay. Many of these small areas of range show signs of overuse, for they have been invaded by undesirable grasses and weeds and are quite brushy. Prominent on well-drained soils, where the grass is in good condition, are little bluestem, prairie dropseed, green needlegrass, side-oats grama, plains muhly, western wheatgrass, needle-and-thread, and blue grama. In poorly drained swales and low flats, the main grasses are big bluestem, prairie cordgrass, and switchgrass.

In the Valentine and the Valentine-Hecla soil associations, the native grasses are on sandy soils, and the range is unbroken by other land use. Most of the grass is grazed, but some of it is used for hay. The main grasses on the well-drained soils of the ranges in good condition are sand bluestem, prairie sandreed, Canada wildrye, sun sedge, green needlegrass, little bluestem, and big bluestem. On more poorly drained soils, switchgrass, Indiangrass, and wetland sedges predominate. Areas of these soils that were once farmed have a high percentage of Kentucky bluegrass in the plant cover. Because these sandy soils are susceptible to wind erosion, the stocking rates generally should be low.

Management of range

This subsection discusses practices of range management that can be used to improve the condition of the range.

Grazing.—The grazing season in Sargent County usually begins between May 1 and May 15 and lasts for 5 or 6 months. Ranges in native grass produce the best yields when part of the growth is allowed to remain from one season to the next. On the well-drained soils, about half of the annual growth should be left at the end of each season if the range is to remain in good condition. On poorly drained soils that receive overflow or have a high water table, about one-fourth of the annual growth should remain.

Even under proper management, the range occasionally becomes uneven or patchy because of undergrazing in some spots and overgrazing in others. When this occurs, heavy stocking for short periods will force livestock to graze the unused patches. The heavy stocking should be followed by a period of nonuse so that the plants can regain strength. Mowing will also help to eliminate the uneven growth.

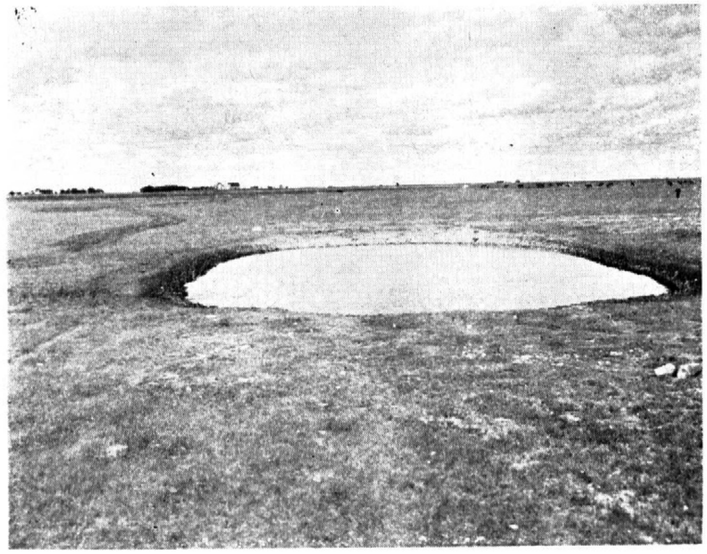

Figure 10.—**Stockwater pond or dugout. Drainage ditch leads into pond from background.**

Salt and Water.—The distribution of grazing can be improved by placing salt and other mineral supplements in areas that are lightly grazed or are far from the water supply. Stockwater ponds should also be located in positions that will encourage even grazing. Suitable sites for ponds are in areas where the water table is high, or are in areas that receive enough runoff to keep water in the ponds. In some areas excess surface water is drained artificially into the ponds, as in figure 10.

Reseeding.—A range in native grass should be reseeded if it is in such poor condition that it will not recover under proper grazing practices. Information about reseeding can be obtained from the local office of the Soil Conservation Service or from the county agricultural agent.

Management of tame pastures

Many of the tame pastures in the county have been overused and are in poor condition, especially those on farms where most of the income is from cash grain and only a small part of the income is from livestock. The desirable tame grasses have been grazed off and replaced by weeds. The pastures generally adjoin farmsteads so that the livestock have easy access to water and are close to the farm buildings.

The most common mixture seeded for tame pasture and hay is bromegrass and alfalfa. This grass-legume mixture is often seeded as part of the regular cropping system. In this system the pastures are broken up and used for cultivated crops once every 3 or 4 years. This rotation helps to improve pasture yields.

Supplementary pastures may be needed when permanent and rotation pastures do not provide enough forage. The supplementary pastures generally are seeded to annual grasses. Piper sudangrass is widely used because it produces heavy forage late in summer when it is hot and dry and most other grasses do not grow much. These pastures are grazed heavily to keep the grass from becoming too coarse.

In Sargent County the forage of many tame pastures could be increased (1) by plowing and reseeding permanent pastures at regular intervals; (2) by constructing stockwater ponds or dugouts, where practical, to provide adequate water; (3) by distributing salt and other mineral supplements more skillfully to distribute grazing; and (4) by applying fertilizer according to needs shown by soil tests. Tests indicate that pastures without legumes respond to applications of nitrogen and that alfalfa and other legumes respond to phosphate.

Further information about pasture seeding, using adapted grasses, fertilizing, and other problems in pasture management can be obtained from the Soil Conservation Service or the county agricultural agent.

Management of Windbreaks

Most of the trees that are grown in Sargent County have been planted to protect farmsteads and fields from wind.

Farmstead windbreaks

Trees and shrubs are planted in belts to protect farmsteads and feedlots from cold, blustery winds in winter and hot, dry winds in summer. These belts should consist of 6 to 12 rows of trees and should be mostly on the north and west sides of the farmstead area. Rows of shrubs and evergreens should be included in each planting to keep drifting snow from entering the farmstead. Also desirable are some plantings on the south and east, but these may be a single row of shrubs, which will prevent drifting snow from entering the farmstead from those directions.

Field windbreaks

Field windbreaks are strips, or belts, of trees and shrubs planted as a barrier against prevailing winds to protect cultivated fields from wind erosion, as shown in figure 11.

Because the prevailing winds in Sargent County are from the northwest, windbreaks generally should be on the north and west sides of cultivated fields. The trees should be planted in the spring about the time that small grain is seeded, preferably before June 1. The soil used for windbreaks must be free of weeds and living sod. Windbreaks are most needed to protect summer-fallowed fields, row-cropped fields that are clean tilled, and fields of clean stubble that are very sandy.

The use of windbreaks that have more than three rows is declining. Windbreaks with three rows are commonly

TABLE 6.—*Estimated height in feet of mature*

[Absence of height indicates tree is not

Map symbol	Soil name	Trees					
		Ash	Boxelder [1]	Cotton-wood [2]	American elm	Siberian and dropmore elm [2]	Hackberry
Aa	Aastad clay loam	35	-----	-----	40	45	30
Ab	Aastad loam	35	-----	-----	40	45	30
Ac	Aastad-Cresbard loams	-----	-----	-----	-----	-----	-----
Ad	Aberdeen silt loam	-----	-----	-----	-----	-----	-----
Ae	Aberdeen-Exline silty clay loams	-----	-----	-----	-----	-----	-----
Am	Artesian ponds	-----	-----	-----	-----	-----	-----
An	Arveson fine sandy loam	52	40	90	58	-----	48
BbC	Barnes-Buse, loams, rolling [3]	32, 21	-----	-----	36, 24	40, 27	27, 18
BbC2	Barnes-Buse loams, rolling, eroded	32, 21	-----	-----	36, 24	40, 27	27, 18
Bc	Barnes-Buse stony loams	-----	-----	-----	-----	-----	-----
BdB	Barnes-Svea loams, undulating	32	-----	-----	36	40	27
BdB2	Barnes-Svea loams, undulating, eroded	32	-----	-----	36	40	27
Bf	Bearden silty clay loam	45	36	80	50	45	40
Bk	Bearden-Tetonka silt loams [4]	45, 40	36, 31	80, 72	50, 45	45, 40	40, 36
Br	Borup, Colvin, and Perella soils [5, 6]	38, 50	28, 38	64, 88	40, 55	-----	32, 44
BvD	Buse-Barnes loams, strongly rolling	21, 32	-----	-----	24, 36	27, 40	18, 27
BvD2	Buse-Barnes loams, strongly rolling, eroded	21, 32	-----	-----	24, 36	27, 40	18, 27
Cp	Colvin and Perella soils, saline	-----	-----	-----	-----	-----	-----
Dc	Dimmick clay	45	35	80	50	-----	40
Dm	Dimmick clay, basins	-----	-----	-----	-----	-----	-----
Dv	Divide loam	40	31	72	45	40	36
EcA	Eckman silt loam, nearly level	38	-----	-----	44	50	33
EcB	Eckman silt loam, undulating	38	-----	-----	44	50	33
EmB	Eckman and Maddock loams, undulating	38	-----	-----	44	50	33
EmC	Eckman and Maddock loams, rolling	34	-----	-----	40	45	30
Ex	Exline complex	-----	-----	-----	-----	-----	-----
Fc	Fargo clay	45	35	80	50	45	40
FoB	Forman-Aastad loams, undulating	36	-----	-----	40	45	30

See footnotes at end of table.

planted on the north or west side of a cultivated field. Parallel or at right angles to the three-row windbreak, single rows are planted at intervals of not more than 40 rods. In many fields single rows are planted without the multiple-row windbreak. Plantings consisting of several rows of trees spaced at intervals are preferred to a single windbreak with many rows because the spaced rows protect a larger area with the same number of trees. Recent tests of wind velocity show that single rows of trees, without leaves, reduce wind velocity as much as it is reduced by a multiple-row windbreak.

The texture of the soil and the height of mature trees determine the intervals at which belts of trees need to be spaced to protect the soil against wind erosion. If windbreaks alone are used to control wind erosion, the space between belts should not be more than ten times the height of mature trees in the belt, plus the strip width listed on page 29 for a soil with texture like that of the soil protected.

Table 6 lists, for each soil in the county, the estimated height of mature trees and shrubs that are suitable for planting in windbreaks. Most trees mature in 50 years, and most shrubs in 30 years.

Windbreaks should be clean cultivated as long as it is possible to get equipment between the rows. The edges of the windbreak should be cultivated for the life of the windbreak. All windbreaks should be protected from fire and grazing. If they adjoin a road, they must be set back to comply with State, county, or local regulations.

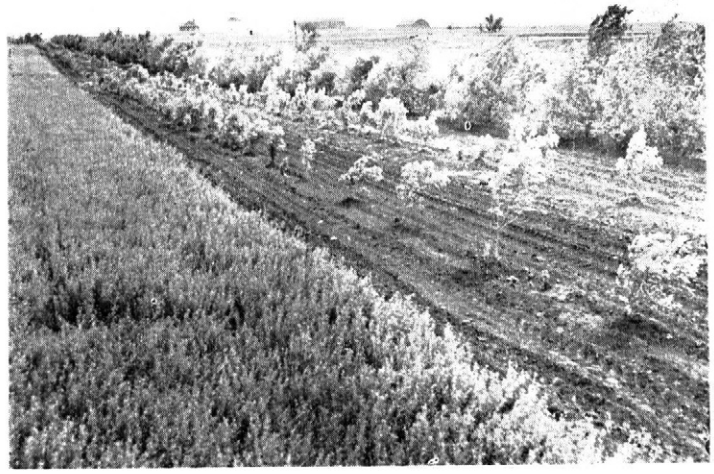

Figure 11.—A 4-year-old field windbreak.

trees and shrubs suitable for windbreaks

planted in windbreaks or is not suited to soil]

Trees—Continued					Shrubs					
White and golden willow	Eastern redcedar and Rocky Mountain juniper	Colorado and Black Hills spruce	Ponderosa pine	Siberian crab	Russian-olive	Lilac	Choke-cherry	Plum	Honey-suckle	Caragana
----------	20	----------	40	20	20	6	10	----------	8	15
----------	20	----------	40	20	20	6	10	----------	8	15
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
48	28	48	58	28	28	11	18	9	8	----------
----------	18, 12	----------	36, 24	18, 12	18, 12	5, 1	9, 6	----------	7, 6	13, 9
----------	18, 12	----------	36, 24	18, 12	18, 12	5, 1	9, 6	----------	7, 6	13, 9
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
----------	18	----------	36	18	18	5	9	----------	7	13
----------	18	----------	36	18	18	5	9	----------	7	13
40	25	40	50	25	25	10	15	8	8	15
40, 36	25, 22	40, 36	50, 45	25, 22	25, 22	10, 9	15, 13	8, 7	8, 7	15, 13
32, 44	20, 27	32, 44	40, 55	20, 27	20, 27	8, 11	12, 16	6, 9	12, 16	----------
----------	12, 18	----------	24, 36	12, 18	12, 18	4, 5	6, 9	----------	6, 7	9, 13
----------	12, 18	----------	24, 36	12, 18	12, 18	4, 5	6, 9	----------	6, 7	9, 13
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
40	25	40	50	25	25	10	15	8	7	----------
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
36	22	36	45	22	22	9	13	7	7	----------
----------	22	----------	44	22	22	7	11	----------	9	16
----------	22	----------	44	22	22	7	11	----------	9	16
----------	22	----------	44	22	22	7	11	----------	9	16
----------	20	----------	40	20	20	6	10	----------	8	14
----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
40	25	40	50	25	25	10	15	8	8	15
----------	20	----------	40	20	20	6	10	----------	8	15

TABLE 6.—*Estimated height in feet of mature trees*

[Absence of height indicates tree is not

Map symbol	Soil name	Trees					
		Ash	Boxelder [1]	Cottonwood [2]	American elm	Siberian and dropmore elm [2]	Hackberry
FoB2	Forman-Aastad loams, undulating, eroded	35	----	----	40	45	30
Fs	Forman-Aastad stony loams	----	----	----	----	----	----
FvC	Forman-Buse loams, rolling	28, 21	----	----	32, 24	36, 27	24, 18
FvC2	Forman-Buse loams, rolling, eroded	28, 21	----	----	32, 24	36, 27	24, 18
Fw	Fresh water marsh	----	----	----	----	----	----
Ga	Gannett loamy fine sand	----	----	----	----	----	----
GgA	Gardena-Glyndon loams, sandy substratum, nearly level	45	35	80	50	45	40
GmA	Gardena-Glyndon silt loams, nearly level	45	35	80	50	45	40
GoA	Glyndon loam, sandy substratum, nearly level	45	35	80	50	45	40
GsA	Glyndon silt loam, nearly level	45	35	80	50	45	40
Ha	Hamar fine sandy loam [5]	45	35	80	----	45	40
Hb	Hamerly complex	38	30	68	42	38	34
Hf	Hamerly-Aastad loams	38	30	68	42	38	34
Hh	Hamerly-Svea loams	38	30	68	42	38	34
Hkx	Hecla fine sand	----	----	----	----	----	----
HlAx	Hecla fine sandy loam, nearly level	45	35	80	50	45	40
HlBx	Hecla fine sandy loam, undulating	45	35	80	50	45	40
HmA	Hecla fine sandy loam, moderately shallow, nearly level	45	35	80	50	45	40
HnAx	Hecla loamy fine sand, nearly level	45	35	80	50	45	40
HoA	Hecla loamy fine sand, moderately shallow, nearly level	45	35	80	50	45	40
Hwx	Hecla-Maddock loamy fine sands	45	35	80	50	45	40
Hz	Hegne clay	31	26	58	35	----	28
Hfa	Hegne-Fargo clays	31, 45	24, 35	56, 80	35, 50	----	28, 40
La	Lamoure silty clay loam	36	28	64	40	----	32
Lf	La Prairie and Fairdale soils	42	36	80	48	54	36
Lp	La Prairie silt loam	42	35	80	48	54	36
MdBx	Maddock loamy fine sand, undulating	32	27	62	36	40	27
MdC	Maddock loamy fine sand, rolling	32	27	62	36	40	27
MkAx	Maddock fine sandy loam, moderately shallow, nearly level	35	30	68	40	45	30
MkBx	Maddock fine sandy loam, moderatley shallow, undulating	35	30	68	40	45	30
MkCx	Maddock fine sandy loam, moderately shallow, rolling	32	27	62	36	40	27
OaA	Overly silt loam, nearly level	38	----	----	44	45	33
OcB	Overly silty clay loam, undulating	38	----	----	44	45	33
Os	Overly-Aastad silt loams	38, 35	----	----	44, 40	45, 10	33, 30
OvC	Overly and Barnes silt loams, rolling	38, 32	----	----	44, 36	45, 35	33, 27
OyA	Overly-Bearden silty clay loams, nearly level	38, 45	----	----	44, 50	50, 45	30, 40
Pa	Parnell soils	----	----	----	----	----	----
Pe	Perella silty clay loam	50	38	88	55	----	44
Ra	Rauville soils	----	----	----	----	----	----
RhA	Renshaw loam, nearly level	28	----	----	32	36	24
RhB	Renshaw loam, undulating	28	----	----	32	36	24
Ro	Renshaw and Sioux soils	14	----	----	----	18	----
SpA	Spottswood-Wessington loams, nearly level	28	----	----	32	36	24
St	Stirum and Arveson loams	----	----	----	----	----	----
Sv	Svea loam	35	----	----	40	45	30
Tk	Tetonka silt loam [5]	40	31	72	45	----	36
Tp	Tetonka and Parnell soils [5]	40	31	72	45	----	36
Un	Ulen fine sandy loam, moderately shallow	45	35	80	50	----	40
VaD	Valentine fine sand, hilly	----	----	----	----	----	----
VhC	Valentine-Hecla fine sands, hummocky	----	----	----	----	----	----
ZmC	Zell silt loam, rolling	28	----	----	32	36	24
ZmD	Zell silt loam, hilly	28	----	----	32	36	24

[1] The growth of boxelder has been severely damaged by 2-4D spray, by a virus, or both. Very little boxelder is now being planted.

[2] Siberian elm or dropmore elm will kill cottonwood if planted in the same part of a windbreak. Some sites suitable for Siberian elm or dropmore elm are too dry for cottonwood.

[3] For mapping units with two soils, tree heights are given for the

and shrubs suitable for windbreaks—Continued

planted in windbreaks or is not suited to soil]

Trees—Continued					Shrubs					
White and golden willow	Eastern redcedar and Rocky Mountain juniper	Colorado and Black Hills spruce	Ponderosa pine	Siberian crab	Russian-olive	Lilac	Choke-cherry	Plum	Honey-suckle	Caragana
----	20	----	40	20	20	6	10	----	8	15
----	----	----	----	----	----	----	----	----	----	----
----	16, 12	----	32, 24	16, 12	16, 12	5, 4	8, 6	----	7, 5	13, 9
----	16, 12	----	32, 24	16, 12	16, 12	5, 4	8, 6	----	7, 5	13, 9
----	----	----	----	----	----	----	----	----	----	----
----	----	----	----	----	----	----	----	----	----	----
40	25	40	50	25	25	7	15	8	10	15
40	25	40	50	25	25	7	15	8	10	15
40	25	40	50	25	25	7	15	8	10	15
40	25	40	50	25	25	7	15	8	10	15
40	25	40	50	25	25	7	15	8	10	----
34	21	34	42	21	21	6	13	7	7	13
34	21	34	42	21	21	6	13	7	7	13
34	21	34	42	21	21	6	13	7	7	13
----	----	----	----	----	----	----	----	----	----	----
40	25	40	50	25	25	10	15	8	9	16
40	25	40	50	25	25	10	15	8	9	16
40	25	40	50	25	25	10	15	8	9	16
40	25	40	50	25	25	10	15	8	9	16
40	25	40	50	25	25	10	15	8	9	16
40	25	40	50	25	25	10	15	8	9	16
28	17	28	35	17	17	7	10	6	6	----
28, 40	17, 25	28, 40	35, 50	17, 25	17, 25	7, 10	10, 15	6, 8	7, 9	----
32	20	32	40	20	20	8	12	6	7	----
40	24	----	60	24	24	7	12	----	10	16
40	24	----	60	24	24	7	12	----	10	16
----	18	----	36	18	18	5	9	----	7	14
----	18	----	36	18	18	5	9	----	7	14
----	20	----	40	20	20	6	10	----	8	15
----	20	----	40	20	20	6	10	----	8	15
----	18	----	36	18	18	5	9	----	7	14
----	22	----	44	22	22	7	11	----	9	16
----	22	----	44	22	22	7	11	----	9	16
----	22, 20	----	44, 40	22, 20	22, 20	7, 6	11, 10	----	9, 8	16, 15
----	22, 18	----	44, 36	22, 18	22, 18	7, 6	11, 9	----	9, 7	16, 14
----	22, 25	----	44, 50	22, 25	22, 25	7, 10	11, 15	----	9, 12	15, 16
----	----	----	----	----	----	----	----	----	----	----
----	27	44	55	27	27	11	17	9	8	----
----	----	----	----	----	----	----	----	----	----	----
----	16	----	32	16	16	5	8	----	6	12
----	16	----	32	16	16	5	8	----	6	12
----	----	----	----	----	8	----	----	----	----	7
----	16	----	32	16	16	5	8	----	6	12
----	----	----	----	----	----	----	----	----	----	----
----	20	----	40	20	20	6	10	----	8	13
36	22	36	45	22	22	9	13	7	7	----
36	22	36	45	22	22	9	13	7	7	----
40	25	40	50	25	25	10	15	8	----	15
----	----	----	----	----	----	----	----	----	----	----
----	----	----	----	----	----	----	----	----	----	----
----	16	----	32	16	16	5	8	----	6	12
----	16	----	32	16	16	5	8	----	6	12

soils in the order that they appear in the name, unless the height is the same for both soils; then only one height is given.

[4] Tetonka soil requires surface drainage.

[5] Requires surface drainage.

[6] The first figure is the height for Borup soils, the second for Perella soils. The height on Colvin soils is the average of the two.

Management of Soils for Wildlife

Wildlife habitats can be developed on large or small tracts of idle land, in corners of fields, in fence rows, along roadsides, and in wet lands. Hundreds of such areas exist in Sargent County, and many of them have been developed.

Records of the Soil Conservation Service show that, as of June 30, 1960, farmers and ranchers had improved the food and cover for wildlife on 2,943 acres in the county. Further improvement is needed on about 7,300 acres.

In Sargent County, the different kinds of wildlife vary in population according to capacity of the land to support them. This capacity, in turn, depends on how the land is used and on the quality, quantity, and distribution of land suitable for wildlife habitats. Changes in land use affect the capacity of land to support different kinds of wildlife. For example, large numbers of sharp-tailed and pinnated grouse were present in Sargent County when grassland was plentiful, but as more land was cultivated and grassland decreased, the grouse population decreased. This change in land use, on the other hand, favored the pheasant. The capacity to support pheasant increased rapidly, and the pheasant population flourished.

Kinds and distribution of wildlife

The kinds of wildlife in Sargent County, their population, and the general areas in which they occur are discussed in the following paragraphs. The soil associations referred to can be located on the general soil map at the back of this report.

Pheasant.—The pheasant, an introduced species, is the most abundant game bird in the uplands of Sargent County. It generally lives in grain fields, pastures, and undrained wet lands. The pheasant is most abundant in the Forman-Aastad soil association, which covers more than one-half of the county, and is least abundant in the Valentine soil association.

Hungarian partridge.—This small game bird was also introduced, and now abounds throughout most of the county. It thrives in cultivated areas in a habitat similar to that of the common pheasant.

Grouse.—Sharp-tailed and prairie chicken grouse are relatively scarce, because grassland is their preferred habitat, and only about 17 percent of the county is grassland. The prairie chicken grouse requires a range of lightly used, tall grasses. The grouse is most abundant in areas where the native grasses are used for pasture rather than for hay. Such areas are in the Valentine, the Barnes-Svea, the Valentine-Hecla, and the Forman-Buse soil associations. The number of grouse can be increased by setting aside a pattern of small ungrazed, unmowed tracts of grass and by controlling grazing on grassland that is not set aside.

Waterfowl.—Generally, the large areas of water in the county are used by waterfowl during migration, and the smaller wet lands are used during the breeding season. Most of the waterfowl habitats are in the Forman-Aastad soil association, but some are in other soil associations, principally the Barnes-Svea and the Gardena-Spottswood-Wessington. Parnell silty clay loam, which occurs in a number of soil associations, is the most common soil in the wet lands preferred by waterfowl during the breeding season.

Small birds and mammals.—Windbreaks and wooded lowlands, especially those that are protected from fire and grazing, provide desirable habitats for mourning doves and song birds and for cottontails and tree squirrels.

Fur bearers.—Mink, muskrat, and other fur bearers of commercial value are fairly common in most of the county. Mink and muskrat are well adapted to areas that are intensively cultivated. Their population and range are limited, however, by lack of a permanent water supply and, especially in the northern half of the county, by water levels that vary extremely in consecutive years. These animals would increase markedly if farm ponds were improved and potholes deepened.

Big game.—Although white-tailed deer have been scarce, they are steadily increasing throughout most of the county. These animals prefer wooded lowlands that have an occasional pothole or pond and are near pasture or cultivated fields. Field windbreaks are also suitable, for they serve as travel lanes, escape cover, and fawning areas. In addition, the twigs and lower branches provide food. Although deer prefer a wooded habitat, they sometimes live in fields of sweetclover or other heavy herbaceous cover.

Fish.—Sargent County has seven fishing lakes: White, Silver, Tewaukon, Cutlers Marsh, Cloud, Sprague, and Mann. The first five provide the best fishing. Even these do not have a good stock of fish, but the State Game and Fish Department is considering the improvement of fishing in them. Fish are in the Wild Rice River seasonally, but only in small numbers. A few farmers and ranchers have put fish in stockwater ponds with some success. If more ponds were stocked, more fishing would be available. But it is probably not advisable to stock shallow ponds or ponds that have a heavy growth of weeds, because these ponds are likely to lose many fish in winter.

Improvement of wildlife areas

Improving wildlife on farmland begins with conserving soil and water. Not only is soil and water conserved by planting windbreaks, constructing ponds, mulching stubble, and properly managing pasture and range, but also food and cover are provided for the kinds of wildlife that farmers want.

A farm plan should have special provisions for wildlife. Although the last three practices listed below are expensive, a farmer or rancher will increase wildlife if he does these things—

1. Protects wildlife areas from burning and grazing.
2. Delays mowing and spraying grass and annual weeds along fence rows and roadsides until after July 15.
3. Disks odd corners and isolated small areas in spring to encourage the growth of grasses and annual weeds for wildlife food and cover. (One of the most simple and productive methods of improving wildlife habitats.)
4. Piles rocks, old hay and straw, and brush near permanent water areas to provide denning sites for furbearers.
5. Plants trees, shrubs, or herbaceous crops for wildlife food and cover.
6. Constructs level ditches in temporary or semipermanent wet lands to create a permanent water area for waterfowl, furbearers, and other wildlife.

7. Constructs shallow ponds and reservoirs that have water-level controls to provide breeding places for waterfowl and denning sites for other wildlife.

Use of Soils for Engineering

This section describes briefly two engineering systems for classifying soils, gives soil test data and interpretations, and discusses engineering uses of some soils. Most of the information is in tables 7, 8, 9, and 10. In table 7 are test data for 14 soils from which samples were taken. Table 8 describes the soils in Sargent County and gives estimates of their physical and chemical properties. Table 9 is an interpretation of the suitability of the soils for engineering purposes. Table 10 gives the location of borrow pits and estimates of the kind and amount of material available.

Other information useful to engineers can be found in the sections "Descriptions of Soils," "Formation and Classification of Soils," and "General Soil Map." The location and distribution of the soils in the county are shown on the soil map in the back of this report.

Technical terms used in this section, as well as in the rest of the report, are used in their agricultural sense, and are so defined in the Glossary. For some terms—for example, clay, silt, sand, granular, and aggregate—the agricultural meaning differs from that generally understood by engineers.

Engineering applications

Engineers can use the information in this report to:

1. Make studies of soil and land use that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Estimate runoff and erosion characteristics of soils in planning farm drainage works, ponds, dams, irrigation systems, and other soil and water conservation structures.
3. Make preliminary evaluations of soils and ground conditions that will aid in selecting locations for highways, airports, and pipelines, and in planning detailed examinations of soil at the selected locations.
4. Locate sources of gravel and other construction materials.
5. Observe performance of engineering structures on soil types and develop information that will be useful in designing and maintaining the structures.
6. Route cross-country movement of vehicles and construction equipment according to the suitability of the soils.
7. Add to information obtained from other sources for the purpose of making maps and reports that can be readily used by engineers.

This report does not eliminate the need for on-site sampling and testing of soils for the design and construction of specific engineering works. The interpretations in this report should be used primarily in planning more detailed field investigations to determine the condition of soil material at the proposed site.

Engineering classification systems

Two engineering systems are in general use for classifying soils. Most highway engineers prefer the system approved by the American Association of State Highway Officials (AASHO) (*1*).[4] The other system, established by the Corps of Engineers, is the Unified System (*9*).

AASHO system.—The AASHO classification of the soils tested in Sargent County is indicated in the second to last column of table 7. This system classifies soil materials in seven principal groups. The groups range from A–1, which are gravelly soils of high-bearing capacity, to A–7, which are clay soils of low strength and low-bearing capacity when wet. Within each group, the relative engineering value of the materials is shown by an index number in parentheses following the soil group symbol. The index numbers range from 0 for the best material to 20 for the poorest.

Unified system.—Many engineers prefer to use the Unified soil classification system established by the Waterways Experiment Station, Corps of Engineers. The Unified classification of soils tested in Sargent County is shown in the last column of table 7. In this system, coarse-grained soil materials are grouped into eight classes: GW, GP, GM, GC, SW, SP, SM, and SC. Fine-grained soil materials are grouped into six classes: ML, CL, OL, MH, CH, and OH. Highly organic soils are in only one class designated as Pt. Soil materials can be approximately classified in the field. Mechanical analyses are used, however, for exact classification of the GW, GP, SW, and SP soils; and mechanical analyses, liquid limit, and plasticity index are used for classifying GM, GC, SM, and SC soils and for all the fine-grained soils. The fine-grained soils are classified, and the secondary component of silty and clayey sands and gravels is identified, by a plasticity chart on which the liquid limit and plasticity index are plotted.

Soil test data

To help evaluate the soils of Sargent County for engineering purposes, the U.S. Bureau of Public Roads tested samples from 14 different soils, as shown in table 7. Of the soils tested, Aastad loam, Forman loam, and Hecla fine sandy loam amount to about 60 percent of the county area. Although there are only small areas of Fargo clay and Exline clay loam, these soils were tested because they may be difficult to handle in engineering construction. Parnell silty clay loam, which occurs in many depressions, was tested for the same reason.

The classifications in the last two columns of table 7 are based on the data obtained from mechanical analyses and tests to determine liquid limits and plastic limits. The mechanical analyses were made according to the procedure described in American Association of State Highway Officials, Designation T–88, which combines sieve and hydrometer methods. The results by this procedure frequently differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service. The mechanical analyses in table 7 are not suitable for naming the textural classes of the soils.

The tests for plastic limit and liquid limit measure the effect of water on the consistency of the soil material. As

[4] Italic numbers in parentheses refer to Literature Cited, p. 96.

moisture is added to a very dry, clayey soil, the material changes from a solid to a semisolid, or plastic. If more water is added, the material changes from a plastic to a liquid. The moisture content at which the soil material passes from a solid to a plastic is the plastic limit. The moisture content at which the soil material passes from a plastic to liquid is the liquid limit. The numerical difference between the plastic limit and the liquid limit is the plasticity index. This index expresses the range of moisture content within which the soil acts as a plastic material.

Table 7 also lists moisture density (compaction) data for the tested soils. Compaction, or compressing soil to a dense state, is desirable (1) to increase strength against shearing; (2) to decrease future settlement; and (3) to decrease permeability.

All facts about compaction are not completely understood, but it is known that the content of water is important when a soil is compacted. If water is added to a dry soil, the soil particles absorb the water and become coated with films of moisture. These films provide lubrication between the soil particles. If a soil material with less than optimum moisture content is compacted at successively increasing moisture content, and the same compactive effort is used, the density of the compacted material will increase up to a maximum. After that, the density will decrease as the moisture content is increased. The greatest density obtained in this compaction test is called the maximum density. The moisture content at which this density was obtained is called the optimum moisture. In earthwork, moisture-density data are important because, as a rule, the best stability is obtained if the soil is compacted to about the maximum density when it is at or near the optimum moisture content.

Engineering descriptions of soils

Table 8 (see p. 54) gives a brief description of the soils in the county and an estimate of their physical and chemical properties. The Unified and AASHO classifications for those soils that were not tested were estimated by comparing them with the tested soils. For any major engineering structure, the information should be supplemented by a detailed soils investigation.

The permeability of soils relates to the downward movement of water through undisturbed soil materials. The range of permeability rates in table 8 are based on limited laboratory data. In the laboratory method used, a constant head of one-half inch of water was provided on a 3-inch core of an undisturbed soil sample until a nearly constant rate of permeability was obtained.

The available water capacity of the soils in inches of water per inch of soil was based primarily on laboratory analysis of soils of similar texture in other counties.

The salinity ratings for the soils are based on the electrical conductivity of saturated soil extract, as expressed in millimhos per centimeter (mmhos/cm) at 25 degrees centigrade. The following ranges in millimhos per centimeter were used to make the ratings: Less than 2 mmhos/cm—none; 2 to 4 mmhos/cm—slight; 4 to 8 mmhos/cm—moderate; 8 to 16 mmhos/cm—severe; and over 16 mmhos/cm—very severe. Depending on the degree of salinity and the quantity of materials affected, a saline condition may seriously affect the piping hazard, internal drainage, and the workability of a soil. Also, salinity restricts the use of vegetation in waterways and other structures.

Dispersion, in table 8, is rated as *high*, *moderate*, or *low*, depending on how readily the soil structure breaks down or slakes because of excess moisture. A rating of *high* indicates that the soil aggregates slake readily. The soils that have a *low* rating are resistant to dispersion.

The ratings of shrink-swell potential are expressed as *low*, *moderate*, and *high* (in table 8). Generally, the A–7 and CH soils have a high shrink-swell potential whereas clean, structureless sands and gravels and those having small amounts of nonplastic to slightly plastic fines have a low shrink-swell potential.

Engineering interpretations of soils

The engineering interpretations in table 9 (see p. 64) are based on the test data in table 7, information in the

TABLE 7.—*Engineering test data* [1]

Soil name and location	Parent material	Bureau of Public Roads report number	Depth	Horizon	Moisture-density: Maximum dry density	Moisture-density: Optimum moisture	Mechanical analysis [2] Percentage passing sieve: 3-in.	Mechanical analysis [2] Percentage passing sieve: 2-in.
			Inches		*Pound per cubic foot*	*Percent*		
Aastad loam (135 feet W. and 90 feet S. of NE. cor. sec. 13, T. 131 N., R. 56 W.)	Glacial till.	S31874	7–14	B_t	101	19		
		S31875	17–28	C_{ca}	119	13		
		S31876	43–60	C_{cs}	120	13		
Borup loam (0.2 mile E. and 80 feet S. of NW. cor. sec. 28, T. 130 N., R. 57 W.)	Glacial delta sediments.	S31892	16–23	A_{12}	100	23		
		S31893	23–36	C_g	110	16		
		S31894	36–50	C_1	105	17		

See footnotes at end of table.

rest of the report, and experience with the same soils in other counties. In table 9 the soils are rated on their suitability as sources of topsoil, and the ratings range from *unsuitable* for Artesian ponds to *excellent* for some loams. These ratings denote degrees of fertility and workability. The soils having large amounts of sand, silt, or clay are generally rated from *poor* to *fair*. Silty clay soils, loamy sands, and sandy loams are rated *fair* to *good*.

Susceptibility to frost action depends on the texture of the soil material, temperature, water content, drainage, and the depth to the water table during the freezing period. A soil generally is not susceptible if less than 10 percent of the soil material passes a No. 200 sieve. Soils that contain a high percentage of silt and clay are generally more susceptible to frost action than soils that have a low percentage of silt and clay.

The suitability of the soil materials for road subgrade and road fill depends mainly on the texture of the soil material and its natural water content. Highly plastic soil materials are rated *very poor* for road subgrade and *very poor* to *fair* for road fill. This kind of subgrade material is classed as A–4 to A–7 in the AASHO system. Sands, fine gravels, and other coarse soil materials are best for subgrade materials, and they are classed as A–3 (good) to A–1 (excellent). Insulating courses of A–1 or A–2 materials are generally required under thin, flexible pavements in places where A–4 to A–7 materials are used in the subgrade.

Ratings for road fill material were determined on the same basis as were ratings for subgrade material. A range in a rating denotes that the profile of the soil varies.

Borrow pits

Table 10 (see p. 74) shows the location, approximate quantity, and quality of all known gravel pits in the county. In general, the sand and gravel material found in Sargent County is limited in quantity and quality. It is unsuitable for concrete aggregate because of the high content of shale, soft rock, and clay. The material from some of the pits has been mixed with local soil material to produce a satisfactory base course for road pavements. Material from some pits has also been mixed with bituminous material to produce a satisfactory pavement for roads that do not have much traffic.

Suitability of soils in soil associations for highway construction

On the general soil map at the back of this report it is apparent that the Forman-Aastad and Forman-Buse soil associations amount to more than 50 percent of the total county area. The major soils in these associations have an AASHO classification of A–6 or A–7, and a group index that ranges from 7 to 10. These major soils are classified CL and ML–CL in the Unified system. The soils are generally poor for road subgrades and require a base course of sandy or gravelly material before flexible pavement is laid on them.

The soils of the Exline-Aberdeen, the Hegne-Fargo, and the Overly-Fargo associations are poor to very poor for road subgrades. These soils are very plastic and have a high shrink-swell potential. If the soils are too wet when pavement is laid, it will crack lengthwise when the soils dry. This cracking can be controlled to some extent by compacting these soils to maximum density when their moisture content is slightly higher than optimum. Warping caused by wetting and drying of the soil will be minimized if soil material having low volume change is used under the pavement as a blanket course.

The soils of the Valentine-Hecla, the Hecla-Renshaw, and the Valentine soil associations are very good for road subgrade. The soils in the other soil associations are fair to good as road subgrade materials.

Major soil variations may occur within the depth of the proposed excavation, and several different soils may occur within short distances of each other. This is especially true of the Forman-Aastad and the Barnes-Svea soil associations. The detailed soil map at the back of this report shows the location of each soil mapping unit and will give engineers some idea of how intermingled the soils are.

for soil samples from profiles of 14 soils

Mechanical analysis [2]—Continued												Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued								Percentage smaller than						AASHO [3]	Unified [4]
1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
------	------	------	100	99	91	84	66	63	52	36	29	41	18	A–7–6(10)	CL.
------	------	------	100	99	95	85	61	57	45	35	28	31	15	A–6(7)	CL.
100	99	97	94	91	83	74	54	51	42	30	23	27	14	A–6(5)	CL.
------	------	------	------	------	100	97	73	(5)	------	------	------	33	5	A–4(8)	ML.
------	------	------	------	------	100	99	95	85	45	24	17	29	7	A–4(8)	ML–CL.
------	------	------	------	------	------	100	98	83	38	18	14	32	5	A–4(8)	ML.

TABLE 7.—*Engineering test data*[1] *for soil*

Soil name and location	Parent material	Bureau of Public Roads report number	Depth	Horizon	Moisture-density: Maximum dry density	Moisture-density: Optimum moisture	Mechanical analysis[2] — Percentage passing sieve: 3-in.	Mechanical analysis[2] — Percentage passing sieve: 2-in.
			Inches		*Pound per cubic foot*	*Percent*		
Exline clay loam (Exline complex) (80 feet E. and 760 feet N. of SW. cor. sec. 4, T. 132 N., R. 53 W.)	Lacustrine sediments.	S31886	5–9	B_2	103	19		
		S31887	14–26	C_{ca}	104	19		
		S31888	39–53	D_2	101	16		
Fargo clay (W¼ cor. sec. 6, T. 129 N., R. 54 W.)	Lacustrine clay.	S31889	0–8	A_p	87	26		
		S31890	8–26	B_g	90	26		
		S31891	32–60	C_{ca}	111	16		100
Forman loam (1,250 feet E. and 150 feet S. of NW. cor. sec. 18, T. 130 N., R. 53 W.)	Glacial till.	S31879	0–8	A_{1p}	94	22	100	96
		S31880	8–14	B_2	100	20		
		S31881	17–26	C_{cal}	118	13		
Hamerly silt loam (Hamerly complex) (74 feet W. and 228 feet S. of NE. cor. sec. 19, T. 132 N., R. 55 W.)	Glacial till.	S31898	0–8	A_{1p}	92	24		
		S31899	8–20	A_{ca}	98	21		
		S31900	31–38	C_{cs}	113	17		
Hecla fine sand (0.2 mile E. of NW. cor. sec. 14, T. 129 N., R. 57 W.)	Eolian fine sand.	S31884	6–30	A_1	104	14		
		S31885	30–46	C	103	15		
Hecla fine sandy loam (200 feet N. of W¼ cor. sec. 3, T. 130 N., R. 57 W.)	Eolian sand.	S31901	0–16	A	108	14		
		S31902	16–26	B	109	14		
		S31903	36–52	C	109	13		
Hecla loamy fine sand (1,060 feet E. and 75 feet N. of S¼ cor. sec. 32, T. 129 N., R. 57 W.)	Lacustrine sediments.	S31882	8–20	AB	108	15		
		S31883	28–58	B_{12}, C, and C_c	108	13		
Lamoure silty clay loam (1,158 feet N. of SW. cor. sec. 25, T. 132 N., R. 53 W.)	Alluvium.	S31895	0–7	A_{11}	87	28		
		S31896	20–27	B_g	102	20		
		S31897	27–36	C_{cag}	114	14		
Parnell silty clay loam (430 feet E. and 110 feet S. of N¼ cor. sec. 18, T. 130 N., R. 55 W.)	Lacustrine sediments.	S31904	10–22	B_{21}	95	24		
		S31905	22–44	B_{22} and B_{23}	95	24		
		S31906	44–50	C_1	97	23		
Stirum loam (970 feet W. and 123 feet S. of E¼ cor. sec. 4, T. 130 N., R. 57 W.)	Lacustrine sediments.	S31877	10–18	B_2	114	14		
		S31878	30–46	D_1 and D_2	109	14		
Tetonka silt loam (100 feet W. and 900 feet N. of SE. cor. sec. 15, T. 131 N., R. 56 W.)	Glacial till.	S31907	6–11	A_2	93	24		
		S31908	11–27	B_{21} and B_{22}	103	20		
		S31909	34–53	C_{ca1} and C_{ca2}	119	13		100
Ulen fine sandy loam (50 feet S. of W¼ cor. sec. 3, T. 132 N., R. 54 W.)	Lacustrine sediments.	S31910	4–12	B_{12}	115	13		
		S31911	20–40	C	114	13		
		S31912	45–60	C_{ca}	120	12		

[1] Tests performed by the Bureau of Public Roads in accordance with standard procedures of the American Association of State Highway Officials (AASHO).

[2] Mechanical analyses according to the American Association of State Highway Officials Designation: T 88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

samples from profiles of 14 soils—Continued

Mechanical analysis [2]—Continued												Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued								Percentage smaller than						AASHO [3]	Unified [4]
1½-in.	1-in.	¾-in.	⅜-in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
------	------	------	------	------	------	100	72	65	52	38	31	40	20	A-6(11)	CL.
------	------	------	------	------	------	100	82	81	76	63	49	52	30	A-7-6(18)	CH.
------	------	------	------	------	------	100	8	7	6	5	5	(6)	(6)	A-3(0)	SP-SM.
------	------	------	------	------	100	98	91	89	76	60	48	57	23	A-7-5(17)	MH.
------	------	------	------	------	100	98	90	86	78	65	55	58	30	A-7-6(20)	CH.
99	98	98	97	95	93	86	72	69	57	44	34	40	21	A-6(12)	CL.
96	95	95	95	95	93	88	69	65	54	36	28	44	17	A-7-6(10)	ML-CL.
------	------	100	99	98	97	90	70	65	52	39	32	41	17	A-7-6(10)	ML-CL.
------	------	100	99	97	94	86	67	62	50	37	28	33	17	A-6(9)	CL.
------	------	------	100	99	98	94	80	76	60	43	35	49	19	A-7-5(13)	ML.
------	------	------	------	------	100	97	83	79	66	51	43	50	18	A-7-5(13)	ML.
------	------	------	100	99	97	88	67	(5)	------	------	------	33	15	A-6(8)	CL.
------	------	------	------	------	------	100	17	10	9	7	5	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	------	100	14	7	5	5	3	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	------	100	26	19	14	11	8	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	------	100	25	16	12	10	9	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	------	100	22	16	13	11	9	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	------	100	37	23	12	9	7	(6)	(6)	A-4(0)	SM.
------	------	------	------	------	------	100	29	20	11	9	8	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	------	100	73	68	55	40	33	56	26	A-7-5(17)	MH-CH.
------	------	------	------	------	------	100	79	73	57	45	38	41	20	A-7-6(12)	CL.
------	------	------	------	------	100	98	66	58	41	32	27	28	12	A-6(7)	CL.
------	------	------	------	------	100	99	95	93	81	60	49	53	27	A-7-6(17)	CH.
------	------	------	------	------	100	99	95	93	79	61	50	54	30	A-7-6(19)	CH.
------	------	------	------	------	100	99	94	91	78	56	44	52	28	A-7-6(18)	CH.
------	------	------	------	------	------	100	51	43	34	30	26	26	10	A-4(3)	CL.
------	------	------	------	------	------	100	34	20	13	10	8	(6)	(6)	A-2-4(0)	SM.
------	------	100	99	99	97	93	78	73	58	39	30	42	15	A-7-6(10)	ML-CL.
------	------	------	100	99	93	87	65	62	50	40	35	42	22	A-7-6(11)	CL.
99	98	97	95	93	88	81	62	59	44	33	26	32	17	A-6(8)	CL.
------	------	------	------	------	100	98	29	23	16	12	11	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	100	97	23	17	13	11	11	(6)	(6)	A-2-4(0)	SM.
------	------	------	------	------	100	97	52	45	40	31	26	24	10	A-4(3)	CL.

[3] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (Pt. 1, Ed. 7): The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, AASHO Designation: M 145-49.

[4] Based on the Unified Soil Classification System, Technical Memorandum No. 3-357, v. 1, Waterways Experiment Station, Corps of Engineers, March 1953.

[5] Hydrometer test could not be performed because of the presence of calcium sulfate.

[6] Nonplastic.

TABLE 8.—*Brief description of soils and their*

[Absence of data

Map symbol	Soil name	Site and soil description	Depth of profile	Classification
				USDA
			Inches	
Aa	Aastad clay loam.	Nearly level, moderately fine textured soil in glacial till; 3 feet to seasonally high water table.	0 to 60	Clay loam
Ab	Aastad loam.	Deep, dark, nearly level, medium-textured soil in glacial till; 3 feet to seasonally high water table.	0 to 60	Loam
Ac	Aastad-Cresbard loams.	Deep, dark, nearly level, medium-textured soil in glacial till; 3 feet to seasonally high water table. About 40 percent of the mapping unit is Cresbard loam, which has a medium-textured surface layer and a fine-textured, slowly permeable subsoil; 2½ feet to seasonally high water table.	0 to 14 14 to 60	Loam Clay loam and clay
Ad	Aberdeen silt loam.	Nearly level, medium-textured soil that formed in glacial lake basins over moderately fine textured, water-deposited material and has a slowly permeable subsoil; 3 feet to seasonally high water table.	0 to 8 8 to 60	Silt loam Clay and clay loam
Ae	Aberdeen-Exline silty clay loams.	Like Aberdeen silt loam, but underlain by sandy materials at a depth of 24 to 48 inches; 2½ feet to seasonally high water table.	0 to 5 5 to 24 or 48 24 or 48 to 60	Silty clay loam Clay Fine sand and silt loam
Am	Artesian ponds.	Depressions that catch overflow from artesian wells; variable depth to seasonally high water table.	Variable	
An	Arveson fine sandy loam.	Dark, moderately fine textured, moderately wet soil in depressions of glacial lake plains; 1½ feet to seasonally high water table.	0 to 18 18 to 60	Fine sandy loam Loamy fine sand and fine sand.
BbC BbC2	Barnes-Buse loams, rolling. Barnes-Buse loams, rolling, eroded.	Medium-textured soils in glacial till that has kame and kettle topography and slopes of 3 to 9 percent; 4 feet to seasonally high water table.	0 to 60	Loam
Bc	Barnes-Buse stony loams.	Soils that have enough stones to prevent cultivation but are otherwise similar to Barnes-Buse stony loams; 4 feet to seasonally high water table.	0 to 60	(2)
BdB BdB2	Barnes-Svea loams, undulating. Barnes-Svea loams, undulating, eroded.	Deep, dark, medium-textured soils in glacial till; 4 feet to seasonally high water table.	0 to 60	Loam
Bf	Beardon silty clay loam.	Moderately fine textured, calcareous soil in water-deposited materials; 2½ feet to seasonally high water table.	0 to 60	Silty clay loam
Bk	Beardon-Tetonka silt loams.	Medium to moderately fine textured soils in water-deposited materials; 2½ feet to seasonally high water table.	0 to 60	Silt loam and silty clay loam.
Br	Borup, Colvin, and Perella soils.	Medium-textured soils in depressions of glacial lake basins; 1 foot to seasonally high water table.	0 to 60	Silt loam
BvD	Buse-Barnes loams, strongly rolling.	Medium-textured soils in glacial till that has slopes of 0 to 25 percent; 4 feet to seasonally high water table.	0 to 60	Loam
BvD2	Buse-Barnes loams, strongly rolling, eroded.	Eroded soils that are otherwise like Buse-Barnes loams, strongly rolling.	0 to 60	Loam

See footnotes at end of table.

estimated physical and chemical properties [1]

indicated by dashed lines]

Classification—Continued		Percentage passing			Permeability	Available water capacity	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve					
					Inches per hour	*Inches per inch*			
CL	A-6	97	90 to 95	65 to 85	0. 2 to 5. 0	0. 166	None	Low	Moderate.
CL	A-6	97	85 to 95	55 to 75	0. 2 to 5. 0	0. 166	None	Low	Moderate.
CL	A-6	97	85 to 95	60 to 80	0. 8 to 5. 0	0. 166	None	Low	Moderate.
CH	A-7	97	80 to 90	60 to 70	0. 2 to 5. 0	0. 166	Moderate	Moderate	High.
CL	A-6	100	100	70 to 80	0. 8 to 2. 5	0. 166	None	Low	Moderate.
CH	A-7	100	100	75 to 90	0. 0 to 0. 2	0. 183	Moderate to severe.	High	High.
CL	A-6	100	100	70 to 85	0. 8 to 2. 5	0. 166	None	Low	Moderate.
CH	A-7	100	100	80 to 95	0. 0 to 0. 2	0. 183	Moderate to severe.	High	High.
SM	A-2	100	100	20 to 30	2. 5 to 5+	0. 066	None	Low	Low.
CL	A-6	100	100	50 to 80	0. 8 to 2. 5	0. 166	None	Low	Moderate.
----------	----------	----------	----------	----------	----------	----------	Severe	Variable	Variable.
SM	A-2	100	100	25 to 40	2. 5 to 5. 0	0. 141	Moderate	Low	Low.
SM	A-2	100	100	15 to 25	5+	0. 100	Slight	Low	Low.
CL	A-6	95	80 to 90	55 to 75	0. 2 to 5. 0	0. 166	None	Low	Moderate.
----------	----------	----------	----------	----------	----------	----------	----------	----------	
CL	A-6	96	85 to 95	50 to 70	----------	----------	None	Low	Moderate.
CL	A-6	100	100	75 to 90	0. 2 to 2. 5	0. 183	Moderate	Low	Moderate.
CL	A-6	100	100	75 to 90	0. 2 to 2. 5	0. 183	Moderate	Low	Moderate.
ML	A-4	100	100	65 to 85	0. 8 to 2. 5	0. 166	Moderate	Low	Moderate.
CL	A-6	90 to 95	75 to 85	55 to 70	0. 8 to 5. 0	0. 166	None	Low	Moderate.
CL	A-6	90 to 95	85 to 90	60 to 80	0. 8 to 5. 0	0. 166	None	Low	Moderate.

TABLE 8.—*Brief description of soils and their*

[Absence of data

Map symbol	Soil name	Site and soil description	Depth of profile	Classification
				USDA
			Inches	
Cp	Colvin and Perella soils, saline.	Deep, moderately wet, calcareous soils that are in depressions of the glacial lake plain and may be underlain by sand at depths greater than 3 feet; 1½ feet to seasonally high water table.	0 to 12 12 to 60	Silty clay loam Clay loam
Dc	Dimmick clay.	Deep, dark, fine-textured soil in depressions of glacial lake plains; 1½ feet to seasonally high water table.	0 to 60	Clay
Dm	Dimmick clay, basins.	Wet soil that is similar to Dimmick clay but is limy and ponded occasionally.	0 to 60	Clay
Dv	Divide loam.	Moderately deep, medium-textured, slightly wet soil over sand and gravel; 2½ feet to seasonally high water table.	0 to 20 20 to 60	Loam Gravelly coarse sand
EcA EcB	Eckman silt loam, nearly level. Eckman silt loam, undulating.	Medium-textured soils in medium-textured, water-deposited materials of glacial lake basins; 0 to 6 percent slopes; 4 feet to seasonally high water table.	0 to 40 40 to 60	Silt loam Silt loam
EmB EmC	Eckman and Maddock loams, undulating. Eckman and Maddock loams, rolling.	Soils similar to Eckman silt loam but underlain by sandy material at a depth of 20 to 40 inches; 5 feet to seasonally high water table.	0 to 30 30 to 60	Loam Fine sandy loam and loamy fine sand.
Ex	Exline complex.	Very nearly level, moderately fine and fine textured soils with a heavy, very slowly permeable subsoil; 2 feet to seasonally high water table; limy, sandy, and clayey layers at a depth of 2 to 5 feet.	0 to 5 5 to 60	Clay and clay loam Clay
Fc	Fargo clay.	Deep, dark, fine-textured soil in water-deposited clay; 3 feet to seasonally high water table.	0 to 8 8 to 60	Clay Clay
FoB FoB2 Fs	Forman-Aastad loams, undulating. Forman-Aastad loams, undulating, eroded. Forman-Aastad stony loams.	Deep, medium and moderately fine textured soils in glacial till; 3 feet to seasonally high water table, except in Forman-Aastad stony loams, which have a seasonally high water table at a depth of 4 feet.	0 to 60	Loam
FvC FvC2	Forman-Buse loams, rolling. Forman-Buse loams, rolling, eroded.	Deep, dark, medium-textured soils in glacial till that has kame and kettle topography; 4 feet to seasonally high water table.	0 to 60	Loam
Fw	Fresh water marsh.	Depressions in the glacial lake plain that contain water most of the time.		
Ga	Gannett loamy fine sand.	Coarse-textured soil in depressions of sandy material; 1 foot to seasonally high water table.	0 to 60	Loamy fine sand and fine sand.
GgA	Gardena-Glyndon loams, sandy substratum, nearly level.	Deep, dark, medium-textured soils in silty glacial lake material; sandy substratum at about 20 inches; 5 feet to seasonally high water table.	0 to 20 20 to 60	Loam Loamy fine sand and fine sand.
GmA	Gardena-Glyndon silt loams, nearly level.	Deep, dark, nearly level, medium-textured soils in silty glacial lake material; 3 feet to seasonally high water table.	0 to 60	Silt loam
GoA	Glyndon loam, sandy substratum, nearly level.	Deep, calcareous soil, in water-deposited material that overlies a sandy substratum; 2½ feet to seasonally high water table.	0 to 20 20 to 60	Loam Loamy fine sand and fine sand.

See footnotes at end of table.

estimated physical and chemical properties [1]—Continued

indicated by dashed lines]

Classification—Continued		Percentage passing			Permeability	Available water capacity	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve					
					Inches per hour	*Inches per inch*			
ML-CL	A-7	100	100	75 to 95	0. 8 to 5. 0	0. 166	Moderate	Low	Moderate.
CL	A-6	100	100	70 to 90	0. 2 to 5. 0	0. 166	Severe	Moderate	Moderate.
CH	A-7	100	100	85 to 95	0. 2 to 5. 0	0. 183	None	Low	High.
CH	A-7	100	100	90 to 95	0. 2 to 5. 0	0. 183	Slight	Low	High.
CL	A-4, A-6	99	65 to 85	50 to 65	2. 0	0. 166	Slight	Low	Moderate.
SM	A-1, A-2	70 to 85	55 to 65	5 to 15	------------	0. 041	None	Low	Low.
CL	A-4	100	100	65 to 80	0. 2 to 0. 5	0. 166	None	Low	Low.
ML-CL	A-4	100	100	80 to 90	0. 2 to 0. 5	0. 166	None	Low	Low.
CL	A-4	100	100	65 to 80	0. 8 to 5. 0	0. 166	None	Low	Low.
SM	A-2	100	100	20 to 30	2. 5 to 5. 0	0. 083	None	Low	Low.
CL	A-6	100	100	80 to 90	0. 2 to 2. 5	0. 166	None	Low	High.
CH	A-7	100	100	85 to 95	0. 0 to 0. 2	0. 150	None	High	High.
MH	A-7	100	100	85 to 95	0. 2 to 5. 0	0. 150	None	Low	High.
CH	A-7	100	100	85 to 95	0. 0 to 0. 2	0. 183	None	Low	High.
CL	A-7	96	80 to 90	55 to 70	0. 2 to 5. 0	0. 166	None	Low	Moderate.
CL	A-6	96	80 to 90	60 to 75	0. 2 to 5. 0	0. 166	None	Low	Low.
SM	A-2	100	100	15 to 30	5+	0. 083	None	Low	Low.
CL	A-6	100	100	60 to 80	0. 8 to 5. 0	0. 150	None	Low	Low.
SM	A-2	100	100	20 to 35	5+	0. 100	None	Low	Low.
ML-CL	A-6	100	100	65 to 85	0. 2 to 5. 0	0. 166	None	Low	Low.
CL	A-6	100	100	60 to 80	0. 8 to 5. 0	0. 150	None	Low	Low.
SM	A-2	100	100	20 to 30	5+	0. 100	None	Low	Low.

TABLE 8.—*Brief description of soils and their*

[Absence of data

Map symbol	Soil name	Site and soil description	Depth of profile	Classification USDA
			Inches	
GsA	Glyndon silt loam, nearly level.	Deep, calcareous soil in water-deposited material; 2½ feet to seasonally high water table.	0 to 60	Silt loam
Ha	Hamar fine sandy loam.	A noncalcareous, moderately light textured, moderately wet soil in depressions of sandy material; rapidly permeable subsoil and substratum; 1½ feet to seasonally high water table.	0 to 60	Fine sandy loam
Hb	Hamerly complex.	Moderately fine textured, calcareous soils in glacial till; 2½ feet to seasonally high water table.	0 to 60	Loam and clay loam
Hf	Hamerly-Aastad loams.	A complex of Hamerly and Aastad loams. See Hamerly complex and Aastad loam for descriptions; 3 feet to seasonally high water table.		
Hh	Hamerly-Svea loams.	Deep, calcareous soils in medium-textured glacial till. See data for Hamerly complex and Svea loam.		
Hkx	Hecla fine sand.	Coarse-textured soil that is dark in color to a depth of 10 to 20 inches and is underlain by light-colored fine sand; 5 feet to seasonally high water table.	0 to 12 12 to 60	Loamy fine sand Fine sand
HlAx HlBx	Hecla fine sandy loam, nearly level. Hecla fine sandy loam, undulating.	Dark, moderately coarse textured soils that have coarse-textured subsoil and substratum; 5 feet to seasonally high water table.	0 to 20 20 to 60	Fine sandy loam Loamy fine sand and fine sand.
HmA	Hecla fine sandy loam, moderately shallow, nearly level.	Moderately coarse textured and coarse textured soil, underlain by medium to fine-textured water-deposited material; 4 to 5 feet to seasonally high water table.	0 to 30 30 to 60	Fine sandy loam and loamy fine sand. Silty clay loam
HnAx	Hecla loamy fine sand, nearly level.	Coarse-textured soil in water-deposited sands that may have been reworked by wind. Severely eroded areas have a choppy relief of generally less than 5 feet; 5 feet to seasonally high water table.	0 to 60	Loamy fine sand
HoA	Hecla loamy fine sand, moderately shallow, nearly level.	Coarse-textured soil, underlain by silty material at 1½ to 4 feet; 4 to 5 feet to seasonally high water table.	0 to 30 30 to 60	Loamy fine sand Loam
Hwx	Hecla-Maddock loamy fine sands.	Deep, very sandy soils on slopes of 3 to 9 percent; 4 to 5 feet to seasonally high water table.	0 to 60	Loamy fine sand
Hz	Hegne clay.	Deep, fine-textured, calcareous soil in water-deposited clay on the very nearly level glacial lake plain; 2 feet to seasonally high water table.	0 to 60	Clay
Hfa	Hegne-Fargo clays.	Complex of Hegne clay and Fargo clay. See those soils for descriptions.		
La	Lamoure silty clay loam.	Deep, moderately wet soil on bottom land; generally calcareous at or near surface; may be saline in some places; 1½ feet to seasonally high water table.	0 to 60	Silty clay loam
Lf	La Prairie and Fairdale soils.	Deep, dark, very nearly level soils on bottom land	0 to 60	Silt loam and silty clay loam.

See footnotes at end of table.

estimated physical and chemical properties [1]—Continued

indicated by dashed lines]

Classification—Continued		Percentage passing			Permeability	Available water capacity	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve					
					Inches per hour	*Inches per inch*			
ML–CL	A–6	100	100	65 to 85	0. 8 to 5. 0	0. 166	None	Low	Low.
SM	A–2	100	100	20 to 35	2. 5 to 5. 0	0. 116	None	Low	Low.
CL	A–6	97	85 to 95	55 to 75	0. 2 to 5. 0	0. 166	Slight	Low	Moderate.
					5. 0				
SM	A–2	100	100	25 to 40	5+	0. 083	None	Low	Low.
SM	A–2	100	100	15 to 25	5+	0. 058	None	Low	Low.
SM	A–2	100	100	25 to 40	2. 5 to 5+	0. 141	None	Low	Low.
SM	A–2	100	100	15 to 30	5+	0. 100	None	Low	Low.
SM	A–2	100	100	15 to 30	2. 5 to 5. 0	0. 125	None	Low	Low.
CL	A–6	100	100	75 to 90	0. 2 to 5. 0	0. 166	None	Moderate	Moderate.
SM	A–2	100	100	15 to 30	5+	0. 100	None	Low	Low.
SM	A–2	100	100	15 to 30	5+	0. 100	None	Low	Low.
CL	A–6	98	95	60 to 80	0. 2 to 5. 0	0. 166	None	Low	Low.
SM	A–2	100	100	15 to 30	5+	0. 083	None	Low	Low.
CH	A–7	100	100	80 to 95	0. 2 to 5. 0	0. 183	None	Low	High.
CL	A–7	100	100	70 to 85	0. 2 to 5. 0	0. 183	None to slight	Low	Moderate.
CL	A–7	100	100	70 to 90	0. 2 to 5. 0	0. 166	None	Low	Moderate.

TABLE 8.—*Brief description of soils and their*

[Absence of data

Map symbol	Soil name	Site and soil description	Depth of profile	Classification USDA
			Inches	
Lp	La Prairie silt loam.	Deep, dark, very nearly level soil on bottom land; 4 feet to seasonally high water table.	0 to 60 0 to 60	Silt loam Silty clay loam
MdBx	Maddock loamy fine sand, undulating.	Fine-textured soil, on 3 to 6 percent slopes, that is underlain by glacial till at a depth of 12 to 28 inches; 3 to 5 feet to seasonally high water table.	0 to 12 or 48 12 or 48 to 60	Loamy fine sand and fine sand. Clay loam
MdC	Maddock loamy fine sand, rolling.	Fine-textured soil, on 6 to 15 percent slopes, that is underlain by glacial till at a depth of 18 inches; 4 to 5 feet to seasonally high water table.	0 to 18 or 60 18 to 60	Loamy fine sand and fine sand. Clay loam
MkAx MkBx MkCx	Maddock fine sandy loam, moderately shallow, nearly level. Maddock fine sandy loam, moderately shallow, undulating. Maddock fine sandy loam, moderately shallow, rolling.	Moderately fine textured soils, on 0 to 6 percent slopes, that are underlain by glacial till at a depth of about 20 inches; 4 to 5 feet to seasonally high water table.	0 to 20 or 40 20 or 40 to 60	Fine sandy loam Clay loam
OaA OcB	Overly silt loam, nearly level. Overly silty clay loam, undulating.	Deep, dark, medium to moderately fine textured soils in water-deposited material; 4 feet to seasonally high water table.	0 to 60 0 to 60	Silt loam Silty clay loam
Os	Overly-Aastad silt loams.	Complex of Overly silt loam and Aastad loam. See those soils for description.	----------	----------
OvC	Overly and Barnes silt loams, rolling.	Water-deposited soils and glacial-till soils, on 3 to 9 percent slopes, in an area between the glacial lake plain and the glacial till plain; 3 feet to seasonally high water table.	0 to 60	Silt loam
OyA	Overly-Bearden silty clay loams, nearly level.	Complex of Overly silty clay loam and Bearden silty clay loam. See those soils for description.	----------	----------
Pa	Parnell soils.	Moderately fine textured soil in kettle holes or other depressions of the glacial till plain; ponded occasionally.	0 to 60	Silty clay loam
Pe	Perella silty clay loam.	Deep, dark, noncalcareous soil in depressions of the glacial lake plain; 1½ feet to seasonally high water table.	0 to 30 30 to 60	Silty clay loam Silty clay loam
Ra	Rauville soils.	Wet, poorly drained soils in calcareous, water-deposited material on bottom lands. Stratified sands, silts, and clays at depth of 30 inches.	0 to 30 30 to 60	Silty clay loam Variable
RhA RhB	Renshaw loam, nearly level. Renshaw loam, undulating.	Moderately deep, medium-textured soils underlain by gravel and sand at depth of 16 to 36 inches; 5 feet to seasonally high water table.	0 to 18 or 36 18 or 36 to 60	Loam Gravel and sand
Ro	Renshaw and Sioux soils.	Shallow soils underlain by gravel less than 16 inches from the surface; 5 feet to seasonally high water table.	0 to 10 or 16 10 or 16 to 60	Loam and sandy loam Gravel
SpA	Spottswood-Wessington loams, nearly level.	Medium-textured soils underlain by shaly sand and gravel at depth of about 2 feet; 5 feet to seasonally high water table.	0 to 24 24 to 60	Loam Sand and gravel
St	Stirum and Arveson loams.	Medium-textured, saline soils in low areas of the glacial lake plain, underlain by sandy material at depth of 18 to 30 inches; generally high in percentage of exchangeable sodium below the top 6 inches; 1½ feet to seasonally high water table.	0 to 18 or 30 18 or 30 to 60	Loam Loamy fine sand and fine sand.

See footnotes at end of table.

estimated physical and chemical properties [1]—Continued

indicated by dashed lines]

Classification—Continued		Percentage passing			Permeability	Available water capacity	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve					
					Inches per hour	*Inches per inch*			
CL	A-6	100	100	65 to 85	0.2 to 5.0	0.166	None	Low	Low.
CL	A-7	100	100	75 to 90	0.2 to 5.0	0.183	None	Low	Moderate.
SM	A-2	100	100	15 to 30	5+	0.058	None	Low	Low.
CL	A-6	96	75 to 90	55 to 70	0.2 to 2.5	0.183	Slight	Low	Moderate.
SM	A-2	100	100	15 to 30	5+	0.058	None	Low	Low.
CL	A-6	96	75 to 90	55 to 70	0.2 to 2.5	0.183	Slight	Low	Moderate.
SM	A-2	100	100	20 to 35	2.5 to 5.0	0.133	None	Low	Low.
CL	A-6	96	75 to 90	55 to 70	0.2 to 2.5	0.183	Slight	Low	Moderate.
CL	A-6	100	100	70 to 90	0.2 to 5.0	0.166	None	Low	Low.
CH	A-7	100	100	75 to 95	0.2 to 5.0	0.183	None	Low	High.
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CL	A-6	98	90 to 95	65 to 85	0.2 to 5.0	0.166	None	Low	Low.
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CH	A-7	99	97	90 to 95	0.2 to 2.5	0.183	None	Low	High.
CH	A-7	100	100	80 to 90	0.2 to 0.5	0.166	None	Low	Moderate.
CH	A-7	100	100	80 to 90	0.2 to 0.5	0.166	None	Low	Moderate.
CL	A-6	100	100	85	0.2 to 5.0	0.166	None	Low	Moderate.
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ML	A-4	100	100	60 to 80	2.5 to 5.0	0.150	None	Low	Low.
GW, SW	A-1	50	15 to 30	5	5+	0.016	None	Low	Low.
ML	A-4	97	97	50 to 70	2.5 to 5.0	0.150	None	Low	Low.
GW	A-3	30 to 45	10 to 20	5	5+	0.016	None	Low	Low.
ML	A-4	100	100	50 to 60	2.5 to 5.0	0.150	None	Low	Low.
SW, GW	A-1	20 to 75	10 to 35	3 to 5	5+	0.016	None	Low	Low.
CL	A-4	100	100	55 to 70	0.2 to 5.0	0.150	Slight	Moderate	Low.
SM	A-2	100	100	20 to 35	2.5 to 5+	0.100	Moderate	Low	Low.

TABLE 8.—*Brief description of soils and their*

[Absence of data

Map symbol	Soil name	Site and soil description	Depth of profile	Classification
				USDA
			Inches	
Sv	Svea loam.	Deep, medium-textured soil in friable glacial till; 3 feet to seasonally high water table.	0 to 60	Loam
Tk	Tetonka silt loam.	Deep soil that has a distinct, gray, leached horizon and is in kettle holes or other depressions of the glacial till plain; 1½ feet to seasonally high water table.	0 to 15 15 to 60	Silt loam Clay loam
Tp	Tetonka and Parnell soils.	See Tetonka silt loam and Parnell soils for description; 1½ feet to seasonally high water table.	----------	----------
Un	Ulen fine sandy loam, moderately shallow.	Deep, moderately sandy, calcareous soil over medium-textured glacial till or lacustrine silts.	0 to 36 36 to 60	Fine sandy loam Loam
VaD	Valentine fine sand, hilly.	Stabilized sand that is dark in the top 1 or 2 inches and has relief of about 50 feet; 5 feet to seasonally high water table.	1 to 60	Fine sand
VhC	Valentine-Hecla fine sands, hummocky.	About 5 inches of dark loamy fine sand and fine sand underlain by a lighter colored fine sand in choppy relief that varies from 3 to 8 feet; 5 feet to seasonally high water table.	0 to 60	Loamy fine sand and fine sand.
ZmC ZmD	Zell silt loam, rolling. Zell silt loam, hilly.	Deep, medium-textured soils with a thin surface layer; along banks of the Wild Rice River; 5 feet to seasonally high water table.	0 to 60	Silt loam

[1] All soils are slightly alkaline; average pH values in soil profile vary from 6.5 to 8.3.

estimated physical and chemical properties [1]—Continued

indicated by dashed lines]

Classification—Continued		Percentage passing			Permeability	Available water capacity	Salinity	Dispersion	Shrink-swell potential
Unified	AASHO	No. 4 sieve	No. 10 sieve	No. 200 sieve					
					Inches per hour	*Inches per inch*			
CL	A-6	96	90 to 95	55 to 75	0. 2 to 5. 0	0. 166	None	Low	Moderate.
ML-CL	A-7	99	90 to 95	70 to 85	0. 2 to 5. 0	0. 150	None	Low	Low.
CL	A-6	92	80 to 90	55 to 75	0. 2 to 5. 0	0. 166	None	Low	Moderate.
SM	A-2	100	100	25 to 35	2. 5 to 5. 0	0. 141	None	Low	Low.
CL	A-6	96	92	55 to 70	0. 2 to 5. 0	0. 166	None	Low	Moderate.
SM	A-2	100	100	15 to 25	5+	0. 041	None	Low	Low.
SM	A-2	100	100	15 to 30	5+	0. 058	None	Low	Low.
ML-CL	A-6	100	100	70 to 90	0. 2 to 5. 0	0. 150	None	Low	Low.

[2] About 60 percent of material will not pass the 3-inch sieve; majority of stones are larger than 1 foot in diameter.

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Table 9.—*Engineering*

Map symbol	Soil	Susceptibility to frost action	Suitability of soil material for—		Suitability as source of—		Vertical alinement for highways	
			Road subgrade	Road fill	Topsoil	Sand and gravel	Soil material	Drainage
Aa	Aastad clay loam.	Susceptible	Poor	Poor	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; moderate shrink-swell potential.	May need some drainage in low areas.
Ab	Aastad loam.	Moderately susceptible.	Poor	Fair	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; moderate shrink-swell potential.	Low areas may need drainage.
Ac	Aastad-Cresbard loams.	Moderately susceptible.	Very poor	Fair to poor	Fair	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; low to high shrink-swell potential; some dispersion.	May need some drainage.
Ad	Aberdeen silt loam.	Susceptible	Poor to very poor.	Poor to very poor.	Fair	Unsuitable	Subject to volume change; not suitable under thin, flexible base courses or bituminous surfaces; lacks bearing power after moisture enters.	Seasonal high water table; may need drainage.
Ae	Aberdeen-Exline silty clay loams.	Susceptible	Poor to very poor.	Poor	Fair	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; low to high shrink-swell potential; some dispersion.	Need drainage
Am	Artesian ponds.	Susceptible	Unsuitable; high water table and dispersion.	Unsuitable; dispersion and salt content.	Unsuitable	Unsuitable	Unsuitable	Need drainage
An	Arveson fine sandy loam.	Susceptible	Fair	Fair	Poor; saline	Poor; high content of silt.	Suitable under thin, flexible base courses or bituminous surfaces; not subject to volume change.	Needs some drainage; high water table.
BbC BbC2	Barnes-Buse loams, rolling. Barnes-Buse loams, rolling, eroded.	Slightly susceptible.	Fair	Fair	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; should have a course of A-1 or A-2 soils.	Generally well drained.
Bc	Barnes-Buse stony loams.	Slightly susceptible.	Fair	Fair	Poor because of stones.	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; should have a course of A-1 or A-2 soils; contain many stones more than 1 foot in diameter.	Generally well drained.
BdB BdB2	Barnes-Svea loams, undulating. Barnes-Svea loams, undulating, eroded.	Slightly susceptible.	Fair	Fair	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces.	Generally not needed.
Bf	Bearden silty clay loam.	Susceptible	Poor	Poor	Excellent	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; should have a course of A-1 or A-2 soils.	Surface and subsurface drainage needed.
Bk	Bearden-Tetonka silt loams.	Susceptible	Poor	Poor	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces.	Need some drainage.
Br	Borup, Colvin, and Perella soils.	Very susceptible.	Poor	Poor	Excellent	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; should have a course of A-1 or A-2 soils.	Surface and subsurface drainage needed.

interpretation of soils

Farm ponds: Reservoir area	Farm ponds: Embankment and dikes or levees	Agricultural drainage	Irrigation: Land leveling	Irrigation: Application of water	Terraces and diversions	Waterways	Corrosiveness of pipelines in soil
Holds water well.	Slowly permeable; good embankment material for small dams.	None needed	Not suggested; permeability slow.	Sprinkler only; slowly permeable substratum.	Irregular topography.	Nonerosive when vegetation is established.	Corrosive.
Holds water very well.	Slowly permeable; good embankment material for small dams.	None needed	Not suggested; permeability slow; not generally irrigated by gravity methods.	Sprinkler only; slowly permeable substratum.	Irregular topography.	Resistant to erosion; no problem when vegetation is established.	Corrosive.
Hold water well.	Slowly permeable; hard to compact; subject to dispersion; some cracking possible.	Moderately well drained; slow permeability; slow surface drainage.	Not suggested	Not suggested	Not needed	Erosion may be a problem because of dispersion.	Highly corrosive.
Holds water well if kept wet.	Impervious when compacted; poor shearing strength; poor workability; high dispersion; fair as homogeneous embankment; fair as core material; subject to cracking.	Moderately well drained; slow permeability; slow surface drainage.	Not suggested	Not suggested; slowly permeable and high in salt.	Not needed	Erosive	Highly corrosive.
Hold water well.	Slowly permeable	Need drainage	Not suggested	Not suggested; very slowly permeable.	Not needed	No problem	Corrosive.
Hold water well.	Unsuitable; high dispersion and easily eroded.	Poorly drained; source of water should be controlled.	Not suitable	Not suitable	Not suitable	Not suitable	Highly corrosive.
Highly permeable; water table can be tapped; may fluctuate considerably.	Semipervious to impervious when compacted; good shearing strength; fair workability; good as homogeneous embankment.	Needs surface and subsurface drainage.	Easily leveled	If well drained, can be irrigated by gravity or sprinkler.	No problem	No problem	Corrosive.
Hold water well.	Impervious when compacted; fair shearing strength; good to fair workability; good as homogeneous embankment; excellent as core material.	Well drained	Not suitable	Sprinkler; only moderately permeable; slowly permeable in subsurface layers.	Irregular topography; resistant to erosion; some stones.	Resistant to erosion; no problem where vegetation is established.	Corrosive.
Hold water well.	Impervious when compacted; fair shearing strength; good to fair workability; good as homogeneous embankment; excellent as core material.	Well drained	Not suitable	Generally not cultivated; sprinkler irrigation of pasture possible.	Stones are quite a problem.	Stones are the major problem.	Corrosive.
Hold water well.	Fair embankment material.	Well drained	Not suitable	Sprinkler; only excessive and irregular slopes.	Not practical	Erosion may be a problem until vegetation is established.	Corrosive.
Holds water well.	Impervious when compacted; fair shearing strength; good to fair workability; good as homogeneous embankment, excellent as core material.	Needs surface drainage; may need subsurface drainage also.	Suitable	Subsurface drainage needed; slightly saline.	No particular problem.	No particular problem.	Corrosive.
Hold water well.	Slowly permeable; good embankment material.	Need surface drainage.	Suitable	Gravity or sprinkler	No problem	No problem	Corrosive.
Hold water well.	Impervious when compacted; fair shearing strength; good as homogeneous embankment; excellent as core material.	Need surface drainage; may need subsurface drainage.	Not suitable; poor drainage.	Not suitable; poor drainage.	Generally not used	No particular problem.	Corrosive.

TABLE 9.—*Engineering interpretation*

Map symbol	Soil	Susceptibility to frost action	Suitability of soil material for—		Suitability as source of—		Vertical alinement for highways	
			Road subgrade	Road fill	Topsoil	Sand and gravel	Soil material	Drainage
BvD BvD2	Buse-Barnes loams, strongly rolling. Buse-Barnes loams, strongly rolling, eroded.	Not susceptible	Fair	Fair	Poor	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; should have a course of A-1 or A-2 soils.	Water moves through soils slowly; some drainage may be needed.
Cp	Colvin and Perella soils, saline.	Susceptible	Very poor	Very poor	Poor	Unsuitable	Subject to volume change; not suitable under thin, flexible base courses or bituminous surfaces; lack bearing power after moisture enters; need insulating course of A-1 or A-2 soils under base courses or bituminous surfaces.	Flow of gravitational water slow; ordinary drainage installations of little value.
Dc	Dimmick clay.	Susceptible	Very poor; subject to consolidation under high fills.	Poor	Poor; surface layer saline.	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; volume change critical; lacks bearing power when wet; poor workability; needs insulating course of A-1 or A-2 soils under base courses or bituminous surfaces.	Flow of gravitational water slow; ordinary drainage installations of little value.
Dm	Dimmick clay, basins.	Susceptible	Very poor	Very poor	Poor	Unsuitable	Subject to volume change; not suitable under thin, flexible base courses or bituminous surfaces.	Needs drainage
Dv	Divide loam.	Susceptible	Fair to good	Fair to good	Excellent	Excellent for gravel surfacing; fair for asphalt; poor for concrete (shaly).	Top 2 feet fair; substratum very good for base courses under bituminous surfaces; excellent workability.	May require some drainage because of water table.
EcA EcB	Eckman silt loam, nearly level. Eckman silt loam, undulating.	Slightly susceptible.	Top 2½ feet poor; substratum fair.	Substratum fair; surface material poor.	Excellent	Unsuitable	Top 2½ feet not suitable under thin, flexible base courses or bituminous surfaces; substratum is somewhat better material.	Do not need special drainage.
EmB EmC	Eckman and Maddock loams, undulating. Eckman and Maddock loams, rolling.	Slightly susceptible.	Top 2½ feet poor; substratum good.	Surface material poor; substrataum good.	Excellent	Unsuitable	Top 2½ feet not suitable under thin, flexible base courses or bituminous surfaces; substratum good.	Do not need special drainage.
Ex	Exline complex.	Very susceptible.	Very poor	Very poor	Fair	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; volume change critical; should have base course of A-1 or A-2 soils.	Flow of gravitational water is slow; ordinary drainage is of little value; need insulating course of A-1 or A-2 soils under base courses or bituminous surfaces.
Fc	Fargo clay.	Susceptible	Very poor; subject to consolidation under high fills.	Poor	Excellent	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; volume change critical; lacks bearing power when wet; poor workability; needs insulating course of A-1 or A-2 soils under base courses or bituminous surfaces.	Flow of gravitational water is slow; ordinary drainage installations are of little value.
FoB FoB2 Fs FvC FvC2	Forman-Aastad loams, undulating. Forman-Aastad loams, undulating, eroded. Forman-Aastad stony loams. Forman-Buse loams, rolling. Forman-Buse loams, rolling, eroded.	Not susceptible	Poor	Poor	Fair	Unsuitable	Same as Fargo clay; low to moderate volume change. Not suitable under thin, flexible base courses or bituminous surfaces; volume change critical; lack bearing power when wet; poor workability; need insulating course of A-1 or A-2 soils under base courses or bituminous surfaces. Have better internal drainage than Fargo clay.	Flow of gravitational water is slow; ordinary drainage installations are of little value.

of soils—Continued

Farm ponds		Agricultural drainage	Irrigation		Terraces and diversions	Waterways	Corrosiveness of pipelines in soil
Reservoir area	Embankment and dikes or levees		Land leveling	Application of water			
Hold water very well.	Same as Barnes-Buse loams, rolling; also stony; impervious when compacted; fair shearing strength; good as homogeneous embankment; excellent as core material; stony.	Well drained	Too rough	Generally not cultivated.	Slopes are steep and irregular; stones are numerous.	Gully control and waterways are needed but may be hard to establish.	Corrosive.
Hold water very well.	Some dispersion; subject to cracking when dry; piping possible through cracks; hard to compact because of moisture content; low density.	Need surface drainage; no particular construction problem; spoil banks should be kept low.	Not suggested	Very slowly permeable; generally nonirrigable.	Generally not applicable.	No special construction problems.	Saline parts highly corrosive; other parts moderately corrosive.
Holds water very well.	Impervious when compacted; volume change critical; subject to cracking; poor material for homogeneous embankment; poor workability; poor shearing strength.	Needs surface drainage; subsurface drainage desirable if practical.	May be leveled if surface drains are installed.	Not suggested for gravity or sprinkler; slow permeability and infiltration.	Terraces not suggested; no problem with diversions.	No problem	Corrosive.
Holds water well.	Cracks when dry	Needs surface drainage.	Not suggested	Very slowly permeable; nonirrigable.	Not needed	No construction problem.	Corrosive.
Too permeable	Top 2 feet fair; substratum not suitable for embankment; good for shell material if core is impervious.	Requires some additional drainage.	Suitable on 0 to 3 percent slopes; ditches may need lining.	Sprinkler on steeper slopes; gravity on flatter slopes.	Not needed	Not needed	Corrosive.
Hold water well.	Semipervious to impervious when compacted; fair shearing strength; fair to good workability; fair material for homogeneous embankment.	Well drained	Slopes of 0 to 5 percent can be leveled at a reasonable cost.	Moderate permeability; high water-holding capacity; good land for irrigation.	No problem if needed.	Can easily be established where needed.	Corrosive.
Do not hold water well.	Substratum is pervious; top 2½ feet can be used as core material; substratum can be used as shell material, but it is subject to wave erosion.	Well drained	Too sloping to be extensively leveled.	Surface layer moderately permeable; substratum rapidly permeable.	No problem if needed.	Can easily be established.	Noncorrosive.
Holds water well.	Impervious when compacted; volume change critical; subject to cracking; poor material for homogeneous embankment or core; unsuitable for shell material because of high dispersion.	Needs agricultural drainage; vegetation hard to establish.	Not suggested	Not suggested; high content of sodium; needs leaching and gypsum.	No problem if needed.	No problem	Highly corrosive.
Holds water well.	Impervious when compacted; volume change critical; subject to cracking; poor material for homogeneous embankment; poor workability; poor shearing strength.	Needs surface drainage; subsurface drainage is desirable if practical.	May be leveled if surface drains are installed.	Not suggested for gravity or sprinkler; slow permeability and infiltration.	Terraces not suggested; no problem with diversions.	No problem	Corrosive.
Hold water well.	Impervious when compacted; fair shearing strength; good to fair workability; fair to poor as homogeneous embankment.	No problem; adjoining soils in depressions may need drainage.	Not suggested	Questionable; slow infiltration.	Short slopes	No problem; resistant to erosion.	Corrosive.

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TABLE 9.—*Engineering interpretation*

Map symbol	Soil	Susceptibility to frost action	Suitability of soil material for—		Suitability as source of—		Vertical alinement for highways	
			Road subgrade	Road fill	Topsoil	Sand and gravel	Soil material	Drainage
Fw	Fresh water marsh.[1]							
Ga	Gannett loamy fine sand.	Susceptible	Fair	Fair	Fair	Poor; high content of silt.	Suitable under thin, flexible base courses or bituminous surfaces; not subject to volume change.	Needs some drainage; has high water table.
GgA	Gardena-Glyndon loams, sandy substratum, nearly level.	Not susceptible	Surface material fair; substratum good.	Surface material fair; substratum good.	Excellent	Unsuitable	Top 20 inches not suitable under thin, flexible base courses or bituminous surfaces; substratum very good under structural pavements.	No problem
GmA	Gardena-Glyndon silt loams, nearly level.	Moderately susceptible.	Fair	Fair	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; low volume change.	May need some drainage.
GoA	Glyndon loam, sandy substratum, nearly level.	Not susceptible	Surface material fair; substratum good.	Surface material fair; substratum good.	Excellent	Unsuitable	Top 20 inches not suitable under thin, flexible base courses or bituminous surfaces; substratum very good under structural pavements.	High water table
GsA	Glyndon silt loam, nearly level.	Moderately susceptible.	Fair	Fair	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; low volume change.	May need some drainage.
Ha	Hamar fine sandy loam.	Susceptible	Excellent	Excellent	Fair	Poor because of silt.	Good for subgrade and base course under any type of surfacing.	Needs drainage because of high water table.
Hb Hf	Hamerly complex. Hamerly-Aastad loams.[2]	Moderately susceptible.	Very poor	Very poor; hard to compact; elastic.	Fair	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; subject to volume change; lose bearing power after moisture enters; need insulating course of A-1 or A-2 soils under base courses or bituminous surfaces.	Flow of gravitational water is slow; ordinary drainage installations are of little value.
Hh	Hamerly-Svea loams[3]	Low susceptibility.	Fair	Fair	Good	Unsuitable	Not suitable under thin base courses or bituminous surfaces.	Low areas may need drainage.
Hkx	Hecla fine sand.	Slightly susceptible.	Very good	Very good; susceptible to wind erosion.	Poor	Poor source for concrete or asphalt road surfaces; good for mixing with high clay soils.	Good shearing strength when compacted; low compressibility; fair workability; excellent as a base course under flexible or bituminous surfaces.	Well drained
HlAx HlBx	Hecla fine sandy loam, nearly level. Hecla fine sandy loam, undulating.	Not susceptible	Good	Good	Good	Poor; too many fines.	Suitable for base course under bituminous surface when compacted and drained; not subject to volume change.	Do not need special drainage; good permeability.

See footnotes at end of table.

of soils—Continued

Farm ponds: Reservoir area	Farm ponds: Embankment and dikes or levees	Agricultural drainage	Irrigation: Land leveling	Irrigation: Application of water	Terraces and diversions	Waterways	Corrosiveness of pipelines in soil
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Highly permeable; water table can be tapped but may fluctuate considerably.	Semipervious to impervious when compacted; good shearing strength; fair workability; good as homogeneous embankment.	Needs surface and subsurface drainage.	Easily leveled	If well drained, can be irrigated by gravity or sprinkler.	No problem	No problem	Corrosive.
Permeable; do not hold water well.	Surface material fair; can be used in center core; substratum highly permeable; can be used on outer shell; subject to wave erosion.	May need drainage; ditchbanks may be unstable.	Easily leveled	Either gravity or sprinkler; good infiltration rate; good subsurface drainage; good water-holding capacity in surface material.	No problem	No problem	Corrosive.
Hold water well.	Semipervious to impervious when compacted; fair shearing strength; fair to good workability; good as homogeneous embankment; excellent as core material.	Need some drainage	Can be leveled	Either gravity or sprinkler; need subsurface drainage.	No problem	No problem	Corrosive.
Permeable; does not hold water well.	Surface material fair; can be used in center core; substratum highly permeable; can be used on outer shell; subject to wave erosion.	May need drainage; ditchbanks may be unstable.	Easily leveled	Either gravity or sprinkler; good infiltration rate; good subsurface drainage; good water-holding capacity in surface material.	No problem	No problem	Corrosive.
Holds water well.	Semipervious to impervious when compacted; fair shearing strength; fair to good workability; good as homogeneous embankment; excellent as core material.	Needs some drainage	Can be leveled	Either gravity or sprinkler; needs subsurface drainage.	No problem	No problem	Corrosive.
Permeable; not recommended; high water table.	Good shearing strength; fair workability; semipervious; good for homogeneous embankment; erosion critical.	Needs drainage; surface ditches subject to erosion.	Needs drainage before it can be made irrigable.	Needs drainage before installing irrigation system.	Generally not used on this soil.	Erosion is critical; velocity of water should be kept low.	Noncorrosive.
Hold water well; require no sealing.	Subject to cracking when dry; piping possible through cracks; hard to compact; low density.	May need surface drainage; no problem in construction of drains.	Not suggested	Not suggested; slowly permeable.	Not needed	No construction problem.	Corrosive; subsoil contains much lime.
Hold water well.	Slowly permeable; good for embankments.	Generally not needed	Generally suitable; may have to stockpile topsoil.	Either sprinkler or gravity.	Generally not applicable.	Erosion may be a problem.	Corrosive.
Poor; does not hold water well.	Semipervious; good shearing strength; fair workability; fair for homogeneous embankment; should have a core of impervious soil; erosive.	None needed	Not suitable	Not suggested; rapid infiltration and low water-holding capacity.	Highly erodible	Highly erodible	Noncorrosive.
Do not hold water well; require sealing of pond area and clay core in dam.	Permeable; require clay core in center of dam; good density; subject to wave erosion.	Well drained if ditches are constructed; soils erosive under concentrated flows.	Easily leveled on 0 to 3 percent slopes; leveling slopes exceeding 3 percent would be costly.	Either sprinkler or gravity; may need ditch lining; length of runs may be limited.	Irregular topography on 3 to 6 percent slopes.	Erodible under concentrated flows; need good vegetation.	Noncorrosive.

TABLE 9.—*Engineering interpretation*

Map symbol	Soil	Susceptibility to frost action	Suitability of soil material for—		Suitability as source of—		Vertical alinement for highways	
			Road subgrade	Road fill	Topsoil	Sand and gravel	Soil material	Drainage
HmA	Hecla fine sandy loam, moderately shallow, nearly level.	Top 30 inches generally not susceptible; subsurface susceptible.	Top 30 inches excellent; substratum very poor.	Top 30 inches excellent; substratum very poor.	Fair to poor	Poor	Top 30 inches excellent subgrade material for base courses under any kind of surfacing; in cuts over 2 feet the material would be subject to volume change and not suitable under thin, flexible base courses or bituminous surfaces.	Generally well drained; does not need extensive drainage.
HnAx HoA Hwx	Hecla loamy fine sand, nearly level. Hecla loamy fine sand, moderately shallow, nearly level. Hecla-Maddock loamy fine sands.	Not susceptible	Good	Good	Good	Poor; too many fines.	Suitable for base course under bituminous surface when compacted and drained; not subject to volume change.	Do not need special drainage; good permeability.
Hz Hfa	Hegne clay. Hegne-Fargo clays.	Susceptible	Very poor; subject to consolidation under high fills.	Poor	Fair	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; volume change critical; lack bearing power when wet; poor workability; need insulating course of A–1 or A–2 soils under base courses or bituminous surfaces.	Flow of gravitational water is slow; ordinary drainage installations are of little value.
La Lf	Lamoure silty clay loam. La Prairie and Fairdale soils.	Highly susceptible or susceptible.	Very poor	Very poor	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; low volume change; need insulating course of A–1 or A–2 soil under base courses or bituminous surface.	Need side drainage.
Lp	La Prairie silt loam.	Susceptible	Poor	Poor	Excellent	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; low volume change; needs insulating course of A–1 or A–2 soil under base courses or bituminous surface.	Needs side drainage.
MdBx MdC MkAx MkBx MkCx	Maddock loamy fine sand, undulating. Maddock loamy fine sand, rolling. Maddock fine sandy loam, moderately shallow, nearly level. Maddock fine sandy loam, moderately shallow, undulating. Maddock fine sandy loam, moderately shallow, rolling.	Not susceptible	Surface material very good; substratum fair.	Surface material very good; substratum fair.	Fine sandy loam is good; loamy fine sand is poor.	Poor	Top 18 inches has good workability and is good as a base course under thin, flexible bituminous surfaces; the substratum has fair workability and is not suitable under thin, flexible base courses or bituminous surfaces.	Do not need special drainage except in low areas.
OaA OcB Os OvC OyA	Overly silt loam, nearly level. Overly silty clay loam, undulating. Overly-Aastad silt loams. Overly and Barnes silt loams, rolling. Overly-Bearden silty clay loams, nearly level.	Moderately susceptible.	Poor	Poor	Good	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; should have a course of A–1 or A–2 soils.	Do not need special drainage.
Pa Pe Ra	Parnell soils. Perella silty clay loam. Rauville soils.	Susceptible	Very poor	Very poor	Poor	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; subject to volume change; lack bearing power after moisture enters; need insulating course of A–1 or A–2 soils under base courses or bituminous surfaces.	Flow of gravitational water is slow; ordinary drainage installations are of little value.
RhA RhB	Renshaw loam, nearly level. Renshaw loam, undulating.	First 0 to 18 inches moderately susceptible; subsoil not susceptible.	First 0 to 18 inches good; excellent at 18 inches and below.	First 0 to 18 inches good; excellent below.	Good from 0 to 18 inches.	Excellent for gravel surfacing; good for asphalt; may require washing on concrete.	May require pneumatic or vibratory compaction to obtain high density; very good under bituminous surfaces.	Generally well drained.

of soils—Continued

Farm ponds		Agricultural drainage	Irrigation		Terraces and diversions	Waterways	Corrosiveness of pipelines in soil
Reservoir area	Embankment and dikes or levees		Land leveling	Application of water			
Substratum holds water well.	Top 30 inches has good shearing strength; semi-pervious; fair workability. The substratum has fair shearing strength and is impervious. Generally the soil is acceptable as embankment material.	Generally well drained.	Slopes of 0 to 3 percent can be leveled; not suggested on 3 to 6 percent slopes; deep cuts should be avoided.	Either sprinkler or gravity; substratum is slowly permeable; too much water may cause a salt problem.	Generally not used on this soil.	Erosion is critical	Corrosive.
Do not hold water well; would require sealing of pond area and clay core in dam.	Permeable; require clay core in center of dam; good density; subject to wave erosion.	Well drained; if ditches are constructed, soils are erosive under concentrated flows.	Easily leveled on 0 to 3 percent slopes; leveling slopes exceeding 3 percent would be costly.	Either sprinkler or gravity; may need ditch lining in coarser textured soil; length of runs may be limited.	Irregular topography on 3 to 6 percent slopes.	Erodible under concentrated flows; require good vegetation.	Noncorrosive.
Hold water well.	Impervious when compacted; volume change critical; subject to cracking; poor material for homogeneous embankment; poor workability; poor shearing strength.	Need surface drainage; subsurface drainage is desirable if practical.	May be leveled if surface drains are installed.	Not suggested for gravity or sprinkler; slow permeability and infiltration.	Terraces not suggested; no problem with diversions.	No probelm	Corrosive.
Hold water well; stratified layers of sand may cause seepage.	Fair density; acceptable as material for embankment; compaction may be a problem when wet; some dispersion.	Some drainage needed in low areas; no problems.	Not suggested; seasonal flooding.	Sprinkler only and with low rates of application.	If needed, no construction problems.	Resist erosion; no construction problems.	Corrosive.
Holds water well; stratified layers of sand may cause seepage.	Fair density; acceptable as material for embankment; compaction may be a problem when wet; some dispersion.	Some drainage needed in low areas; no problems.	Not suggested; seasonal flooding.	Sprinkler only and with low rates of application.	If needed, no construction problems.	Resists erosion; no construction problems.	Corrosive.
Core trench needed to tie into substratum; have low runoff potential.	Top 18 inches semi-pervious; substratum impervious when compacted; the material is only fair as a homogeneous embankment; substratum is good for a core; the surface material can be used for a shell but is subject to wave erosion.	Well drained; do not require special drainage.	Not suggested; generally too rough.	Could be irrigated by sprinkler; water table may rise; accumulation of salts could be a problem.	Not applicable	No problem	Substratum is corrosive.
Hold water well; require no sealing.	Slowly permeable; good embankment material for small dams.	Do not need special drainage.	Generally not suitable.	Generally not suitable.	Irregular slopes; no special construction problems.	No special construction problems.	Corrosive.
Hold water well.	Subject to cracking when dry; piping possible through cracks; hard to compact because of moisture content; low density.	Need surface drainage; no problem in construction of drains; spoil banks should be kept low.	Not suggested	Not suggested	Generally not applicable.	No special construction problems.	Corrosive.
Not suitable; too permeable.	Not suitable unless core can cut off gravel; require mixing with clay if used as embankment material at some other location.	Require no additional drainage.	Generally not desirable; surface layer is shallow; leveling may expose gravel.	Rapidly permeable; would require ditch lining; sprinklers generally used instead of gravity irrigation.	Generally not applicable.	Generally not needed.	Noncorrosive.

TABLE 9.—*Engineering interpretation*

Map symbol	Soil	Susceptibility to frost action	Suitability of soil material for—		Suitability as source of—		Vertical alinement for highways	
			Road subgrade	Road fill	Topsoil	Sand and gravel	Soil material	Drainage
Ro	Renshaw and Sioux soils.	Top 12 inches moderately susceptible; subsoil not susceptible.	First 12 inches good; excellent below 12 inches.	First 12 inches good; excellent below.	Good from 0 to 12 inches.	Excellent for gravel surfacing; good for asphalt; may require washing on concrete.	May require pneumatic vibratory compaction to obtain high density; very good under bituminous surfaces.	Generally well drained.
SpA	Spottswood-Wessington loams, nearly level.	Not susceptible	First 2 feet fair; good below 2 feet.	First 2 feet fair; good below 2 feet.	Excellent	Excellent for gravel surfacing; fair for asphalt; poor for concrete (shaly gravel).	Top 2 feet fair; substratum is very good as base course under bituminous surfaces; excellent workability.	Do not need special drainage.
St	Stirum and Arveson loams.	Susceptible	Fair	Fair	Poor	Poor	Satisfactory as a base when properly drained and compacted; difficult to compact because of narrow moisture range for maximum compaction.	Need drainage because of high water table.
Sv	Svea loam.[1]							
Tk Tp	Tetonka silt loam. Tetonka and Parnell soils.	Susceptible	Very poor	Very poor	Fair to poor	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; subject to volume change; lack bearing power after moisture enters; need insulating course of A-1 or A-2 soils under base courses or bituminous surfaces.	Flow of gravitational water is slow; ordinary drainage installations are of little value.
Un	Ulen fine sandy loam, moderately shallow.	Moderately susceptible because of water table.	First 3 to 3½ feet excellent; poor material below this depth.	First 45 inches excellent; poor below this depth.	Fair to poor	Poor	Top 3 to 3½ feet excellent; subgrade material for base courses under any type of surfacing has good workability. Below 3½ feet the material is not suitable under thin, flexible base courses of bituminous surfaces.	Internal drainage somewhat slow; has a semihigh water table.
VaD	Valentine fine sand, hilly.	Not susceptible	Very good; erosive unless covered with silt or vegetation.	Very good; need protection from erosion.	Poor	No gravel; dirty sand.	Fair workability; good as a base course under thin, flexible pavements; erosive.	Does not require special drainage.
VhC	Valentine-Hecla fine sands, hummocky.	Not susceptible	Very good; susceptible to wind erosion unless covered with silt or vegetation.	Very good; need protection from wind erosion.	Poor	Poor; sand is high in silt and clay.	Fair workability; very good as a base course under thin, flexible bituminous surfaces.	Well drained; do not need special drainage except in low areas.
ZmC ZmD	Zell silt loam, rolling. Zell silt loam, hilly.	Susceptible	Fair	Fair	Poor	Unsuitable	Not suitable under thin, flexible base courses or bituminous surfaces; subject to volume change; lack bearing power after moisture enters; need an insulating course of A-1 or A-2 soils under base courses or bituminous surfaces.	Flow of gravitational water is slow; ordinary drainage installations are of little value.

[1] Soil unclassified; should be investigated before engineering uses or structures are planned.
[2] Interpretations are for Hamerly component of complex. See Aastad loam for Aastad component of complex.

of soils—Continued

Farm ponds		Agricultural drainage	Irrigation		Terraces and diversions	Waterways	Corrosiveness of pipelines in soil
Reservoir area	Embankment and dikes or levees		Land leveling	Application of water			
Not suitable; permeability rate too high.	Not suitable unless core can cut off gravel; require mixing with clay if used as embankment material at some other location.	Do not require additional drainage.	Not suggested	Irrigation not suggested; high permeability and low water-holding capacity.	Generally not applicable.	Generally not needed.	Noncorrosive.
Highly permeable.	Top 2 feet fair; substratum material not suitable for a homogeneous embankment; good shell material if embankment has a core of impervious material.	Well drained	Suitable on 0 to 6 percent slopes; ditches may need lining.	Sprinkler on 3 to 6 percent slopes; gravity on 0 to 3 percent slopes; substratum highly permeable.	If cut too deep, banks may undercut.	If cut more than 2 feet, vegetation may be hard to establish.	Noncorrosive.
Not suitable; highly permeable but have high water table.	Fair for homogeneous embankment; fair as core material; fair to good shearing strength; compaction may be difficult because of narrow moisture range.	Generally not drained.	Not suggested; soils are saline.	Not suggested; high water table and salinity.	Generally not applicable.	No special construction problem.	Highly corrosive.
Hold water well.	Good to fair as material for homogeneous embankment: excellent for core material; fair shearing strength; crack when dry; difficult to compact when wet.	Need drainage; no construction problems.	Not suggested	Not suggested; slowly permeable.	Generally not suggested.	No construction problems.	Corrosive.
Somewhat permeable; generally not too good as reservoir.	Top 3½ feet has good shearing strength; semipervious; fair workability; substratum has fair shearing strength and is impervious; generally acceptable as embankment material; erosive.	Generally requires no additional drainage.	Can be leveled; deep cuts should be avoided.	Either sprinkler or gravity.	Erodible; otherwise no construction problems.	Erodible	Corrosive.
Low runoff potential; highly permeable; not suitable as reservoir area.	Good density; fair shearing strength; permeable; requires nonpermeable center section; subject to wave and wind erosion.	Well drained	Not suggested	Not suggested	Not applicable	No problem	Noncorrosive.
Do not hold water well; highly permeable.	Semipervious; fair shearing strength; fair workability; may require core of impervious material; subject to wave erosion.	Well drained	Too rough and susceptible to wind erosion.	Sprinkler for pasture; highly permeable.	Not needed	Not needed	Noncorrosive.
Hold water well; impervious.	Fair shearing strength; fair to good workability; fair as a homogeneous embankment; semipervious to impervious.	Generally do not need additional drainage.	Not irrigable	Not irrigable	Steep slopes	Steep slopes; velocities may be high.	Corrosive.

[3] Interpretations are for Svea component of complex. See Hamerly complex for Hamerly component.
[4] See Hamerly-Svea loams for interpretations of Svea component.

TABLE 10.—*Location of borrow pits and quantity and properties of material available* [1]
[Dashed lines indicate information not known]

Pit location	Quantity available	Percentage of shale and soft rock	Percentage retained ¼-inch sieve	Percentage of clay colloids	Plasticity index	Liquid limit	Weight (rodded)	Quality and suitability
	Tons						*Lbs. per cu. ft.*	
SE¼ sec. 18, T. 130 N., R. 53 W.	----------	20.7	7	8.4	5.2	20.9	99	Poor; high in shale; very plastic; very fine.
N½SE¼ and S½NE¼ sec. 18, T. 130 N., R. 53 W.	----------	5.6	12	6.4	0	(2)	103	Fair; fine; suitable only for base material.
NW¼ sec. 19, T. 130 N., R. 53 W.	----------	3.1	8	5.4	0	(2)	101	Fair; fine; suitable for base material.
SW¼ sec. 15, T. 131 N., R. 53 W.	104,000	2.0–4.0	30	3.4	0	(2)	115	Good; suitable for all road construction except use in concrete aggregate.
E½ sec. 13, T. 130 N., R. 54 W.	(3)	4.6	10	7.4	0	(2)	100	Fair; fine; suitable for base material.
SE¼ sec. 23, T. 132 N., R. 54 W.	12,000	6.6	24	8.6	3.3	21.1	110	Good; suitable for all road construction except use in concrere aggregate.
NW¼ sec. 25, T. 132 N., R. 54 W.	----------	9.8	18	--------	4.9	27.2	107	Fair; fine; suitable for base material.
SE¼ sec. 17, T. 129 N., R. 55 W.	16,500	1.6	44	--------	5.9	23.9	119	Good; suitable for all road construction except use in concrete aggregate.
NW¼ sec. 20, T. 129 N., R. 55 W.	----------	7.9	34	5.4	4.3	21.0	113	Good; suitable for all road construction except use in concrete aggregate.
SW¼ sec. 26, T. 129 N., R. 55 W.	105,000	17.3	28	6.7	0–4.4	22.2	110	Fair; high in shale; suitable for gravel surface and base material.
NE¼ sec. 30, T. 129 N., R. 55 W.	----------	19.6	20	4.4	0	(2)	105	Fair; high in shale; suitable only for base material.
SW¼ sec. 30, T. 129 N., R. 55 W.	----------	13.0–20.0	16	2.4	0	(2)	109	Fair; high in shale; suitable only for base material.
NW¼ sec. 3, T. 131 N., R. 57 W.	33,000	19.0–23.0	36	5.7	0	(2)	107	Fair; high in shale; suitable only for base material.
SE¼ sec. 34, T. 132 N., R. 57 W.	----------	24.8	29	--------	1.0	23.4	108	Poor; high in shale; suitable only for base material.
SW¼ sec. 29, T. 130 N., R. 58 W.	98,000	5.5	33	2.4	0	(2)	113	Good; suitable for all road construction except use in concrete aggregate.

[1] In addition to the deposits listed in this table, small amounts of gravelly material have been available from deposits in the following locations, but the quantity and quality of these deposits are unknown: SW¼ sec. 18, T. 130 N., R. 53 W.; NW¼ sec. 13, T. 130 N., R. 54 W.; NW¼ sec. 16, T. 129 N., R. 54 W.; SW¼ sec. 16, T. 129 N., R. 54 W.; NW¼ sec. 15, T. 132 N., R. 56 W.; SW¼ sec. 15, T. 132 N., R. 56 W.; W½ sec. 16, T. 132 N., R. 56 W.; SW¼ sec. 22, T. 132 N., R. 56 W.; SW¼ sec. 20, T. 131 N., R. 57 W.; NE¼ sec. 35, T. 131 N., R. 58 W.; NW¼ sec. 3, T. 129 N., R. 55 W.; NE¼ sec. 34, T. 129 N., R. 55 W.; NW¼ sec. 29, T. 131 N., R. 54 W.; NW¼ sec. 21, T. 131 N., R. 53 W.

[2] Not determined.

[3] Almost exhausted.

Formation and Classification of Soils

This section describes the outstanding morphologic characteristics of the soils of Sargent County and relates these to the factors of soil formation. The section has three main parts. The first part deals with the formation of the soils; the second, with the classification of soils; and the third, with the chemical and physical analysis of selected soils.

Formation of Soils

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

Climate and living organisms are active factors of soil genesis, or formation. They act on the parent material, which has accumulated through the weathering of rocks, and slowly change it into soil with genetically related horizons, or layers. The effects of climate and growing things are conditioned by relief. The composition of the parent material also affects the kind of soil and the soil profile that forms. Finally, time is needed to change the parent material into soil. This time may be long or short, but some time is always required for horizons to form. Usually a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor unless the effects of the others are known. Many things about soil development are unknown.

Parent material

The soils of Sargent County have formed mainly in glacial till and glacial melt-water deposits. Other parent materials are recent alluvium and glacial outwash. These parent materials largely determine the texture and mineralogical composition of the soils in the county.

The late Wisconsin ice sheet deposited a thick mantle of glacial till in Sargent County. This glacial till plain covers about 65 percent of the county and is much the same today as when the glacier left it. Soils that have formed in the till are a mixture of sand, silt, and clay, and are mainly loam in texture. Small pebbles and stones are distributed throughout the soil profile.

The soils in glacial Lake Agassiz, in the northeastern part of the county, have formed in deposits of lacustrine silt and clay. Those in glacial Lake Dakota, in the western part of the county, have formed mainly in sandy melt-water deposits. A small part of the Lake Dakota area contains silt and clay deposits. The hummocky topography and buried surface horizons in the soil profile indicate that the sandy parts of the lake sediments have been reworked by wind in many places.

Soils in the Gardena-Spottswood-Wessington soil association, shown on the general soil map at the back of this report, have formed mainly in glacial outwash. These soils have a loamy surface layer and a substratum of sand, shaly gravel, or both.

The Hecla-Renshaw soil association in the northeastern part of the county is a beach area of glacial Lake Agassiz. The soils in this association formed in a variety of materials but mostly sandy or loamy material underlain by a substratum of sand, granitic gravel, or both.

The soils that formed in recent alluvium are in small areas on the narrow bottom lands along the Wild Rice River. Since these deposits are relatively new, the soils show little development.

Climate

Climate, an active soil-forming factor, affects the physical, chemical, and biological relationships in the soil. Rainfall, humidity, and the length of the frost-free period affect the amount of water that percolates through a soil. The water, in turn, dissolves minerals and transports them downward through the soil. Temperature regulates the growth of organisms and the speed of chemical reactions.

The climate of Sargent County is dry; only a little more than 20 inches of moisture falls annually. In this subhumid climate, the winters are long and cold, the summers are hot, and the frost-free periods are short. Because the climate is uniform throughout the county, local differences in soils are not caused by climate.

Plant and animal life

All forms of life, in and on the soil, influence the chemical and biological processes in soil. Bacteria, fungi, earthworms, and other forms of animal life aid the weathering of rock materials and the decomposition of organic matter. Vegetation affects soil formation by leaving residue in the soil and by transferring elements from subsurface horizons to the surface horizon.

The kinds of plant and animal life are determined by environmental factors, which are climate, parent material, relief, and age of the soil. In turn, the kinds of plants and animals determine the kinds of organic matter added to the soil.

The soils in Sargent County have formed under native grasses. The environment was most favorable for the tall grasses, and they made up the largest part of the vegetation. Mid and short grasses grew in smaller amounts. Organic matter, in the form of dead grass plants, was added to the soil. This matter was decomposed by micro-organisms and other forms of life and by chemicals in the soil and in the plant remains. Because the soils of the county are subject to little leaching, they have accumulated a large amount of organic matter in the A horizon. Consequently, the A horizon is generally black when the soils are moist and is very dark gray when they are dry.

Relief

Relief influences soil formation by affecting the relationship between temperature and water, and between erosion and vegetation. The effect of relief on the formation of soils is modified by the other four factors of soil formation, particularly by the active factors, climate and vegetation.

The influence of relief is most evident in the soils formed on the glacial till plain in Sargent County. In undulating and rolling topography the hilltops, knolls, or ridges are occupied by Regosols, which have a thin, dark surface layer. This layer, or A horizon, is thin because, during soil development, slopes were strong, vegetation was sparse, and erosion was very active. Vegetation was sparse because there was not enough available moisture. Much of the moisture was lost in runoff. Since no B horizon formed in these soils, the A horizon is directly underlain by a weak zone of lime accumulation in the parent till. Chernozem soils have formed downslope. In Chernozem soils, the A horizon is thicker, a B horizon has formed, and the depth to the lime zone is greater than in the Regosols. Humic Gley soils are in depressions on the till plain. They have a thick surface horizon, and because they are stained by organic matter, they are dark colored deep in the profile. The poor drainage of these soils has also influenced color and the degree of mottling in the profile.

Time

A soil profile requires a long time to develop and depends on the other soil-forming factors for its development. Less time is required for a soil to form in a humid region with dense vegetation than in a cold region with sparse vegetation. Also, less time is required for soils to form from coarse-textured parent material than from fine-textured parent material. Soils on glacial till form in a relatively short time, compared to soils on hard bedrock.

In terms of geologic time all the soils of Sargent County are young. This is true because the entire county was glaciated by the Wisconsin ice sheet, the latest advance of ice into the area. This ice sheet melted less than 25,000 years ago.

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The soils that formed in glacial till have fairly well developed profiles with distinct A, B, and C horizons. The horizons are less distinct in the glacial Lake Agassiz and Dakota areas. The only soils in the county showing little development are the inextensive soils forming in recent alluvium, mainly along the Wild Rice River.

Classification of Soils

Soils are placed in narrow classes so that knowledge about their behavior within farms, ranches, or counties can be organized and applied. They are placed in broad classes so that they can be studied and compared in continents or other large areas. In the comprehensive system of soil classification followed in the United States (*2*), the soils are placed in six categories, one above the other. Beginning at the top, the six categories are order, suborder, great soil group, family, series, and type.

In the highest category the soils of the whole country are grouped into three orders, whereas in the lowest category thousands of soil types are recognized. The suborder and family categories have never been fully developed and thus have been little used. Attention has been given largely to the classification of soils into soil types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders. *Soil series*, *type*, and *phase* are defined in the Glossary in the back of this report.

In the highest category of the classification scheme are the zonal, intrazonal, and azonal orders (*8*). The zonal order consists of soils with evident, genetically related horizons that reflect in their formation the dominant influences of climate and living organisms. In the intrazonal order are soils with evident, genetically related horizons that reflect the dominant influence 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, generally because of youth, resistant parent material, or steep topography.

In table 11 the soil series are classified by order and great soil group and important characteristics of the series are given. In the following pages is a discussion of the morphology of the soil series and a description of a soil profile typical of each series.

TABLE 11.—*Soil series classified by order and great soil group*

ZONAL ORDER

Great soil group and series	Horizon characteristics			Drainage	Physiographic position	Parent material
	Development of B horizon	Texture of B horizon	Depth to C_{ca} horizon			
Chernozem soils:			*Inches*			
Aastad	Moderate	Clay loam	15–36	Moderately good.	Nearly level till plain	Fine loam till.
Barnes	Weak	Loam	12–20	Good	Undulating to rolling till plain.	Friable loam till.
Eckman	Weak	Silt loam	14–34	Good	Nearly level to undulating glacial lake plain, and stream terraces.	Deep glacial melt-water deposits of fine sand to silt loam.
Forman	Moderate	Clay loam	12–20	Good	Undulating to rolling till plain.	Fine loam till.
Gardena	Weak	Silt loam	16–30	Moderately good.	Nearly level glacial lake plain.	Deep glacial melt-water deposits of fine sand to silt loam.
Maddock [1]	Color of B horizon only.	Loamy fine sand.	(2)	Good	Nearly level to rolling glacial lake sand plain.	Moderately shallow deposits of fine sand or loamy fine sand over glacial till or lacustrine silts.
Overly	Weak	Silt loam or silty clay loam.	16–34	Good	Nearly level to undulating glacial lake plain, and stream terraces.	Deep glacial melt-water deposits of silt loam or silty clay loam.
Renshaw	Weak	Sandy loam to clay loam.	18–30	Good	Nearly level and undulating glacial outwash plains.	Moderately shallow deposits of loam over granitic gravel and sand.

See footnotes at end of table.

TABLE 11.—*Soil series classified by order and great soil group*—Continued

ZONAL ORDER—Continued

Great soil group and series	Horizon characteristics			Drainage	Physiographic position	Parent material
	Development of B horizon	Texture of B horizon	Depth to C_{ca} horizon			
			Inches			
Chernozem soils—Continued						
Spottswood	Weak	Sandy loam to clay loam.	24–30	Good	Nearly level glacial outwash plain.	Moderately shallow deposits of loam over shaly gravel and sand.
Svea	Weak	Loam to clay loam.	15–36	Moderately good.	Nearly level till plain	Friable loam till.
Wessington	Weak	Sandy loam to clay loam.	30–40	Good	Nearly level glacial outwash plain.	Moderately shallow deposit of loam over shaly gravel and sand.

INTRAZONAL ORDER

Great soil group and series	Development of B horizon	Texture of B horizon	Depth to C_{ca} horizon	Drainage	Physiographic position	Parent material
Solonchak soils:						
Bearden	No B horizon	No B horizon	<15	Moderately good to imperfect.	Nearly level glacial lake plain.	Deep glacial lake sediments of silt loam or silty clay loam.
Borup	No B horizon	No B horizon	<15	Poor	Level areas or broad, shallow depressions in glacial lake plain.	Deep glacial melt-water deposits of fine sand to silt loam.
Colvin	No B horizon	No B horizon	<15	Poor	Level areas; broad, shallow depressions; or long, narrow depressions in the glacial lake plain.	Deep glacial lake deposits of silt loam or silty clay loam.
Divide	No B horizon	No B horizon	<15	Moderately good to imperfect.	Nearly level outwash plain.	Moderately shallow loamy glacial alluvium over granitic gravel and sand.
Glyndon	No B horizon	No B horizon	<15	Moderately good.	Nearly level glacial lake plain.	Deep glacial lake deposits of fine sand to silt loam.
Hamerly	No B horizon	No B horizon	<15	Moderately good.	Nearly level glacial till plain.	Fine or friable loam till.
Hegne	No B horizon	No B horizon	<15	Poor	Nearly level glacial lake plain.	Deep glacial lake deposits of silty clay or clay.
Ulen	No B horizon	No B horizon	<15	Moderately good.	Nearly level sandy glacial lake plain.	Moderately shallow deposits of fine sandy loam or loamy fine sand over lacustrine silts.
Humic Gley soils:						
Arveson	No B horizon	No B horizon	[3] 10–30	Poor and very poor.	Closed depressions or floors of swales in glacial lake plain.	Deep glacial lake deposits of fine sand.
Dimmick	Weak	Silty clay or clay.	[3] 10–20	Poor and very poor.	Flat depressions of the glacial lake plain.	Deep glacial melt-water deposits of silty clay or clay.
Gannett	No B horizon	No B horizon	([2])	Very poor	Depressions in sandy glacial lake plain.	Deep glacial melt-water deposits of fine sand or loamy fine sand.

See footnotes at end of table.

TABLE 11.—*Soil series classified by order and great soil group*—Continued

INTRAZONAL ORDER—Continued

Great soil group and series	Horizon characteristics: Development of B horizon	Texture of B horizon	Depth to C_{ca} horizon	Drainage	Physiographic position	Parent material
			Inches			
Humic Gley soils—Continued						
Hamar	No B horizon	No B horizon	35–45	Imperfect	Swales in sandy glacial lake plain where topography has been modified in places by wind.	Deep glacial melt-water deposits of fine sand or loamy fine sand.
Lamoure	No B horizon	No B horizon	15–25	Imperfect and poor.	Wet bottom lands	Postglacial deposits of silt loam or silty clay loam.
Parnell	Moderate	Clay loam to clay.	30–40	Poor and very poor.	Closed depressions in glacial till plain.	Loam till or mantle of local loam to clay alluvium deposited over till.
Perella	Moderate	Silty clay	30–40	Imperfect and poor.	Shallow depressions in glacial lake plain.	Deep glacial melt-water deposits of fine sand to silt loam.
Rauville	No B horizon	No B horizon	(2)	Very poor	Depressions or swales in bottom lands.	Stratified alluvium ranging from sandy loam to clay; substratum may be loose sand or gravel.
Planosols:						
Tetonka	Strong	Clay loam to clay.	25–40	Imperfect and poor.	Depressions in the till plain or glacial lake plain.	Loam till or mantle of loam to clay alluvium over till.
Grumusols:						
Fargo	Weak	Silty clay or clay.	[4] 15–25	Poor	Nearly level glacial lake plain.	Deep glacial melt-water deposits of silty clay or clay.
Solonetz soils:						
Aberdeen (strongly solodized).	Strong	Silty clay loam to clay.	20–30	Moderately good and imperfect.	Nearly level glacial lake plain with microrelief in inches.	Deep glacial lake deposits ranging from silt loam to clay.
Cresbard (strongly solodized).	Strong	Clay loam to clay.	20–30	Moderately good and imperfect.	Very shallow small dips or depressions in till plain.	Fine loam till.
Exline (weakly solodized).	Strong	Clay	15–25	Moderately good and imperfect.	Flat glacial lake plain with microdepressions.	Deep glacial lake deposits of clay.
Stirum	Moderate	Loam or sandy clay loam.	15–25	Poor	Level depressions in sandy glacial lake plain.	Deep glacial melt-water deposits ranging from fine sandy loam to fine sand.

AZONAL ORDER

Great soil group and series	Development of B horizon	Texture of B horizon	Depth to C_{ca} horizon	Drainage	Physiographic position	Parent material
Alluvial soils:						
Fairdale	No B horizon	No B horizon	(2)	Moderately good and good.	Nearly level bottom land dissected by abandoned stream or river channels.	Postglacial deposits of sandy loam to silty clay loam.
La Prairie	Weak	Silt loam or silty clay loam.	20–40	Moderately good.	Nearly level bottom land dissected by abandoned stream or river channels.	Postglacial deposits of silt loam or silty clay loam.

See footnotes at end of table.

TABLE 11.—*Soil series classified by order and great soil group*—Continued

AZONAL ORDER—Continued

Great soil group and series	Horizon characteristics			Drainage	Physiographic position	Parent material
	Development of B horizon	Texture of B horizon	Depth to C_{ca} horizon			
Regosols:			*Inches*			
Buse	No B horizon	No B horizon	[4] 4–12	Excessive	Tops of knolls, ridges, and hills in rolling and strongly rolling topography.	Friable or fine loam till.
Hecla [5]	No B horizon in most places.	No B horizon in most places.	([2])	Moderately good.	Nearly level to hummocky sand of glacial lake plain.	Deep glacial melt-water deposits of fine sand or loamy fine sand.
Sioux	No B horizon	No B horizon	<15	Excessive	Nearly level outwash plains or sloping and steep escarpments of terraces.	Shallow deposits of loam or sandy loam over gravel or sand.
Valentine	No B horizon	No B horizon	([2])	Excessive	Hilly and hummocky sand of glacial plain where topography has been modified by wind.	Deep glacial melt-water deposits of fine sand.
Zell	No B horizon	No B horizon	[2] 4–12	Excessive	Rolling and hilly slopes on points of terrace escarpments.	Deep silty lacustrine deposits.

[1] Maddock soils grade toward Regosols if a B horizon has not developed.
[2] No C_{ca} horizon.
[3] No C_{ca} horizon in some places.
[4] Weakly expressed C_{ca} horizon.
[5] Hecla soils grade toward Chernozems if a weak B horizon has developed.

Zonal order

In Sargent County all the soils in the zonal order are in the Chernozem great soil group.

CHERNOZEM SOILS

The soil series in this great soil group are the Aastad, Barnes, Eckman, Forman, Gardena, Maddock, Overly, Renshaw, Spottswood, Svea, and Wessington. The soils in these series formed under a dense vegetation of tall and mid grasses. These soils have weak or moderate horizonation in the A_1, B_2, and C_{ca} and C horizons and in the D_{ca} and D horizons if those horizons are present. Maddock, Renshaw, Spottswood, and Wessington soils have D_{ca} and D horizons.

Except for some Hecla soils that grade toward Chernozems, all Chernozem soils in the county have a structural B horizon in which the prisms are weak to strong and medium or coarse. The B horizon of the Forman and Aastad soils has a compound prismatic-blocky structure in which the blocks are generally stronger than the prisms. The B horizon of the Hecla soils is distinguishable only by color. Only in the Forman and Aastad soils has enough clay accumulated for the B horizon to be classified as a textural B. The B horizon of the Forman and Aastad soils has continuous, distinct clay films on all ped faces.

In all the soils the A_1 horizon is high in organic matter and is dark colored. It has a value of less than 2 and a chroma of less than 1 in moist soil. The B_2 horizon, even where weakly expressed, has a stronger chroma than the A_1 horizon. The C_{ca} horizon is weakly or moderately expressed. It contains films and threads of segregated lime, small to large, soft nodules of nearly pure calcium carbonate, or calcium carbonate in the form of lime flour.

AASTAD SERIES.—Aastad soils are moderately well drained Chernozems that developed in loam or light clay loam, calcareous glacial till. These soils have a thick, black A_1 horizon and a dark-colored B_2 horizon that is stained with organic matter and has a compound prismatic-blocky structure. Continuous, distinct clay films are on the faces of all peds in the B_2 horizon. The segregated lime in the distinct C_{ca} horizon occurs mainly as masses of lime flour and in films.

The Aastad soils are in the same catena as the Forman soils. This association with Forman soils distinguishes the Aastad soils from the Svea soils. In addition, the B horizon of Aastad soils has stronger structure than that of the Svea soils and more distinct clay films on the prisms and blocks.

Typical profile:

A_{1p}—0 to 7 inches, black (10YR 2.5/1) clay loam, black (N 2/0) when moist; fine, granular structure; slightly hard when dry, very friable when moist, and slightly sticky and slightly plastic when wet; clear grains of quartz sand common throughout; abrupt, smooth boundary.

B_1—7 to 14 inches, black (10YR 2.5/1) clay loam, black (10YR 2/1) when moist; weak, fine prisms with indistinct clay films; hard when dry, friable when moist, and sticky and plastic when wet; clear grains of quartz sand common throughout; diffuse boundary.

B_2—14 to 17 inches, very dark grayish-brown (2.5Y 3/2) clay loam, black (2.5Y 2/2) when moist; moderate, medium prisms and blocks with distinct, continuous clay films; firm when moist, sticky and plastic when wet; strongly calcareous without segregated lime; wavy boundary.

C_{ca1}—17 to 28 inches, light olive-brown (2.5Y 5/4) loam, olive brown (2.5Y 4/4) when moist; moderate, fine, blocky structure; hard when dry, firm or friable when moist, slightly sticky and plastic when wet; very strongly calcareous; soft segregated lime forming many fine, white threads and nodules and coatings on pebbles.

C_{ca2}—28 to 32 inches, light yellowish-brown (2.5Y 6/3) loam, grayish brown (2.5Y 5/2) when moist; many prominent mottles of strong brown (7.5YR 5/6) when dry or moist, white (2.5Y 8/2) when dry, and light gray (2.5Y 7/2) when moist; fine, blocky structure; hard when dry, friable when moist, and slightly sticky and slightly plastic when wet; strongly calcareous; many threads of segregated lime; soft lime coatings around pebbles and in pebble sockets.

C_{ca3}—32 to 43 inches, light yellowish-brown (2.5Y 6/2) loam mottled with brownish yellow and dark gray (10YR 6/6 and 2.5Y 4/0); grayish brown (2.5Y 5/2) when moist, with mottles of yellowish brown and very dark gray (10YR 5/8 and 2.5Y 3/0); hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous; many threads of segregated lime; soft lime coats on pebbles and in sockets of pebbles.

C_{cs}—43 to 60 inches, loam that is grayish brown (2.5Y 5/2) when moist and is prominently mottled with white (2.5Y 8/2), gray (N 5/0), and olive brown (2.5Y 4/8); fine, blocky structure; sticky and plastic when wet; strongly calcareous; small amount of segregated lime; common nests of gypsum crystals.

The structure of the B horizon ranges from moderate, medium, prismatic and blocky to strong, medium and fine, blocky. Distinct clay films are on even the finest peds. Clay films and organic stains coat the medium and coarse prisms and extend deep into the horizon of segregated lime.

BARNES SERIES.—Barnes soils developed in calcareous glacial till and are deep, dark colored, and well drained. Horizonation is moderate and is based on differences of color and structure in the A_1, B_2, and C_{ca} horizons. The clay increase in the B_2 horizon over the content of clay of the A_1 horizon is small, if any. Lime is segregated in soft films and in soft flourlike masses.

The Barnes soils have a profile similar to that of the Forman soils and occupy similar positions on the till landscape. The Barnes soils, however, have weaker structure than the Forman soils and a lower content of clay in the B_2 horizon. Also, only patches of clay films are on prism faces in the B horizon of Barnes soils, whereas Forman soils have continuous, distinct clay films on all ped faces. The Barnes soils are higher and better drained than Svea soils.

Typical profile:

A_{1p}—0 to 7 inches, very dark gray (10YR 3/1), granular loam, black (10YR 2/1) when moist; slightly hard when dry, friable when moist; abrupt, smooth boundary as a result of tillage.

B_2—7 to 11 inches, dark-gray (10YR 4/1) light clay loam, very dark gray (10YR 3/1) when moist; tongues from the A_{1p} horizon; moderate, medium, prismatic structure; very hard when dry, friable when moist, sticky and plastic when wet; patches of clay films on vertical faces of prisms; diffuse, smooth boundary.

C_{ca}—11 to 25 inches, very pale brown (10YR 8/3) loam, light yellowish brown (10YR 6/4) when moist; weak, coarse, prismatic structure; strongly calcareous with large soft masses of lime flour.

C_1—25 to 40 inches, very pale brown (10YR 7/4) light clay loam, yellowish brown (10YR 5/4) when moist; weak, coarse, prismatic structure; calcareous.

C_2—40 to 60 inches, pale-yellow (2.5Y 7/4) light clay loam mottled with white (2.5Y 8/2) and red (2.5YR 5/8); light olive brown (2.5Y 5/4) when moist, and mottled with light gray (2.5Y 7/2) and red (2.5YR 4/8); calcareous.

The depth to the C_{ca} horizon ranges from 10 to 20 inches. The B_2 horizon is generally moderate, prismatic, but in some places it is strong, prismatic and breaks to weak, blocky.

ECKMAN SERIES.—In the Eckman series are deep, dark-colored, well-drained soils that developed in calcareous silt deposited by glacial melt water. These soils have a black or very dark gray A_1 horizon and a B_2 horizon with weak to moderate, prismatic structure. The C_{ca} horizon is distinct but not prominent. The parent material is generally silt loam or very fine sandy loam. It contains a high percentage of silt, fine sand, and very fine sand and a very low percentage of coarser sand. These characteristics of the parent material distinguish the Eckman soils from the Barnes soils.

Eckman soils have better drainage and more prominent horizons than the Gardena soils, which are the moderately well drained catenary associates.

Typical profile:

A_{1p}—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

B_2—8 to 16 inches, light yellowish-brown (10YR 6/4) silt loam, yellowish brown (10YR 5/4) when moist; weak, coarse, prismatic structure; hard when dry, friable when moist.

C_{ca}—16 to 34 inches, white (2.5Y 8/2) silt loam, light yellowish brown (2.5Y 6/4) when moist; weak, coarse, subangular blocky structure; soft when dry, very friable when moist.

C_1—34 to 46 inches, pale-yellow (2.5Y 8/4) silt loam mottled with olive yellow (2.5Y 6/6); light olive brown (2.5Y 5/4) mottled with light olive brown (2.5Y 5/6) when moist; weak, fine and very fine, blocky structure; slightly hard when dry, very friable when moist; calcareous.

C_2—46 to 60 inches, pale-yellow (2.5Y 7/4) silt loam with common, distinct mottles of brownish yellow (10YR 6/6) and reddish yellow (7.5YR 6/8 and 7/8); light olive brown (2.5Y 5/4) when moist, with mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8); slightly hard when dry, very friable when moist; calcareous.

The A_1 horizon of Eckman soils ranges from 6 to 10 inches in thickness. The C_{ca} horizon is weakly to moderately expressed. The profile, in some places, has a high content of silt to a depth of 5 feet. And in other places there is a high content of fine and very fine sand below a depth of 2 feet.

FORMAN SERIES.—The Forman series consists of deep, well-drained soils that developed under native tall grasses in calcareous loam or light clay loam glacial till. The loam surface layer has a weak, granular or crumb structure.

The Forman soils have a higher content of clay than have the Barnes soils, and stronger structure in the B_2 horizon. Continuous, distinct clay films cover all faces of prisms and blocks in the B_2 horizon of the Forman soils but occur only as patches on the vertical faces of prisms in the Barnes soils. The Forman soils are better drained than the Aastad soils and have a brighter colored B horizon.

Typical profile:

A_{1p}—0 to 8 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, fine, crumb structure; slightly hard when dry, very friable when moist; abundant, clear, very fine and fine quartz sand; abrupt, smooth boundary as a result of tillage.

B_2—8 to 14 inches, brown (10YR 4.5/3) clay loam, dark brown (10YR 3.5/3) when moist; continuous, thick tongues of material from A_1 horizon; moderate, medium prisms and blocks; continuous, distinct clay films of very dark grayish brown (10YR 3/2), when dry or moist, on all ped faces; very hard when dry, friable when moist, sticky and plastic when wet; diffuse, smooth boundary.

B_3—14 to 17 inches, grayish-brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; tongues of material from A_1 horizon; moderate, coarse, prismatic, blocky structure; many patches of clay films on vertical faces of prisms; prism faces have a coating that is dark grayish brown (10YR 3.5/2) when dry and very dark grayish brown (10YR 3/2) when moist; very hard when dry, firm when moist, sticky and plastic when wet; mildly to moderately calcareous on inside of prisms and blocks.

C_{ca1}—17 to 26 inches, light yellowish-brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/4) when moist; many, small, soft concretions of lime that are white (2.5Y 8/2) when dry or moist; weak, coarse, prismatic structure; few patches of clay films on the vertical faces of prisms; hard when dry, friable when moist, sticky and plastic when wet; very strongly calcareous; diffuse boundary.

C_{ca2}—26 to 44 inches, light yellowish-brown (2.5Y 6/3) clay loam; very strongly calcareous, but less segregated lime than in horizon above; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; diffuse boundary.

C—44 to 60 inches, light yellowish-brown (2.5Y 6/3) loam; light olive brown (2.5Y 5/4) when moist, with common, distinct mottles of grayish brown and white (2.5Y 5/2 and 8/2); strongly calcareous; common, fine, soft concretions of lime; many small nests of gypsum crystals; weak, coarse prisms breaking to weak, fine blocks; hard when dry, friable when moist.

The surface layer of the Forman soils ranges from 5 to 9 inches in thickness. Some profiles have a B_{3ca} horizon. The depth to the lime zone ranges from 12 to 20 inches. A C_{cs} horizon occurs where there are many large nests of gypsum crystals in the parent till.

GARDENA SERIES.—The Gardena series consists of deep, dark-colored, moderately well drained soils that developed in smooth, medium-textured deposits from glacial melt water. These soils have slight horizonation. Only small differences in color and structure can be seen in the gradual transition of the thick, black A_1 horizon to the dark-colored B horizon. The B horizon is underlain by a weakly to moderately expressed C_{ca} horizon.

The Gardena soils have a thicker A_1 horizon and a weaker B_2 horizon than the well-drained Eckman soils and are deeper to the C_{ca} horizon. The Gardena soils have formed in lacustrine material that feels smooth because it contains a high percentage of silt and very fine sand. In contrast, the Aastad soils have formed in glacial till that contains clay, silt, and sand in about equal amounts and, consequently, feel gritty.

Typical profile:

A_1—0 to 14 inches, dark-gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate, fine, granular structure; soft when dry, very friable when moist; noncalcareous; gradual boundary.

B_2—14 to 20 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; compound structure of weak, medium prisms, subangular blocks, and moderate, fine granules; slightly hard when dry, very friable when moist; noncalcareous; clear, smooth boundary.

C_{ca}—20 to 30 inches, light-gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) to light olive brown (2.5Y 5/4) when moist; massive (structureless); many pores; slightly hard when dry, very friable when moist; strongly calcareous; moderate amount of lime in threads and films; gradual boundary.

C—30 to 60 inches, pale-yellow (2.5Y 7/4) silt loam with common, coarse, faint mottles of light gray (2.5Y 7/2); light yellowish brown (2.5Y 6/4) when moist, with mottles of light brownish gray (2.5Y 6/2); massive (structureless); many pores; soft to slightly hard when dry; calcareous.

The A_1 horizon of Gardena soils ranges from 8 to 16 inches in thickness. The substratum is generally very fine sand or silt loam, but the range is from silt loam to fine sand.

MADDOCK SERIES.—In the Maddock series are deep, excessively drained soils that developed in sand deposited by glacial melt water, and well-drained, moderately shallow soils that developed in sandy material over glacial till. Most Maddock soils in Sargent County are moderately shallow. They have a thin to moderately thick A_1 horizon, a weak B horizon, and a D horizon in which lime has accumulated.

Maddock soils are better drained and are higher in the landscape than the Hecla soils.

Soil profile:

A_1—0 to 5 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; weak, fine, granular structure; very friable when moist; noncalcareous.

B_1—5 to 15 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; weak, medium, prismatic structure; very friable when moist.

C—15 to 18 inches, grayish-brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, medium, blocky structure; very friable when moist.

D_1—18 to 23 inches, light yellowish-brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) when moist; moderate, coarse, blocky structure; hard when dry, friable when moist; weakly calcareous.

D_{ca}—23 to 40 inches, pale-yellow (2.5Y 7/4 and 8/4) silt loam, light olive brown (2.5Y 5/4) when moist; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous.

D_2—40 to 60 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) when moist; hard when dry, firm when moist, sticky and plastic when wet; calcareous.

Maddock soils in Sargent County have developed in deep sands, are excessively drained, and in many places do not have a B horizon. Where a B horizon has not developed, Maddock soils grade toward Regosols. In some moderately shallow phases, the substratum is silty to clayey, lacustrine deposits or glacial till.

OVERLY SERIES.—In the Overly series are deep, dark-colored, moderately well drained soils that formed in silt loam or silty clay loam, glacial lacustrine deposits. These soils have a thick, black A_1 horizon, a weak or moderate, prismatic B_2 horizon, and a distinct C_{ca} horizon.

The Overly soils are in the same catena as the Bearden (calcareous Solonchak) soils. The Overly soils, however, are better drained than the Bearden soils, which do not have a B horizon. They have formed in finer textured materials than the Gardena soils. A typical profile of Overly soils resembles that of the Aastad soils, but the Aastad soils formed in glacial till instead of glacial lacustrine deposits.

Typical profile:

A_{1p}—0 to 8 inches, dark-gray (10YR 4/1) silty clay loam, black (N 2/0) when moist; very fine, granular structure; hard when dry, friable when moist.

B_2—8 to 16 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; weak, coarse, prismatic structure; hard when dry, friable when moist, sticky and plastic when wet.

C_{ca1}—16 to 28 inches, light-gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; very fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous.

C_{ca2}—28 to 36 inches, brownish-yellow (10YR 6/6) and pale-yellow (2.5Y 7/4) silty clay loam, yellowish brown (10YR 5/6) and light yellowish brown (2.5Y 6/4) when moist; very fine, granular structure; strongly calcareous.

C_1—36 to 44 inches, brownish-yellow (10YR 6/6 and 6/8) silty clay loam with a few, fine, distinct mottles of reddish yellow (7.5YR 6/6); yellowish brown (10YR 5/6) when moist, with mottles of strong brown (7.5YR 5/6); hard when dry, friable when moist; slightly calcareous; contains some small pebbles and shale particles.

C_2—44 to 60 inches, brownish-yellow (10YR 6/6) silt loam with many mottles of white (2.5Y 8/2) and reddish yellow (7.5YR 6/6); yellowish brown (10YR 5/6) when moist, with mottles of light gray (2.5Y 7/2) and strong brown (7.5YR 5/6); soft when dry, very friable when moist; slightly calcareous.

The A_1 horizon in Overly soils ranges from 6 to 14 inches in thickness and is silt loam or silty clay loam. In some places the substratum consists of alternating layers of silt loam and silty clay loam.

RENSHAW SERIES.—The soils of the Renshaw series are moderately deep and well drained. They have formed in loamy glacial alluvium over loose gravel, sand, or both. These soils have a thin to moderately thick A_1 horizon over a B_2 horizon. The B horizon contains no more clay than the A_1 and has a moderate, prismatic structure. The B_2 horizon is underlain by a zone of lime accumulation in the substratum, which is gravel, sand, or both.

The Renshaw soils have a thinner mantle of loamy alluvium over the substratum than the Wessington soils. The gravelly or sandy substratum of the Renshaw soils is granitic, whereas that of the Spottswood soils in Sargent County contains 10 to 25 percent shale and other soft rock.

Soil profile:

A_1—0 to 17 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; fine, granular structure; slightly hard when dry, very friable when moist.

B_2—17 to 25 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure; hard when dry, friable when moist.

D_{ca}—25 to 30 inches, white and light brownish-gray (2.5Y 8/2 and 6/2) gravelly loam, grayish brown and dark grayish brown (2.5Y 5/2 and 4/2) when moist; strongly calcareous.

D—30 to 60 inches, mixed granitic gravel and coarse sand.

This profile just described has a thicker A_1 horizon than is considered the modal for the series. The A_1 horizon ranges from 6 to 18 inches in thickness. The thickness of the loamy alluvium ranges from 18 to 36 inches.

SPOTTSWOOD SERIES.—The Spottswood soils are moderately well drained and moderately shallow. They have formed in shaly loam glacial alluvium over shaly gravel, sand, or both. These soils have a moderately thick A_1 horizon. The B horizon, if present, contains little or no more clay than the A_1 horizon and has a moderate or weak, prismatic structure.

The Spottswood soils occur with the Wessington soils but have a thicker solum and thicker A_1 horizon. They formed in more shaly material than the Renshaw soils.

Typical profile:

A_{1p}—0 to 5 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; weak, medium, subangular blocky structure breaking to very fine, granular structure; soft when dry, very friable when moist; abrupt, smooth boundary.

A_{12}—5 to 18 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure breaking to very fine, granular structure; soft when dry, very friable when moist.

B_2—18 to 29 inches, grayish-brown (2.5Y 5/2) coarse sandy loam, very dark grayish brown (2.5Y 3/2) when moist; weak, coarse, prismatic structure; prisms coated with dark gray (10YR 4/1, dry) and very dark grayish brown (10YR 3/2, moist); hard when dry, friable when moist.

D_1—29 to 38 inches, light brownish-gray (2.5Y 6/2) coarse sand, dark grayish brown (2.5Y 4/2) when moist; loose when dry or moist; single grain (structureless); 50 percent or more of material is shale particles that give the moist material coherence under pressure.

D_{ca}—38 to 50 inches, light-gray (2.5Y 7/2) coarse sand, grayish brown (2.5Y 5/2) when moist; many shale particles; strongly calcareous.

D_2—50 to 60 inches, light brownish-gray (2.5Y 6/2) coarse sand, dark grayish brown (2.5Y 4/2) when moist; slightly calcareous; many reddish to clear, colorless grains of quartz sand.

The Spottswood soils in Sargent County do not always have a B horizon. In broad swales, the dark color of the A_1 horizon extends deep in the profile and becomes gradually lighter without an increase in chroma until it reaches the substratum.

SVEA SERIES.—Svea soils are moderately well drained and have formed in loam or light clay loam calcareous till. They are in the same catena as the Barnes soils but have a thicker solum, a thicker A_1 horizon, and a darker colored B horizon. The Svea soils are similar to the Aastad soils but are coarser textured and have a less distinct B horizon. Svea soils and Gardena soils are similar, but the Gardena soils have formed in medium-textured lacustrine material instead of calcareous till.

Typical profile:

A_{1p}—0 to 7 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; fine, granular structure; friable when moist, slightly sticky and slightly plastic when wet.

A_1—7 to 11 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; very weak, coarse, subangular blocky structure, breaking readily to medium and fine, granular structure; friable when moist, slightly sticky and slightly plastic when wet.

B_2—11 to 20 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, prismatic structure; hard when dry, firm when moist, sticky and plastic when wet; patches of clay films on the vertical faces of prisms.

C_{ca}—20 to 36 inches, very pale brown (10YR 7/3) loam, brown (10YR 5/3) when moist; strongly calcareous; lime flour and a few, large, soft concretions; soft when dry, friable when moist.

C—36 to 60 inches, light yellowish-brown (10YR 6/4) loam and silt loam, yellowish brown (10YR 5/4) when moist; few, distinct, gray and brown mottles.

The B horizon is missing in some places, and in these places the Svea soils are similar to the Hamerly soils. The depth to the C_{ca} horizon ranges from 15 to 36 inches and is shallowest where Svea soils are near Barnes soils. The parent material of Svea soils has been reworked by water in some places.

WESSINGTON SERIES.—The Wessington soils [5] are moderately deep and well drained. They developed in glacial alluvium that is underlain by shaly sand or gravel containing 10 to 25 percent shale and other soft rock. These soils have a thin to moderately thick A_1 horizon and a dark-colored B_2 horizon that has a weak or moderate, prismatic structure.

Wessington soils have a thinner solum and a thinner A_1 horizon than have the Spottswood soils. The parent material of the Wessington soils contains more shale than that of the Renshaw soils.

Typical profile:

A_{1p}—0 to 6 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; weak, medium and fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; clear boundary.

B_2—6 to 20 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; prism faces are organically stained and coated with colors of the A_{1p}.

D—20 to 60 inches, grayish-brown (2.5Y 5/2) mixed coarse sand and gravel containing 50 percent or more shale, very dark grayish brown (2.5Y 3/2) when moist.

The thickness of the loam over the D horizon ranges from 18 to 30 inches.

Intrazonal order

In Sargent County the soils of the intrazonal order are in the calcareous Solonchak, the Humic Gley, the Planosol, the Grumusol, and the Solontez great soil groups.

SOLONCHAK SOILS

The soil series in the calcareous Solonchak great soil group are the Bearden, Borup, Colvin, Divide, Glyndon, Hamerly, Hegne, and Ulen. All of these contain soluble salts. All the soils except the Hamerly have developed in deposits from glacial melt water. The Hamerly soils formed in glacial till. The Divide soils are loamy alluvium over granitic gravel and sand. Except for the moderately deep Divide soils, all the soils are deep. Natural drainage ranges from moderately well drained to poorly drained.

[5] After this report and map had been prepared for publication, the soils called Wessington were classified with soils of the Fordville series. Similar soils will be called Fordville in other publications.

Modally, the Solonchak soils in the county are calcareous at the surface and have a C_{ca} horizon at a depth of less than 15 inches. The range, however, includes soils that (1) are noncalcareous at the surface, (2) are calcareous within 6 inches of the surface, and (3) have a C_{ca} horizon at a depth of less than 15 inches. In the Solonchak soils, the lime zone is weak to prominent. The Ulen and Hegne soils have the most weakly expressed C_{ca} horizon, and the Hamerly soils have the most prominent lime zone.

In most places, the dark-colored A_1 horizon is calcareous and is separated from a distinct or prominent C_{ca} horizon by a clear lower boundary. In some areas the soils have an A_{ca} horizon in which enough lime has accumulated to mask the color of the soil and to give the horizon a gray to white color. This horizon is lighter colored than the A_1 horizon and is at least 1 value lighter than the underlying C horizon.

BEARDEN SERIES.—In the Bearden series are deep, moderately well drained to imperfectly drained soils that are high in lime. These soils developed in silt loam or silty clay loam lacustrine sediments. They have a black A_1 horizon that is calcareous in some areas and is separated from a prominent, light-colored C_{ca} horizon by a clear, irregular boundary. Wide tongues of the A_1 horizon extend deep into the C_{ca} horizon, and thinner tongues extend to shallower depths.

Soil profile:

A_{1p}—0 to 8 inches, dark-gray (10YR 4/1) silty clay loam, black (N 2/0) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; slightly calcareous.

A_{ca}—8 to 16 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist, slightly sticky and slightly plastic when wet; very strongly calcareous.

C_{ca}—16 to 30 inches, pale-yellow (2.5Y 7/4) silty clay loam, light yellowish brown (2.5Y 6/4) when moist, with a few, faint mottles of white and light brownish gray (2.5Y 8/2 and 6/2); weak, medium, granular structure; slightly hard when dry, friable when moist; very strongly calcareous.

C_1—30 to 34 inches, light yellowish-brown (2.5Y 6/4) silty clay loam, pale yellow (2.5Y 7/4) when moist, with common mottles of light brownish gray (2.5Y 6/2); fine, granular structure; friable when moist; strongly calcareous.

C_2—34 to 48 inches, yellowish-brown and brownish-yellow (10YR 5/6 and 6/8) silt loam with common mottles of light brownish gray (2.5Y 6/2); yellowish brown (10YR 5/4) when moist, with mottles of grayish brown (2.5Y 5/2); friable when moist; slightly calcareous.

C_3—48 to 60 inches, light yellowish-brown and olive-yellow (2.5Y 6/4 and 6/6) silt loam with many mottles of light gray (2.5Y 7/2); light olive brown (2.5Y 5/4) when moist, with mottles of light brownish gray (2.5Y 6/2); friable when moist; slightly calcareous.

The top 6 inches of Bearden soils in some places is free of lime. In some places the A_1 horizon is directly above a prominent C_{ca} horizon; in other places a distinct A_{ca} horizon separates the A_1 horizon and the C_{ca}. The surface layer ranges from 6 to 16 inches in thickness. Alternating layers of silt loam and silty clay loam are common in the substratum.

BORUP SERIES.—Borup soils developed in sandy and silty deposits from glacial melt water and are poorly drained and very poorly drained. These soils have a thick, black A_1 horizon that is calcareous in some places and is separated from a prominent C_{ca} horizon by an abrupt, irregular boundary. Tongues of the A_1 horizon commonly extend into the C_{ca} horizon.

The Borup soils are more poorly drained than the Bearden soils and have formed in less clayey materials. They are more poorly drained than the Glyndon soils and have more olive-colored material in the substratum.

Typical profile:

A_1—0 to 10 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; weak, fine, granular structure; friable when moist; slightly calcareous.

C_{ca}—10 to 32 inches, gray and white (10YR 6/1 and 8/1) clay loam, dark gray and gray (10YR 4/1 and 6/1) when moist; weak, medium, platy structure; hard when dry, friable when moist, sticky and plastic when wet; strongly calcareous.

C_1—32 to 44 inches, pale-yellow and white (2.5Y 8/4 and 8/2) silt loam, light yellowish brown and pale yellow (2.5Y 6/4 and 7/4) when moist; friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous.

C_2—44 to 60 inches, white (2.5Y 8/2) silt loam mottled with brownish yellow and yellow (10YR 6/6 and 7/6); light brownish gray (2.5Y 6/2) when moist, with mottles of yellowish brown and strong brown (10YR 5/6 and 7.5YR 5/6); friable when moist; calcareous.

The surface layer is generally 6 to 12 inches thick. It is dominantly silt loam but ranges from fine sand to silty clay. In many places the entire profile is silt loam, but in some places the profile is silt loam to a depth of about 3 feet and is sandy below.

COLVIN SERIES.—Colvin soils are poorly drained and have developed in moderately fine textured glacial lacustrine deposits. These soils have a black A_1 horizon and a prominent gray or light-gray C_{ca} horizon.

The Colvin soils and the Borup soils are similar, but the Colvin soils formed in moderately fine textured material, whereas the Borup soils formed in medium-textured material. Colvin soils are more poorly drained than the Bearden soils.

Typical profile:

A_1—0 to 10 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; moderate, fine, crumb structure in upper part and moderate, very fine, blocky structure in the lower part; friable when moist, sticky and plastic when wet; noncalcareous.

C_{ca1}—10 to 14 inches, grayish-brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate, very fine, blocky structure; firm when moist, sticky and plastic when wet; calcareous.

C_{ca2}—14 to 17 inches, light brownish-gray (2.5Y 6/2) clay loam, brownish gray (2.5Y 5/2) when moist; friable when moist, sticky and plastic when wet; strongly calcareous.

C_{cs}—17 to 27 inches, light olive-brown (2.5Y 5/4) silty clay loam, olive brown (2.5Y 4/3) when moist; firm when moist, sticky and plastic when wet; many gypsum crystals; strongly calcareous.

C_1—27 to 60 inches, grayish-brown and light olive-brown (2.5Y 5/2 and 5/4) silty clay loam, dark grayish brown and olive brown (2.5Y 4/2 and 4/4) when moist; firm when moist, sticky and plastic when wet; many gypsum crystals in the lower part; calcareous.

The lime zone varies in its degree of prominence and in its depth from the surface. The boundary between the A_1 and C_{ca} horizons is gradual in some places but generally is clear and irregular. In other places, however, the boundary is broken by large masses of soft lime, which are surrounded by black or olive colors.

DIVIDE SERIES.—Divide soils are moderately deep and moderately well drained to imperfectly drained. They developed in loamy glacial alluvium over loose, gravelly or sandy outwash. These soils have a black or very dark gray A_1 horizon that is separated from a distinct or prominent C_{ca} horizon by an irregular boundary. Below the loose gravel and sand the soil material probably is more slowly permeable than that above. A temporary water table is held up, and there is a capillary rise of water that brings lime up into the finer material.

The sequence of the horizons differentiates the Divide soils from the Hamerly soils on the till plain, and from the Glyndon soils on the glacial lake plain.

Typical profile:

A_1—0 to 6 inches, dark-gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; weak, fine and very fine, granular structure; hard when dry, very friable when moist; slightly calcareous.

C_{ca}—6 to 16 inches, gray (10YR 5/1) loam, dark gray (10YR 4/1) when moist; weak, coarse, prismatic structure; slightly hard when dry, friable when moist; strongly calcareous.

D_{ca}—16 to 26 inches, light olive-gray (5Y 6/2) mixed coarse sand and gravel, olive gray (5Y 4/2) when moist; many shale particles give material weak coherence; strongly calcareous.

D—26 to 60 inches, medium and coarse granitic sand and gravel; common shale particles; slightly calcareous.

The loamy alluvium ranges from 16 to 30 inches in thickness. Although this alluvium is calcareous in some areas, the zone of lime accumulation is in the sandy or gravelly substratum.

GLYNDON SERIES.—The Glyndon series consists of deep, moderately well drained soils that formed in medium-textured, lacustrine deposits. These soils have a dark-colored A_1 horizon that is separated from a prominent C_{ca} horizon by a gradual to clear, irregular boundary. Lime is disseminated in the C_{ca} and decreases gradually in the C horizon.

The Glyndon soils occur with the Gardena soils but differ from them by having a thinner A_1 horizon, no B_2 horizon, and a C_{ca} horizon closer to the surface.

Typical profile:

A_{1p}—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, coarse, blocky structure; slightly hard when dry, friable when moist; slightly calcareous.

C_{ca}—8 to 21 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/3) when moist; weak, coarse, blocky structure; soft when dry, friable when moist; very strongly calcareous.

C_1—21 to 42 inches, pale-yellow (2.5Y 8/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) when moist; soft when dry, very friable when moist; strongly calcareous.

C_2—42 to 60 inches, pale-yellow (2.5Y 8/4) very fine sandy loam, light yellowish brown (2.5Y 6/4) when moist, with few, medium, distinct mottles of light brownish gray and yellowish brown (2.5Y 6/2 and 10YR 5/6); soft when dry, very friable when moist, slightly calcareous.

Tongues of the A_1 horizon commonly extend deep into the C_{ca} horizon. The A_1 horizon ranges from 6 to 10 inches in thickness. In some places nests of gypsum crystals are at a depth greater than 3 feet. In a sandy substratum phase of Glyndon soils, fine sandy loam or loamy fine sand generally occurs at a depth greater than 2 feet.

HAMERLY SERIES.—In Sargent County Hamerly soils are the only calcareous Solonchak soils that have formed in glacial till. These soils have a thin to moderately thick A_1 horizon that is generally calcareous and is separated from the C_{ca} horizon by a gradual or abrupt, irregular boundary. Lime is distributed throughout the soil in the form of lime flour.

The Hamerly soils occur in irregularly shaped rings around morainic depressions that are occupied by the Parnell or Tetonka soils. Hamerly soils also occur on irregularly shaped, slight rises, in complex association with the Aastad and Svea soils. In plowed fields, many closely spaced areas of the Hamerly soils are conspicuous where the shallow, light-gray to white C_{ca} horizon is exposed. The lime in the C_{ca} horizon accumulates as the result of capillary moisture rising from a seasonal perched water table.

Typical profile:

A_{1p}—0 to 8 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; common, fine specks of white (2.5Y 6/2) when moist and light brownish gray (2.5Y 8/2) when dry; moderate, medium, granular structure; slightly hard when dry, friable when moist; slightly calcareous; abrupt boundary.

C_{ca}—8 to 18 inches, white (2.5Y 8/2) loam, light brownish gray (2.5Y 6/2) when moist; weak, coarse, prismatic structure; slightly hard when dry, friable when moist; slightly sticky and slightly plastic when wet; very strongly calcareous; lime flour distributed; gradual boundary.

C_1—18 to 25 inches, light yellowish-brown and white (2.5Y 6/4 and 8/2) loam, light olive brown and light brownish gray (2.5Y 5/4 and 6/2) when moist; weak, coarse, prismatic structure; hard when dry, friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous with films and soft masses of segregated lime; gradual boundary.

C_2—25 to 60 inches, pale-yellow (2.5Y 7/4) clay loam mottled with light gray and brownish yellow (2.5Y 7/1 and 10YR 6/6); light olive brown (2.5Y 5/4) when moist, with mottles of gray and yellowish brown (2.5Y 5/1 and 10YR 5/6); massive (structureless); hard when dry, firm when moist; slightly calcareous; large shale fragments in lower part.

The dark-colored A_1 horizon may extend gradually to a distinct A_{1ca} horizon, and that horizon to the C_{ca}. The depth to the C_{ca} horizon varies greatly. In plowed fields are mottled patterns of gray, light gray, and white where the plow has turned up limy material.

HEGNE SERIES.—In the Hegne series are poorly drained soils that developed in glacial lacustrine deposits of clay. These soils have a thin to moderately thick, black A_1 horizon that has a clear or abrupt, irregular boundary over a prominent, light-gray C_{ca} horizon. The lime, in the form of lime flour, decreases in amount with increasing depth. A gradual boundary separates the C_{ca} horizon from the C_g.

The Hegne soils are associated with the Fargo soils in a complex pattern. They are a few inches higher than Fargo soils in the microrelief. In most places the surface of Hegne soils shows a mottled pattern of gray because some of the C_{ca} horizon has been mixed with the A_1 horizon.

Typical profile:

A_1—0 to 10 inches, silty clay that is black (N 2/0) when dry or moist; moderate, medium, granular structure; very hard when dry, firm when moist, sticky and plastic when wet; calcareous.

C_{gca}—10 to 20 inches, light-gray and olive-gray (5Y 7/1 and 4/2) clay, olive gray and dark olive gray (5Y 5/2 and 3/2) when moist; fine and medium, blocky structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; strongly calcareous.

C_{g1}—20 to 32 inches, gray (5Y 6/2) clay, olive gray (5Y 5/2) when moist; fine and medium, blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; calcareous.

C_{g2}—32 to 38 inches, white and light-gray (5Y 8/1 and 7/2) clay, white and olive gray (5Y 8/2 and 5/2) when moist; medium, blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; calcareous.

C_{g3}—38 to 60 inches, pale-olive (5Y 6/3) clay mottled with white and olive yellow (5Y 8/1 and 2.5Y 6/6); olive (5Y 5/3) when moist, with mottles of white and light olive brown (5Y 8/2 and 2.5Y 5/6); massive (structureless); extremely hard when dry, firm when moist, very sticky and very plastic when wet; calcareous.

The A_1 horizon ranges from 6 to 14 inches in thickness, but wide tongues of it extend deep into the C_{gca} horizon. The texture of the A_1 horizon is silty clay or clay.

ULEN SERIES.—The Ulen soils are moderately well drained or imperfectly drained and have formed in sandy glacial deposits. The A_1 horizon of these soils is moderately thick or thick and very dark gray. It is underlain by a C_{ca} horizon that is strongly calcareous, but weakly expressed. In Sargent County, the Ulen soils have a more weakly expressed lime zone than have other Solonchak soils in which the difference in color between the A_1 and C_{ca} horizons is not prominent.

The Ulen soils occur with Hecla soils but differ from those soils by having a calcareous profile and no B horizon.

Typical profile:

A_{11}—0 to 10 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, fine, granular structure; very friable when moist; slightly calcareous.

A_{12}—10 to 18 inches, dark grayish-brown (10YR 4/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; very weak, medium, prismatic structure; very friable when moist; slightly calcareous.

C_{ca}—18 to 30 inches, grayish-brown (10YR 5/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; weak, granular structure; very friable when moist; strongly calcareous.

C_1—30 to 38 inches, light brownish-gray (2.5Y 6/2), loose fine sand, grayish brown (2.5Y 5/2) when moist; strongly calcareous.

C_2—38 to 60 inches, pale-olive (5Y 6/3), loose fine sand, olive (5Y 5/3) when moist; calcareous.

The surface layer of Ulen soils is fine sandy loam or loamy fine sand. In some places the C_{ca} horizon is nearer the surface and more prominent than that described.

HUMIC GLEY SOILS

The Humic Gley soils of this county are in the Arveson, Dimmick, Gannett, Hamar, Lamoure, Parnell, Perella, and Rauville series. The soils of these series have an A_1 horizon that is black when moist. Some of the soils have a B horizon. Because of poor drainage, these Humic Gley soils are almost neutral gray, have colors of 5Y hue, or, at a depth below 3 feet, have greener or bluer hues. Prominent mottles of brown and reddish brown increase as the organic staining decreases in the subsoil.

Some Humic Gley soils are calcareous throughout the profile, and some are calcareous only in the horizon of lime accumulation. Generally this horizon, or lime zone, does not occur just below the A_1 horizon but is deeper in the profile. If it does occur immediately below the A_1 horizon, the lime zone is very weak.

The Parnell soils are the only Humic Gley soils in the county that are on the glacial till plain. These soils are in closed depressions on the plain, generally in local alluvium that washed from surrounding hillsides. In some places the alluvium is more than 5 feet thick, but in most places till occurs at a depth between 3 and 5 feet.

The Lamoure and Rauville soils are in postglacial alluvium. These soils are calcareous at the surface more commonly than are any other Humic Gley soils in the county. In many places the Lamoure soils in Sargent County have a very weak lime zone below the A_1 horizon.

The Arveson soils developed in sandy deposits of glacial melt water. Arveson soils are limy at the surface in many places but generally do not have a lime zone. The Gannett soils formed in fine sand or loamy fine sand. They are generally mildly calcareous at about 4 feet but are entirely free of lime in some places.

Arveson series.—The Arveson soils are poorly drained or very poorly drained and have formed in sandy glacial lacustrine deposits. They generally are calcareous at the surface and have a C_{gca} horizon in some places, but this horizon is not prominent enough for the series to be classified as calcareous Solonchak.

The Arveson soils are similiar to the Gannett soils but are generally calcareous at the surface, whereas the Gannett soils are noncalcareous at the surface and are calcareous deep in the profile.

Typical profile:

A_1—0 to 20 inches, gray (2.5Y 5/1) fine sandy loam, very dark gray (2.5Y 3/1) when moist; hard when dry, very friable when moist; strongly calcareous.

C_{g1}—20 to 30 inches, light-gray (5Y 6/1) loamy fine sand, gray (5Y 5/1) when moist; loose when dry or moist; single grain (structureless); moderately calcareous.

C_{g2}—30 to 36 inches, light olive-gray (5Y 6/2) fine sand mottled with brownish yellow (10YR 6/6); olive gray (5Y 5/2) when moist, with mottles of yellowish brown (10YR 5/8); loose when dry or moist; single grain (structureless); slightly calcareous.

C_{g3}—36 to 48 inches, light-gray and light olive-gray (5Y 7/1 and 6/2) fine sand with many, medium, prominent mottles of brownish yellow (10YR 6/8); gray and olive gray (5Y 6/1 and 5/2) when moist, with mottles of yellowish brown (10YR 5/8); loose when dry or moist; single grain (structureless); slightly calcareous.

C_{g4}—48 to 60 inches, yellowish-brown (10YR 5/4) fine sand with many, medium, prominent mottles of dark yellowish brown and light gray (10YR 4/4 and 5Y 7/1); dark yellowish brown (10YR 4/4) when moist, with mottles of very dark brown and gray (10YR 3/4 and 5Y 6/1); loose when dry or moist; single grain (structureless); slightly calcareous.

Dimmick series.—In the Dimmick series are poorly drained and very poorly drained soils that have formed in clay sediments. Dimmick soils in Sargent County occur in shallow depressions or swales in the glacial lake plains.

These soils have a thick to moderately thick, black A_1 horizon that is calcareous in some places. In other places Dimmick soils are calcareous throughout the profile and have a weak to distinct lime zone. The lime zone, however, is not close enough to the surface or prominent enough for the series to be classified as calcareous Solonchak.

In Sargent County, Dimmick clay is in shallow basins. This soil is poorly drained but is generally not limy at the surface and does not have a C_{ca} horizon. Dimmick clay, basins, occurs in very wet depressions and is generally calcareous at the surface and strongly calcareous immediately below the A_1 horizon.

The Dimmick soils occur with Fargo soils but are more poorly drained.

Typical profile:

A_1—0 to 8 inches, silty clay that is black (10YR 2/1) when dry or moist; fine and medium, granular structure; noncalcareous.

B—8 to 20 inches, very dark gray (2.5Y 3/0) clay, black (2.5Y 2/0) when moist; moderate, medium and coarse, prismatic structure breaking to fine and very fine, blocky structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; noncalcareous.

C_{g1}—20 to 34 inches, gray (5Y 5/1) clay, very dark gray (5Y 3/1) when moist; massive (structureless); extremely hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous.

C_{g2}—34 to 60 inches, light-gray (5Y 6/1) clay, with many mottles of white (5Y 8/1)); dark gray (5Y 4/1) when moist, mottled light olive gray (5Y 6/2); massive (structureless); extremely hard when dry, firm when moist, very sticky and very plastic when wet; calcareous.

The surface layer is silty clay loam or silty clay in some places. Prisms in the B horizon are from 2 to 6 inches thick. In areas where the prisms are 6 inches thick, tongues of the A_1 horizon extend through the entire B horizon, but where the prisms are about 2 inches thick, the tongues of the A_1 horizon extend to a depth of 10 inches. These tongues are wedge shaped. They are larger at the top and narrower with increasing depth.

Gannett series.—The Gannett soils developed in fine sand or loamy fine sand and are deep and very poorly drained. They have a moderately thick or thick, black A_1 horizon that is separated from the gray and olive-gray subsoil by a clear or gradual boundary. These soils are noncalcareous to a depth of about 4 feet.

Gannett soils have formed in coarser material than have the Arveson soils and are noncalcareous from the surface to a depth of several feet. The Arveson soils are generally calcareous at the surface. The Gannett soils are more poorly drained than the Hamar soils.

Typical profile:

A_{11}—0 to 4 inches, dark-gray (10YR 4/1) loamy fine sand, black (10YR 2/1) when moist; single grain (structureless); noncalcareous.

A_{12}—4 to 8 inches, dark-gray (10YR 4/1) fine sand with a few, faint mottles of dark grayish brown (10YR 4/2); very dark gray (10YR 3/1) when moist, with mottles of very dark grayish brown (10YR 3/2); loose when dry or moist; single grain (structureless); noncalcareous.

C_{g1}—8 to 15 inches, gray (10YR 5/1) fine sand with many, fine, distinct mottles of dark yellowish brown (10YR 4/4); dark gray (10YR 4/1) when moist, with mottles of dark yellowish brown (10YR 3/4); loose when dry or moist; single grain (structureless); noncalcareous.

C_{g2}—15 to 22 inches, grayish-brown (10YR 5/2) fine sand with many, fine, distinct mottles of dark yellowish brown (10YR 4/4); dark grayish brown (10YR 4/2) when moist, with mottles of dark yellowish brown (10YR 3/4); loose when dry or moist; single grain (structureless); noncalcareous.

C_{g3}—22 to 45 inches, grayish-brown (10YR 5/2) fine sand with many, medium, prominent mottles of reddish brown (2.5YR 4/4); dark grayish brown (10YR 4/2) when moist, with many, medium, prominent mottles of dark reddish brown (2.5YR 3/4); loose when dry or moist; single grain (structureless); noncalcareous.

C_{g4}—45 to 60 inches, pale-olive (5Y 6/3) fine sand with many, fine, prominent mottles of reddish brown (2.5YR 4/4); olive (5Y 5/3) when moist, with mottles of dark reddish brown (2.5YR 3/4); loose when dry or moist; single grain (structureless); slightly calcareous.

HAMAR SERIES.—The Hamar soils developed in moderately sandy, glacial lacustrine deposits and are deep and imperfectly drained. They have a thick dark A_1 horizon that, in many places, is separated by a gradual boundary from a C horizon unstained by organic matter. A weak B horizon has formed in some places. Brown and reddish-brown mottles increase as organic staining decreases. These soils are calcareous at the surface in some places but are not strongly calcareous within a depth of 15 inches.

The Hamar soils developed in more sandy material than the Ulen soils and do not have a prominent lime zone. Hamar soils are less calcareous than the Arveson soils, which have a prominent C_{ca} horizon.

Typical profile:

A_1—0 to 8 inches, dark-gray (10YR 4/1) fine sandy loam, very dark gray (10YR 3/1) when moist; weak, granular structure; very friable when moist; noncalcareous.

AB—8 to 17 inches, dark-gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; weak, coarse, prismatic structure; very friable when moist; noncalcareous.

B—17 to 25 inches, gray (10YR 5/1) loamy fine sand, dark gray (10YR 4/1) when moist; very weak, granular structure to single grain (structureless); noncalcareous.

C_1—25 to 36 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; loose when dry or moist; single grain (structureless); noncalcareous.

C_2—36 to 52 inches, light-gray (2.5Y 7/2) fine sand with many mottles of brownish yellow (10YR 6/6); grayish brown (10YR 5/2) when moist, with mottles of yellowish brown (10YR 5/6); loose when dry or moist; single grain (structureless); noncalcareous.

C_3—52 to 60 inches, light-gray and light brownish-gray (2.5Y 7/2 and 6/2) fine sand with mottles of reddish yellow (7.5YR 6/6 and 6/8); grayish brown (2.5Y 5/2) when moist, with mottles of brown and strong brown (7.5YR 5/4 and 5/6); loose when dry or moist; single grain (structureless); noncalcareous.

Some Hamar soils are noncalcareous throughout the profile, and others are calcareous at the surface but are not strongly calcareous within 15 inches of the surface. In some soils the C_{ca} horizon is at a depth of more than 15 inches.

LAMOURE SERIES.—In the Lamoure series are deep, poorly drained soils that developed in recent medium-textured and moderately fine textured alluvium on the bottom lands of streams or rivers. These soils have a thick, dark-colored A_1 horizon and a gleyed subsoil. Although they are generally limy at the surface, and the maximum amount of lime is below the A_1 horizon, a distinct C_{ca} horizon has not formed.

The Lamoure soils occur with the La Prairie soils, which are better drained than the Lamoure.

Typical profile:

A_1—0 to 7 inches, very dark gray (2.5Y 3/0) silty clay loam, black (2.5Y 2/1) when moist; moderate, granular structure; friable when moist, slightly sticky and plastic when wet; calcareous.

A_{gca}—7 to 15 inches, dark-gray (5Y 4/1) loam and clay loam, very dark gray (5Y 3/1) when moist; texture variations in pockets; common, medium sand particles; strongly calcareous.

A_{1b1}—15 to 20 inches, very dark gray (2.5Y 3/1) silty clay loam, black (2.5Y 2/1) when moist; medium, granular structure; strongly calcareous.

C_{gca1}—20 to 27 inches, gray (5Y 5/1) silty clay loam, dark gray (5Y 4/1) when moist; weak, coarse, angular blocky structure; friable when moist, slightly sticky and plastic when wet; strongly calcareous.

C_{gca2}—27 to 36 inches, light-gray (5Y 6/1) loam with few large lime concretions of white (5Y 8/1); gray (5Y 5/1) when moist, with lime concretions of light gray and white (5Y 7/2 and 8/2); moderate, granular structure; very friable when moist, slightly sticky and plastic when wet.

A_{1b2}—36 to 40 inches, very dark gray (2.5Y 3/0) silt loam, black (2.5Y 2/1) when moist; more strongly calcareous than A horizon.

C_{gca1b}—40 to 46 inches, gray (5Y 5/1) loam, dark gray (5Y 4/1) when moist; weak, coarse, angular blocky structure; strongly calcareous.

C_{gca2b}—46 to 52 inches, light-gray (5Y 7/2) loam with large concretions of white (5Y 8/1) lime; light olive gray (5Y 6/2) when moist, with concretions of light-gray (5Y 7/1) lime.

D—52 to 56 inches, pale-yellow (5Y 7/3) very fine sandy loam with many mottles of dark reddish gray (5YR 4/2); pale olive (5Y 6/3) when moist, with mottles of dark reddish brown (5YR 3/2).

In Sargent County a black, buried A horizon is common in the soil profile. In some places a gravel or sand substratum occurs at a depth below 3 feet.

PARNELL SERIES.—The Parnell soils are deep, dark, and poorly drained or very poorly drained. They are on the till plain in morainic depressions, where they developed in glacial till and local alluvium that washed into the depressions from surrounding higher soils. In some areas of Sargent County, till occurs at a depth of 3 feet, but in many areas the alluvium is more than 5 feet thick. The Parnell soils have a thick, black A_1 horizon that is very high in organic matter and in places is covered by a thin mat of plant remains. The B horizon is firm, blocky, and fine textured. Segregated lime is in the upper part of the mottled parent material.

Parnell soils occur with the Barnes and Forman soils, which are Chernozems. The Parnell soils occur in deeper, wetter depressions on the till plain than do the Tetonka soils (Planosols).

Typical profile:

A_1—0 to 8 inches, black (10YR 2.5/1) silty clay loam, black (10YR 2/1) when moist; weak, medium, platy structure; hard when dry, friable when moist, sticky and plastic when wet; smooth boundary.

AB—8 to 11 inches, black (10YR 2.5/1) silty clay loam, black (10YR 2/1) when moist; medium, angular blocky structure; hard when dry, friable when moist, sticky and plastic when wet; smooth boundary.

B_{21}—11 to 20 inches, very dark gray (2.5Y 3/1) silty clay, black (2.5Y 2/1) when moist; strong, very fine, angular blocky structure; firm when moist, very sticky and very plastic when wet; continuous, distinct clay films on all ped faces; wavy boundary.

B_{22} and B_{23}—20 to 39 inches, very dark gray (2.5Y 3/1) silty clay, black (2.5Y 2/1) when moist; moderate, medium, angular blocky structure; sticky and plastic when wet; noncalcareous; wavy boundary.

C_{gca}—39 to 46 inches, light-gray (5Y 7/1) silty clay, gray (5Y 5/1) when moist; weak, angular blocky structure; firm when moist, sticky and plastic when wet; very strongly calcareous; clear, smooth boundary.

C_g—46 to 60 inches, light-gray and white (5Y 6/1 and 8/1) silty clay loam with many prominent mottles of reddish yellow (7.5YR 6/6); olive gray (5Y 5/2) when moist, with mottles of strong brown (7.5YR 5/6); weak, angular blocky structure; firm when moist, sticky and plastic when wet; moderately calcareous, with common, large, soft segregations of lime.

Generally Parnell soils are noncalcareous to a depth greater than 3 feet and contain large segregations of lime below that depth, but in some areas these soils are calcareous at or near the surface and do not have a prominent lime zone immediately below the A_1 horizon. The degree of mottling varies considerably in the lower part of the profile. In some places the lower subsoil contains hard, brown, rounded concretions of ironstone that are between 1/16 and 1/4 inch in diameter.

PERELLA SERIES.—In the Perella series are imperfectly drained soils that developed in medium-textured and moderately fine textured glaciofluvial deposits. These soils have a moderately thick or thick A_1 horizon and a weakly expressed B horizon that shows little or no increase in content of clay. The soils are free of lime to a depth greater than 15 inches.

With the Perella soils, in a catena that formed in lacustrine materials, are the Overly, Bearden, and Colvin soils. The Overly soils are Chernozems, and the Bearden and Colvin are calcareous Solonchaks. The Perella soils are more poorly drained than the Overly soils and differ from the Bearden soils by having a B horizon.

Typical profile:

A_1—0 to 7 inches, very dark gray (10YR 3/1) heavy silty clay loam, black (10YR 2/1) when moist; fine, granular structure; hard when dry, friable when moist, sticky and plastic when wet; noncalcareous.

B_g—7 to 16 inches, dark grayish-brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; fine and very fine, blocky structure; hard when dry, firm when moist, very sticky and very plastic when wet.

B_{gca}—16 to 32 inches, light-gray (5Y 6/1) silty clay loam, gray (5Y 5/1) when moist; massive (structureless); hard when dry, friable when moist, sticky and plastic when wet.

C_{gca}—32 to 60 inches, light olive-gray (5Y 6/2) silty clay loam with many white (5Y 8/2) concretions of lime; olive gray (5Y 5/2) when moist, with light-gray (5Y 7/2) concretions of lime; massive (structureless); hard when dry, firm when moist, sticky and plastic when wet; strongly calcareous.

The Perella soils vary mainly in the thickness of the A_1 horizon and in the depth to lime.

RAUVILLE SERIES.—In the Rauville series are deep, dark, very poorly drained soils that developed in postglacial alluvium. These soils have a moderately thick to thick, black or very dark gray A_1 horizon and a gleyed subsoil. The substratum consists of stratified gravel, sand, silt, and clay.

Rauville soils occur with Lamoure soils.

Typical profile:

A_1—0 to 10 inches, silty clay loam, black (10YR 2/1) when moist; moderate, fine, granular structure; slightly calcareous.

A_{1g}—10 to 20 inches, clay loam, very dark gray (10YR 3/1) when moist; common grains of clear quartz sand; moderate, granular structure; moderately calcareous.

C_g—20 to 28 inches, sandy clay loam, very dark gray (10YR 3/1 and 5Y 3/1) when moist; many clear grains of quartz sand; slightly calcareous.

D_{g1}—28 to 48 inches, loamy sand, very dark gray (10YR 3/1 and 2.5Y 3/1) when moist; single grain (structureless) slightly calcareous.

D_{g2}—48 to 60 inches, clay loam, olive gray (5Y 4/2) when moist, with common mottles that are dark reddish brown (5YR 3/2) when moist, and with many large concretions of lime that are light brownish gray (2.5Y 6/2) when moist; strongly calcareous.

Variations in the Rauville soils in Sargent County are mainly in the substratum.

PLANOSOLS

The only Planosols in the county are in the Tetonka series. Planosols have an eluviated surface horizon underlain by a B horizon that is more strongly illuviated, cemented, or compacted than the B horizon of associated normal soils. Planosols formed in nearly level upland areas under grass or forest vegetation in a humid or subhumid climate.

TETONKA SERIES.—The Tetonka soils of Sargent County are extensive in shallow depressions in the glacial till plain and are inextensive in depressions in the glacial lake plains. Like the Parnell soils, the Tetonka soils on the till plain generally developed in local alluvium about 3 feet thick over glacial till.

The Tetonka soils are poorly drained and have a moderately thick or thick A_1 horizon and a very dark gray, mottled A_2 horizon. In many places the A_2 horizon is separated from the B_2 horizon by a gradual boundary. The B_2 horizon is prismatic or blocky in structure.

Typical profile:

A_{11}—0 to 3 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; large amount of freshly decomposed organic matter and matted live roots; weak, fine, crumb structure; much fine sand of clear quartz; noncalcareous.

A_{12}—3 to 10 inches, dark-gray (10YR 4/.5) silty clay loam, black (10YR 2/1) when moist; strong, thin to medium, platy structure; plates are coated with bleached very fine sand and silt of clear quartz and are a distinct gray on upper side when dry; slightly hard when dry, very friable when moist, slightly sticky and slightly plastic when wet; noncalcareous; clear, wavy boundary.

A_2—10 to 13 inches, gray (10YR 5/.5) loam with many, fine, distinct mottles of light gray (10YR 6/.5) and brownish yellow (10YR 6/8); very dark gray (10YR 3/.5) when moist, mottles of very dark grayish brown (10YR 3/2); moderate, medium plates coated with very fine sand of clear quartz; very hard when dry, friable when moist, sticky and plastic when wet; noncalcareous; clear, wavy boundary.

B_1—13 to 16 inches, very dark gray (10YR 3.5/1) clay loam with common mottles of brown (10YR 5/3) and coats of gray (10YR 5/1) on blocks; very dark gray (10YR 3/1) when moist, with mottles of dark brown (10YR 4/3) and coats of dark gray (10YR 4/1) on blocks; moderate, very fine, blocky structure; very hard when dry, firm when moist, and very sticky and very plastic when wet; noncalcareous; clear, wavy boundary.

B_2—16 to 25 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; weak, coarse prisms breaking to strong, medium blocks; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous; clear, smooth boundary.

B_g—25 to 31 inches, dark-gray (5Y 4/1) sandy clay loam, dark olive gray (5Y 3/2) when moist, with common mottles of olive (5Y 5/3); weak, coarse prisms breaking to moderate, fine, angular blocks; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous; clear, wavy boundary.

B_{gca}—31 to 36 inches, gray (5Y 6/1 and 5/1) loam with common, fine, distinct mottles of light olive brown (2.5Y 5/4); olive gray (5Y 4/2) when moist, with mottles of dark yellowish brown (10YR 4/4); strongly calcareous but little or no segregated lime; weak, coarse prisms breaking to moderate, fine, angular blocks; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; common, fine- and medium-sized pebbles; clear, smooth boundary.

C_{gca}—36 to 48 inches, light-gray (5Y 6/1) loam, dark gray (5Y 4/1) when moist, with many, fine, distinct mottles of white (5Y 8/1) and medium to large, prominent mottles of strong brown (7.5YR 4/4); weak, medium, angular blocky structure; very hard when dry, firm when moist, sticky and plastic when wet; common, fine- and medium-sized pebbles; very strongly calcareous; many small, soft segregations of lime and soft, thin crusts of lime on pebbles; clear, smooth boundary.

C_g—48 to 60 inches, light-gray (5Y 6/1) and light olive-brown (2.5Y 5/4) loam, gray (5Y 5/1) and olive brown (2.5Y 4/4) when moist, with common, fine mottles of white (10YR 8/1) and many, coarse mottles of dark yellowish brown (10YR 4/4) when dry or moist; hard when dry, firm when moist, slightly sticky and slightly plastic when wet; common, fine- and medium-sized pebbles; strongly calcareous; small amount of soft segregations of lime.

GRUMUSOLS

The only Grumusols in the county are in the Fargo series. Grumusols have a high content of clay, are relatively uniform in texture, and show signs of local soil movement that is a result of shrinking and swelling as the soils are alternately dry and wet. Many of these soils have a thick, dark A horizon over a limy C horizon; others are uniform in general appearance except for signs of churning.

Fargo series.—In the Fargo series are deep, poorly drained clays on the glacial plains of Lake Agassiz and Lake Dakota. These soils have a thick, black A_1 horizon from which prominent tongues extend into the gleyed subsoil. Fargo soils are generally calcareous at a depth of 8 to 20 inches.

The lack of a prominent C_{ca} horizon near the surface distinguishes the Fargo soils from Hegne soils. The Fargo soils are better drained than the Dimmick soils.

Typical profile:

A_{1p}—0 to 6 inches, silty clay that is black (N 2/0) when dry or moist; coarse, blocky structure breaking to very fine, granular; hard when dry, firm when moist, sticky and plastic when wet; slightly calcareous.

A_g—6 to 16 inches, clay that is black (N 2/0) when dry or moist; coarse, blocky structure breaking to fine and very fine, granular structure; hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous.

A_{gca}—16 to 20 inches, very dark gray (2.5Y 3/0) clay, black (N 2/0) when moist; weak, medium, blocky structure breaking to fine, granular; hard when dry, firm when moist, very sticky and very plastic when wet; few large concretions of lime.

C_{g1}—20 to 44 inches, clay that is black (N 2/0) when dry or moist; fine, granular structure; extremely hard when dry, firm when moist, very sticky and very plastic when wet; slightly calcareous; common gypsum crystals.

C_{g2}—44 to 60 inches, light olive-gray (5Y 6/2) clay, dark olive gray (5Y 5/2) when moist; massive (structureless); extremely hard when dry, very firm when moist, very sticky and very plastic when wet; slightly calcareous; many gypsum crystals.

If a C_{ca} horizon occurs, its content of calcium carbonate may be small or large. Nevertheless, the accumulation of calcium carbonate appears to be small. In some places the substratum, when moist, is mottled with few to many yellow and brown mottles. A few glacial stones and pebbles are on the surface and in the profile in some places.

SOLONETZ SOILS

The Solonetz soils in Sargent County are in the Aberdeen, Cresbard, Exline, and Stirum series. The Aberdeen and Cresbard soils are strongly solodized, and the Exline soils are weakly solodized.

The Exline and Stirum soils have a dispersed (deflocculated) surface horizon, and a B_2 horizon that is of columnar or prismatic structure. The Aberdeen and Cresbard soils are solodized Solonetz soils. In these soils the A_2 horizon is light colored and is underlain by a darker, prismatic or columnar B_2 horizon. The Exline soils show some evidence of having an A_2 horizon, which appears as a light-colored coating on the tops of the columns in the B_2 horizon. In road cuts and in other exposed places, the surface of Stirum soils flows to a very smooth surface when the soils are wet. This surface dries out extremely hard. Cultivated fields of the Exline soils have a highly dispersed surface layer and, consequently, are hard and cloddy.

Aberdeen series.—The Aberdeen series consists of moderately well drained, strongly solodized Solonetz soils that formed in medium-textured or moderately fine textured glacial lacustrine deposits. These soils have a moderately thick or thick, black A_1 horizon that abruptly overlies a weak or distinct A_2 horizon. The A_2 horizon is of platy structure and overlies a B_2 horizon that is prismatic or columnar. If the B_2 horizon is columnar, the columns readily break into blocks. These characteristics differentiate the Aberdeen soils from Exline soils, which have a thin A horizon and a strong, columnar B_2 horizon. Cultivated fields of the Aberdeen soils have only slight dispersion in the surface soil, whereas those of the Exline soils have much.

Typical profile:

A_1—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; fine, granular structure; soft when dry, very friable when moist; noncalcareous; abrupt, smooth boundary.

A_2—8 to 12 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; weak, medium, prismatic structure; prisms break readily into medium plates; slightly hard when dry, friable when moist; noncalcareous; abrupt, smooth boundary.

B_2—12 to 26 inches, very dark gray (2.5Y 3/1) clay loam, black (2.5Y 2/1) when moist; weak, medium, flat-topped columns that break readily to moderate, medium blocks; hard when dry, firm when moist, sticky and plastic when wet.

C_{ca}—26 to 40 inches, light brownish-gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; massive (structureless); common gypsum crystals visible; hard when dry, friable when moist; strongly calcareous.

C—40 to 60 inches, pale-yellow (2.5Y 7/4), laminated silty clay loam, light yellowish brown (2.5Y 6/4) when moist; hard when dry, friable when moist; calcareous.

The B_2 horizon is columnar in some places and prismatic in others. The columns or prisms are fragile and break into medium to very fine blocks. The substratum is laminated silty clay loam, laminated silt and clay, or stratified silt, fine sand, and clay.

Cresbard series.—The Cresbard series consists of strongly solodized Solonetz soils that developed in glacial till. They have a moderately thick or thick, black A_1 horizon and a weak or distinct A_2 horizon. The A_2 horizon is underlain by a B_2 horizon that is generally prismatic or blocky in structure. In some areas the B_2 horizon has a columnar structure in which the columns readily break into blocks.

Cresbard soils have a profile similar to that of the Aberdeen soils, but the Aberdeen soils formed in lacustrine deposits instead of glacial till.

Typical profile:

A_{1p}—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; fine and very fine, granular structure; soft when dry, friable when moist; noncalcareous.

A_2—8 to 14 inches, gray (10YR 5/1) silt loam, dark gray (10YR 4/1) when moist; weak, medium, platy structure with many pores; soft when dry, very friable when moist.

B_2—14 to 26 inches, very dark gray (10YR 3/1) clay, black (10YR 2/1) when moist; fine and medium prisms that break easily to moderate, medium blocks; hard when dry, firm when moist, sticky and plastic when wet.

C—26 to 36 inches, very dark gray and grayish-brown (10YR 3/1 and 2.5Y 5/2) clay loam, black and dark grayish brown (10YR 2/1 and 2.5Y 4/2) when moist; hard, when dry, friable when moist, and sticky and plastic when wet; calcareous.

C_{cs}—36 to 47 inches, clay loam that is grayish brown and olive gray (2.5Y 5/2 and 5Y 5/2) when moist, with many, fine mottles of strong brown (7.5YR 5/8); massive (structureless); strongly calcareous; many gypsum crystals.

C—47 to 60 inches, clay loam that is olive gray, light olive brown, and light gray (5Y 5/2, 2.5Y 5/6, and 2.5Y 7/2) when moist; massive (structureless); friable when moist, sticky and plastic when wet; calcareous.

The Cresbard soils in the county vary mainly in the thickness of the A_1 and A_2 horizons.

Exline series.—The Exline soils are weakly solodized Solonetz soils that developed in medium-textured to fine-textured, glacial lacustrine deposits. In areas of native grass the Exline soils have a thin A horizon and a strong, columnar B_2 horizon. In cultivated fields the surface layer is highly dispersed and is hard and cloddy. These characteristics differentiate the Exline from the Aberdeen soils, in which the A_1 horizon is thicker and the B_2 horizon is weaker.

Typical profile:

A_1—0 to 6 inches, very dark gray (10YR 3/1) loam, black (10YR 2/1) when moist; fine, granular structure; sticky and plastic when wet; abrupt, smooth boundary.

B_{21}—6 to 10 inches, very dark gray (5Y 3/1) clay loam, black (5Y 2/1) when moist; strong, medium, columnar structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; noncalcareous; clear, wavy boundary.

B_{22}—10 to 17 inches, dark grayish-brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; strong, medium, columnar structure; extremely hard when dry, very firm when moist, very sticky and very plastic when wet; limy around the columns and in the few large root holes.

B_{3ca}—17 to 24 inches, light-gray (5Y 7/2) clay loam, pale yellow (5Y 7/3) when moist; tongues of olive (5Y 5/3 when dry, 4/3 when moist); fine and very fine, blocky structure; hard when dry, friable when moist, slightly sticky and plastic when wet; very strongly calcareous; abrupt, smooth boundary.

D_1—24 to 30 inches, olive-yellow (2.5Y 6/6) loam, light olive brown (2.5Y 5/6) when moist; friable when moist, slightly sticky and slightly plastic when wet; moderately calcareous; abrupt, smooth boundary.

D_2—30 to 40 inches, pale-olive (5Y 6/3) silt loam, olive (5Y 5/3) when moist; weak, blocky structure; sticky and plastic when wet; strongly calcareous; clear, smooth boundary.

D_{3ca}—40 to 48 inches, light yellowish-brown (2.5Y 6/4) silt loam with common white (5Y 8/1) concretions of lime and reddish-brown (5YR 4/4) concretions of iron; light olive brown (2.5Y 5/4) when moist, with white (5Y 8/2) concretions of lime and dark reddish-brown (5YR 3/4) concretions of iron; weak, angular blocky structure; sticky and plastic when wet; strongly calcareous.

G—48 to 60 inches, light-gray (5Y 6/1) silt loam, gray (5Y 5/1) when moist, with dark reddish-brown (5YR 2/2 and 3/4) concretions of iron; concretions nearly round with vertical axis longer than horizontal; nonsticky and nonplastic when wet; moderately calcareous.

Exline soils have a thin, gray A_2 horizon in some areas, but generally the only evidence of this horizon is a gray coating on the rounded tops of the columns in the B_2 horizon. The substratum in Sargent County commonly is loamy fine sand and fine sand.

Stirum series.—The Stirum series consists of poorly drained Solonetz soils that developed in sandy glacial deposits from melt water. The thin to moderately thick A_1 horizon is underlain by a B_2 horizon that has a coarse, columnar structure. The upper part of the B_2 horizon is stained with organic matter, but the organic matter decreases with increasing depth, and the horizon is nearly neutral, dark gray to dark olive gray in the lower part. Stirum soils are generally calcareous at or near the surface, and they have a weakly to moderately expressed horizon of segregated lime. The differentiating characteristics of these soils are (1) the very large, columnar structure of the B_2 horizon, and (2) the consistence of the soil, which is elastic when moist or wet and is very hard or cementlike when dry. In road cuts or other exposed surfaces, the Stirum soils flow to a smooth surface when they are wet. When the surface dries, it becomes extremely hard and has a continuous covering of clear sand that resembles frost.

The Stirum soils are closely associated with the Arveson soils and differ from them by having very large columns or prisms and an elastic consistence when wet or moist. The faces of the columns or prisms are stained and coated with clay.

Typical profile:

A_{11}—0 to 5 inches, loam that is very dark gray (5Y 3/1) when moist; weak, fine, crumb structure; very friable when moist, slightly sticky and plastic when wet; moderately calcareous; clear, smooth boundary.

A_{12}—5 to 10 inches, fine sandy loam that is dark olive gray (5Y 3/2) when moist; compound structure that is weak, medium, prismatic and moderate, very fine, blocky; friable when moist, slightly sticky and plastic when wet; strongly calcareous; clear, smooth boundary.

B_2—10 to 21 inches, sandy clay loam that is olive gray (5Y 5/2) when moist; coarse, prismatic structure; prism faces coated with continuous, distinct clay films that are dark olive gray (5Y 3/2) when moist; friable to firm when moist, sticky and plastic when wet; very strongly calcareous.

C_{gca}—21 to 26 inches, sandy clay loam that is dark gray (5Y 4/1) when moist; weak, medium, angular blocky structure; friable when moist, sticky and plastic when wet; very strongly calcareous; many light-gray concretions of lime; abrupt, smooth boundary.

C_g—26 to 60 inches, olive-gray (5Y 5/2, moist) fine sandy loam, light yellowish-brown (2.5Y 6/4, moist) loamy fine sand, and olive (5Y 5/3, moist) loamy very fine sand in successive layers; prominently mottled with strong brown, dark reddish brown, black, and pale olive; strongly calcareous.

Stirum loam is the only Stirum soil identified in Sargent County. The prismatic or columnar structure of the B_2 horizon can be seen but is not prominent. In some places segregated lime occurs within or just below the B horizon, or is lower in the profile. The C_g horizon is underlain by a cemented layer. The Stirum soils are strongly alkaline and nonsaline, and they have a high percentage of exchangeable sodium below the upper few inches.

Azonal order

In Sargent County the great soil groups in the azonal order are Alluvial soils and Regosols.

ALLUVIAL SOILS

Alluvial deposits in Sargent County are inextensive. They are mainly on the bottom lands of the Wild Rice River, which has a shallow, narrow valley. Narrow belts of alluvial soils also occur along small tributaries of the Wild Rice River and in old, abandoned channels of other small streams. The soils in these alluvial deposits are cut up into small, irregularly shaped areas by the old channels.

In Sargent County, only the Fairdale and La Prairie soils developed in this postglacial alluvium. The Fairdale and La Prairie soils have an AC horizon sequence. The Fairdale soils are lighter colored than La Prairie soils. The horizons in La Prairie soils are discernible in most places but are not distinct anywhere. Generally, the soils in alluvium have only a thick, dark-colored A horizon, for other genetic horizons have not developed. Beneath the A horizon are alluvial strata that are not related to each other genetically.

FAIRDALE SERIES.—The Fairdale series consists of moderately well drained, medium-textured Alluvial soils of the northern Chernozem region. These soils have a thin or very thin, very dark gray or very dark brown A_1 horizon that overlies grayish-brown to light-gray alluvial layers of calcareous, stratified silt loam and fine sand. The Fairdale soils typically occur on the bottom lands along rivers and streams in the western part of the Lake Agassiz plain. They are distinguished from La Prairie soils by their thinner A_1 horizon and by lighter colored, more stratified parent materials. They are lighter colored and better drained than Lamoure silt loam. The Fairdale soils are subject to frequent flooding and consequently receive thin to thick deposits annually. These soils are inextensive and are unimportant in agriculture.

Soil profile:

A_1—0 to 3 inches, silt loam that is very dark brown (2.5Y 2/2) when moist; moderate, very fine, granular structure; very friable when moist; moderately calcareous; abrupt boundary.

C_1—3 to 6 inches, very fine sand that is light gray (2.5Y 6/1) when moist; loose when dry or moist; moderately calcareous; abrupt boundary.

C_2—6 to 8 inches, silt loam that is dark grayish brown (2.5Y 4/2) when moist; weak, medium, platy (laminar) structure; friable when moist; moderately calcareous; abrupt boundary.

A_{1b}—8 to 11 inches, silt loam that is black (10YR 2/1) when moist; strong, medium, granular structure; very friable when moist; very mildly calcareous; clear boundary.

C_{1b}—11 to 60 inches, very fine sandy loam that is very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/2) when moist; very friable when moist; moderately calcareous.

The substratum of Fairdale soils is stratified silt loam, fine sand, and silty clay loam. Generally, one or more buried surface layers occur within a depth of 5 feet. The Fairdale soils are calcareous in most places, but in some places they are noncalcareous or only mildly calcareous.

LA PRAIRIE SERIES.—La Prairie series consists of deep, dark, medium-textured soils on bottom lands, mainly along the Wild Rice River. These soils have a moderately thick or thick A_1 horizon. La Prairie soils are darker than the Fairdale soils and have a thicker A_1 horizon. They are better drained than the Lamoure soils.

Typical profile:

A_1—0 to 8 inches, very dark gray (10YR 3/1) silt loam, black (10YR 2/1) when moist; fine, granular structure; very friable when moist.

A_{1ca}—8 to 20 inches, dark-gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) when moist; granular structure; friable when moist, slightly sticky and plastic when wet; slightly calcareous.

C_{ca}—20 to 28 inches, light brownish-gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; friable when moist, slightly sticky and plastic when wet; strongly calcareous.

C—28 to 36 inches, grayish-brown (2.5Y 5/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; fine, granular structure; friable when moist; slightly calcareous.

C_{g1}—36 to 42 inches, light-gray (5Y 7/1) silty clay loam, gray (5Y 6/1) when moist; firm when moist, sticky and plastic when wet; slightly calcareous.

C_{g2}—42 to 48 inches, light olive-gray (5Y 6/2) sandy clay loam, olive gray (5Y 7/2) when moist; friable when moist; slightly calcareous.

C_{g3}—48 to 60 inches, gray (5Y 6/1) silty clay loam, gray (5Y 5/1) when moist; firm when moist, sticky and plastic when wet; slightly calcareous.

The profile of La Prairie soils commonly contains a buried surface horizon. In many places the substratum is stratified silty clay loam, sandy loam, sandy clay loam, and silt loam.

REGOSOLS

The Regosols in this county are in the Buse, Hecla, Sioux, Valentine, and Zell series. The soils in these series have an A_1 horizon that is dark colored because organic matter has been added to the soil when plants have died and decayed. The only morphologic changes in the parent material are some organic-matter staining in the upper part of the profile, some removal of the more soluble salts, and a weak horizon of accumulated lime in some places.

The Buse soils developed in glacial till. Small cultivated areas on the tops of knolls or on hillsides are light colored in many places because some of the thin, dark surface soil has been removed by erosion, and some of the light-colored parent material has been mixed with the surface layer by tillage.

The Hecla and Valentine soils developed in sandy deposits from glacial melt water. These deposits have been reworked by wind in many places. Most areas of these soils in the county have a hummocky relief and are so droughty and susceptible to wind erosion that they cannot be cultivated.

The Sioux soils consist of a thin mantle of loam or sandy loam over gravel. These soils generally are in native grass and are not suitable for cultivation.

The Zell soils resemble the Buse soils but have developed in deposits of lacustrine silt rather than in glacial till. In Sargent County the Zell soils occur mainly on the breaks along the Wild Rice River.

BUSE SERIES.—Buse soils are excessively drained Regosols of the Chernozem soil region. They developed in glacial till on the tops of low knolls, on hills or ridges in the till plain, and on the upper part of steep slopes. Buse soils have a thin to moderately thick A_1 horizon that is generally separated from the C horizon by a gradual boundary. In the upper part of the C horizon is a weak lime zone.

The Buse soils and Zell soils have similar profiles but different kinds of parent material. The parent material of the Zell soils is medium-textured lacustrine deposits.

Typical profile:

A_1—0 to 4 inches, dark-gray (10YR 4/1) loam, black (10YR 2/1) when moist; medium and fine, granular structure; very friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous.

C_1—4 to 18 inches, light yellowish-brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) when moist; weak, coarse, prismatic structure; friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous; few shale particles.

C_2—18 to 36 inches, light yellowish-brown (2.5Y 6/4) loam with common mottles of light gray (2.5Y 7/2); light olive brown (2.5Y 5/4) when moist, with mottles of light brownish gray (2.5Y 6/2); weak, coarse, prismatic structure; friable when moist, slightly sticky and slightly plastic when wet; strongly calcareous.

C_3—36 to 60 inches, light yellowish-brown (2.5Y 6/4) loam mottled with light gray and brownish yellow (2.5Y 7/2 and 10YR 6/6); light olive brown (2.5Y 5/4) when moist, with mottles of light brownish gray and yellowish brown (2.5Y 6/2 and 10YR 5/6); massive (structureless); friable when moist, slightly sticky and slightly plastic when wet; slightly calcareous.

The A_1 horizon of Buse soils ranges from 2 to 6 inches in thickness. This horizon directly overlies a weak C_{ca} horizon or grades gradually to a calcareous AC horizon that has a weak, coarse, prismatic structure. The AC horizon grades gradually to the C horizon.

HECLA SERIES.—The Hecla soils are moderately well drained Regosols that have a thick A horizon. They developed mainly in sandy deposits of glacial melt water. These soils have a weak to distinct C horizon below the depth to which the soil is stained by organic matter.

The Hecla soils are on lower, more gentle slopes than Maddock soils and have a thicker A horizon. They are not so well drained as the Maddock soils.

Typical profile:

A_{11}—0 to 12 inches, dark-gray (10YR 4/1) fine sand, very dark gray (10YR 3/1) when moist; very friable when moist; noncalcareous; smooth boundary.

A_{12}—12 to 22 inches, dark-gray (10YR 4/1) loamy fine sand, very dark gray (10YR 3/1) when moist; noncalcareous.

A_{1c}—22 to 30 inches, grayish-brown (10YR 5/2) fine sand, dark gray (10YR 4/1) when moist; loose when dry or moist; single grain (structureless); noncalcareous.

C_1—30 to 48 inches, light brownish-gray (10YR 6/2) fine sand, grayish brown (10YR 5/2) when moist; loose when dry or moist; single grain (structureless); noncalcareous; wavy boundary.

C_2—48 to 60 inches, light brownish-gray (10YR 6/2) loamy fine sand, grayish brown (10YR 5/2) when moist; many mottles of dark yellowish brown (10YR 4/4) when moist and yellowish brown (10YR 5/4) when dry.

The soil types mapped in Sargent County are fine sandy loam, loamy fine sand, and fine sand. The Hecla soils have an AC horizon sequence in most places. In some places a weak B horizon has formed and the soils grade toward Chernozems. In moderately shallow phases of the Hecla soils, the substratum consists of glacial till or of silty or clayey lacustrine deposits.

SIOUX SERIES.—In the Sioux series are excessively drained, shallow soils that developed in a thin mantle of glacial alluvium over outwash of gravel or sand, or both. The soils generally have segregated lime in the upper part of the gravel or sand.

Sioux soils occur with the Renshaw soils but are shallower than those soils over the gravel or sand.

Typical profile:

A_1—0 to 4 inches, very dark grayish-brown (10YR 3/2) loam, very dark brown (10YR 2/2) when moist; medium, granular structure; noncalcareous.

C—4 to 6 inches, dark grayish-brown (2.5Y 4/2) gravelly loam, very dark grayish brown (2.5Y 3/2) when moist; calcareous.

D_{ca}—6 to 13 inches, grayish-brown and white (2.5Y 5/2 and 10YR 8/2) gravelly loam, dark grayish brown and light gray (2.5Y 4/2 and 10YR 7/2) when moist; soft lime coats on pebbles and in pebble sockets; very strongly calcareous.

D—13 to 60 inches, brown, reddish-brown, and yellowish-brown (7.5YR 5/4, 5YR 4/4, and 10YR 5/3) gravel and some coarse sand; colors in stratified layers of varying thickness.

The main variation in the Sioux soils of the county is the thickness of the loamy alluvial mantle, which is less than 18 inches thick.

VALENTINE SERIES.—The Valentine soils are excessively drained Regosols that developed in fine sand or loamy fine sand in areas where the wind has formed hummocks or dunes. The Valentine soils occur closely with the Hecla and Maddock soils but differ from them in having a much thinner surface horizon that is stained with organic matter.

Typical profile:

A—0 to 2 inches, very dark gray and gray (10YR 3/1 and 5/1) fine sand, black and dark gray (10YR 2/1 and 4/1) when moist; loose when dry or moist, single grain (structureless).

C—2 to 60 inches, grayish-brown (2.5Y 5/2) fine sand, dark grayish brown (10YR 4/2) when moist; loose when dry or moist, single grain (structureless).

The Valentine soils vary only in the depth of organic-matter staining. This depth is less than 10 inches.

ZELL SERIES.—The Zell soils are excessively drained and developed in silty lacustrine deposits. In Sargent County these soils are mainly on breaks along the Wild Rice River. They have a thin to moderately thick, dark-colored A horizon that is directly underlain by lighter colored parent material. The parent material has segregated lime in its upper part.

The Zell soils have a profile similar to that of the Buse soils, which formed in glacial till instead of lacustrine deposits.

Typical profile:

A_{1p}—0 to 6 inches, dark-gray (10YR 4/1) silt loam mottled with white (2.5Y 8/2); very dark gray (10YR 3/1) when moist, with mottles of light yellowish brown (2.5Y 6/4); fine and very fine, granular structure; calcareous.

C_{ca}—6 to 18 inches, white (2.5Y 8/2) silt loam, light yellowish brown (2.5Y 6/4) when moist; weak, medium, prismatic structure; soft when dry, very friable when moist; very strongly calcareous.

C_1—18 to 25 inches, white and pale-yellow (2.5Y 8/2 and 8/4) silt loam, mottled with yellow and reddish yellow (10YR 7/6 and 7.5YR 6/6); grayish brown and light olive brown (2.5Y 5/2 and 5/4) when moist, with mottles of brownish yellow and strong brown (10YR 6/6 and 7.5YR 5/6); weak, fine and medium, platy structure; calcareous.

C_2—25 to 35 inches, light brownish-gray to light yellowish-brown (2.5Y 6/2 and 6/4) silt loam that has large circular stains of brownish yellow (10YR 6/6); grayish brown and light olive brown (2.5Y 5/2 and 5/4) when moist, with large circular stains of yellowish brown (10YR 5/6); weak, fine and medium, platy structure; calcareous.

C_3—35 to 60 inches, pale-yellow (2.5Y 8/4) silt loam, light yellowish brown (2.5Y 6/4) when moist; fine, platy structure; calcareous.

The A horizon generally ranges from 2 to 6 inches in thickness and in some places is underlain by a weak C_{ca} horizon. In other places the A horizon grades gradually to a calcareous AC horizon and that, in turn, to the C horizon.

Mechanical and Chemical Analysis

Table 12 contains data on the mechanical and chemical properties of some selected soils in Sargent County. The profiles of these soils are described in the section "Formation and Classification of Soils." The information in the table is useful in determining how soils formed and in classifying them. It can be used in estimating water-holding capacity, fertility, tilth, susceptibility to wind erosion, and other properties that affect soil management. The data on reaction, electrical conductivity, and the percentage of exchangeable sodium can be used in evaluating the possibility of reclaiming and managing saline or alkali soils.

Field and laboratory methods

All samples used to obtain the data in table 12 were collected from carefully selected pits. The samples are representative of the soil material that is made up of particles less than ¾ inch in diameter. During the sampling, estimates were made of the fraction of the sample consisting of particles larger than ¾ inch. If necessary, the sample was sieved after it was dried, and rock fragments larger than ¾ inch in diameter were discarded. Then the material made up of particles less than ¾ inch was rolled, crushed, and sieved by hand to remove rock fragments larger than 2 millimeters in diameter. The fraction that consists of particles between 2 millimeters and ¾ inch in diameter is recorded in the table as the percentage of particles larger than 2 millimeters. This percentage is calculated as percent of the total weight of particles smaller than ¾ inch in diameter.

The percentage of fractions that consists of particles larger than ¾ inch, and the percentage of those between 2 millimeters and ¾ inch, is somewhat arbitrary. But the fractions at these sizes do contain relatively unaltered rock fragments larger than 2 millimeters in diameter and do not contain slakeable clods of earthy material.

Unless otherwise noted, all laboratory analyses were made on oven-dried material that passed the 2-millimeter sieve. In table 12, values for extractable sodium and potassium are the amounts extracted by the ammonium acetate method, minus the amounts that are soluble in the saturation extract.

Standard methods of the Soil Survey Laboratory were used to obtain most of the data in table 12. Determinations of clay were made by the pipette method (*3*, *4*, *5*). The reaction of the saturated paste and that of a 1:10 water suspension were measured with a glass electrode. Organic carbon was determined by wet combustion, using a modification of the Walkley-Black method (*6*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples that were treated with concentrated hydrochloric acid. The cation-exchange capacity was determined by direct distillation of absorbed ammonia (*6*). To determine the extractable calcium and magnesium, calcium was separated as calcium oxalate and magnesium as magnesium ammonium phosphate (*6*). Extractable sodium and potassium were determined on original extracts with a flame spectrophotometer. The methods of the U.S. Salinity Laboratory were used to obtain the saturation extract (*7*). Soluble sodium and potassium were determined on the saturation extract with a flame spectrophotometer.

TABLE 12.—*Mechanical and chemical*

[Absence of data

Soil type	Horizon	Depth	Particle size distribution								Texture	Reaction (pH)		Organic matter		
			Very coarse sand (2–1 mm.)	Coarse sand (1–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (0.002 mm.)	Larger than 2 mm.		Saturated paste	1:10	Organic carbon	Nitrogen	Ratio C/N
		Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*				*Percent*	*Percent*	
Aastad loam	A_{1p}	0–7	3.2	6.4	6.2	10.3	7.3	37.8	28.8	(1)	Clay loam	7.4	7.9	3.99	0.331	12.0
	B_1	7–14	3.9	5.5	5.8	10.6	7.6	33.8	32.8	3.5	Clay loam	7.3	8.0	1.60	.140	11.4
	B_2	14–17	4.2	5.0	4.5	7.6	7.3	39.8	31.6	5.4	Clay loam	7.6	8.6	1.25	.111	11.3
	C_{ca1}	17–28	10.2	11.4	4.7	10.8	4.6	31.5	26.8	3.0	Loam	7.7	8.8	.48	.060	8.0
	C_{ca2}	28–32	8.4	10.4	7.7	12.5	10.8	28.8	21.4	15.5	Loam	8.0	8.7	.32	--------	--------
	C_{ca3}	32–43	6.4	7.9	6.4	10.6	9.0	34.2	25.5	18.1	Loam	8.1	8.6	.21	--------	--------
	[2] C_{cs}	43–60	5.4	7.1	6.2	10.5	9.2	35.9	25.7	8.8	Loam	7.8	8.3	.16	--------	--------
Forman loam	A_{1p}	0–8	3.0	5.6	4.2	10.3	9.5	35.5	31.9	3.2	Clay loam	7.0	7.7	3.47	.325	10.7
	B_2	8–14	2.3	6.2	5.9	11.5	10.1	31.7	32.3	2.6	Clay loam	7.0	7.4	2.30	.195	11.8
	B_3	14–17	3.2	5.4	5.2	11.5	10.6	36.1	28.0	6.4	Clay loam	7.6	8.6	.94	.101	9.3
	C_{ca1}	17–26	4.2	5.9	5.7	11.3	10.2	35.1	27.6	7.8	Clay loam	7.8	8.7	.51	.054	9.4
	C_{ca2}	26–37	4.7	6.8	6.0	10.9	9.7	33.4	28.5	7.3	Clay loam	7.9	8.8	.18	--------	--------
	C_{ca3}	37–44	3.5	6.4	6.3	11.4	9.8	33.6	29.0	6.2	Clay loam	7.8	8.6	.16	--------	--------
	[3] C	[4]44–60	4.2	6.7	6.2	11.8	10.1	33.8	27.2	9.8	Clay loam	7.7	8.2	.16	--------	--------
Hecla fine sand	A_{11}	0–12	--------	.1	2.7	54.5	32.2	6.0	4.5	--------	Fine sand	6.9	7.2	.93	.076	12.2
	A_{12}	12–22	--------	.1	2.2	50.7	34.2	7.4	5.4	--------	Loamy fine sand	6.7	7.0	.98	.087	11.3
	A_{1c}	22–30	--------	.1	2.4	53.8	33.6	5.1	5.0	--------	Fine sand	6.8	7.0	.53	.060	8.8
	C_1	30–40	--------	.1	2.2	54.8	34.2	3.7	5.0	--------	Fine sand	6.8	7.0	.28	--------	--------
	C_2	40–48	--------	.1	2.5	55.8	33.1	3.9	4.6	--------	Fine sand	6.8	7.0	.20	--------	--------
	C_3	48–60	--------	--------	1.4	43.7	40.0	8.7	6.2	--------	Loamy fine sand	6.8	7.3	.29	--------	--------
Parnell silty clay loam	A_1	0–8	.2	.6	1.0	3.7	4.3	50.9	39.3	(1)	Silty clay loam	6.6	7.3	4.64	.412	11.3
	AB	8–11	.5	.8	1.2	4.3	4.8	48.9	39.5	(1)	Silty clay loam	6.4	7.0	2.18	.237	9.2
	B_{21}	11–20	.2	.5	.9	3.1	4.9	47.3	43.1	(1)	Silty clay	6.5	7.0	.88	.107	8.2
	B_{22}	20–30	.3	.6	.9	3.0	4.9	44.2	46.1	(1)	Silty clay	6.7	7.5	.48	.070	6.8
	B_{23}	30–39	.2	.5	.8	3.1	5.8	44.3	45.3	--------	Silty clay	7.2	8.2	.46	--------	--------
	C_{gca}	39–46	.1	.4	.3	1.0	1.9	55.2	41.1	--------	Silty clay [5]	7.6	8.4	.46	--------	--------
	C_g	46–60	.3	.5	.2	.3	1.1	61.2	36.4	--------	Silty clay loam [6]	7.5	8.4	.13	--------	--------
Stirum loam	A_{11}	0–5	.3	.5	1.0	21.3	26.6	28.3	22.0	--------	Loam [5]	7.8	8.4	6.23	.606	10.3
	A_{12}	5–10	.5	11.9	4.2	39.2	7.5	18.0	18.7	--------	Fine sandy loam [5]	8.4	9.5	2.23	.213	10.5
	B_2	10–21	.2	2.4	1.9	48.8	10.7	13.7	22.3	--------	Silty clay loam [5]	8.8	9.9	.93	.093	10.0
	C_{gca}	21–26	--------	.2	1.2	27.4	30.4	14.1	26.7	--------	Silty clay loam [5]	8.7	9.8	.49	.048	10.2
	D_{g1}	26–34	--------	.1	1.0	40.4	34.7	11.9	11.9	--------	Fine sandy loam	8.4	9.5	.14	--------	--------
	D_{g2}	34–48	--------	--------	1.0	46.9	35.4	7.5	9.2	--------	Loamy fine sand	8.2	9.3	.09	--------	--------
	D_{g3}	48–64	.2	.3	3.0	38.0	39.8	11.9	6.8	--------	Loamy very fine sand. [7]	8.1	9.0	.08	--------	--------
	(8)	64–65	15.0	5.9	5.0	23.8	30.9	15.8	3.6	--------	Loamy sand [9]	8.2	9.1	.08	--------	--------
Svea loam	A_{1p1}	0–7	2.3	4.4	5.1	11.1	8.0	43.0	26.1	1.0	Loam	6.8	--------	4.6	.359	12.8
	A_{12}	7–13	1.7	4.6	4.8	9.7	7.8	44.1	27.3	1.0	Clay loam	6.6	--------	2.67	.209	12.8
	A_{31}	13–18	2.4	5.5	5.0	9.4	7.4	42.4	27.9	.9	Clay loam	6.6	--------	1.20	.114	10.5
	B_1	18–21	2.5	5.1	4.8	9.3	7.2	40.6	30.5	1.4	Clay loam	6.6	--------	1.03	.102	10.1
	B_2	21–28	3.4	5.9	6.6	13.3	8.7	33.5	28.6	2.9	Clay loam	7.0	--------	.56	.068	8.2
	C_{ca1}	28–35	4.6	5.4	5.6	12.3	8.5	36.0	27.6	3.0	Clay loam	8.0	--------	.43	.048	9.0
	C_{ca2}	35–43	3.2	4.5	4.9	10.3	7.4	38.9	30.8	2.6	Clay loam	8.3	--------	.30	.034	8.8
	C_1	43–60	2.1	3.2	3.2	6.9	6.0	42.8	35.8	1.6	Clay loam	8.3	--------	.21	.030	7.0
Tetonka silty clay loam	A_{11}	0–3	--------	.7	1.6	8.3	9.2	46.4	33.8	--------	Silty clay loam	6.4	6.9	6.87	.565	12.2
	A_{12}	3–10	.3	1.0	1.4	4.0	5.5	55.6	32.2	--------	Silty clay loam	5.7	6.3	6.29	.581	10.8
	A_2	10–13	3.8	4.3	4.3	9.0	8.6	45.4	24.6	2.9	Loam	5.6	6.3	1.26	.141	8.9
	B_1	13–16	2.5	3.5	3.7	7.9	7.8	39.6	35.0	1.8	Clay loam	5.4	6.3	.87	.104	8.4
	B_2	16–25	2.8	4.5	5.0	9.6	7.9	29.2	41.0	2.9	Clay	5.5	6.8	.53	.064	8.3
	B_g	25–31	8.5	10.7	8.8	13.5	8.3	20.4	29.8	6.0	Silty clay loam	6.2	6.9	.41	--------	--------
	B_{gca}	31–36	5.9	8.4	7.7	14.3	9.8	29.0	24.9	10.5	Loam	7.6	8.7	.33	--------	--------
	C_{gca}	36–48	10.8	10.3	7.2	11.5	8.5	31.0	20.7	15.2	Loam	7.6	8.9	.24	--------	--------
	C_g	48–60	8.4	9.5	7.5	13.1	9.6	31.5	20.4	11.0	Loam	7.7	8.9	.18	--------	--------

[1] Trace.
[2] C_{cs} horizon of Aastad loam contains 33 milliequivalents of gypsum per 100 grams of soil.
[3] C horizon of Forman loam contains 29 milliequivalents of gypsum per 100 grams of soil.
[4] Below 60 inches, the volume weight of Forman loam is 1.84 grams of soil per cubic centimeter.
[5] Snail shells in sand fraction.

properties of selected soil profiles

indicated by dashed lines]

Electrical conductivity (EC x 10^3 millimhos per cm. at 25° C.)	$CaCO_3$ equivalent	Moisture held at— 1/10 atmosphere	1/3 atmosphere	15 atmospheres	Cation-exchange capacity NH_4AC	Extractable cations Ca	Mg	Na	K	Exchangeable Na	Saturation extract soluble Na	K	Ca	Mg	Volume weight	Moisture at saturation
		Percent	Percent	Percent	Meq./100 gm.	Meq./100 gm.	Meq./100 gm.	Meq./100 gm.	Meq./100 gm.	Percent	Meq./liter	Meq./liter	Meq./liter	Meq./liter	Gm./cc.	Percent
0.9	---	40.1	29.0	14.1	31.9	26.0	8.0	0.1	1.1	---	0.7	0.4	5.3	3.5	---	59.3
.8	---	30.0	23.3	13.0	27.6	19.3	9.1	.2	[illegible]	---	.8	.2	4.4	3.8	---	54.2
1.0	12	27.3	22.2	12.0	23.0	---	---	.1	.4	---	1.1	.2	4.6	4.6	---	55.4
3.1	32	23.0	17.4	7.4	11.5	---	---	.5	.2	2	7.2	.2	14.1	22.5	---	43.4
7.4	26	19.6	14.0	6.3	9.1	---	---	1.3	.2	4	22.3	.2	20.3	80.8	---	38.6
7.9	29	22.1	16.6	7.7	10.8	---	---	1.9	.2	6	27.2	.2	20.5	82.7	---	43.3
7.5	22	22.5	17.4	8.8	10.2	---	---	1.6	.2	6	24.0	.3	22.2	75.7	---	42.2
1.6	---	38.5	27.1	15.4	29.4	24.3	8.0	---	2.3	---	.6	1.8	8.8	5.0	---	58.9
1.1	---	32.4	24.0	13.9	25.5	20.8	7.8	---	1.0	---	.5	.5	5.8	4.0	1.24	54.0
.9	17	25.2	18.8	9.8	16.2	---	---	---	.4	---	.5	.3	4.4	3.1	---	46.9
.8	22	23.1	16.8	7.9	12.9	---	---	.1	.3	1	.6	.2	3.5	3.8	1.35	41.4
2.8	28	24.0	18.0	8.2	12.2	---	---	.3	.3	1	3.6	.3	12.1	24.0	---	46.3
3.5	23	24.5	18.2	8.6	13.3	---	---	.7	.3	3	7.5	.3	16.8	25.9	---	45.8
4.5	23	24.5	17.8	8.7	11.4	---	---	.9	.3	4	11.1	.4	23.3	34.5	---	44.4
.5	---	10.0	5.9	3.7	7.7	5.8	1.6	---	.5	---	.4	.8	2.6	2.2	---	33.2
.4	---	10.9	6.6	4.6	8.6	6.8	1.6	---	.4	---	.4	.4	2.2	2.4	---	31.7
.4	---	8.7	5.1	3.4	7.0	5.4	1.6	---	.2	---	.4	.2	1.9	1.7	---	32.8
.4	---	7.4	4.4	3.0	5.8	4.1	1.6	---	.2	---	.4	.2	2.2	1.6	---	30.5
.4	---	7.6	4.6	3.0	5.3	3.8	1.5	---	.2	---	.4	.2	1.8	1.5	---	31.0
.5	---	11.7	6.4	3.8	7.1	5.3	2.2	---	.2	---	.4	.2	2.6	2.2	---	30.6
1.1	---	56.1	45.6	20.5	35.6	28.2	8.6	.1	1.9	---	.4	1.2	7.6	4.4	---	76.3
.8	---	46.2	36.2	18.1	30.8	23.3	8.2	.1	1.6	---	.4	.8	4.6	3.0	---	62.6
.7	---	41.9	33.4	18.0	28.1	20.2	8.6	.1	1.5	---	.4	.7	3.6	2.3	---	63.5
.6	---	38.9	34.4	18.8	29.1	21.1	9.1	.1	1.7	---	.3	.6	3.2	2.3	---	67.0
.8	---	39.6	34.2	19.3	29.8	26.2	9.2	.1	1.8	---	.3	.9	4.9	2.7	---	67.9
.8	32	41.7	37.7	15.9	18.4	---	---	.1	1.0	1	.4	.6	5.0	2.5	---	69.6
.9	16	39.7	36.5	17.4	21.8	---	---	.1	1.2	---	.5	.7	5.2	2.7	---	63.6
1.1	7	47.6	37.6	19.4	27.9	29.4	14.6	.7	2.1	2	2.6	1.7	3.7	4.4	---	87.4
1.3	12	30.9	20.2	10.7	13.4	19.6	10.5	3.3	1.6	20	11.5	1.0	1.6	1.2	---	50.5
1.4	16	28.8	21.5	10.2	8.4	17.7	6.6	3.5	1.4	34	14.0	.6	1.5	1.8	1.44	46.0
3.2	17	28.0	20.8	9.9	8.4	---	---	4.2	1.1	31	27.0	.8	1.6	2.2	---	59.0
6.2	13	24.1	14.3	5.8	7.5	---	---	3.9	.8	23	51.6	1.2	6.1	20.4	---	42.2
6.0	5	17.2	10.0	5.0	7.2	---	---	3.0	.6	21	41.0	1.1	10.4	33.3	---	36.7
6.0	10	15.4	9.1	4.2	6.2	---	---	2.4	.5	19	35.0	.9	16.1	25.5	1.58	32.9
5.5	29	15.1	7.8	2.8	4.4	---	---	2.5	.4	39	23.7	.8	18.1	21.1	---	34.2
.6	---	47.5	33.5	16.6	35.9	22.6	8.5	.1	.4	---	---	.1	---	---	---	60.8
.6	---	41.5	29.7	14.9	27.8	15.8	7.6	.1	.2	---	.2	---	---	---	---	53.9
.6	---	31.6	24.8	12.2	22.5	11.8	7.8	---	.2	---	.2	---	---	---	---	43.8
.6	---	31.5	24.2	11.6	22.8	11.5	8.4	---	.4	---	.2	---	---	---	---	44.5
.7	---	29.5	22.1	10.7	20.5	9.8	9.1	---	.1	---	.2	---	---	---	---	45.4
.7	17	27.5	19.6	9.4	32.7	23.3	9.2	.1	.1	---	.2	---	---	---	---	43.8
.8	20	29.8	22.0	10.5	35.8	22.5	12.9	.2	.1	---	.6	---	---	---	---	50.2
.8	19	35.2	27.9	13.9	30.2	20.5	9.2	.3	.2	---	1.5	---	---	---	---	57.6
1.2	---	50.1	37.3	21.9	37.3	25.6	7.9	---	3.1	---	.5	2.3	7.1	4.1	---	88.8
.6	---	54.2	42.4	20.8	35.0	19.6	6.3	---	2.1	---	.3	1.0	3.3	2.1	---	87.2
.5	---	27.8	21.4	9.8	15.9	8.2	3.7	---	1.1	---	.3	.6	1.8	1.5	---	43.6
.5	---	30.1	23.2	13.0	22.2	12.1	5.9	---	1.2	---	.3	.5	2.2	1.3	---	47.5
.4	4	31.5	24.8	14.8	25.9	15.7	7.9	---	1.1	---	.3	.4	1.9	1.2	---	59.8
.5	2	26.3	20.0	11.0	18.8	12.1	5.7	---	.6	---	.4	.3	2.2	1.7	---	47.2
.7	16	18.5	16.7	8.8	13.2	---	---	---	.4	---	.6	.4	4.4	2.1	---	41.7
.7	26	16.0	14.6	6.5	9.3	---	---	---	.3	---	.5	.4	4.1	2.2	---	36.1
.7	23	16.0	14.2	6.6	9.3	---	---	---	.3	---	.4	.4	4.2	2.0	---	30.6

[6] Shot, probably manganese, in sand fraction.
[7] Some calcium carbonate in sand fraction.
[8] Horizon not designated.
[9] Fractions of very coarse, coarse, and medium sand are mostly calcium carbonate.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well-aerated soil is similar to that in the atmosphere; but the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster, such as a clod, crumb, block, or prism.

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has such a high degree of alkalinity (pH 8.5 or higher) or such a high percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is reduced.

Alluvial soils. A great soil group in the azonal order. Soils forming from material (alluvium) recently deposited by water and showing little or no modification of the original materials by soil-forming processes.

Alluvium. Fine material, such as sand, silt, or clay, that has been deposited on land by water.

Available moisture capacity. The difference between the amount of water in a soil at field capacity and the amount in the same soil at the permanent wilting point. Commonly expressed as inches of water per inch depth of soil. The amount of water that the soil can hold available to plants.

Calcareous soil. A soil that contains calcium carbonate, or a soil that is alkaline in reaction because of the presence of calcium carbonate. 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 that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Color, soil. See Munsell system.

Complex, soil. A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map. Barnes-Buse loams, rolling, is a soil complex in Sargent County.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The combination of properties that causes soil particles in an aggregate to crumble or stick together when crushed between the fingers. Because it is affected by moisture, consistence is described for soil when it is dry, moist, or wet.

Loose.—Noncoherent; when moist or dry, will not hold together in a mass.

Friable.—When moist, crushes easily under 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; tends to stretch somewhat and pull apart, rather than 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.

Deflocculate. To separate or break down soil aggregates into individual particles; to disperse the particles of a granulated clay to form a clay that runs together or puddles.

Dispersion. The deflocculation of the soil and its suspension in water.

Fertility. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when light, moisture, temperature, physical condition (or tilth) of the soil, and other growth factors are favorable.

Friable. See Consistence, soil.

Genesis, soil. The manner in which the soil originated, with special reference to the processes responsible for the development of the solum, or true soil, from the unconsolidated parent material.

Glacial till. Unassorted, nonstratified rock materials (clay, silt, sand, and boulders) that have been transported by glacial ice and then deposited, or have been deposited by melt water as it flowed from glacial ice.

Glaciofluvial deposits. Material moved by glaciers and subsequently sorted and deposited by streams flowing from melting ice; the deposits are stratified and occur in the form of kames, eskers, deltas, and outwash plains.

Granular. See Structure, soil.

Green-manure crop. A crop grown for the purpose of being turned under in an early stage of maturity, or soon after maturity, to improve the soil, especially by the addition of organic matter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Lacustrine deposits. Materials deposited in lake waters and subsequently exposed by the lowering of the water level or by the rising of the land.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and poor drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; contrast—*faint*, *distinct*, and *prominent*. The size measurements are—*fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell system. A system for designating color by three variables—hue, value, and chroma. For example, a notation of 10YR 6/4 (light yellowish brown) is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps others obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from air and water.

Parent material. The horizon of weathered rock or partly weathered soil material from which the soil has formed; horizon C in the profile.

Ped. A crumb, prism, block, or other individual natural soil aggregate, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Phase, soil. A subdivision of a soil type, series, or other unit in the soil classification system made because of differences in the soil that affect management. A soil type, for example, may be divided into phases because of slope, stoniness, thickness, or other characteristic. Phase variations have practical importance, although they may or may not be reflected in the profile and do not affect the classification of the soil.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material. See also Horizon, soil.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; or contains harmful salts and has a highly alkaline reaction; or contains harmful salts and exchangeable sodium and is strongly alkaline in reaction. The salts, exchangeable sodium, and alkaline reaction occur in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil that contains soluble salts in amounts that impair the growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual mineral particles in a soil ranging in diameter 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 is 85 percent or more sand and not more than 10 percent clay. See also Texture, soil.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter in diameter) to the lower limit of very fine sand (0.05 millimeter in diameter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by the relief of the soil over periods of time.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans). In Sargent County the principal forms of soil structure are granular, platy, blocky, columnar, and prismatic, and there are structureless soils.

Subsoil. That part of the soil profile commonly below plow depth and above the parent material. Technically, the B horizon.

Substratum. Any layer lying beneath the solum, or true soil; the C or D horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness; the plowed layer.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also Clay, Sand, and Silt.) 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.*

Tilth, soil. The physical condition of the soil, especially soil structure, in relation to tillage and to plant growth. Good tilth refers to the friable state of a soil and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Topography. The elevations or inequalities of the land surface, considered collectively. Relief.

Type, soil. A subdivision of the soil series made on the basis of differences in the texture of the surface layer.

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