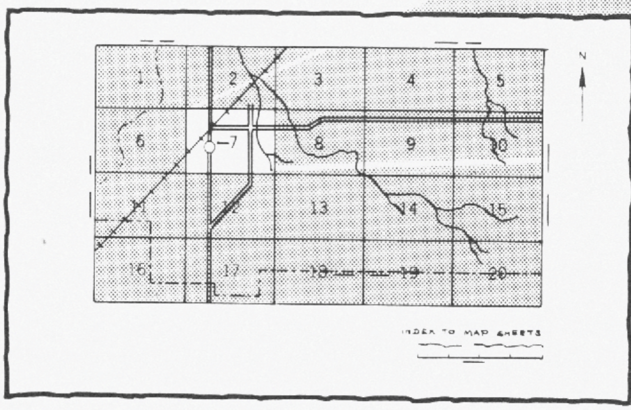
Soil survey of

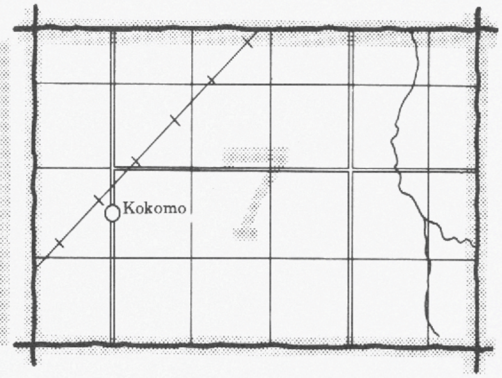
Yellow Medicine County, Minnesota

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Minnesota Agricultural Experiment Station

HOW TO USE

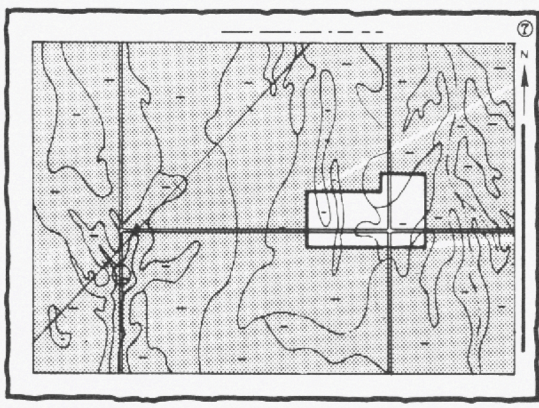
1. Locate your area of interest on the "Index to Map Sheets" (the last page of this publication).

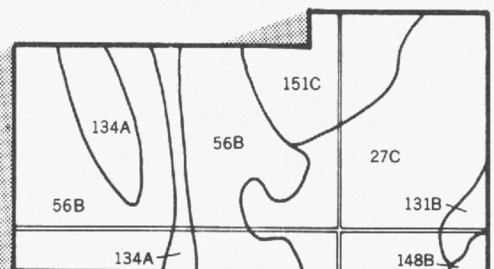




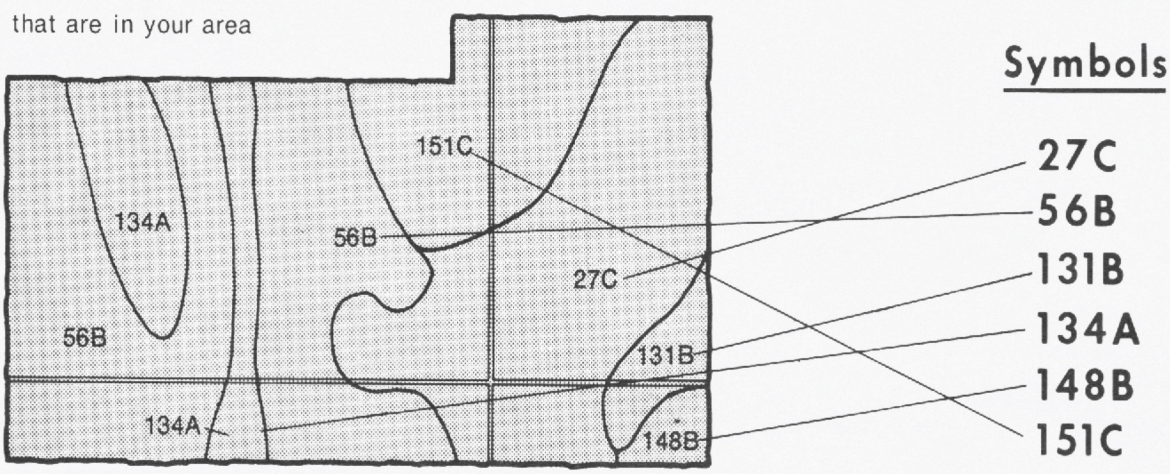
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



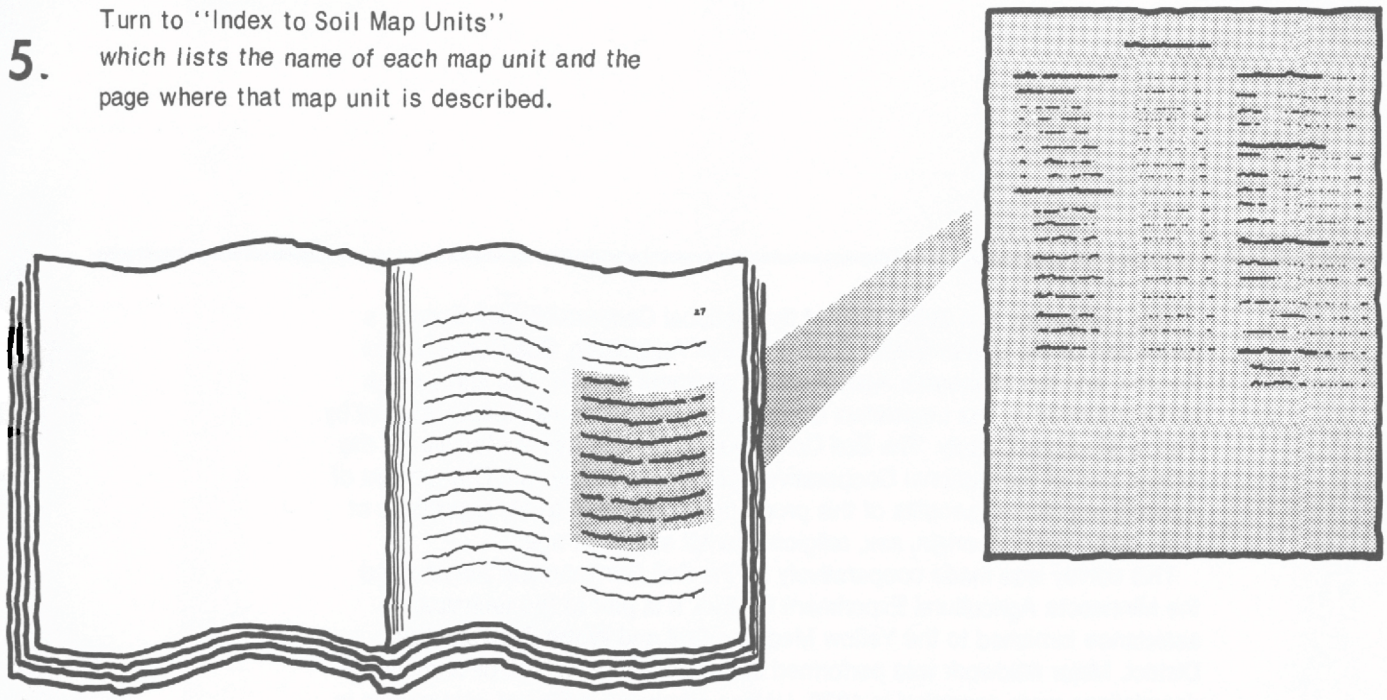


4. List the map unit symbols that are in your area

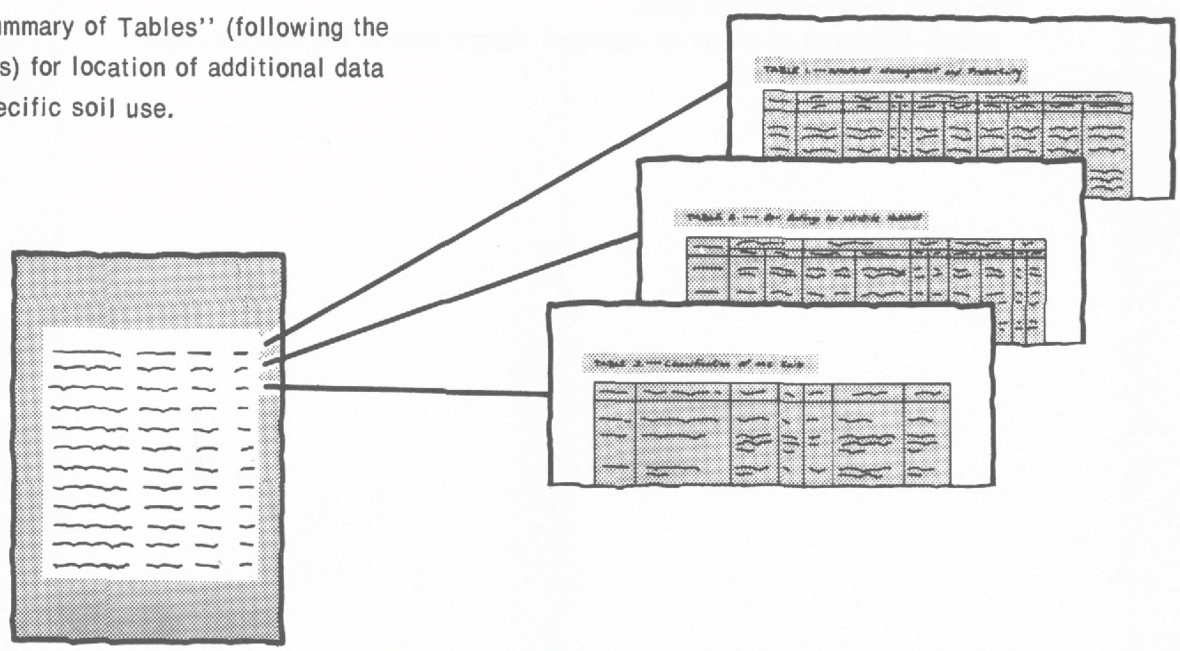


THIS SOIL SURVEY

5. Turn to ''Index to Soil Map Units'' *which lists the name of each map unit and the page where that map unit is described.*



6. See ''Summary of Tables'' (following the Contents) for location of additional data on a specific soil use.



7. Consult ''Contents'' for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture, Soil Conservation Service, and the Minnesota Agricultural Experiment Station. The survey was partially funded by the Legislative Commission for Minnesota Resources and by Yellow Medicine County. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Yellow Medicine Soil and Water Conservation District. Major fieldwork was performed in the period 1975-78. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1978.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Windrows of wheat on McIntosh Variant soils in the Burr-Du Page-McIntosh Variant map unit.

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Issued July 1981

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foreword

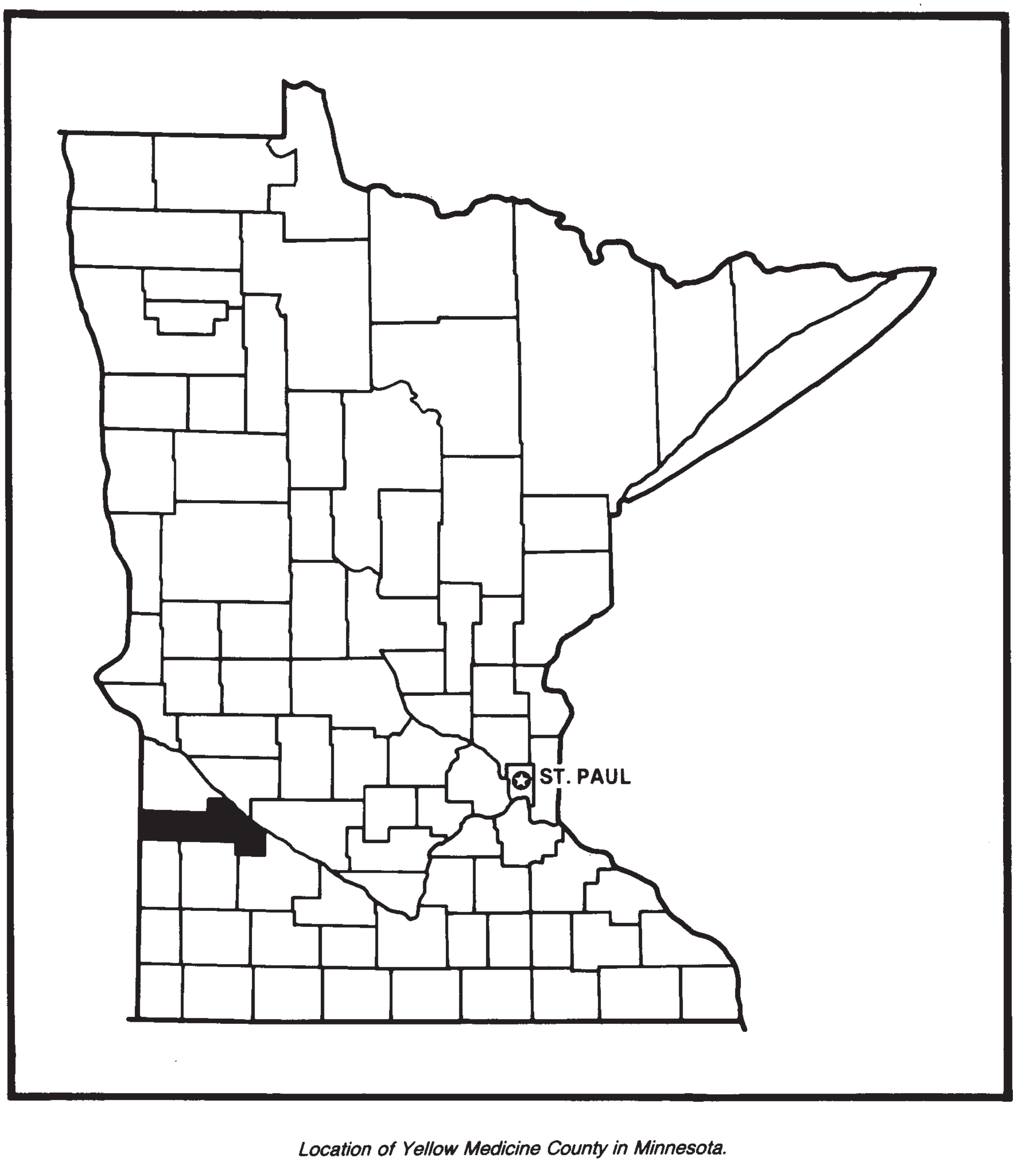
This soil survey contains information that can be used in land-planning programs in Yellow Medicine County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

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

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Harry M. Major
State Conservationist
Soil Conservation Service



Location of Yellow Medicine County in Minnesota.

soil survey of
Yellow Medicine County, Minnesota

By Hilding L. Hokanson, Soil Conservation Service

Fieldwork by Thomas C. Jackson, Gary D. Nelson, Hilding L. Hokanson,
and Michael L. Lieser, Soil Conservation Service,
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United States Department of Agriculture, Soil Conservation Service
in cooperation with
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YELLOW MEDICINE COUNTY is long, narrow, and hammer-shaped. It is in the southwestern part of Minnesota. It has a total area of 485,120 acres or 758 square miles, of which about 5 square miles are water. The population of Yellow Medicine County was 14,148 in 1970. The county has 9 incorporated cities and villages; Canby, Clarkfield, Echo, Granite Falls, Hanley Falls, Hazel Run, Porter, St. Leo, and Wood Lake. Granite Falls, the county seat and largest city, had a population of 3,225 in 1970.

Yellow Medicine County lies mainly on an undulating glacial ground moraine. The soils, which generally are dark colored and loamy, formed in glacial till or in material sorted out of the till by water. The original vegetation was tall and medium prairie grasses.

The county was established in 1871. It is crossed by the Yellow Medicine River. The name Yellow Medicine originated with the Sioux Indians. It refers to the yellow root of the moonseed plant, which the Indians used for medicine.

Farming is the most important enterprise. Corn, soybeans, small grain, and hay crops and cattle feeding, livestock raising, and dairying are sources of most of the income in the county.

general nature of the county

This section gives general information concerning the county. It describes climate; transportation and markets; water supply; farming; and physiography, relief, and drainage.

climate

Prepared by the National Climate Center, Asheville, North Carolina.

Yellow Medicine County is cold in winter and is quite hot with occasional cool spells in summer. Precipitation during winter frequently occurs as snowstorms. During the warm months it is chiefly showers, often heavy, occurring when warm moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grain.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Canby in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 17 degrees F, and the average daily minimum is 7 degrees. The lowest temperature on record, which occurred at Canby on January 21, 1970, is -31 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at Canby on July 10, 1966, is 108 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 19 inches, or 76 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of ten, the rainfall in April through September is less than 15 inches. The heaviest 1-day rainfall during the period of record was 5.29 inches at Canby on July 27, 1963. Thunderstorms occur on about 44 days each year, and most occur in summer.

Rainfall in April through September is generally adequate for all crops, but nearly every year some parts of the county receive less than adequate moisture because most midsummer moisture is from thunderstorms. Crops generally are adversely affected in these areas, especially if available water capacity of the soil is moderate or low. Even though available water capacity is high, crops are affected if moisture reserves in the subsoil and underlying material are depleted.

Average seasonal snowfall is 37 inches. The greatest snow depth at any one time during the period of record was 40 inches. On an average of 47 days, at least 1 inch of snow is on the ground. The number of days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The prevailing wind is from the south. Average windspeed is highest, 14 miles per hour, in April.

Tornadoes and severe thunderstorms strike occasionally. These storms are local and of short duration, and result in sparse damage in narrow belts. Hailstorms occur at times during the warmer part of the year in irregular patterns and in relatively small areas.

transportation and markets

One railway in the western part of Yellow Medicine County serves Porter, Canby, and Burr. Another railway crossing from northwest to southeast serves Clarkfield, Hazel Run, Hanley Falls, Wood Lake, and Echo. A railway running north to south serves Hanley Falls and Granite Falls. St. Leo depends on trucks for marketing.

The major highways are concrete or blacktop. U.S. Highway 59 crosses the county from north to south. U.S. Highway 212 crosses the northern tip of the county and follows the Minnesota River to Granite Falls. Minnesota Highways 23, 67, 68, and 274 serve parts of the county. Gravel or blacktop county and township roads serve the farms.

Livestock generally are taken to market by trucks. Grain elevators are in each of the cities. Most of the milk produced is marketed as whole milk and processed at local plants in the county. Some of the milk is dehydrated, and some is processed into cheese curd.

water supply

The water supply is drawn from three major sources: the sand and gravel deposits in glacial drift, the formations of Cretaceous sedimentary rocks, and the formations of Precambrian rocks.

The glacial drift is thick on the Coteau slope and the Altamont moraine (fig. 1). Most of the water is obtained from the sand and gravel deposits in this drift. The opportunities for development of a good water supply

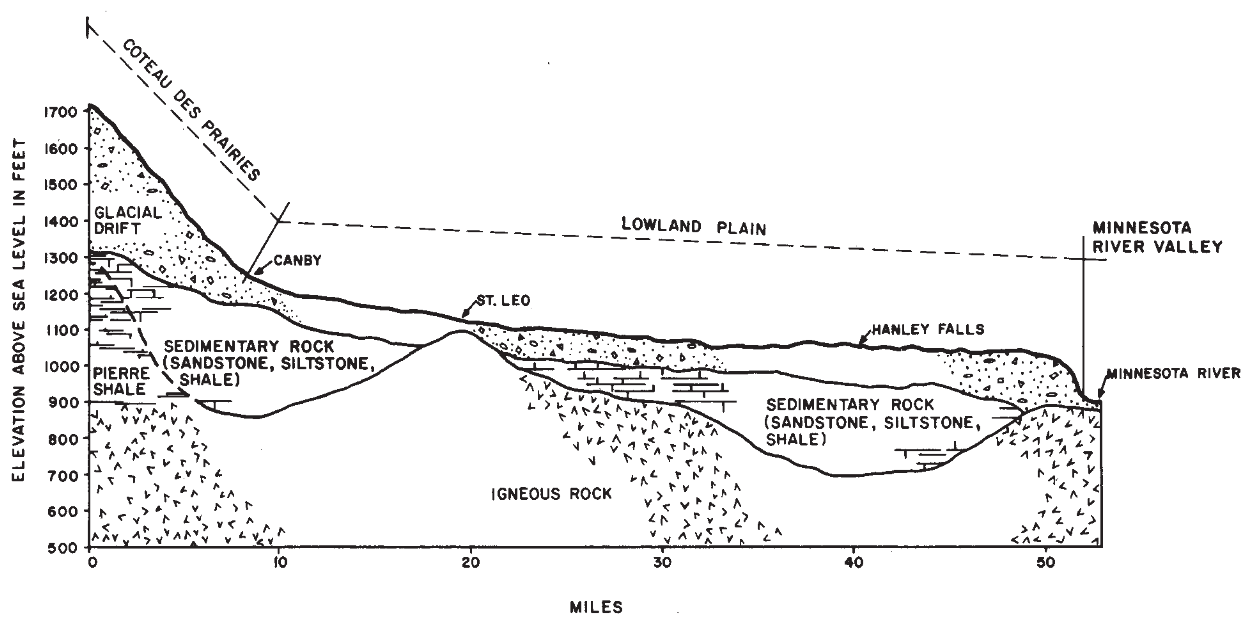

Figure 1.—Cross-sectional west to east view of Yellow Medicine County showing relative differences in elevation, thickness of glacial drift, and kinds of underlying rock.

are better in thick sections of the drift because they contain more aquifers.

On the lowland plain and the lake plain, the drift is generally too thin to be a reliable source of water. In these areas, the major sources of water are the formations of Cretaceous sedimentary rocks. These formations consist mostly of shale and fairly continuous beds of poorly cemented siltstone and sandstone. They generally range from 125 to 400 feet or more in thickness. The beds of sandstone yield substantial supplies of water.

In the eastern one-third of the county and in an area north of St. Leo, the glacial drift rests directly on Precambrian rocks. These rocks are mostly granite and gneisses and some are of the oldest rocks on earth. Water comes from the weathered or fractured zones.

Most of the underground water in the county is very hard and contains a high proportion of dissolved solids, mainly calcium, magnesium, and sulfates. Some of the sandstone aquifers, however, have softer water.

Although the water is not suitable for domestic use, many pits and ponds have been dug and built to provide water for livestock. The pits have been dug on bottom land in other areas of poorly drained soils. They intercept runoff and are partly filled by ground water. Farm ponds are built on intermittent streams and drainageways. Some farm ponds are spring fed.

farming

Farms in Yellow Medicine County are decreasing in number and increasing in size. The number decreased from 1,724 in 1964 to 1,466 in 1974. During this period, the average size increased from 274 to 313 acres.

Corn is the most important crop. The acreage in soybeans, the second most important crop, has increased significantly since 1944. The trend has been toward a decrease in the acreage of alfalfa and flax and an increase in the acreage of wheat. In 1964, about 150,900 acres was in corn, 90,200 acres in soybeans, 6,200 acres in wheat, 20,600 acres in flax, and 22,600 acres in alfalfa. In 1974, about 197,700 acres was in corn, 120,500 acres in soybeans, 26,000 acres in wheat, 2,800 acres in flax, and 16,100 acres in alfalfa.

The number of beef cows has increased from 7,179 in 1964 to 10,081 in 1974. The number of milk cows has decreased from 6,195 in 1964 to 3,955 in 1974. Most of the farms that once had dairy enterprises now grow cash crops. The largest herds of beef cows are in the western part of Yellow Medicine County. The number of hogs and pigs fluctuates, but the trend is toward fewer and larger hog operations.

physiography, relief, and drainage

The western part of Yellow Medicine County is part of the Coteau des Prairies, a wedge-shaped bedrock plateau that covers eastern South Dakota and southwestern Minnesota (*3*). The rest of the county is mostly a lowland plain which is an undulating glacial ground moraine. It ends abruptly at the bluffs overlooking the Minnesota River Valley (*5*). The floor of the river valley is about 100 feet below the bluffs.

From the southwest corner of the county to the edge of the Coteau des Prairies, about 8 miles, the descent in elevation is more than 450 feet (see fig. 1). The steep gradient is probably the result of the underlying bedrock, presumably Cretaceous sedimentary rocks. From the foot of the Coteau des Prairies near Canby to the bluffs overlooking the Minnesota River Valley, about 44 miles, the descent in elevation is about 300 feet. The elevation is 1,714 feet in the southwest corner of the county, 1,380 feet in the northwest corner, 920 feet in the northeast tip of the county, and 1,059 feet in the southeast corner. The highest point, which is near the southwest corner, is 1,739 feet. The lowest point, which is where the Minnestoa River flows out of the county, is about 860 feet.

Most of Yellow Medicine County is an undulating plain. Slopes are irregular and generally less than 150 feet long. The surface drainage pattern is young, and shallow, closed depressions are common. The western part of the county is more rolling and has steeper slopes than the rest of the county. The lake plain is nearly level. Large, nearly level areas are also on the part of the Coteau slope that extends southwest from the lake plain.

All of the runoff flows into the Minnesota River. The Lac qui Parle River and its tributaries drain the western one-fourth of the county. The Yellow Medicine River and its tributaries and Hazel Creek drain the central part, which is about 40 percent of the county. Stony River Creek drains most of the northeastern part. Wood Lake, Boiling Spring, and Ramsey Creeks drain most of the southeastern part of the county.

Outcrops of igneous rock, which is mainly gneiss, occur over large areas in the Minnesota River Valley, especially in the vicinity of Granite Falls and in a number of small areas in the vicinity of Echo, Wood Lake, and St. Leo (*5*). These rock formations are the oldest dated in the world. The rock is generally less than 300 feet below the surface. In the western part of the county, it is further below the surface. At Canby, bedrock is 385 feet below the surface. The upper portion of the bedrock generally is much weathered, especially where it has been protected from glacial erosion by overlying Cretaceous sediment. It consists of gneiss fragments and kaolinitic material.

Glacial drift and sedimentary deposits of Cretaceous age overlie the bedrock or weathered material. The drift is less than 50 feet thick in some areas near Echo and Wood Lake and in an area north of St. Leo. Over the rest of the county the mantle of glacial drift is 50 to 300 feet thick, except in the southwestern corner where the drift is nearly 400 feet thick. The sedimentary material, which was deposited in former inland seas, consists mostly of shale, sandstone, siltstone, and clay.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of improvements in the classification of soils, particularly modifications or refinements in soil series concepts, and of the range in slope that is permitted in map units in different surveys, some of the boundaries and soil series names on the general soil map of Yellow Medicine County do not match those on the general soil maps of adjacent counties published at a different date.

Areas dominated by loamy and silty soils on uplands

These soils dominantly formed in glacial till and lacustrine sediment. The relief is mainly rolling to nearly level, but steeper soils are around some of the depressions and along the streams and larger drainageways. Nearly all areas of these soils are used for cultivated crops. The nearly level to gently sloping and undulating soils have no limitations or few limitations for crops, but the steeper soils are subject to water erosion and soil blowing.

1. Barnes-Buse-Flom

Well drained and poorly drained, nearly level to very steep soils formed in glacial till

Areas of this map unit are mainly on irregular, complex slopes and smooth, simple slopes of lake plains. Elevation of areas is the highest in the county. Slope is mainly nearly level to rolling but in some places is moderately steep to very steep.

This map unit makes up about 6 percent of the county. It is about 38 percent Barnes soils and soils that are similar to Barnes, 19 percent Buse soils, 8 percent Flom soils, and 35 percent soils of minor extent (fig. 2).

The Barnes soils are well drained. They are mainly undulating but are steeper near the Buse soils. The surface layer is very dark gray loam about 8 inches thick. The subsoil is friable loam about 15 inches thick. It is dark brown in the upper part, brown in the middle part, and olive brown and calcareous in the lower part. The underlying material is light olive brown, calcareous loam glacial till.

The Buse soils are well drained, calcareous, and mainly rolling to very steep. They are closely intermingled with Barnes soils, except in steeper areas. The surface layer is very dark gray loam about 8 inches thick. The next 4 inches is very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels. The underlying material is yellowish brown and light olive brown loam glacial till.

The Flom soils are nearly level and poorly drained. They are in shallow drainageways on wet flat areas. The surface soil is clay loam about 28 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The subsoil is olive gray, mottled, firm clay loam about 14 inches thick. The underlying material is olive gray, mottled, calcareous clay loam and silty clay loam.

Of minor extent in this map unit are Terril, Okoboji, Vallers, Hamerly, Sinai, and Poinsett soils. The moderately well drained Terril soils are on foot slopes. The very poorly drained Okoboji soils are in closed depressions. The calcareous, poorly drained Vallers soils are on the rims of closed depressions. The calcareous, somewhat poorly drained and moderately well drained Hamerly soils are on low rises within areas of Flom soils. The nearly level, moderately well drained Sinai soils and gently sloping, well drained Poinsett soils are on some of the highest parts of the landscape.

Available water capacity is moderate or high. The content of organic matter and the content of potassium are moderate or high, and that of phosphorus is low.

Erosion on the Barnes and Buse soils and wetness in the Flom soils are the major management concerns. In many areas of the Barnes and Buse soils, slopes are too irregular or complex for contour farming. Conservation tillage and growing grasses and legumes in the crop rotation help control erosion. Tile drains and surface

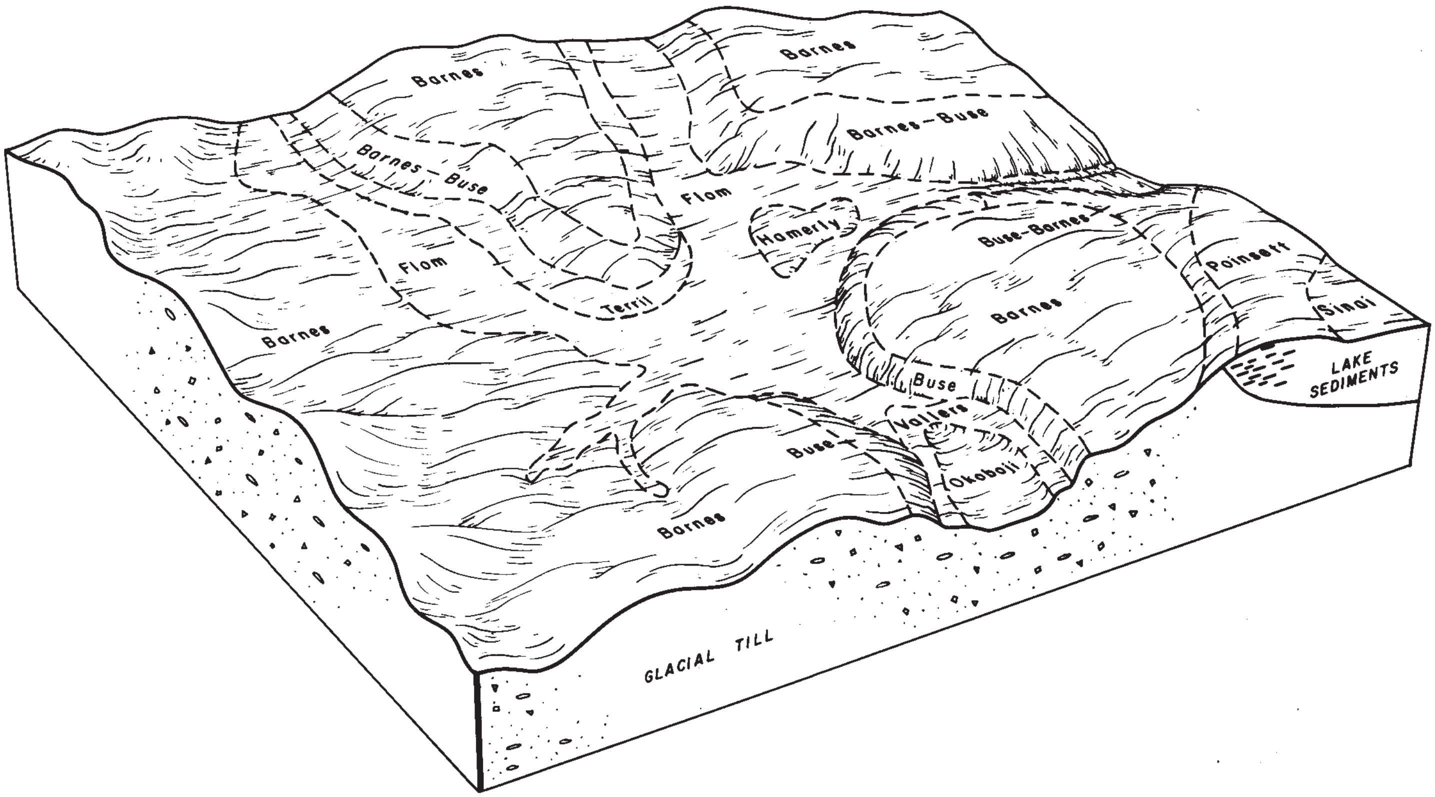

Figure 2.—Pattern of soils and underlying material in the Barnes-Buse-Flom map unit.

ditches can be used to remove the excess wetness in Flom soils.

Slope and wetness are the main limitations for building sites and sanitary facilities. Deep cuts are needed for highway construction in areas where roads cross the steep drainageways.

The soils in this map unit generally have good suitability for cultivated crops. Most of the acreage is cultivated, and corn, small grain, and hay are the principal crops. Steep hillsides, frequently flooded bottom lands, and undrained wet areas are used mostly for range and wildlife habitat. Ponds constructed in the glacial till generally hold water satisfactorily, but borings are needed to determine if veins or pockets of sand and gravel are present. Dugout pits in Flom soils generally supply an adequate amount of water for livestock. The main enterprises are cash crops, raising beef cattle and hogs, and feeding beef cattle.

2. Forman-Flom-Aastad

Well drained, poorly drained, and moderately well drained, nearly level to moderately steep soils formed in glacial till

Areas of this map unit are on the Coteau slope, the first slope of the Coteau des Prairies. The Coteau slope has slope of about 75 feet per mile from southwest to northeast and a very gradual slope from northwest to southeast. Deep narrow drainageways that run in a northeasterly direction dissect the Coteau slope every half mile to every mile. These drainageways mostly have sloping to moderately steep sides.

This map unit makes up about 7 percent of the county. It is about 59 percent Forman soils, 14 percent Flom soils, 13 percent Aastad soils, and 14 percent soils of minor extent (fig. 3).

The Forman soils are on the convex parts of the Coteau slope and are adjacent to the steep side slopes along drainageways. They are well drained and are mainly undulating, but are steeper near the Buse soils. The surface layer is black clay loam about 8 inches thick. The subsoil is firm clay loam about 13 inches thick. The upper part of the subsoil is dark brown and contains 10 to 20 percent wormcasts, and the lower part is brown. The underlying material is dark yellowish brown and grayish brown, calcareous clay loam glacial till.

The Flom soils are in the shallow drainageways. They are nearly level and poorly drained. The surface soil is clay loam about 28 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The subsoil is olive gray, mottled, firm clay loam about

14 inches thick. The underlying material is olive gray, mottled, calcareous clay loam and silty clay loam.

The Aastad soils formed in plane and slightly convex parts of the Coteau slope. They are nearly level and moderately well drained. The surface soil is clay loam about 12 inches thick. The upper part of the surface soil is black, and the lower part is black and very dark gray. The subsoil is very dark grayish brown and dark grayish brown firm clay loam about 15 inches thick. It is mottled in the lower part. The underlying material is light olive brown, mottled, calcareous clay loam.

Of minor extent in this map unit are Buse, Terril, Calco, Du Page, and Okoboji soils. The well drained Buse soils are sloping and moderately steep near the Forman soils, and are steep and very steep along deep drainageways and along the streams that cross the unit. The moderately well drained Terril soils are on foot slopes and at the head of drainageways. The poorly drained Calco and moderately well drained Du Page soils are on flood plains along the streams. They are subject to flooding. The very poorly drained Okoboji soils are in closed depressions.

Available water capacity is moderate or high. The content of organic matter and content of potassium are generally high, and that of phosphorus is low.

Water erosion is a major hazard on the steeper side slopes along the deep drainageways. Soil blowing can be a problem, especially in spring. Wetness is the major limitation to the use of the Flom soils. Other management concerns are improving drainage and maintaining tilth and fertility.

Slope and wetness are the main limitations for building sites and sanitary facilities. Deep cuts are needed for highway construction in areas where roads cross the deep drainageways. Permeability is moderately slow, and because of this septic tank absorption fields need to be enlarged.

The soils in this map unit have good suitability for the cultivated crops commonly grown in the county. Corn, soybeans, small grain, and hay are well suited to the nearly level and undulating soils. Nearly all areas are used for cultivated crops, but the steeper drainageways and the undrained wet areas are used for range and wildlife habitat. Ponds constructed in these areas generally hold water, but borings are needed to determine if veins or pockets of sand and gravel are present. The main enterprises are cash crops and feeding beef cattle.

3. Ves-Canisteo

Well drained and poorly drained, nearly level to rolling soils formed in glacial till

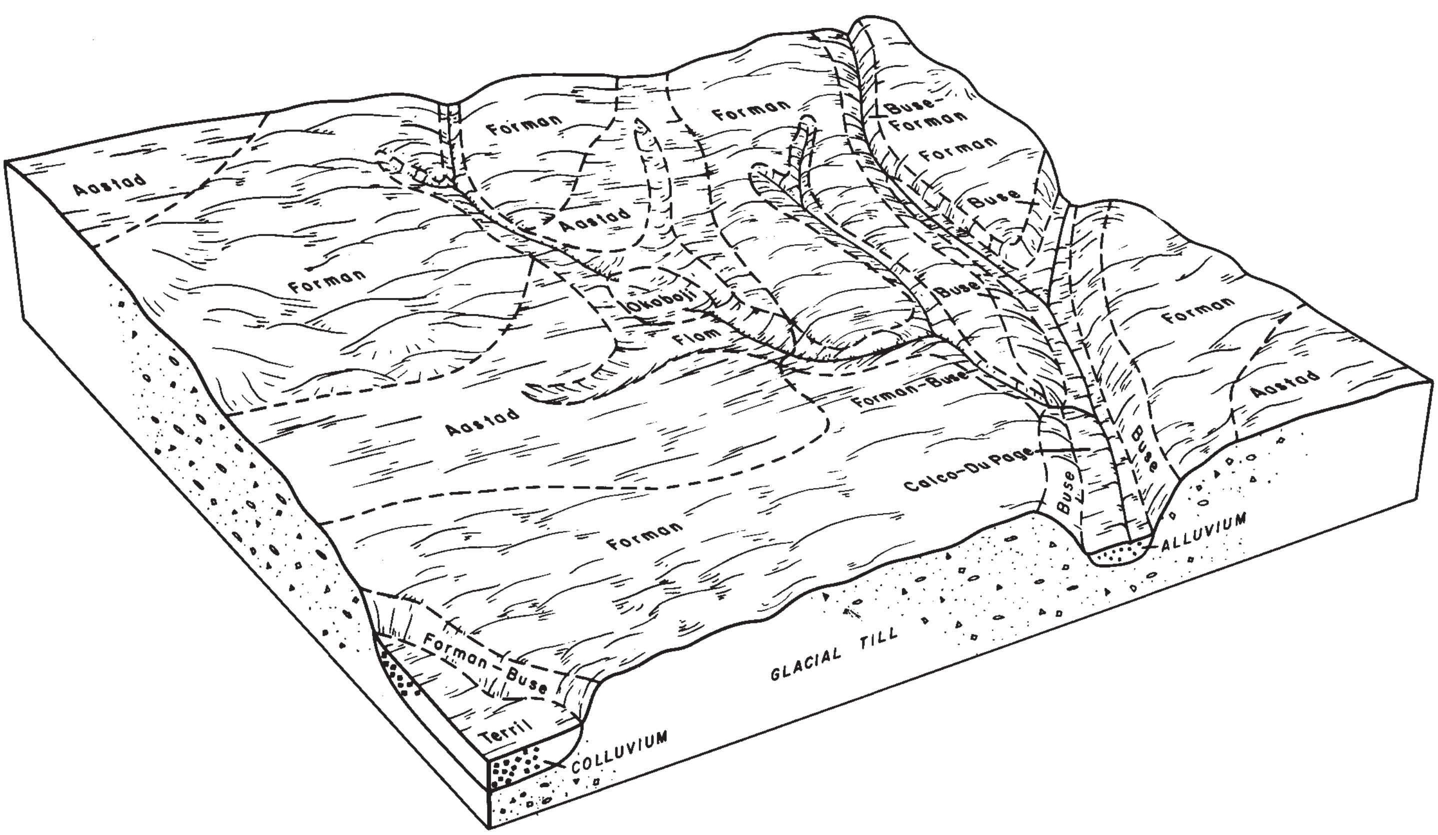

Figure 3.—Pattern of soils and underlying material in the Forman-Flom-Aastad map unit.

Areas of this map unit are on a ground moraine having short, irregular, convex knolls, most of which rise only 1 foot to 10 feet above the floor of the lowland till plain (fig 4). Closed depressions are common.

This map unit makes up about 46 percent of the county. It is about 34 percent Ves soils and soils similar to Ves soils, 25 percent Canisteo soils and soils similar to Canisteo soils, and 41 percent soils of minor extent.

The Ves soils are well drained and are on convex knolls that rise 4 to 10 feet above the floor of the till plain. The surface layer is black loam about 9 inches thick. The subsoil is about 17 inches thick. It is dark brown and dark yellowish brown, friable clay loam in the upper part and olive brown, calcareous, friable loam in the lower part. The underlying material is olive brown, calcareous loam glacial till.

The Canisteo soils are poorly drained and calcareous. They are in flat areas and on rims of depressions. The surface soil is clay loam about 19 inches thick. It is black in the upper part and very dark gray and mottled with gray in the lower part. The subsoil is olive gray, mottled, friable clay loam about 14 inches thick. The underlying material is olive gray, mottled, loam glacial till.

Of minor extent in this map unit are Glencoe, Normania, Seaforth, Storden, and Webster soils. The very poorly drained Glencoe soils are in shallow, closed depressions and other low, wet areas. The moderately well drained Normania soils are on the higher parts of drainageways and in swales on the undulating knolls. The moderately well drained Seaforth soils are in convex areas 1 foot to 3 feet above the floor of the till plain. The well drained Storden soils formed on the steepest and most exposed convex parts of hillsides. The poorly drained Webster soils are in drainageways that are slightly above the Canisteo soils on the landscape.

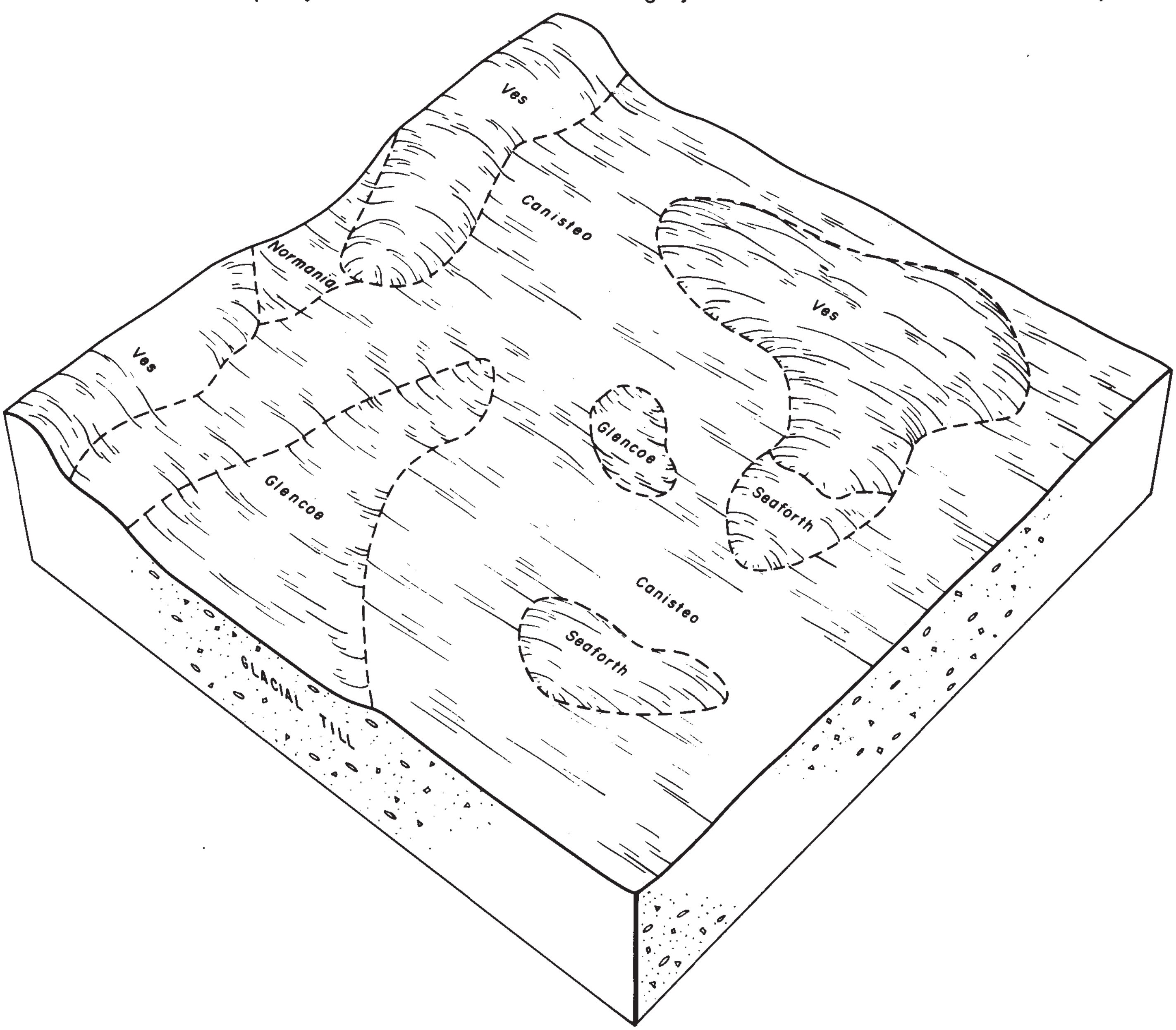

Figure 4.—Pattern of soils and underlying material in the Ves-Canisteo map unit.

In most areas the content of organic matter and content of potassium are high, and that of phosphorus is low. Available water capacity is high.

Erosion is a hazard on the Ves soils. Wetness limits the use of Canisteo soils, and the high content of lime causes imbalance of fertility in some areas. In areas where the lime content is especially high, fertilizers are needed to correct the fertility imbalance. Tile drains and surface ditches can be used to remove the excess wetness. Other management concerns are maintaining tilth and fertiity and controlling water erosion and soil blowing.

Wetness is the main limitation for building sites and sanitary facilities. The Canisteo soils have a seasonal high water table within a depth of 3 feet. The Ves soils are suitable sites for dwellings and sanitary facilities.

The soils in this map unit have good suitability for all cultivated crops commonly grown in the county. Corn, soybeans, small grain, and hay are well suited. Nearly all of the acreage is used for cultivated crops. A few wet areas where more drainage is needed before crops can be successfully grown are used for pasture. The main enterprises are cash crops, raising hogs, and feeding beef cattle.

4. Ves-Canisteo-Spicer

Well drained and poorly drained, undulating and nearly level soils formed in glacial till and lacustrine deposits

Areas of this map unit are in parts of the lowland plain and coincide with the shoreline of former glacial Lake Benson. Elevation is generally less than 1,050 feet. Glacial lake sediment was deposited on the floor of the lowland plain. Short, irregular, convex knolls mostly of glacial till rise from 1 foot to 20 feet above the floor.

This map unit makes up about 24 percent of the county. It is about 29 percent Ves soils, 17 percent Canisteo soils, 13 percent Spicer soils, and 41 percent soils of minor extent.

The Ves soils are well drained and are on the convex knolls. The surface layer is black loam about 9 inches thick. The subsoil is about 17 inches thick. It is dark brown and dark yellowish brown, friable clay loam in the upper part and olive brown, calcareous, friable loam in the lower part. The underlying material is olive brown, calcareous, loam glacial till.

The Canisteo soils are poorly drained and calcareous. They formed in a 20- to 40-inch thick mantle of silty lake-deposited sediment that overlies the loam glacial till. The surface soil is black and very dark gray silty clay loam about 22 inches thick. The subsoil is grayish brown, mottled, friable silty clay loam about 10 inches thick. The underlying material is olive gray, mottled loam.

The Spicer soils are poorly drained and calcareous. They formed in a mantle of silty, lake-deposited sediment about 40 to 80 inches thick. The surface soil is black and very dark gray silty clay loam and silt loam 22 inches thick. The subsoil is grayish brown, mottled, friable silty clay loam and silt loam about 16 inches thick. The underlying material is olive gray, mottled silt loam.

Of minor extent in this map unit are Storden, Okoboji, Webster, Seaforth, Normania, McIntosh, Tara, and Perella soils. The well drained Storden soils formed on the steepest, most exposed convex parts of hillsides. The very poorly drained Okoboji soils are in shallow depressions. The poorly drained Webster and Perella soils are in drainageways and are slightly above the Canisteo soils on the landscape. The calcareous, moderately well drained Seaforth and McIntosh soils are on low, convex knolls. The moderately well drained Normania and Tara soils are on the higher parts of drainageways and in swales on the undulating knolls.

In most areas the content of organic matter is high. The content of potassium is medium or high, and that of phosphorus is low. Available water capacity is high.

Erosion is a hazard on the Ves soils. Wetness limits the use of Canisteo and Spicer soils, and the high content of lime causes imbalance of fertility in some areas. In areas where the lime content is especially high, fertilizer is needed to correct the fertility imbalance. Tile drains and surface ditches can be used to remove the excess wetness. Other management concerns are maintaining tilth and fertility and controlling water erosion and soil blowing.

The Ves soils and other well drained soils included in this map unit are suitable sites for dwellings and septic tank absorption fields. Wetness is the main limitation for building sites and sanitary facilities on the Canisteo and Spicer soils. The Canisteo and Spicer soils have a seasonal high water table within a depth of 3 feet.

The soils in this map unit have good suitability for the cultivated crops commonly grown in the county. Corn, soybeans, small grain, and hay are well suited. Nearly all the acreage is used for cultivated crops. A few wet areas where more drainage is needed before crops can be successfully grown are used for pasture or wild hay. The main enterprises are cash crops, raising hogs, and feeding beef cattle.

5. Doland-Spicer

Well drained and poorly drained, gently sloping and nearly level soils formed in lacustrine deposits and glacial till

Areas of this map unit are on the lowland plain that was a part of glacial Lake Benson. They have hills and drainageways mantled with silty glacial lake sediment. The hills are streamlined and separated by wet drainageways that are 1/4 to 1 mile apart. They generally are parallel with the Minnesota River.

This map unit makes up about 2 percent of the county. It is about 30 percent Doland soils and soils that are similar to Doland soils, 23 percent Spicer soils and soils that are similar to Spicer soils, and 47 percent soils of minor extent.

The Doland soils are on the smooth side slopes and are well drained. The surface soil is black and very dark gray silt loam about 11 inches thick. The subsoil is about 12 inches thick. The upper part of the subsoil is dark yellowish brown, friable silt loam, and the lower part is olive brown, calcareous, friable silt loam. The underlying material is glacial till of light olive brown and light brownish gray, calcareous loam.

The Spicer soils are in the drainageways and are poorly drained and calcareous. The surface soil is black and very dark gray silty clay loam and silt loam about 22 inches thick. The subsoil is grayish brown, mottled, friable silty clay loam and very friable silt loam about 16 inches thick. The underlying material is olive gray, mottled silt loam.

Of minor extent in this map unit are Normania, Storden, Tara, Zell, McIntosh, and Okoboji soils. The moderately well drained Normania and Tara soils are on the higher parts of drainageways, in swales, and on foot slopes of hillsides. The well drained, calcareous Storden and Zell soils formed on the steepest, most exposed convex parts of knolls and hillsides. The moderately well drained, calcareous McIntosh soils are on low convex knolls. The very poorly drained Okoboji soils are in shallow depressions.

Available water capacity is high or very high. The content of organic matter generally is high, that of potassium is medium or high, and that of phosphorus is low.

Erosion is a hazard on the Doland soils, but their smooth slopes make these soils well suited to contour farming. Wetness limits the use of the Spicer soils, and the high content of lime causes imbalance of fertility in some areas. In areas where the lime content is especially high, fertilizer is needed to correct the fertility imbalance. Tile drains and surface ditches can be used to remove the excess wetness. Other management concerns are maintaining tilth and fertility and controlling water erosion and soil blowing.

Wetness is the main limitation of Spicer soils for building sites and sanitary facilities. Doland soils are well suited to these uses. Many dwellings have been constructed on the Doland soils and other well drained soils in this map unit.

The soils in this map unit have good suitability for all cultivated crops commonly grown in the county. Corn, soybeans, small grain, and hay are well suited. Nearly all the acreage is used for cultivated crops. A few wet swales and drainageways where more drainage is needed before crops can be successfully grown are used for pasture, wild hay, or wildlife habitat. The main enterprises are cash crops, raising hogs and turkeys, and feeding beef cattle.

Areas dominated by loamy and silty soils on flood plains and lake plains

These soils dominantly formed in alluvial and lacustrine sediment. The relief is mostly nearly level. Most areas of these soils are cultivated. The frequently flooded areas are used for pasture, for growing hay, and for wildlife habitat. Wetness, the hazard of flooding, and maintenance of tilth are the main management concerns.

6. Burr-Du Page-McIntosh Variant

Poorly drained, moderately well drained, and somewhat poorly drained, nearly level soils formed in lacustrine and alluvial deposits

Areas of this map unit are in a narrow glacial lake that was between the higher land to the southwest, the Coteau slope, and glacial ice to the north. The silty lacustrine deposits on the lake plain in many places have been mixed with loamy alluvium deposited by flowing water of rivers, creeks, and many minor drainageways that flow from the Coteau slope. Areas of Burr and Du Page soils in this map unit are subject to flooding.

This map unit makes up about 5 percent of the county. It is about 33 percent Burr soils and soils similar to Burr soils, 17 percent Du Page soils, 8 percent McIntosh Variant, and 42 percent soils of minor extent.

The Burr soils are on the flat and slightly concave parts of the lake plain. They are poorly drained, calcareous, and have a high content of gypsum. The surface soil is black and very dark gray silty clay loam and silty clay about 30 inches thick. The next layer is dark olive gray silty clay about 5 inches thick. The underlying material is dark olive gray and olive gray, mottled silty clay loam and clay.

The Du Page soils generally are next to the streams that cross the lake plain but at a slightly higher elevation. They are moderately well drained and calcareous. The surface soil is black and very dark gray loam about 36 inches thick. The underlying material is dark grayish brown loam.

The McIntosh Variant soils are on plane and slightly convex areas that are 1 foot to 3 feet above areas of Burr soils. They are calcareous and somewhat poorly drained. The surface soil is black and very dark gray loam about 13 inches thick. The underlying material is about 30 inches of brown and dark grayish brown, friable loam and dark grayish brown, mottled, friable silty clay loam. At a depth of 43 inches is the buried surface layer of a former lakebed. It is black loam about 15 inches thick. Below this is olive, mottled loam.

Of minor extent in this map unit are Oldham, Egeland, Arvilla, and Ves soils. The very poorly drained Oldham soils formed in depressions and wet swales. The well drained Egeland and somewhat excessively drained Arvilla soils are in small areas on terraces. The well drained Ves soils formed on a few islands in the lake basin where glacial till is exposed.

Available water capacity is high or very high. The content of organic matter is high, potassium is medium or high, and phosphorus is low.

Wetness and flooding on the Du Page and Burr soils are the major management concerns. Construction of open ditches may be necessary to drain the surface water, to help confine floodwater, and to serve as outlets for tile drains. Soil blowing is also a hazard, especially on fall plowed fields during winter and on tilled fields in spring. In many areas fertilizer is needed to correct the fertility imbalance caused by high lime content.

Wetness and flooding are the main limitations for building sites and sanitary facilities. The hazard of flooding should be determined before dwellings are constructed. The McIntosh Variant soils are more suited to dwelling construction than are Burr and Du Page soils.

The soils in this map unit have good suitability for cultivated crops, especially corn and soybeans. Most areas are cultivated. Corn, small grain, and soybeans are the major crops. Some areas are used for pasture, wild hay, or wildlife habitat. Cash grain crops are grown on most of the farms. A few farmers raise hogs or feed beef cattle.

7. Calco-Du Page

Poorly drained and moderately well drained, nearly level soils formed in alluvial deposits

Areas of this map unit are on nearly level flood plains and in overflow channels. They are subject to flooding.

This map unit makes up about 5 percent of the county. It is about 50 percent Calco soils and soils similar to Calco soils, 30 percent Du Page soils, and 20 percent soils of minor extent.

The Calco soils are typically on the lower levels of the flood plain. These poorly drained, calcareous soils formed in silty material deposited by floodwaters. The surface soil is silty clay loam about 32 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material is very dark gray, mottled silty clay loam alluvium.

The Du Page soils are on the slightly higher levels of the flood plain. They are deep and moderately well drained. The surface soil is black and very dark gray, calcareous loam about 36 inches thick. The underlying material is dark grayish brown, calcareous loam alluvium.

Of minor extent in this map unit are Marysland, Fordville, Sverdrup, and Arvilla soils. The poorly drained Marysland soils are in the overflow channels and on low parts of flood plains that are underlain by sand and gravel. The well drained Fordville and Sverdrup soils and the somewhat excessively drained Arvilla soils are in small areas on terraces.

Available water capacity is high. The content of organic matter is high, potassium is medium or high, and phosphorus is low.

The Calco soils have a seasonal high water table and are frequently or occasionally flooded. The Du Page soils are occasionally flooded. Flooding is generally in spring. About once in every 10 years, flooding occurs during the growing season and crops are damaged. Most areas of this map unit can benefit from the use of fertilizer to correct the fertility imbalance caused by high lime content.

Flooding and wetness are the main limitations for building sites and sanitary facilities. The suitability is poor for dwellings, septic tank absorption fields, and most other engineering uses. If local roads are constructed on these soils, builders need to determine the extent of flooding.

The soils in this map unit have good suitability for cultivated crops, especially where artificial drainage and flood control are feasible. Corn and soybeans are grown on most of the cropland. Small grain is grown on a small acreage. About half of the areas are cultivated. Some areas that are frequently flooded or are too wet for cropland are used for pasture or wildlife habitat. On most of the farms in this map unit, the main enterprises are cash grain crops and livestock.

Areas dominated by loamy soils on outwash plains, terraces, and moraines

These soils dominantly formed in loamy deposits underlain by sand and gravel. The relief is mainly nearly level and gently sloping. Nearly all areas of these soils are cultivated. The main management concerns are droughtiness and soil blowing.

8. Arvilla-Egeland

Somewhat excessively drained and well drained, nearly level and gently sloping soils formed in loamy material over sandy and gravelly outwash deposits

Areas of this map unit are on outwash plains, terraces, and moraines. The outwash deposits generally are less than 4 feet thick and are underlain by glacial till or silty sediment.

This map unit makes up about 2 percent of the county. It is about 29 percent Arvilla soils and soils similar to Arvilla soils, 28 percent Egeland soils and soils similar to Egeland soils, and 43 percent soils of minor extent.

The Arvilla soils are somewhat excessively drained. They are dominantly nearly level, but a few areas are gently sloping. The surface layer is black sandy loam about 8 inches thick. The subsoil is dark brown, friable sandy loam about 8 inches thick. Below this is yellowish brown, calcareous gravelly loamy sand to a depth of about 30 inches. Next is about 5 inches of brownish yellow, calcareous sand over grayish brown and yellowish brown, calcareous sand and gravel.

The Egeland soils are well drained. These soils are in nearly level swales and on gently sloping side slopes. The surface layer is very dark gray loam about 10 inches thick. The subsoil is dark yellowish brown, friable loam and fine sandy loam. Next is yellowish brown, calcareous fine sandy loam to a depth of about 48 inches. Below this is brown, calcareous loamy fine sand.

Of minor extent in this map unit are Fieldon, Marysland, Ves, Storden, Spicer, and Canisteo soils. The poorly drained Fieldon and Marysland soils are on the lower parts of the landscape. The Ves and Storden soils are on low knolls that extend 3 to 10 feet above the outwash plain. They are loamy throughout. The poorly drained Spicer and Canisteo soils are in the low areas associated with the Ves and Storden soils.

The Arvilla soils have low available water capacity, and the Egeland soils have moderate available water capacity. The organic matter content is low to moderate.

Soil blowing and droughtiness are the major hazards of these soils. Soil blowing can be severe, especially where the soils have been fall plowed. Conservation tillage or leaving crop residue on the surface helps reduce erosion and conserve moisture.

The soils in this map unit are suited to building sites and local roads and streets. They are also suited to sanitary facilities, but contamination of underground water is a hazard because of seepage. These soils are a probable source of sand and gravel.

These soils have fair to poor suitability for cultivated crops and good suitability for hay and pasture. Small grain, corn, soybeans, and hay are the main crops. Most of the acreage is cultivated. The main enterprises are cash crops, raising hogs and beef cattle, and feeding beef cattle.

Areas dominated by loamy soils on river bluffs

These soils formed in loamy colluvium and glacial till. The relief is mainly steep and very steep. Most areas of these soils have forest or grass vegetation and are used as pasture and wildlife habitat. The main management concern is control of water erosion in overgrazed areas.

9. Terril-Storden-Swanlake

Moderately well drained and well drained, steep and very steep soils formed in colluvium and glacial till

Areas of this map unit are on the foot slopes and side slopes that border the Minnesota River Valley and on side slopes of tributaries that lead into the valley. The side slopes that face mostly north and east are suited to the growth of trees and shrubs (fig. 5). In areas where the valley dominantly was forest, the adjacent side slopes are wooded. In areas where the valley dominantly was prairie, the adjacent side slopes have prairie vegetation.

This map unit makes up about 2 percent of the county. It is about 38 percent Terril soils and soils similar to Terril soils, 22 percent Storden soils, 8 percent Swanlake soils and soils similar to Swanlake soils, and 32 percent soils of minor extent.

The Terril soils are on foot slopes, in slump areas on the back parts of side slopes, and in drainageways that dissect the side slopes. These soils are moderately well drained and noncalcareous. The surface soil is loam about 30 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil to a depth of about 60 inches is very dark gray, friable loam colluvium. Many areas are underlain by calcareous loam at a depth of 36 to 60 inches.

The Storden soils are on steep and very steep convex side slopes that support prairie vegetation. These soils are well drained and calcareous. The surface layer is dark grayish brown loam about 9 inches thick. Below this is olive brown and light olive brown loam glacial till.

The Swanlake soils are on steep and very steep convex side slopes that are covered by forest vegetation. These soils are well drained and calcareous. The surface layer is black loam about 9 inches thick. Next is yellowish brown loam about 4 inches thick that contains many very dark gray wormcasts. Below this is yellowish brown, brown, and light olive brown loam glacial till.

Of minor extent in this map unit are Calco and Du Page soils on narrow flood plains of the streams that empty into the Minnesota River. These included soils are subject to flooding. The poorly drained Calco soils are on the first bottom, which includes the main stream channel. The moderately well drained Du Page soils are at a slightly higher elevation on the flood plain than Calco soils. Some areas along the foot slopes have springs and are seepy.

The soils in this map unit are too steep to be suitable for cropland. The main hazard is erosion. The erosion is severe on the steep slopes that have been overgrazed or the forest canopy that has been removed.

Slope is the main limitation for building sites and sanitary facilities. Deep cuts are required for highway construction in areas where roads cross soils of this unit. Suitable sites for dwellings generally are above the steep side slopes.

Most areas of these soils are used for grazing. The grassy foot slopes and the included soils on the frequently flooded bottom lands are well suited to pasture and rangeland. Many species of trees and shrubs grow well on the cool side slopes facing north and east. The steep slopes of these soils limit their use as woodland. The suitability for wildlife habitat and recreational uses is good.

Areas dominated by shallow loamy soils and rock outcrop on bottom lands

These soils dominantly formed in a mantle of loamy alluvium and colluvium over bedrock. They are intermingled with areas of Rock outcrop. The relief is mostly undulating but ranges to steep. Most areas of

Figure 5.—Steep wooded side slopes of Swanlake soils in the Terril-Storden-Swanlake map unit.

these soils are used as pasture and wildlife habitat. The major concern in management is droughtiness.

10. Copaston-Rock outcrop

Well drained, undulating to steep soils formed in alluvium and colluvium over bedrock; and areas of rock outcrop

Areas of this map unit are in the Minnesota River Valley (fig. 6). Rugged, grayish, and reddish outcrops of rock project as much as 50 feet above the valley floor. Slopes are very complex. Most areas have scattered surface stones and boulders. Deposited on and among the outcrops of rock is loamy alluvial material that is mostly 2 feet or less in thickness.

This map unit makes up about 1 percent of the county. It is about 34 percent Copaston soils, 22 percent Rock outcrop, and 44 percent soils of minor extent.

The Copaston soils are well drained and are undulating to steep. The surface layer is black loam about 10 inches thick. The subsoil is about 8 inches thick. It is very dark gray, friable loam over very dark gray, calcareous, loose gravelly sandy loam that contains many fragments of igneous rock. Hard bedrock is at a depth of about 18 inches.

Figure 6.—Typical landscape in the Copaston-Rock outcrop map unit. Note the scattered Rock outcrop. Bedrock is within 40 inches of the surface in most places.

The Rock outcrop part of the unit is Precambrian igneous rock. It is mostly gneiss.

Of minor extent in this map unit are Rothsay, Zell, Sioux, Arvilla, Calco, and Du Page soils. The gently sloping, well drained Rothsay and Zell soils formed on side slopes and knolls among outcrop areas. The excessively drained Sioux soils and somewhat excessively drained Arvilla soils formed in a loamy mantle over sand and gravel deposits, generally on foot slopes. The poorly drained Calco soils and moderately well drained Du Page soils formed in drainageways that transect the areas of Rock outcrop.

The low available water capacity is a major limitation of the Copaston soils. This map unit is too rocky and shallow for crops. Most areas are used for grazing and wildlife habitat.

Depth to bedrock is the main limitation for building sites and sanitary facilities. Blasting of bedrock is required before gas, sewer, and waterlines can be laid and dwellings can be constructed.

Nearly all the areas of this map unit are in permanent grassland and are used for pasture. The suitability for pasture is fair or poor. A quarry is in operation where bedrock is removed and crushed for road and railbed fill and other uses. Gravel pits are in some areas of the included Sioux and Arvilla soils.

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detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Arvilla sandy loam, 0 to 2 percent slopes, is one of several phases in the Arvilla series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Buse-Sioux complex, 12 to 18 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

6—Aastad clay loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on uplands. A few stones and boulders are on the surface and in the soil. Slopes are plane or slightly concave. Individual areas range from 3 acres to more than 200 acres.

Typically, the surface soil is clay loam about 12 inches thick. It is black in the upper part and black, very dark gray, and very dark grayish brown in the lower part. The subsoil is very dark grayish brown and dark grayish brown, firm clay loam about 15 inches thick. It is mottled in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam. In some eroded spots, the brownish subsoil is exposed.

Included with this soil in mapping are small areas of poorly drained Flom soils in narrow drainageways, nearly level areas of well drained Forman soils above deep drainageways, areas of Hamerly soils on slightly convex knolls, and areas of the very poorly drained Okoboji soils in shallow depressions. In Wergeland township, a few included areas have many stones in the surface soil and have a loam surface soil and subsoil. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately slow, surface runoff is slow, and available water capacity is high or moderate. The surface layer is neutral or slightly acid. The content of organic matter is high, phosphorus is low, and potassium is medium or high. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas of this Aastad clay loam are cropped. This soil is well suited to all crops commonly grown in the county. It has few limitations that restrict its use, and it can be cropped intensively. This moderately well drained soil does not dry out as quickly in spring as the nearby well drained Forman soil, and it cannot be worked as early. Leaving crop residue on the surface of fall plowed fields helps to control soil blowing. An occasional green manure or sod crop helps to maintain good structure and tilth.

This soil has few characteristics detrimental to the growth and survival of the trees and shrubs commonly needed in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. Seedlings are difficult to establish, and some die during the first year because of the high content of clay. Seedling mortality can be partly overcome by not working the soil or by not planting seedlings when the soil is too wet. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness and the slow absorption rate. Contamination of ground water by effluent seeping into the water table is also a hazard. Septic tank absorption fields do not function properly when the water table rises nearly to the level of the filter field. Absorption systems built above the soil surface in mounds of soil material keep the absorption fields above the wet zone. The size of the absorption field should be adjusted according to the absorptive capacity of the soil material.

Areas of this soil have fair suitability as sites for low buildings and for roads and streets. Wetness, low strength, and shrink-swell properties of the soil cause construction difficulties and can result in damage to structures. The damage due to wetness can be reduced by artificially draining excess water from the soil and by building above the wet zone. The damage to roads and streets due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability class I.

31E—Storden loam, 18 to 25 percent slopes. This steep, well drained soil is on ridges and side slopes along streams and drainageways and around the edges of ponds and lakes on the lowland plain. A few stones and boulders are on the surface. Slopes are convex and simple and about 150 feet long. Individual areas generally are long and narrow and range from 3 acres to 50 acres.

Typically, the surface layer is dark grayish brown loam about 6 inches thick. The underlying material to a depth of about 60 inches is olive brown and light olive brown loam glacial till. The soil is generally calcareous throughout, but in places, part or all of the surface layer does not have free lime.

Included with this soil in mapping are small areas of the more poorly drained Calco, Du Page, Canisteo, and Webster soils. These soils are in drainageways that dissect this unit. Also included are the moderately well drained Terril soils on concave parts of foot slopes and in shallow drainageways. Small deposits of sand and gravel are on some of the ridgetops. A few small seep areas are on foot slopes along the Minnesota River. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, available water capacity is high, and surface runoff is very rapid. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is moderate or low, phosphorus is very low, and potassium is medium.

Most areas of this Storden loam are used for pasture. They generally have been overgrazed. As a result, the native grass species have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by weeds, such as gumweed, buckbrush, and goldenrod. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system can improve the pasture and keep the pasture and soil in good grazing condition. A few potential pond reservoir sites are in areas of this soil.

A few small, less sloping areas of this soil are used for cultivated crops. The hazard of erosion is very severe in cropped areas. Also, because of the very rapid runoff, this soil is droughty. Gullies can be shaped and seeded to form grassed waterways. Diversion terraces can be built on some of the slopes above this soil to prevent or retard the formation of gullies.

This soil is too steep for windbreaks but is suitable for other plantings. The hazard of erosion is severe if the surface is disturbed. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees and shrubs. Mortality of trees and shrubs during the first year is slight to severe, depending on the aspect and the slope. Conditions are less favorable on the hot, dry slopes facing south and west. More species of trees and shrubs can be grown on the cooler and more moist slopes facing north and east. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

This steep soil is generally not used as a site for sanitary facilities. Construction of sanitary facilities and proper placement of septic tank filter fields are difficult on the steep slopes. Also, there is a hazard of effluent seeping laterally downslope and surfacing at a lower elevation. This soil is poorly suited to building sites. The hazard of erosion is severe if buildings or roads are built on the steep slopes. Erosion control measures are needed during and following construction. Mulching the surface and seeding grass or sodding disturbed areas help to reduce erosion.

This soil is in capability subclass VIe.

31F—Storden loam, 25 to 40 percent slopes. This very steep, well drained soil is on side slopes and ridges along rivers, creeks, and deep drainageways. In most places, a few stones and boulders are on the surface and in the soil. Small, narrow drainageways dissect this soil at irregular intervals. Slopes are convex, simple, and 100 to 200 feet long. Individual areas are long and narrow and range from 3 acres to 120 acres.

Typically, the surface layer is dark grayish brown loam about 5 inches thick. The underlying material to a depth of about 60 inches is olive brown and light brown loam glacial till. The soil generally is calcareous throughout, but in places part or all of the surface layer does not have free lime.

Included with this soil in mapping are narrow areas of the more poorly drained Calco and Du Page soils in the deep drainageways and areas of the moderately well drained Terril soils on the concave parts of foot slopes and in shallow drainageways. Also included are small areas of Arvilla, Sverdrup, and Sioux soils that are on the summmits of slopes and have sandy and gravelly underlying material. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderate, and available water capacity is high. Surface runoff is very rapid. In most places the surface layer is mildly alkaline. The content of organic matter is moderate or low, phosphorus is very low, and potassium is medium.

Most areas of this Storden loam are used for pasture. This soil is too steep for cropland. Most areas have been overgrazed. As a result, native grass species have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as buckbrush, gumweed, and goldenrod. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good grazing condition. A few potential pond reservior sites are in areas of this soil.

This soil is too steep for windbreaks but is suitable for other plantings. The hazard of erosion is severe if the surface is disturbed. Planting sites can be prepared by scalping away the sod for individual trees and shrubs. Mortality of trees and shrubs during the first year is slight to severe, depending on the aspect and slope position. Conditions are less favorable on the hot, dry slopes facing south and west. More species of trees and shrubs can be grown on the cooler slopes facing north and east. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

This very steeply sloping soil is generally not used as a site for sanitary facilities. Construction of sanitary facilities and proper placement of septic filter fields are difficult on the very steep slopes. The hazard of effluent seeping laterally downslope and surfacing at a lower elevation is severe.

This soil is poorly suited to building sites. The hazard of erosion is severe when buildings or roads are built on the very steep slopes. Erosion control measures are needed during and following construction. Mulching the surface and seeding grasses or sodding in disturbed areas help to reduce the hazard of erosion.

This soil is in capability subclass VIIe.

33B—Barnes loam, 1 to 4 percent slopes. This gently undulating, well drained soil is on glaciated uplands. Slopes are complex and convex and range from 100 to 175 feet long. Individual areas range from 3 acres to 60 acres.

Typically, the surface layer is black loam about 11 inches thick. The subsoil is friable loam about 15 inches thick. It is dark brown in the upper part, brown in the middle part, and olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam glacial till. In a few eroded spots, the brownish subsoil is exposed.

Included with this soil in mapping are small areas of more sloping and eroded Barnes soils and small areas of Waubay, Hamerly, Flom, and Okoboji soils. The moderately well drained Waubay soils are on foot slopes and other slightly concave areas, the moderately well drained, calcareous Hamerly soils are on slight rises and low convex peninsulas, the poorly drained Flom soils are in shallow drainageways, and the very poorly drained Okoboji soils are in closed depressions. Also included are areas of Arvilla and Sverdrup soils. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is high or moderate. The surface layer is mildly alkaline or neutral. The content of organic matter is naturally high, phosphorus is very low, and potassium is medium.

Most areas of this Barnes loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is slight. Stones are sometimes pushed to the surface by tillage and by frost action. Tillage is easier if the stones on the surface are removed periodically. The short, complex slopes are generally not well suited to terracing and contour farming. Minimum tillage practices, such as chisel plowing, help control erosion. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to the trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. Soil blowing and water erosion can be controlled by maintaining a mulch of crop residue on the surface. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting can increase the moisture supply and destroy unwanted vegetation.

This soil has fair suitability as a site for sanitary facilities. It has a slow absorption rate, and septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rates of specific areas of soils are desirable. This soil is well suited for building sites. It has low bearing strength and is subject to frost heave. These limitations can cause damage to roads and streets. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches. This soil is a fair source of topsoil.

This soil is in capability subclass IIe.

33B2—Barnes loam, 3 to 6 percent slopes, eroded. This undulating, well drained soil is on ridgetops, knolls, and side slopes. Slopes are complex and convex and range from 100 to 200 feet long. A few stones and pebbles are on the surface and in the soil. Individual areas range from 3 acres to 200 acres.

Typically, the surface layer is very dark gray loam about 8 inches thick. The subsoil is friable loam about 15 inches thick. It is dark brown in the upper part, brown in the middle part, and calcareous and olive brown in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam glacial till. In a few spots the brownish subsoil is exposed.

Included with this soil in mapping are small areas of sandy, gravelly, and stony soils. Also included are small areas of Okoboji, Poinsett, Buse, and Flom soils. The very poorly drained Okoboji soils are in depressions; the well drained Poinsett soils are more silty than this Barnes soil; the well drained Buse soils have a thin, calcareous surface layer and are on the steeper side slopes; and the poorly drained Flom soils are in shallow drainageways. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is high or moderate. The surface layer is neutral or mildly alkaline. The content of organic matter is moderate or high. Phosphorus is very low, and potassium is medium.

Most areas of this Barnes loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is moderate. Stones are sometimes pushed to the surface by tillage and by frost action. Tillage is easier if the stones on the surface are removed periodically. If the slopes are suitable, contour farming is effective in controlling erosion and in holding water on the soil. Minimum tillage practices, such as chisel plowing, also help to control erosion, particularly in areas not suited to contour farming. The risk of soil blowing on fall plowed fields during winter and spring can be reduced by leaving crop residue on the surface and keeping the surface rough. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to the trees and shrubs in windbreaks. Water erosion and soil blowing can be controlled by maintaining a mulch of crop residue. In places windbreaks can be planted on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting can be used to increase the moisture supply and destroy unwanted vegetation.

This soil has fair suitability as a site for sanitary facilities. It has a slow absorption rate and septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rates of specific areas of soil are desirable. This soil is well suited to building sites. It has low bearing strength and is subject to frost heave. These limitations can cause damage to roads and streets. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches. This soil is a fair source of topsoil.

This soil is in capability subclass IIe.

35—Blue Earth silt loam. This nearly level, very poorly drained soil is in lake basins and shallow depressions. It is subject to ponding. The lake basins typically have escarpments along their sides. Fragments of snail shells and clam shells are on the surface and in the soil. Individual areas range from 5 acres to several hundred acres.

Typically, the highly organic surface soil is about 37 inches thick. It is black silt loam in the upper 8 inches and mottled, black and very dark gray silt loam and silty clay loam in the lower 29 inches. The underlying material to a depth of about 53 inches is dark gray, mottled, calcareous, clay loam glacial till. Below this to a depth of about 60 inches is olive gray, mottled, calcareous loam glacial till. The soil is calcareous throughout. Some depressions in the part of the lowland plain formerly covered by glacial Lake Benson have lake deposits more than 10 feet thick.

Included with this soil in mapping are areas of Canisteo, Oldham, and Vallers soils. Canisteo and Vallers soils formed in glacial till on islands, peninsulas, and borders of the depressions. Oldham soils are more clayey than this Blue Earth soil. Also included are small areas of sandy soils along the borders of the depressions. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderate or moderately slow, and available water capacity is high or very high. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter and potassium is very high, and phosphorus is medium. The seasonal high water table is on or near the surface in areas that have been only partly drained by surface ditches and drainage tile.

Most areas of this Blue Earth silt loam are cropped. Some undrained areas are used for grazing or wild hay. This soil is well suited to all crops commonly grown in the county if it is adequately drained and fertilized. Excess lime in the surface layer causes problems in maintaining fertility. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. Soil blowing occurs in large open areas but can be controlled by leaving fall plowed fields rough and by leaving some crop residue on the surface. In places, the soil contains enough magnesium sulfate to disintegrate ordinary cement tile. Clay tile or alkali-resistant cement tile should be used. If this soil is worked when too wet, hard clods form that are difficult to break.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. The wetness and the high content of lime reduce the number of species that can grow well. Chlorosis occurs in many trees and shrubs on this soil but can be controlled by planting trees and shrubs that can tolerate a high lime content. Surface water must be removed or prevented from accumulating on the soil before trees are planted. Site preparation should be completed in fall before planting to provide a proper seedbed and to reduce plant competition. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil, ponding, and frost heave can damage roads and streets built across areas of this soil. Damage due to ponding and frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIIw.

36—Flom clay loam. This nearly level, poorly drained soil is in low areas in drainageways and around depressions in the glaciated uplands. Some areas are briefly flooded after heavy rains and when the snow melts in spring. Individual areas are irregular in shape and range from 3 acres to several hundred acres.

Typically, the surface soil is clay loam about 28 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The subsoil is olive gray, mottled, firm clay loam about 14 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay loam and silty clay loam.

Included with this soil in mapping are small areas of Hamerly, Vallers, Fulda, and Okoboji soils. The moderately well drained Hamerly soils are on low knolls; the poorly drained, calcareous Vallers soils are on the rims of depressions; the poorly drained, clayey Fulda soils are in low areas in drainageways and around depressions; and the very poorly drained Okoboji soils are in shallow, closed depressions. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately slow, available water capacity is high or very high, and surface runoff is slow. The surface layer is neutral in most places but is slightly acid or mildly alkaline in some places. The content of organic matter is high, phosphorus is low, and potassium is medium or high. In undrained areas, the seasonal high water table is at a depth of 1 foot to 3 feet.

Most areas of this Flom clay loam are cropped. A few areas are used for grazing or wild hay. Drainage generally is needed before this soil can be farmed intensively. If drainage is provided, this soil is well suited to all crops commonly grown in the county. The main limitation is wetness. Tile drains are needed to provide subsurface drainage. If this soil is worked when it is too wet, severe compaction and clodding of the surface layer are likely to occur. If crop residue or plant cover is not adequate, large open areas are subject to soil blowing. Returning crop residue to the soil helps maintain tilth and prevent soil blowing. Grassed waterways are needed in areas where water flows across the soil.

Unless excessive surface water is present, this soil has fair suitability for trees and shrubs in windbreaks. If adequate subsurface drainage is provided, many species of trees and shrubs can be grown successfully. Site preparation should be completed during fall before planting, because in many years clods form if the soil is worked early in spring when it is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of seasonal wetness. In some years, the water table is within a depth of 1 foot during wet periods. The hazard of contaminating the ground water is severe. Low strength in this soil and frost action can damage roads and streets built across areas of this soil. Damage due to frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches. Damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

85—Calco silty clay loam, occasionally flooded. This nearly level, poorly drained, calcareous soil is on flood plains that are a few feet higher than the rivers, creeks, and drainageways that dissect them. It is occasionally flooded. Individual areas are long and narrow and range from 5 acres to more than 150 acres.

Typically, the surface soil is silty clay loam about 32 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is very dark gray, mottled silty clay loam. The soil is calcareous throughout. In some areas the surface soil is loam or clay loam. In the Minnesota River Valley, in places, it is silty clay. Pockets of gypsum are in the surface soil and in the underlying material in some areas. In a few areas, the calcareous alluvium is covered by 1 foot to 3 feet of noncalcareous, dark colored sediment that has washed in from the uplands. Thin sandy layers can occur throughout the profile. A few areas in the Minnesota River Valley have numerous stones and boulders on the surface.

Included with this soil in mapping are small areas of Du Page, Nishna, and Zumbro soils. The modertely well drained Du Page and Zumbro soils are on slightly higher landscape positions and the poorly drained Nishna soils are in oxbows and slightly lower positions. A few areas on the Minnesota River flood plain and an area near St. Leo have underlying bedrock at a depth of less than 40 inches. Rock outcrop is in a few spots. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderate, and available water capacity is high or very high. Surface runoff is slow. The surface layer is mildly alkaline in most places. The content of organic matter and potassium is high and available phosphorus is low. In undrained areas, the seasonal high water table is at a depth of 1 foot to 3 feet.

Most areas of this Calco silty clay loam are cropped or are used for grazing. This soil is well suited to all crops commonly grown in the county. The major limitation is wetness. Flooding of the soil after heavy rains and by melt water during spring runoff can damage crops. In places the surface layer has a high lime content that causes a fertility imbalance. Drainage tile is difficult to install in most areas, and sufficiently sloping outlets are difficult to establish. Dikes that protect the soil from floodwater are practical in places. If the soil is worked when too wet, clods form that are difficult to break up.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. Wetness, occasional flooding, and high lime content reduce the number of species that can grow well. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs on this soil. This condition is best controlled by planting trees and shrubs that can tolerate the lime content. Site preparation should be completed in fall before planting, because in many years clods form if the soil is worked early in spring when too wet. Weeds and grasses in newly established windbreaks can be controlled by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of flooding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil and wetness can damage roads and streets built across areas of this soil. Damage due to wetness can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

86—Canisteo clay loam. This nearly level, poorly drained, calcareous soil is on the rims of depressions and in other low areas on the floor of the lowland plain. Accumulation of lime in the surface layer has caused it to be grayish when dry. Slopes are plane or slightly convex. Areas of this soil range from 3 acres to several hundred acres.

Typically, the surface soil is clay loam about 19 inches thick. It is black in the upper part and very dark gray and mottled with gray in the lower part. The subsoil is olive gray, mottled, friable clay loam about 14 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled loam glacial till (fig. 7). The soil typically is calcareous throughout. In places, the soil has a high content of gypsum crystals.

Included with this soil in mapping are small areas of Glencoe, Webster, and Seaforth soils. The very poorly drained Glencoe soils are in shallow depressions; the poorly drained Webster soils are in drainageways or in flat areas at a slightly higher elevation; and the moderately well drained Seaforth soils are on islands and knolls within areas of the Canisteo soil. Also included are small areas of soils that have sandy and gravelly underlying material. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, surface runoff is slow, and available water capacity is high. The surface layer is mildly alkaline or moderately alkaline, and the soil contains an excessive amount of lime. The content of organic matter is high, available phosphorus is low or very low, and potassium is medium or high. In undrained areas, the seasonal high water table is at a depth of 1 foot to 3 feet in spring and during wet periods.

Most areas of this Canisteo clay loam are cropped. Some areas are used for grazing. This soil is well suited to intensive cropping if adequately drained and fertilized and if all crop residue is returned to the soil. Tile drains are needed to provide subsurface drainage. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers help to correct the fertility imbalance caused by the high lime content. Soybeans grown on these soils commonly suffer from chlorosis. This can be overcome by drainage and by growing varieties of soybeans that tolerate excessive lime. Good results also have been obtained by using iron chelates. The ground water in some areas contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkaline-resistant tile should be used. Fall tillage permits earlier preparation of a seedbed in spring.

The suitability of this soil for the trees and shrubs in windbreaks is fair to poor. The wetness and the high content of lime reduce the number of species that can grow well. The excessive amount of lime interferes with the uptake of nutrients in many woody plants (fig. 8). Chlorosis occurs in many trees and shrubs. This condition is best controlled by planting trees and shrubs that can tolerate the high lime content. Drainage lowers the seasonal high water table and allows deeper rooting.

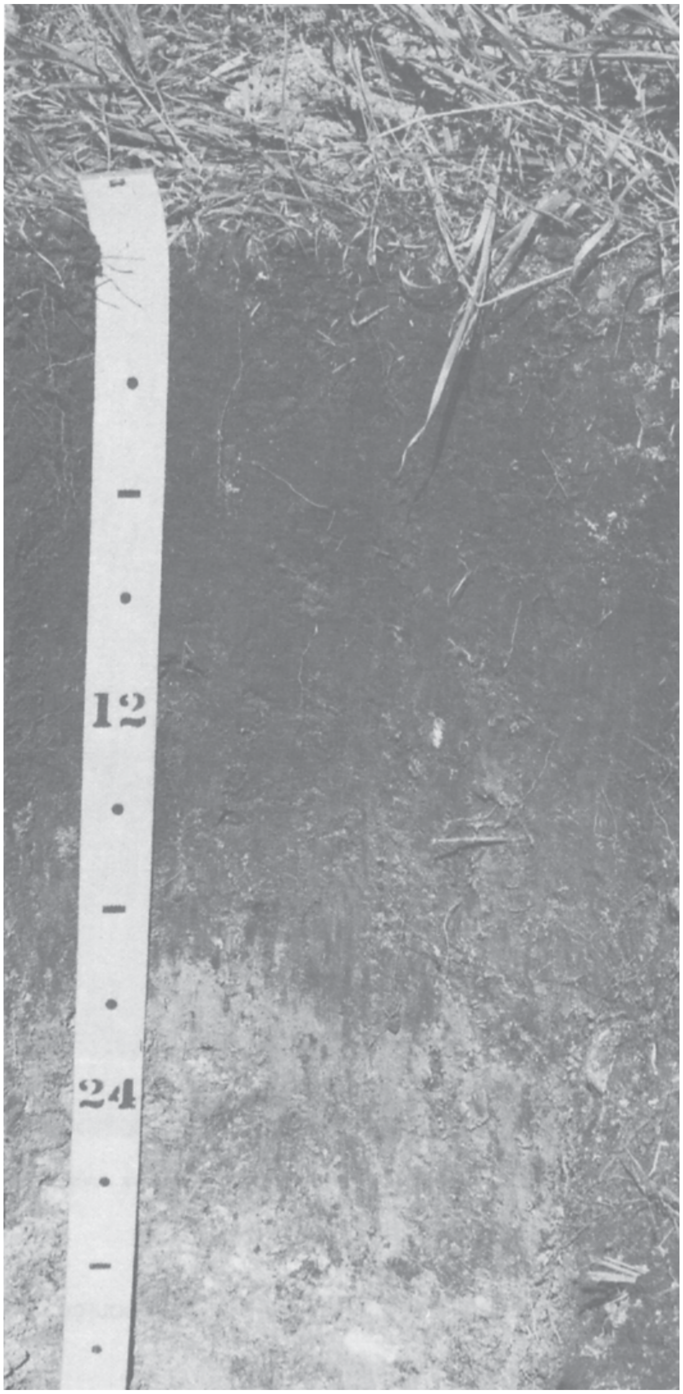

Figure 7.—Profile of Canisteo clay loam. The surface layer is about 19 inches thick. The subsoil is about 10 inches thick. The underlying material is light colored, calcareous glacial till. White spots in the upper part are accumulations of lime.

Site preparation should be completed in fall before planting, because working the soil early in spring when it is too wet can cause clodding. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of seasonal wetness. The water table can be within a depth of 1 foot during wet periods. Contamination of the ground water is a severe hazard. Low strength in this soil and frost action can damage roads and streets built across areas of this soil. Damage due to frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches. Damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

94B—Terril loam, 2 to 6 percent slopes. This gently sloping, moderately well drained soil is on narrow, concave strips along the foot of the steeper slopes and at the upper end of drainageways. Individual areas range from 3 acres to 50 acres.

Typically, the surface soil is loam about 30 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil to a depth of about 60 inches is very dark gray, friable loam. In many areas, calcareous loam underlying material is at a depth of 36 to 60 inches. Thin, gravelly, sandy or cobbly layers are in the underlying material in places. In some areas, the surface soil is less than 24 inches thick.

Included with this soil in mapping are small areas of the nearly level Terril soils, small areas of the more sloping Terril soils, small areas of Du Page soils, and small areas of sandy soils. The moderately well drained Du Page soils are on the bottom land next to the Terril soils on foot slopes. They are subject to flooding. Granitic outcrops are in some areas in the Minnesota River Valley. Hillside seeps occur in a few places. The included soils make up 2 to 7 percent of the map unit.

Permeability is moderate, and available water capacity is high. Surface runoff is medium or slow. The surface layer is neutral or slightly acid. The content of organic matter is high, phosphorus is low, and potassium is medium. In most areas the seasonal high water table is at a depth of more than 6 feet.

Most areas of this Terril loam are cropped. Because this soil commonly is adjacent to steeper soils, many areas are used for grazing. A few areas along the sides of the Minnesota River Valley are wooded.

This soil is well suited to corn, small grain, soybeans, and alfalfa. The hazard of erosion is slight. If erosion occurs on the adjacent higher lying soils, the material deposited on this soil is likely to injure or smother plants. Terraces and contour rows should be on a slight grade so that water does not collect between the rows. Grassed waterways are needed in areas where water collects on and crosses this soil.

Figure 8.—High lime content and wetness in an area of Canisteo soils have caused poor growth of Norway poplar. Normania soils in foreground and background show improved growth.

This soil is well suited to trees and shrubs in windbreaks. Texture and drainage characteristics allow deep penetration of moisture and roots and uniform distribution of roots. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and tilling during the summer or fall before planting help to increase the moisture supply and destroy unwanted vegetation.

This soil is well suited to sanitary facilities and building sites. It has low bearing strength, which can cause damage to roads and streets. This damage can be reduced by building the base of roads with material that has greater bearing strength. This soil is a fair source of topsoil.

This soil is in capability subclass IIe.

94C—Terril loam, 6 to 12 percent slopes. This sloping, moderately well drained soil is on foot slopes along the valley of the Minnesota River. Slopes are concave to slightly convex and several hundred feet long. Individual areas are long and narrow; some are several miles long. They are 5 acres to 100 acres.

Typically, the surface soil is loam about 30 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil to a depth of about 60 inches is very dark gray friable loam. Many places have calcareous loam underlying material at a depth of 30 to 60 inches. Thin, gravelly, sandy, or cobbly layers are in the underlying material in places. In some places the surface soil is less than 24 inches thick.

Included with this soil in mapping are small areas of steeper Terril soils and small areas of Du Page soils. Areas of Du Page soils are on bottom lands next to Terril soils on foot slopes. They are subject to flooding. Granitic outcrops are in some areas and hillside seeps occur in a few places. The included soils make up 2 to 7 percent of most map units.

Permeability is moderate, and available water capacity is high. Surface runoff is medium or rapid. The surface layer is neutral or slightly acid. The content of organic matter is high, phosphorus is low, and potassium is medium.

Most areas of this Terril loam are used for crops. Some areas are used for grazing. This soil is moderately well suited to all crops commonly grown in the county if the erosion is controlled. The hazard of erosion on this soil is moderate or severe. Row crops can be planted on the contour to conform with the shape of the soil areas. Where erosion is excessive, terraces or contour stripcropping can be easily adapted. Grassed waterways are needed in areas where runoff moves across this soil.

This soil is well suited to trees and shrubs in windbreaks. Texture and drainage characteristics allow for the deep penetration of moisture and roots and for the uniform distribution of roots. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and tilling during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil has fair suitability as a site for sanitary facilities and buildings. The hazard of erosion is moderate where vegetative cover is removed during construction, and erosion control measures should be taken. Covering the surface with a mulch during construction and seeding grass or sodding disturbed areas following construction help reduce the hazard of erosion. This soil has low bearing strength that can result in damage to roads and streets. This damage can be reduced by building the base of roads with material that has greater bearing strength. This soil is a fair source of topsoil.

This soil is in capability subclass IIIe.

108—McIntosh silt loam, 1 to 3 percent slopes. This nearly level, moderately well drained and somewhat poorly drained soil is on knolls or islands within areas of more poorly drained soils and on low peninsulas. It is in the part of the lowland plain that was covered by glacial Lake Benson and generally is less than 1,050 feet above sea level. Slopes are convex and less than 100 feet long. Individual areas range from 3 acres to 40 acres.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The next layer is very dark grayish brown silt loam and has many yellowish brown wormcasts. To a depth of about 24 inches the underlying material is light olive brown silt loam. Below this and extending to a depth of about 60 inches is light olive brown, mottled loam glacial till. The soil generally is calcareous throughout. In places, part or all of the surface layer does not have free lime, or the surface layer is loam. Pockets of gypsum are in the subsoil and underlying material in places.

Included with this soil in mapping are small areas of Doland, Tara, and Spicer soils. The well drained Doland soils are at a higher elevation than this McIntosh soil and do not have free lime in the surface layer and subsoil; the moderately well drained Tara soils are in concave parts of slopes at an elevation similar to this McIntosh soil but do not have free lime in the surface layer and subsoil; and the poorly drained Spicer soils are at a slightly lower elevation. Also included are small areas of Clontarf, Sverdrup, and Arvilla soils. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderate, available water capacity is high, and surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline. The content of lime is high. The soil has a high content of organic matter, lime, and potassium, and very low available phosphorus. The seasonal high water table is at a depth of 3 to 6 feet.

Except for small tracts that lie within larger undrained areas of more poorly drained soils, most areas of this McIntosh silt loam are cropped. All crops commonly grown in the county are well suited to this soil. In places, the high lime content causes a fertility imbalance, which can be corrected by liberal applications of potassium and phosphorous fertilizers. The hazard of soil blowing is moderate. Drainage of adjoining soils makes this soil easier to manage. Leaving crop residue on the surface reduces the risk of soil blowing on fall plowed fields during winter and spring.

The suitability for trees and shrubs in windbreaks is fair. The high content of lime adversely affects the uptake of plant nutrients. Chlorosis occurs in the plants growing on this soil, but can be controlled by planting trees and shrubs that tolerate a high content of lime. Soil blowing on bare knobs can be controlled by maintaining a mulch of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness. Septic tank absorption fields do not function properly when the water table rises to or near the filter field. Contamination of ground water by effluent seeping into the water table is a hazard. Absorption systems can be built above the soil surface in mounds of soil material, thus keeping the absorption field above the wet zone. Areas of this soil have fair suitability as sites for low buildings and for roads and streets. Wetness, frost action, and the shrink-swell properties of the soil cause construction difficulties and can result in damage to structures. Damage due to wetness and frost action can be reduced by artificially draining excess water from the soil and by building above the wet zone. The damage due to shrink-swell can be reduced by properly designing buildings and by using fill material that has less shrink-swell potential.

This soil is in capability subclass IIs.

113—Webster clay loam. This nearly level, poorly drained soil is in low lying, flat areas, near the foot of slopes, and in drainageways of the lowland plain. Most slopes are slightly concave. Individual areas are irregular in shape and range from 3 acres to 200 acres or more.

Typically, the surface soil is clay loam about 19 inches thick. It is black in the upper part and mixed very dark gray, very dark grayish brown, and dark grayish brown in the lower part. The subsoil is dark grayish brown, mottled, friable loam about 7 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam glacial till. In places, thin layers of sandy material are in the lower part of the subsoil, and in places the surface soil is more than 24 inches thick.

Included with this soil in mapping are small areas of Glencoe, Okoboji, Canisteo, Fulda, and Normania soils. The very poorly drained Glencoe and Okoboji soils are in slight depressions, the calcareous Canisteo soils are on the rims of depressions, the clayey Fulda soils are on parts of the landscape similar to this Webster soil, and the moderately well drained Normania soils are in slightly raised positions. The included soils make up 3 to 10 percent of the map unit.

Permeability is moderate, and available water capacity is high. After heavy rains or snowmelt in spring, water runs off slowly. The surface layer is typically neutral. The content of organic matter is high, phosphorus is low, and potassium is medium or high. In undrained areas the seasonal high water table is at a depth of 1 foot to 2 feet in spring and during wet periods.

Most areas of this Webster clay loam are cropped. Drainage is needed before this soil can be farmed intensively. If drainage is provided, this soil is well suited to all crops commonly grown in the county. Some undrained areas are used for grazing or wild hay. The soil dries out and warms up slowly in spring. If this soil is worked when it is too wet, severe compaction and clodding of the surface layer are likely to occur. Fall tillage permits earlier preparation of the seedbed in spring. Large open areas are subject to soil blowing. Tilth can be maintained by leaving adequate amounts of crop residue on the surface.

This soil has fair suitability for trees and shrubs in windbreaks. If adequate subsurface drainage is provided, most species of trees and shrubs can grow successfully. Site preparation should be completed in fall before planting, because in many years clods form if the soil is worked early in spring when it is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of seasonal wetness. The water table can be within a depth of 1 foot during wet periods. The hazard of contaminating the ground water is severe. Low strength in this soil and frost action can damage roads and streets built across areas of this soil. Damage due to frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches. Damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

114—Glencoe clay loam. This nearly level, very poorly drained soil is in shallow depressions on the lowland plain. It is subject to ponding. Individual areas range from 3 acres to 100 acres.

Typically, the surface soil is clay loam about 33 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The subsoil is dark grayish brown, mottled, friable clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous clay loam glacial till. Near the center of some depressions, the subsoil is clayey. In a few depressional areas a thin layer of muck is at the surface, and in some places free lime is at the surface.

Included with this soil in mapping are small areas of Canisteo, Dovray, Okoboji, and Oldham soils. The poorly drained, calcareous Canisteo soils are along the edges of depressions and on low knolls that are slightly higher than the floor of the depressions. The very poorly drained Dovray and Okoboji soils and the very poorly drained, calcareous Oldham soil are in the depressions. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderately slow, and available water capacity is high or very high. Surface runoff is ponded or very slow. Typically, the surface layer is neutral, but in a few places it is slightly acid or mildly alkaline. The content of organic matter is high or very high, phosphorus is medium to low, and potassium is very high. On undrained sites a seasonal water table is at or near the surface.

Most areas of this Glencoe clay loam are drained and cropped. Undrained areas are marshy and are well suited to wetland wildlife habitat. Drained areas are well suited to all crops commonly grown in the county. The major limitation is wetness. Tile drains are needed to provide subsurface drainage. Open ditches drain surface water and in places provide outlets for tile drains. Fall plowing permits earlier preparation of a seedbed in spring. If fall-tilled fields are left rough and some crop residue is left on the surface, soil blowing can be controlled. Management is needed to maintain good tilth and keep soil compaction to a minimum. If this soil is worked when too wet, hard clods form that are difficult to break. An occasional sod or green manure crop helps to maintain good tilth in the surface layer.

In areas where surface water is not a problem, this soil is well suited to the trees and shrubs in windbreaks. If adequate subsurface drainage is provided, more kinds of trees and shrubs can be grown successfully. Site preparation should be completed during the fall before planting because in many years working the soil early in spring when it is too wet causes clodding. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Pollution of the water table by sanitary facilities is also a hazard. The low strength in this soil and frost heave can damage roads and streets built across areas of this soil. The damage due to frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIIw.

127A—Sverdrup fine sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on ridgetops and in swales on glaciated uplands and lowland plains and on beaches on the lake plain. Slopes are convex. Individual areas range from 4 acres to 160 acres.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The subsoil is about 16 inches thick. It is dark brown, friable fine sandy loam in the upper part and yellowish brown, loose fine sand in the lower part. The underlying material to a depth of about 60 inches is brown, light yellowish brown, and light brownish gray, calcareous fine sand.

Included with this soil in mapping are small areas of soils that have a surface layer and subsoil of loamy sand and, in places, the underlying material is loam. Also included are areas of Egeland soil in which the surface layer and the subsoil are loam less than 20 inches thick. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the profile and rapid in the underlying sand material. Surface runoff is slow. The soil takes in water readily, but available water capacity is low or moderate. The surface layer is neutral or slightly acid. The content of organic matter is moderate, phosphorus is very low, and potassium is medium.

Most areas of this Sverdrup fine sandy loam are cropped or used for grazing. This soil has moderate suitability for all crops commonly grown in the county. Because of the low available water capacity, droughtiness is the major limitation. Soil blowing is a hazard, particularly after fall tillage. Leaving stubble and stalks on the surface during winter helps to trap snow, conserve moisture, and reduce soil blowing. Minimum tillage practices, such as chisel plowing, also reduce the risks of soil blowing and moisture loss. A single-row shelterbelt and wind stripcropping, or close-growing crops and intertilled crops in alternate narrow bands, reduce the risk of soil blowing and the loss of moisture through evaporation and transpiration.

This soil is not well suited to many species of trees and shrubs. The mortality rate in windbreaks is likely to be severe if drought occurs while the trees and shrubs are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and planting and by weed control. Trees planted on this soil generally grow slowly and are commonly stunted. They also tend to have a shorter life than the same species on soils that are underlain by finer textured material. Field windbreaks are effective in controlling soil blowing, but care is needed to keep young trees or shrubs from being damaged by windblown particles. A cover of grass or of crop residue reduces the risk of damage to young windbreaks from soil blowing.

This soil is well suited as a site for low buildings and for roads and streets. Caving of sidewalls in shallow excavations is a hazard. The caving can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields in this soil do not adequately filter the effluent. However, contamination of ground water by effluent is a severe hazard. This hazard can be reduced by placing the absorption field above the soil surface in a mound of more suitable filtering material. In places, the soil can be excavated and the absorption field placed in more suitable filtering material.

This soil is in capability subclass IIIs.

127B—Sverdrup fine sandy loam, 2 to 6 percent slopes. This well drained soil is on sandy ridges, in pockets, and on side slopes. It is undulating in the glaciated uplands and on the lowland plain and gently sloping on stream terraces. Slopes are convex. Individual areas are irregular in shape and range from 3 acres to 90 acres.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsoil is about 18 inches thick. It is dark brown, friable fine sandy loam in the upper part and yellowish brown, loose fine sand in the lower part. The underlying material to a depth of about 60 inches is brown, light yellowish brown, and light brownish gray, calcareous fine sand. In places, the underlying material is gravelly coarse sand.

Included with this soil in mapping are areas of soils that have loamy underlying material, small areas of Egeland soils that have a loam surface layer and subsoil, and, in places, soils in which the surface layer and subsoil are loamy sand. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the profile and rapid in the underlying sand. Surface runoff is slow. Available water capacity is low or moderate. The surface layer is neutral or slightly acid. The content of organic matter is moderate, phosphorus is very low, and potassium is medium.

Most areas of this Sverdrup fine sandy loam are cropped or used for grazing. This soil has moderate suitability for all crops commonly grown in the county. Droughtiness is the major limitation. The soil is easy to work, but it is subject to blowing unless it is protected. Minimum tillage and the return of all crop residue to the soil help to control erosion and conserve moisture. Spring tillage helps to control erosion and soil blowing. Leaving stubble on the surface during winter also helps to trap snow and conserve moisture. A single-row shelterbelt helps to control erosion and conserve moisture.

This soil is poorly suited to many species of trees and shrubs. The mortality rate in windbreaks is likely to be severe if drought occurs while the trees and shrubs are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and planting and by weed control. Trees planted on this soil generally grow slowly and are commonly stunted. Also, they tend to have a shorter life than the same species on soils that are underlain by finer textured material. Field windbreaks are effective in controlling soil blowing, but care is needed to keep young trees and shrubs from being damaged by windblown particles. A cover of grass or of crop residue reduces the risk of damage to young windbreaks from soil blowing.

This soil is well suited as a site for low buildings and for roads and streets. The hazard of erosion is moderate, and care should be taken to keep erosion to a minimum during construction of buildings and roads. Disturbed areas should be revegetated immediately following construction. Caving of sidewalls in shallow excavations is also a hazard. Caving can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields in this soil do not adequately filter the effluent. The hazard of the effluent contaminating ground water is severe. This hazard can be reduced by placing the absorption field above the soil surface in a mound of more suitable filtering material. In places, the soil can be excavated and the absorption field placed in more suitable filtering material. There is a hazard of effluent from improperly placed septic tank filter fields seeping laterally downslope and surfacing at a lower elevation.

This soil is in capability subclass IIIs.

127C—Sverdrup sandy loam, 6 to 12 percent slopes. This sloping, well drained soil is on sandy ridges and side slopes. Slopes are about 150 feet long and are convex. Individual areas range from 3 acres to 15 acres.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is dark brown, friable fine sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is brown, light yellowish brown, and light brownish gray, calcareous fine sand. The surface layer in cultivated areas generally is lighter in color and contains a small amount of free lime. In places, the underlying material is gravelly coarse sand.

Included with this soil in mapping are small areas of steeper Sverdrup soils, small areas of soils that have loamy underlying material, and in places, small areas of soils that have a sandy surface layer and subsoil. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying sand. Surface runoff is medium, and available water capacity is low or moderate. Reaction in the surface layer typically is neutral. The content of organic matter is moderate, phosphorus is very low, and potassium is low or medium.

Most areas of this Sverdrup sandy loam are used for grazing or are cropped. Most cropped areas are too droughty for corn; they are better suited to hay and small grain. As a result of the low available water capacity, droughtiness is the major hazard. Erosion also is a severe hazard. Spring tillage, heavy applications of manure, and return of all crop residue to the soil are needed. Terraces generally are not built on this soil because it is too shallow over sand. Gullies should be reshaped and seeded to form grassed waterways. Grassed waterways need to be maintained, and in some places, need to be reestablished. In waterways where erosion has exposed the sand, replacing the top layer with topsoil promotes the growth of grass. Field windbreaks are effective in controlling soil blowing.

This soil is poorly suited to many species of trees and shrubs. The mortality in windbreaks is likely to be severe if drought occurs while the trees and shrubs are becoming established. The survival rate can be increased by providing special care in site preparation and planting and by weed control. Trees on this soil generally grow slowly and are stunted. Also, they tend to have a shorter life than the same species on soils that are underlain by fine textured material. Care is needed to keep young trees or shrubs from being damaged by windblown particles. A cover of grass or of crop residue reduces the risk of damage to young windbreaks from soil blowing.

This soil is well suited to building site development. If it is used as a site for a building or road, special design and care in selecting the site are needed to reduce the risk of erosion. Septic tank absorption fields are difficult to lay out because of the slopes. In addition, contamination of underground water and streams is a hazard because of seepage and rapid permeability. Caving of cutbanks in shallow excavations is a hazard but can be overcome by providing retaining walls or by enlarging the excavation.

This soil is in capability subclass IVe.

134—Okoboji silty clay loam. This nearly level, very poorly drained soil is on uplands in shallow, round depressions and in drainageways. It is subject to ponding. Individual areas range from 3 acres to 100 acres.

Typically, the surface soil is silty clay loam about 34 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is olive gray, mottled, firm silty clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled clay loam glacial till. A surface layer of muck as much as 15 inches thick is evident in some larger depressions. In a few areas, the surface soil is clay loam. In some areas, free lime is at or near the surface.

Included with this soil in mapping are narrow areas of Vallers, Canisteo, and Spicer soils. These soils are on narrow rims of depressions and on some sandy beach areas adjacent to some of the larger depressions. Also included are small areas of Barbert and Dovray soils which are more clayey than this Okoboji soil. The included areas make up 3 to 10 percent of the map unit.

Permeability is moderately slow, and available water capacity is high or very high. Surface runoff is very slow, and in places water ponds. Reaction in the surface layer is mainly neutral. The content of organic matter is high or very high, potassium is high, and phosphorus is medium or low. In undrained areas, the water table is at or on the surface in spring and during wet periods.

Most areas of this Okoboji silty clay loam are drained and cropped. Undrained areas are marshy and are well suited to wetland wildlife habitat. If drained, this soil is well suited to all crops commonly grown in the county. The major limitation is wetness. Tile drains are needed to provide subsurface drainage. Open ditches drain away surface water and in places can provide outlets for tile drains. Fall plowing permits earlier preparation of a seedbed the following spring. Soil blowing can be controlled if fall plowed fields are left rough and crop residue is left on the surface. Management that maintains good tilth and keeps compaction to a minimum is needed. If this soil is worked when too wet, hard clods form that are difficult to break. An occasional sod or green manure crop helps to maintain good tilth in the surface layer.

Unless surface water is a problem, this soil has fair suitability for trees and shrubs in windbreaks. If adequate subsurface drainage is provided, more species of trees and shrubs can be grown successfully. Site preparation should be completed the fall before planting because in many years clods form if the soil is worked early in spring when it is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Pollution of the water table by sanitary facilities is also a hazard. The low strength in this soil and the frost heave can damage roads and streets built across areas of this soil. The damage due to frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. Damage due to low strength can be reduced by strengthening the soil or by building the base of roads with material that has greater bearing strength and is less susceptible to shrink-swell.

This soil is in capability subclass IIIw.

137—Dovray silty clay. This nearly level, very poorly drained soil is in shallow depressions on the lowland plain and in overflow channels between the Yellow Medicine River and Spring Creek. It is subject to ponding. Individual areas range from 3 acres to 40 acres.

Typically, the surface soil is black silty clay about 25 inches thick. The subsoil is olive gray, mottled, firm silty clay about 17 inches thick. The underlying material to a depth of about 60 inches is dark gray, gray, and olive gray, mottled, calcareous silty clay and silty clay loam. In a few areas, the surface soil is silty clay loam. Thin layers of sandy material are in the underlying material in some areas.

Included with this soil in mapping are calcareous, clayey soils on the rims of depressions and on small, sandy beach areas adjacent to some of the larger depressions. The included soils make up 2 to 7 percent of the map unit.

Permeability is very slow, available water capacity is moderate or high, and surface runoff is very slow or ponded. The surface layer is neutral or slightly acid. The content of organic matter is high or very high, potassium is very high, and phosphorus is high. The availability of phosphorus is low. In undrained areas, the water table is at or on the surface in spring or during wet periods.

Most areas of this Dovray silty clay are drained and cropped. Undrained areas are marshy and are well suited to wetland wildlife habitat. If drained, this soil is well suited to all crops commonly grown in the county. The major limitation is wetness. Tile drains are needed to provide subsurface drainage, but they need to be closely spaced because of the very slow permeability. Surface intakes in the tile systems are needed to help remove surface water. Open ditches also drain away surface water and in places can provide outlets for tile drains. Management is needed that keeps compaction to a minimum and maintains good tilth. Fall plowing permits rapid preparation of a seedbed the following spring. If fall plowed fields are left rough and some residue is left on the surface, soil blowing can be controlled. If this soil is worked when too wet, hard clods form that are difficult to break. An occasional sod or green manure crop helps to maintain good tilth in the surface layer.

Unless surface water is a problem, this soil is moderately well suited to trees and shrubs in windbreaks. If adequate subsurface drainage is provided, more species of trees and shrubs can be grown successfully. Site preparation should be completed the fall before planting because in many years clods form if the soil is worked early in spring when it is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Pollution of the water table by sanitary facilities is also a hazard. The wetness, low strength, and shrink-swell in this soil can result in damage to roads and streets built across areas of this soil. The damage due to wetness can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The potential damage due to low strength and shrink-swell can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength and is less susceptible to shrink-swell.

This soil is in capability subclass IIIw.

140—Spicer silty clay loam. This nearly level, poorly drained, calcareous soil is in low swales. It is also on the edges of depressions in the lowland plain generally at an elevation of less than 1,050 feet, which was about the elevation of the shoreline of glacial Lake Benson. The surface layer in cultivated fields is light gray when dry. Slopes are mostly plane. Individual areas are irregular in shape and range from 5 acres to several hundred acres.

Typically, the surface soil is about 22 inches thick. It is black and very dark gray silty clay loam in the upper part and very dark gray silt loam in the lower part. The subsoil is about 16 inches thick. It is grayish brown, mottled, friable silty clay loam in the upper part and grayish brown, mottled, very friable silty loam that has thin layers of very fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is olive gray, mottled silt loam. This soil is generally calcareous throughout, but in places the upper part of the profile does not have free lime. The surface layer is very fine sandy loam or fine sandy loam in a few places.

Included with this soil in mapping are small areas of Okoboji, Barbert, McIntosh, and Seaforth soils. The very poorly drained Okoboji and Barbert soils are in shallow depressions. The moderately well drained McIntosh and Seaforth soils are on islands and knolls within areas of the Spicer soils. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, surface runoff is very slow, and available water capacity is high or very high. The surface layer is mildly alkaline or moderately alkaline. The amount of lime in this soil is excessive, and in some spots the amount of gypsum is excessive. The content of organic matter is high, phosphorus is very low, and potassium is medium or high. The water table is at a depth of 1 foot to 3 feet in spring and during wet periods in undrained areas.

Most areas of this Spicer silty clay loam are cropped. Some areas that are not adequately drained for cultivated crops are used as pastureland. This soil is well suited to intensive cropping if it is adequately drained and fertilized, and if all crop residue is returned to the soil. This soil dries out and warms up slowly in spring. Tile drains are needed to provide subsurface drainage. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. These nutrients help to correct the fertility imbalance caused by the high content of lime. The ground water in some areas contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant tile should be used. Soybean plants are susceptible to chlorosis in areas of this soil. The chlorosis can be overcome by drainage and by growing varieties of soybeans that tolerate excessive lime. Good results also have been obtained by using iron chelates. Fall plowing permits earlier preparation of the seedbed in spring.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. The wetness and the high content of lime reduce the number of species that can grow well. The excessive amount of lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs because of the high content of lime. Site preparation should be completed in the fall before planting because in many years working the soil early in spring when too wet can cause clodding. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of seasonal wetness. The water table can be within a depth of 1 foot during wet periods of the year. Contamination of the ground water by effluent is a severe hazard. The low strength in this soil, frost action, and wetness can damage roads and streets that are built across areas of this soil. The damage due to wetness and frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent the ponding of water in ditches. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

141A—Egeland loam, 0 to 2 percent slopes. This nearly level, well drained soil is in gentle swales and drainageways. It is also on beaches of the lake plain, on glaciated uplands, and on lowland plains. Slopes are concave. Individual areas range from 5 acres to 60 acres.

Typically, the surface layer is black loam about 10 inches thick. The subsoil is dark yellowish brown and is about 22 inches thick. It is friable loam in the upper part and friable fine sandy loam in the lower part. The underlying material to a depth of about 48 inches is yellowish brown, calcareous fine sandy loam. Below this and extending to a depth of about 60 inches is brown, calcareous loamy fine sand. In some areas, loam glacial till or silty sediment is at a depth of 3 to 6 feet.

Included with this soil in mapping are small areas of steeper Egeland soils and small areas of Arvilla, Sverdrup, and Rothsay soils. The Arvilla soils have more gravel in the underlying material and are at a higher elevation than this Egeland soil; the Sverdrup soils have sand at a shallow depth; the Arvilla and Sverdrup soils have lower available water capacity; and the Rothsay soils are at a slightly higher elevation, are silty, and have higher available water capacity. The included soils make up 3 to 10 percent of the map unit.

Permeability is moderately rapid. Available water capacity is moderate, and surface runoff is slow. The surface layer in most places is slightly acid or neutral. The content of organic matter is moderate, phosphorus is low, and potassium is medium.

Most areas of this Egeland loam are cropped. Except in years of below normal rainfall, corn, soybeans, small grain, and alfalfa are moderately well suited. Droughtiness is the major hazard. This soil is subject to soil blowing, especially after fall plowing. Leaving crop residue on the surface during winter helps to hold snow and to provide moisture for the next crop. The surface layer can be easily worked into a good seedbed. Other management needs are to increase fertility, to maintain organic matter content, and to increase available water capacity. Grassed waterways in the drainageways that cross areas of this soil help to prevent gullying into the sandy underlying material. This soil is well suited to irrigation. It can be row cropped intensively if water for irrigation is available.

The suitability of this soil for trees and shrubs in windbreaks is fair. Available water capacity is moderate, and many trees and shrubs are likely to die if drought occurs while they are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and in planting, and by weed control. In exposed areas, soil blowing is a hazard to young trees and shrubs. It can be controlled by maintaining a mulch of crop residue. Competition for moisture generally is critical. Weeds and grasses can be controlled by shallow cultivation or by applying approved herbicides.

This soil is well suited as a site for low buildings and for roads and streets. Caving of sidewalls is a hazard in shallow excavations. This can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields work well in this soil.

This soil is in capability subclass IIIs.

141B—Egeland loam, 2 to 6 percent slopes. This well drained soil is on ridges, in pockets, and on side slopes. It is undulating in the glaciated uplands and on the lowland plain and gently sloping on beaches of the lake plain and on sandy outwash plains. Individual areas are irregular in shape and range from 3 acres to 120 acres.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsoil is dark yellowish brown and about 22 inches thick. It is friable loam in the upper part and friable fine sandy loam in the lower part. The underlying material to a depth of about 48 inches is yellowish brown, calcareous fine sandy loam. Below this and extending to a depth of about 60 inches is brown, calcareous loamy fine sand. In some areas, loam glacial till or silty sediment is at a depth of more than 3 feet.

Included with this soil in mapping are small areas of steeper Egeland soils and a few areas of nearly level Egeland soils in narrow swales and drainageways. Also included are small areas of Arvilla, Sverdrup, and Rothsay soils at an elevation similar to that of this Egeland soil. The Arvilla soils have more gravel in the underlying material than this Egeland soil, the Sverdrup soils are sandy and have a slightly lower available water capacity, and the Rothsay soils are silty and have higher available water capacity. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid. Surface runoff is slow or medium. Available water capacity is moderate. The surface layer is neutral or slightly acid in most places. The content of organic matter is moderate or low, phosphorus is very low, and potassium is medium.

Most areas of this Egeland loam are cropped or used for grazing. Small grain, soybeans, and alfalfa are better suited than most other crops. Corn is less well suited. The major concerns of management are the moderate hazard of erosion and moderate available water capacity. A good seedbed is easy to prepare on this soil. The hazards of soil blowing and water erosion can be reduced by spring plowing. Leaving stubble and cornstalks on the surface during winter holds snow and helps to provide moisture for the next crop. Grassed waterways help to prevent the formation of gullies in the sandy underlying material.

The suitability of this soil for the trees and shrubs in windbreaks is fair. Available water capacity is moderate, and many trees and shrubs are likely to die if drought occurs. The mortality rate can be partly overcome by providing special care in site preparation and in planting and by weed control. In some exposed areas, soil blowing is a hazard to young trees and shrubs. Soil blowing and water erosion can be controlled by maintaining a cover of crop residue. Competition for moisture generally is critical. Weeds and grasses can be controlled by shallow cultivation or by applying approved herbicides.

This soil is well suited as a site for low buildings and for roads and streets. The hazard of erosion on this soil is slight. Care should be taken to keep erosion to a minimum during construction of buildings and roads. Caving of sidewalls in shallow excavations is a hazard. This can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields work well in this soil.

This soil is in capability subclass IIIe.

160—Fieldon fine sandy loam. This nearly level, poorly drained, calcareous soil is on rims of depressions and on flats in outwash plains. Slopes are plane or slightly convex. Individual areas are irregular in shape and range from 10 acres to 60 acres.

Typically, the surface soil is fine sandy loam about 17 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is dark gray, mottled, very friable fine sandy loam about 11 inches thick. The underlying material to a depth of about 50 inches is grayish brown and olive, mottled loamy fine sand. Below this and extending to a depth of about 60 inches is gray, mottled loamy fine sand that has thin layers of fine sandy loam. The soil is calcareous throughout. In a few areas, the surface soil and subsoil are leached of free lime and are typically neutral in reaction. In many areas on the sandy outwash plain northeast of Clarkfield, the loamy glacial till or silty lake deposited sediment is at a depth of 30 to 40 inches.

Included with this soil in mapping are small areas of Okoboji, Glencoe, Spicer, and Clontarf soils. The very poorly drained Okoboji and Glencoe soils are in depressions and are ponded after snowmelt in spring or after heavy rains during the growing season. The Spicer soils have finer textured underlying material than this Fieldon soil, and the moderately well drained Clontarf soils are at a higher elevation. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Available water capacity is moderate, and surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high, phosphorus is very low, and potassium is medium. In undrained areas, the seasonal high water table is at a depth of 1 foot to 3 feet.

Most areas of this Fieldon fine sandy loam are cropped. This soil is moderately well suited to corn, soybeans, small grain, and alfalfa. The major limitation is wetness. In places, the surface layer has a high content of lime (fig. 9), which causes a fertility imbalance. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. These nutrients help correct the fertility imbalance. Soil blowing is a hazard in large, open areas, especially those which have been fall plowed. Productivity is increased if adequate tile drainage is installed. Surface intakes are needed so that incoming surface water can flush the tile lines and help keep them from becoming clogged by sand.

The suitability of this soil for the trees and shrubs in windbreaks is fair to poor. The wetness and high lime content reduce the number of species that can grow well. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs because of the high content of lime in this soil. This condition is best controlled by planting trees and shrubs that can tolerate the lime content. Drainage lowers the seasonal high water table and allows deeper rooting. Site preparation should be completed during the fall before planting because clods can form if the soil is worked early in spring when too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of wetness. The water table can be at a depth of 1 foot during wet periods. Contamination of the water table by sanitary facilities is a severe hazard. The hazards of frost action and wetness can damage roads and streets built across areas of this soil. The damage due to frost action and wetness can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches. Caving of sidewalls in shallow excavations is also a hazard. This can be prevented by sloping the sidewall or by the use of retaining walls.

This soil is in capability subclass IIw.

168B—Forman clay loam, 2 to 4 percent slopes. This gently undulating, well drained soil is on slightly elevated convex rises and on gentle side slopes that enclose shallow drainageways on the Coteau slope. A few stones and boulders are on the surface and in the soil. Slopes are convex and as much as 125 to 200 feet long. Most areas are long and range from 3 acres to 100 acres.

Typically, the surface layer is black clay loam about 8 inches thick. The subsoil is firm clay loam about 13 inches thick. It is dark brown and contains about 15 percent wormcasts in the upper part and is brown in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown and grayish brown, calcareous clay loam glacial till. Some small areas are more sloping and eroded.

Included with this soil in mapping are small areas of Okoboji, Flom, Hamerly, and Aastad soils. The very poorly drained Okoboji soils are in shallow depressions that become ponded for short periods after heavy rains; the poorly drained Flom soils are in narrow, shallow drainageways; the moderately well drained, calcareous Hamerly soils are on low, slightly convex knolls; and the moderately well drained Aastad soils are in slightly concave areas. Also included, next to the lake plain, are small areas of Poinsett soils that are silty and areas of Sverdrup soils that are underlain by sandy material. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately slow. Available water capacity is high or moderate, and surface runoff is medium. The surface layer typically is neutral or mildly alkaline. The content of organic matter is high, phosphorus is low, and potassium is medium or high.

Most areas of this Forman clay loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is slight. Stones are

Figure 9.—Field windbreak on Fieldon and Clontarf soils. Soybeans on high lime Fieldon soils in the foreground are yellowish, the result of a fertility imbalance.

sometimes pushed to the surface by tillage and by frost action. Tillage is easier if stones on the surface are removed periodically. Most areas are generally not well suited to terracing and contour farming. In areas where erosion is a problem, minimum tillage practices, such as chisel plowing, help to control erosion. The risk of soil blowing on fall tilled fields can be reduced by leaving crop residue on the surface and keeping the surface rough. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed wherever water collects on and crosses this soil.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil is poorly suited as a site for septic tank absorption fields. It has a slow absorption rate, and septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of the soil are desirable. This soil becomes sticky when wet. This can interfere with the excavation of soil material around sanitary landfills.

This soil is well suited to building sites. It has low strength and is subject to shrink-swell and frost heave. These limitations can cause damage to buildings and to roads and streets. The damage due to low strength and shrink-swell can be reduced by using a base of material that has greater bearing strength and less shrink-swell potential. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches.

This soil is in capability subclass IIe.

168B2—Forman clay loam, 3 to 6 percent slopes, eroded. This undulating, well drained soil is on side slopes and low knolls on the Coteau slope. It is also along drainageways and around closed depressions. A few stones and boulders are on the surface and in the soil. The surface of this soil is grayish because erosion has removed part of the surface layer, and material from the subsoil has been mixed into the remaining part. Also, the subsoil is exposed in places. Slopes are convex and as much as 100 to 200 feet long. Individual areas range from 5 acres to 160 acres; most areas are slightly long.

Typically, the surface layer is very dark gray clay loam about 8 inches thick. The subsoil is firm clay loam about 10 inches thick. It is dark brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown and grayish brown, calcareous clay loam glacial till.

Included with this soil in mapping and making up 5 to 10 percent of the map unit are small areas of Okoboji, Flom, Aastad, and Buse soils. The very poorly drained Okoboji soils are in small depressions; the poorly drained Flom soils are in narrow drainageways; the moderately well drained Aastad soils are in small, slightly concave areas; and the well drained, calcareous Buse soils are on the steepest, most convex parts of hillsides. Also included, next to the lake plain, are small areas of Poinsett soils that are silty and Sverdrup soils that are underlain by sandy material. These Poinsett and Sverdrup soils make up 5 to 15 percent of the mapped areas next to the lake plain.

Permeability is moderately slow. Available water capacity is high or moderate, and surface runoff is medium. Reaction in the surface layer is neutral in most places. The content of organic matter is moderate or high, phosphorus is low, and potassium is medium or high.

Most areas of this Forman clay loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is moderate. Stones are sometimes pushed to the surface by tillage and by frost action. Tillage is easier if stones on the surface are removed periodically. If the slopes are suitable, contour farming is effective in controlling erosion and in holding water on the soil. Minimum tillage practices, such as chisel plowing, also help to control erosion, particularly in areas that are not suited to contour farming. The risk of soil blowing on fall plowed fields during winter and spring can be reduced by leaving crop residue on the surface and keeping the surface rough. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to trees and shrubs in windbreaks. Erosion can be controlled by maintaining a mulch of crop residue on the surface. In places, windbreaks can be planted on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing or disking during the summer or fall before planting increases the moisture supply and destroys unwanted vegetation.

This soil is poorly suited as a site for septic tank absorption fields. It has a slow absorption rate and septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of soils are desirable. This soil becomes sticky when wet. This can interfere with excavation of soil material around sanitary landfills.

This soil is well suited to building sites. It has low strength and is subject to shrink-swell and frost heave. These can cause damage to buildings and roads and streets. The damage due to low strength and shrink-swell can be reduced by building the base of roads with material that has greater bearing strength and less shrink-swell potential. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches.

This soil is in capability subclass IIe.

184—Hamerly loam, 1 to 3 percent slopes. This nearly level, somewhat poorly drained and moderately well drained, calcareous soil is on complex knolls or islands and on the low peninsulas in the glaciated uplands. Slopes are convex and less than 100 feet long. Stones are on the surface in places. Individual areas range from 3 acres to 100 acres.

Typically, the surface soil is loam about 15 inches thick. It is black in the upper part and very dark gray in the lower part. The next layer is very dark gray and olive brown loam about 4 inches thick. The underlying material to a depth of about 60 inches is loam glacial till. It is olive brown and light olive brown in the upper part and olive brown mottled with grayish brown in the lower part. The soil is calcareous throughout. In places, the surface layer has been mostly leached of free lime. Pockets of gypsum are in the subsoil and underlying material in many places.

Included with this soil in mapping are small areas of the poorly drained Vallers soils at a slightly lower elevation, small spots of very poorly drained Okoboji soils in depressions, and small areas of Sverdrup and Arvilla soils. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately slow. Available water capacity is high, and surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline in most places because the content of lime is high. The content of organic matter is high, phosphorus is low, and potassium is medium. The seasonal high water table is at a depth of 2 to 4 feet for short periods.

Except for small tracts that lie within larger undrained areas of more poorly drained soils and a few areas that are stony, most areas of this Hamerly loam are cropped. This soil is well suited to all crops commonly grown in the county. In places the high content of lime causes a fertility imbalance which can be corrected by liberal applications of potassium and phosphorous fertilizers. The hazard of soil blowing is slight. Leaving crop residue on the surface reduces the risk of soil blowing on fall plowed fields during winter and spring. Drainage of the adjoining soils makes this soil easier to manage.

The suitability of this soil for trees and shrubs in windbreaks is fair. The high content of lime adversely affects the uptake of plant nutrients. Chlorosis occurs in the plants growing on this soil and is best controlled by planting trees and shrubs that are tolerant of a high content of lime. Soil blowing on bare knobs can be controlled by maintaining a mulch of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings with basements because of the seasonal wetness. The water table can be within a depth of a few feet of the surface during wet periods. Contamination of the water table is a severe hazard. The seasonal wetness can damage roads built across areas of this soil. The damage due to wetness and to frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches.

This soil is in capability subclass IIs.

210—Fulda silty clay. This nearly level, poorly drained soil mainly is on low flats and in drainageways at the lowest elevation of former ice-walled lake plains. In some areas, it is flooded after heavy rains or during snowmelt in spring. Individual areas range from 3 acres to 20 acres.

Typically, the surface soil is silty clay about 19 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The subsoil is dark grayish brown, mottled, firm silty clay about 9 inches thick. It has many tongues of very dark gray. The underlying material to a depth of about 60 inches is lake-deposited, grayish brown and gray, mottled, calcareous silty clay loam. In drainageways and near the base of slopes, the surface soil is more than 24 inches thick. In places, gypsum crystals are in the parent material.

Included with this soil in mapping are a few areas of soils that are calcareous. Also included are very poorly drained, clayey Dovray soils in small depressions and moderately well drained Sinai soils on small islands. The included soils make up 2 to 8 percent of the map unit.

Permeability is slow, available water capacity is moderate or high, and surface runoff is slow. Reaction of the surface layer is neutral in most places. The content of organic matter is high or very high, phosphorus is low, and potassium is medium to high. In undrained areas the seasonal high water table is at the surface or within a depth of 1 foot.

Most areas of this Fulda silty clay are cropped. A few areas that are not adequately drained for cultivated crops are used for grazing. This soil is well suited to all crops commonly grown in the county if adequate drainage is provided. Because of the wetness and the clayey texture, careful management is needed to maintain good tilth. Tile drains are needed to provide subsurface drainage. Alfalfa, sweet clover, and other deep-rooted legumes open channels in the clayey subsoil and help to maintain adequate drainage. The soil dries out and warms up slowly in spring. Fall tillage permits earlier preparation of a seedbed in spring. Hard clods are likely to form if the soil is plowed or worked when wet. A rough plowed surface and some crop residue on the surface reduce the risk of soil blowing.

This soil has fair suitability for trees and shrubs in windbreaks. It is too clayey for optimum growth of trees and shrubs. If adequate subsurface drainage is provided, most species of trees and shrubs can be grown. Site preparation should be completed the fall before planting because in many years clods form if the soil is worked early in spring when too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of seasonal wetness and the hazard of flooding. The water table can be at a depth of 1 foot during wet periods. The low strength in this soil and the hazards of wetness and frost action can damage roads and streets built across areas of this soil. The damage due to wetness and frost action can be reduced by draining excess water from the soil and by building above the wet zone. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The clayey nature of this soil makes working it difficult.

This soil is in capability subclass IIw.

212—Sinai silty clay, 1 to 3 percent slopes. This nearly level, moderately well drained soil is mainly on summits of slopes. Slopes are simple and are several hundred feet long. Individual areas range from 3 acres to 150 acres.

Typically, the surface soil is about 17 inches thick. It is black silty clay in the upper part and black and very dark gray silty clay loam in the lower part. The subsoil is about 8 inches thick. It is very dark grayish brown, friable silty clay loam in the upper part and dark grayish brown, mottled, firm, calcareous silty clay in the lower part. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous silty clay. In places, the surface layer is calcareous.

Included with this soil in mapping are a few areas of soils that have glacial till within a depth of 40 inches. Also included are small areas of Fulda, Waubay, and Poinsett soils. The poorly drained Fulda soils are in lower positions in more concave areas, and the moderately well drained Waubay soils and the well drained Poinsett soils are generally on higher positions in the landscape. The included soils make up 2 to 15 percent of the map unit.

Permeability is slow, and surface runoff is slow to medium. Available water capacity is moderate or high. The surface layer is slightly acid or neutral. The content of organic matter is high, phosphorus is low, and potassium is medium or high.

Most areas of this Sinai silty clay are cropped. This soil is well suited to all crops commonly grown in the county. It is clayey, and working it is somewhat difficult. The hazard of erosion is slight to moderate. Wind is likely to blow the fine particles in the surface layer if the soil is bare. If the soil is plowed when it is wet, a dense, compact tillage pan develops below the plow layer. Also, hard clods that are difficult to break can form in the plow layer. Alfalfa, sweet clover, and other deep-rooted legumes open channels in the clayey subsoil and help to maintain adequate drainage. If the soil is plowed in fall, leaving the surface rough and leaving crop residue on the surface reduce the risk of soil blowing. Grassed waterways help to control water that flows across this soil.

This soil is moderately well suited to trees and shrubs in windbreaks. Seedling mortality is a moderate hazard during the first year because the texture is clayey. The survival rate can be improved by not planting the seedlings when the soil is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by using approved herbicides.

This soil has fair suitability for building sites. It has high shrink-swell potential and low bearing strength. The foundations and footings of buildings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. Materials that are less subject to shrink-swell and that have more bearing strength should be used to build the bases of roads and streets. Septic tank absorption fields generally do not function properly in this soil because of the slow absorption rate. The clayey nature of this soil makes working with it difficult during construction.

This soil is in capability subclass IIs.

236—Vallers clay loam. This nearly level, poorly drained, calcareous soil is on the edges of depressions, in drainageways, and on flats in the glaciated uplands. Some areas are flooded briefly during snowmelt in spring or after heavy rains. In most plowed fields, the surface layer has a light colored crust when it dries. Slopes are plain or slightly convex. Individual areas are irregular in shape and range from 3 acres to 100 acres.

Typically, the surface soil is black and very dark gray clay loam about 16 inches thick. The underlying material to a depth of about 23 inches is grayish brown and light brownish gray, mottled clay loam. Below this to a depth of about 60 inches is olive gray, mottled clay loam. Fragments of snail shells are in the soil in places. In some areas, the surface layer and subsoil have fewer stones and are more silty than the underlying material. The soil is generally calcareous throughout.

Included with this soil in mapping are small areas of Hamerly, Flom, and Okoboji soils. Also included are narrow sandy beaches adjacent to the large water areas in the southwestern corner of the county. The moderately well drained, calcareous Hamerly soils are on islands and low knolls; the poorly drained, noncalcareous Flom soils are in drainageways and other positions dominantly at a slightly higher elevation than the Vallers soils; and the very poorly drained Okoboji soils are in depressions. The included soils make up 3 to 15 percent of the map unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline because the content of lime is high. The content of organic matter is high, available phosphorus is very low, and potassium is medium or high. The water table is at a depth of 1 foot to 2.5 feet in spring or during extended wet periods unless the soil has been artificially drained.

Most areas of this Vallers clay loam are cropped. Some areas that are not adequately drained for cultivated crops are used for grazing. This soil is well suited to intensive cropping if it is adequately drained and fertilized and if crop residue is returned. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers may be needed to correct the fertility imbalance caused by the high content of lime. Soybean plants generally suffer from chlorosis, and they turn yellow nearly every spring in areas of this soil. This can be overcome by drainage and growing varieties of soybeans that tolerate excessive lime. Good results also have been obtained by using iron chelates. The ground water in places contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant cement tile should be used. Fall tillage permits earlier preparation of a seedbed in spring.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. The wetness and the high content of lime reduce the number of species that can grow well. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs in areas of this soil because of the high content of lime. This condition is best controlled by planting trees and shrubs that can tolerate the lime content. Drainage lowers the seasonal high water table and allows deeper rooting. Site preparation should be completed in fall before planting because in many years clods form if the soil is worked early in spring when too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of seasonal wetness. The water table can be within a depth of 1 foot during wet periods. Contamination of the ground water is a severe hazard. The frost action in this soil can damage roads and streets built across areas of this soil. The damage to roads and streets due to frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches.

This soil is in capability subclass IIw.

246—Marysland clay loam. This nearly level, poorly drained, calcareous soil is in low sandy areas on the lake plain, on stream deltas, on outwash plains, and in melt water channels. It is also in some overflow channels that lie between the streams on the lowland plain. Some areas are flooded during snowmelt in spring or after heavy rains. Individual areas range from 5 acres to several hundred acres.

Typically, the surface soil is clay loam about 20 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 28 inches is dark grayish brown, mottled loam. Below this to a depth of about 60 inches, it is grayish brown, mottled gravelly coarse sand. The soil is calcareous throughout, and generally some part of the surface layer has a high content of gypsum. In some areas, the surface layer is 24 to 36 inches thick. In a few areas, the surface layer and subsoil are leached of free lime and are typically neutral in reaction. In places, the underlying sand is 40 to 60 inches below the surface. In a few areas, the underlying sand is only a few feet thick and is underlain by glacial till or silty alluvium.

Included with this soil in mapping are small areas of Burr and Malachy soils. The Burr soils do not have sandy underlying material, and the Malachy soils are at a slightly higher elevation than this Marysland soil and are better drained. The included soils make up 2 to 20 percent of the map unit.

Permeability is moderate in the surface layer and rapid in the underlying sand. Surface runoff is slow, and available water capacity is moderate. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high, available phosphorus is very low, and potassium is medium. The seasonal high water table is at a depth of 1 foot to 2.5 feet.

Most areas of this Marysland clay loam are cropped. Some areas that are not adequately drained for cultivated crops are used for grazing. This soil is well suited to corn, soybeans, small grain, and alfalfa. The major limitation is wetness. The surface layer has a high content of lime which causes fertility imbalance. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. Soybean plants suffer from chlorosis, and they turn yellow nearly every spring in areas of this soil. This can be overcome by drainage and by growing varieties of soybeans that tolerate excessive lime. Good results also have been obtained by using iron chelates. Fall tillage makes it possible to prepare a good seedbed earlier in spring.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. The wetness and the high content of lime reduce the number of species that can grow well. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs in areas of this soil because of the high content of lime. This condition is best controlled by planting trees and shrubs that can tolerate the lime content. Drainage lowers the seasonal high water table and favors deeper rooting. Site preparation should be completed during the fall before planting because in many years clods form if the soil is worked early in spring when too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of wetness and the hazard of flooding. The water table can be within a depth of 1 foot during wet periods. Contamination of the water table is a severe hazard. The frost action in this soil can damage roads built across areas of this soil. The damage to roads due to frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches. Caving of sidewalls in shallow excavations in this soil is a hazard. This can be prevented by sloping the sidewall or by building retaining walls.

This soil is in capability subclass IIw.

276—Oldham silty clay loam. This nearly level, very poorly drained, calcareous soil is in drained depressions on the lake plain and in drained basins of shallow lakes and ponds on glacial uplands. It is subject to ponding. In most areas, fragments of snail shells and clam shells are on the surface and in the soil. Individual areas range from 5 acres to 75 acres.

Typically, the surface soil is very dark gray silty clay loam about 17 inches thick. It contains many fragments of snail shells and pockets of gypsum. The subsoil is black, friable silty clay loam about 26 inches thick. It is mottled in the lower part. The underlying material to a depth of about 60 inches is very dark gray and dark gray, mottled clay loam glacial till. The soil is calcareous throughout. In some areas, the soil has layers that range from silty clay and silt loam to clay loam and loam. In a few places the combined thickness of the dark colored surface layer and the subsoil is less than 24 inches.

Included with this soil in mapping are small areas of soils in which the surface layer and subsoil are not calcareous. Also included are areas of the poorly drained Canisteo, Spicer, and Vallers soils on narrow rims and sandy soils on beaches. The included soils make up 5 to 15 percent of some map areas.

Permeability is moderately slow or slow, available water capacity is high, and surface runoff is very slow or ponded. The soil is mildly alkaline to moderately alkaline in most places, and some layers have a high content of lime and gypsum. The contents of organic matter and potassium are high, and available phosphorus is very low. A seasonal high water table generally is at or above the surface in undrained areas.

Most areas of this Oldham silty clay loam are cropped. Some areas that are too wet for cultivated crops are used for grazing or wild hay. If adequately drained, fertilized, and properly managed, this soil is well suited to all crops commonly grown in the county. Wetness is the main limitation. Drainage helps overcome the wetness. Excess lime in the surface layer causes problems in maintaining fertility. If crop growth is poor after adequate drainage, liberal applications of potassium and phosphorous fertilizers are needed. These nutrients help to correct the fertility imbalance caused by the high content of lime. Soil blowing occurs in places but can be controlled by leaving fall plowed fields rough and by leaving crop residue on the surface. Crops are subject to frost and, as a result, a variety of corn that matures early is desirable. Fall tillage permits earlier preparation of a seedbed in spring, and an occasional sod or green manure crop helps to maintain good tilth in the surface layer. In places, the ground water contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant tile should be used.

The suitability of this soil for trees and shrubs in windbreaks is poor. The wetness and the high content of lime reduce the number of species that can grow well. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs on this soil because of the high content of lime. This condition is best controlled by planting trees and shrubs that can tolerate the lime content. Surface water must be removed or prevented from accumulating on the soil before trees can be safely planted. Preparation for planting should be completed the fall before planting because in many years clods form if the soil is worked early in spring when too wet. Weeds and grasses in newly established windbreaks can be controlled by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil and the danger of frost action can damage roads and streets built across areas of this soil. The damage due to frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. Damage due to low strength can be reduced by strengthening the soil or by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIIw.

284B—Poinsett clay loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on hilltops and hillsides. A few stones and pebbles are on the surface in places. Slopes are convex and about 125 to 200 feet long. Individual areas range from 3 acres to 35 acres.

Typically, the surface soil is clay loam about 13 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is about 15 inches thick. It is dark yellowish brown, friable clay loam in the upper part and dark yellowish brown, friable silt loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown, calcareous silt loam and silty clay loam. Some small sandy and gravelly beaches and sandbars are in a few places.

Included with this soil in mapping are small areas of the more sloping, eroded Poinsett soils and small areas of Barnes and Sinai soils. The Poinsett soils are on the complex parts of side slopes, the well drained Barnes soils are in areas where glacial till has been exposed or the silt mantle is thin, and the moderately well drained, nearly level Sinai soils are in slightly concave spots where clayey sediment is evident. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is high or very high. In most places, reaction in the surface layer is neutral. The content of organic matter is moderate or high, phosphorus is low, and potassium is high.

Most areas of this Poinsett clay loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is slight to moderate. The long, smooth slopes are suited to contour farming and terracing. Minimum tillage practices, such as chisel plowing, help to control erosion, particularly in areas that are not suited to contour farming. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall-plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to trees and shrubs in windbreaks. Erosion can be controlled by maintaining mulch or crop residue on the surface. In places, windbreaks can be planted on the contour. Weeds can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil has fair suitability as a site for sanitary facilities. It has a slow absorption rate and septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of the soil are desirable. This soil is well suited to building sites. It has low strength and is subject to frost heave. These limitations can cause damage to roads and streets. This damage can be reduced by building the base of roads with material that has greater bearing strength and is less susceptible to frost action. Roads should be designed to prevent water from ponding in ditches.

This soil is in capability subclass IIe.

290B—Rothsay silt loam, 1 to 4 percent slopes. This very gently sloping, well drained soil is on hillsides and hilltops in the western part of the county; on low knolls in the lake plain; and on side slopes on uplands parallel to the Minnesota River. Slopes are slightly convex and about 150 to 200 feet long. Individual areas range from 5 acres to 65 acres.

Typically, the surface soil is black silt loam about 12 inches thick. The subsoil is about 24 inches thick. It is brown and dark yellowish brown, friable silt loam in the upper part and yellowish brown, calcareous, very friable silt loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous silt loam and very fine sandy loam. In a few places, the surface layer is grayish and the brownish subsoil is exposed in spots. In most areas, loamy glacial till is at a depth of 40 to 80 inches.

Included with this soil in mapping are small areas of the more sloping, eroded Rothsay soils and small areas of Egeland and Zell soils. The Egeland soils formed in fine sandy loam sediment and are on positions similar to those of the Rothsay soils. The well drained Zell soils, which are on the steepest, most exposed parts of side slopes, have a thin, calcareous surface layer. Also included are small areas of somewhat excessively drained Sverdrup soils. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderate, surface runoff is slow, and available water capacity is high or very high. In most places, reaction in the surface layer is neutral. The content of organic matter is high, potassium is medium, and phosphorus is low.

Most areas of this Rothsay silt loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is slight. Some areas are well suited to terracing and contour farming. Minimum tillage practices, such as chisel plowing, help to control erosion. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. Soil blowing and water erosion can be controlled by maintaining crop residue on the surface. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil is well suited as a site for sanitary facilities and for building sites. This soil is subject to frost action which can cause damage to roads and streets. Properly designing roads and streets and building them on suitable base material help reduce such damage.

This soil is in capability subclass IIe.

290B2—Rothsay silt loam, 3 to 6 percent slopes, eroded. This gently sloping, well drained soil is on side slopes and ridges in the western part of the county; on knolls in the lake plain; and on side slopes parallel to the Minnesota River. Slopes are convex and about 175 to 200 feet long. Individual areas range from 4 acres to 25 acres.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. It contains small masses of brown material from the subsoil. The subsoil is silt loam about 24 inches thick. It is brown and dark yellowish brown, friable silt loam in the upper part and yellowish brown, calcareous, very friable silt loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous silt loam and very fine sandy loam. In most areas, loamy glacial till is at a depth of 40 to 80 inches.

Included with this soil in mapping are small areas of more sloping, eroded Rothsay soils and small areas of Doland, Egeland, and Zell soils. The Doland and Egeland soils are on parts of the landscape similar to those of this Rothsay soil. The Doland soils have glacial till at a depth of 18 to 30 inches, and the Egeland soils formed in fine sandy loam sediment. The Zell soils, which are on the steepest and most exposed parts of side slopes, have a thin, calcareous surface layer. Also included are small areas of the well drained Sverdrup soils. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is high or very high. In most places, reaction in the surface layer is neutral. The content of organic matter is moderate or high, phosphorus is low, and potassium is medium.

Most areas of this Rothsay silt loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is moderate. Some areas are suited to contour farming and terracing. Minimum tillage practices, such as chisel plowing, also help to control erosion, particularly in areas not suited to contour farming. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to trees and shrubs in windbreaks. Erosion can be controlled by maintaining mulch or crop residue on the surface. In places, windbreaks can be planted on the contour. Weeds can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil is well suited as a site for sanitary facilities and buildings. This soil is subject to frost action which can cause damage to roads and streets. Properly designing roads and streets and building them on suitable base material help reduce the damage due to frost action.

This soil is in capability subclass IIe.

319—Barbert silt loam. This nearly level, very poorly drained soil is in very shallow, closed depressions. It is subject to ponding. In many cultivated areas the surface layer is dark gray. Individual areas range from 4 acres to 50 acres.

Typically, the surface layer is black silt loam about 8 inches thick. The subsurface layer is dark gray silt loam about 5 inches thick. The subsoil is about 41 inches thick. The upper 8 inches of the subsoil is very dark gray, firm silty clay; the next 10 inches is dark grayish brown, mottled, firm silty clay; the next 9 inches is olive gray, mottled, firm silty clay; and the lower 14 inches is olive gray, mottled, friable silty clay loam. The underlying material to a depth of about 60 inches is gray, mottled silty clay loam. In some areas, loam or clay loam glacial till is at a depth as shallow as 40 inches. In places, the grayish subsurface layer is not present.

Included with this soil in mapping are small areas of Okoboji and Webster soils. The Okoboji soils are in parts of depressions, and the poorly drained Webster soils are on sides of depressions and drainageways. Okoboji and Webster soils are less clayey than this Barbert soil. The included soils make up 0 to 10 percent of the map unit.

Permeability is slow, and available water capacity is moderate or high. Surface runoff is very slow or ponded. The surface layer and subsoil typically are slightly acid or medium acid. This soil is the most acid in the county. The content of organic matter is moderate or high, and phosphorus and potassium are very high. The availability of phosphorus is low. In undrained areas, the seasonal high water table is at or above the surface in spring and during wet periods.

Most areas of this Barbert silt loam are cropped. Undrained areas mostly have marsh vegetation; some are grazed. If adequately drained and fertilized, this soil is well suited to all crops commonly grown in the county. The major limitation is wetness. Management that reduces compaction and maintains good tilth is needed. Tile drains are needed to provide subsurface drainage, but the slowly permeable subsoil reduces the effectiveness of tile drains. Open ditches can serve to drain away surface water and, in places, provide outlets for tile drains. If fall plowed fields are left rough and some residue is left on the surface, soil blowing can be controlled. If this soil is worked when too wet, hard clods form that are difficult to break up. An occasional sod or green manure crop helps to maintain good tilth in the surface layer.

Unless surface water is a problem, this soil has fair suitability for trees and shrubs in windreaks. The clayey subsoil restricts rooting. If adequate subsurface drainage is provided, more species of trees and shrubs can be grown successfully. Site preparation should be completed the fall before planting because clods may form if the soil is worked early in spring when too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil and the danger of frost heave can damage roads and streets built across areas of this soil. The damage due to frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIIw.

338—Waubay clay loam, 1 to 3 percent slopes. This nearly level, moderately well drained soil is on the lower parts of side slopes and the upper parts of drainageways. It is also in other slightly concave, irregularly shaped areas that were formerly parts of ice-walled lake plains in the glaciated uplands. Slopes are simple, slightly concave, and about 150 to 200 feet long. Individual areas range from 3 acres to 50 acres.

Typically, the surface soil is about 25 inches thick. The upper part of the surface soil is black clay loam, the next part is black silty clay loam, and the lower part is very dark gray silty clay loam. The subsoil is about 15 inches thick. It is dark grayish brown, friable silty clay loam in the upper part and dark grayish brown, mottled, friable silt loam in the lower part. The underlying material to a depth of about 49 inches is grayish brown, mottled, calcareous silt loam. Below this to a depth of about 60 inches is grayish brown, mottled, calcareous loam glacial till. In places, the surface layer is calcareous. In some small areas, glacial till is at a depth of less than 40 inches.

Included with this soil in mapping are small areas of Fulda, Sinai, and Poinsett soils. The poorly drained Fulda soils are in lower parts of the landscape and are more clayey than this Waubay soil. The moderately well drained Sinai soils are more clayey but are on similar parts of the landscape. The well drained Poinsett soils are on higher convex parts of the landscape. The included soils make up 3 to 10 percent of the map unit.

Permeability is moderate, available water capacity is high or very high, and surface runoff is slow. Reaction of the surface layer is neutral in most places. The content of organic matter and potassium are high, and the content of phosphorus is low. The seasonal high water table is at a depth of 4 to 6 feet.

Most areas of this Waubay clay loam are cropped. This soil is well suited to all crops commonly grown in the county. It has few limitations and can be cropped intensively. This moderately well drained soil does not dry out so quickly in spring as the nearby well drained Poinsett soil and cannot be worked so early. Leaving crop residue on the surface of fall-plowed fields helps to control soil blowing. An occasional green manure or sod crop helps to maintain good structure and tilth.

This soil is well suited to trees and shrubs in windbreaks. Texture and drainage characteristics allow deep penetration of moisture and roots and uniform distribution of roots. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil is poorly suited as a site for sanitary facilities because of the seasonal wetness and slow absorption rate. Contamination of the ground water by effluent seeping into the water table is a hazard. Septic tank absorption fields do not function properly when the water table rises nearly to the filter field. Absorption systems built above the soil surface in mounds of soil material keep the absorption fields above the wet zone. The size of the absorption field should be adjusted according to the absorptive capacity of the soil material.

Areas of this soil have fair suitability as sites for low buildings and for roads and streets. Wetness, low strength, and frost action can cause construction difficulties and can result in damage to structures. The damage due to wetness and frost heave can be reduced by artificially draining excess water from the soil and by building above the wet zone. The damage to roads and streets due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability class I.

339A—Fordville loam, 0 to 2 percent slopes. This nearly level, well drained soil is on river terraces and outwash plains and in gravelly areas on the glaciated uplands and the lowland plains. Most areas in uplands are irregular in shape, whereas areas along river terraces are more uniform. Individual areas range from 3 acres to 65 acres.

Typically, the surface soil is black loam about 13 inches thick. The subsoil is about 13 inches thick. It is very dark gray, friable loam in the upper part and very dark grayish brown, very dark gray, and dark grayish brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown and dark brown, gravelly coarse sand. In some areas, the underlying material is sandy. In small areas, soil blowing has exposed the brownish subsoil.

Included with this soil in mapping are small areas of sloping Fordville soils. In places, the sandy and gravelly underlying material is only a few feet thick over silty material or glacial till. Also included are small areas of the somewhat excessively drained Arvilla soils that are shallow over gravelly underlying material. In places among the Rock outcrop areas along the Minnesota River are nearly level soils that are underlain by loamy granitic materials and bedrock. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the surface layer and subsoil and rapid in the underlying sand and gravel. Surface runoff is slow. Available water capacity is moderate or low. The surface layer is neutral or slightly acid. The content of organic matter is naturally high, phosphorus is very low, and potassium is medium. Roots are restricted by the sand and gravel below a depth of 20 to 40 inches.

Most areas of this Fordville loam are cropped. If this Fordville soil is adjacent to more droughty soils, it is commonly used for grazing during long droughty periods. Except in some years, corn, soybeans, small grain, and alfalfa are fairly well suited. Droughtiness is a major hazard. This soil is subject to soil blowing, especially after fall plowing. Leaving crop residue on the surface during winter helps to control soil blowing and hold snow in place to provide moisture for the next crop. The surface layer can be easily worked into a good seedbed. The main management needs are increasing fertility, maintaining organic matter content, and increasing available water capacity. Grassed waterways in the drainageways that cross this soil help prevent gullies from forming in the coarse textured underlying material. This soil is well suited to irrigation. It can be row cropped intensively if water for irrigation is available.

This soil has fair suitability for trees and shrubs in windbreaks. Available water capacity is moderate, and many trees and shrubs are likely to die if drought occurs while they are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and in planting and by weed control. In exposed areas where the soil is intermingled with sandy soils, soil blowing is a hazard to young trees and shrubs. It can be controlled by maintaining a mulch of crop residue. Competition for moisture generally is critical. Weeds and grasses can be controlled by shallow cultivation or by applying approved herbicides.

This soil is well suited as a site for low buildings and for roads and streets. Caving of sidewalls in shallow excavations is a hazard. This can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields in this soil do not adequately filter the effluent. Contamination of ground water by the effluent is a severe hazard. This hazard can be reduced by placing the absorption field above the soil surface in a mound of more suitable filtering material. In places, the soil can be excavated and the absorption field placed in more suitable filtering material.

This soil is in capability subclass IIs.

339B—Fordville loam, 2 to 6 percent slopes. This well drained soil is on stream terraces and outwash plains. In a few areas, it is on glaciated uplands or the lowland plain. It is gently sloping on the stream terraces and undulating on the uplands. Slopes are convex. Individual areas range from 3 acres to 25 acres.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is about 13 inches thick. It is very dark gray, friable loam in the upper part and very dark grayish brown, very dark gray, and dark grayish brown, friable loam in the lower part. The underlying material to a depth of about 31 inches is yellowish brown gravelly coarse sand. Below this to a depth of about 60 inches is dark brown, calcareous gravelly coarse sand. In places in eroded areas, tillage has mixed part of the subsoil into the surface layer. In a few areas, the underlying material is fine sand and medium sand.

Included with this soil in mapping are small areas of more sloping Fordville soils. In places, the sandy and gravelly underlying material is only a few feet thick over silty alluvium or glacial till. Also included are small areas of Arvilla soils that are shallow over gravelly underlying material. Small areas of undulating soils are among the outcrops of rock along the Minnesota River and have a surface layer and subsoil similar to this Fordville soil but are underlain by granitic material and bedrock. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the surface layer and subsoil and rapid in the underlying sand and gravel. Surface runoff is medium, and available water capacity is moderate or low. The surface layer is neutral or slightly acid. The content of organic matter is high, phosphorus is very low, and potassium is medium. Roots are restricted by the sand and gravel below a depth of 20 to 40 inches.

Most areas of this Fordville loam are cropped or used for grazing. Small grain, soybeans, and alfalfa are better suited than most other crops. Corn is less well suited. The major concerns of management are the moderate hazard of erosion and the moderate available water capacity. A good seedbed is easy to prepare. The hazards of soil blowing and water erosion can be reduced if plowing is done in spring. Leaving stubble and cornstalks on the surface during winter holds snowfall in place to provide moisture for the next crop. Grassed waterways help to prevent the formation of gullies that can cut into the sand and gravel.

The suitability of this soil for trees and shrubs in windbreaks is fair. Available water capacity is moderate, and many trees and shrubs are likely to die because of droughtiness. The mortality rate can be partly overcome by providing special care in site preparation and planting and by weed control. In some exposed areas where this soil is intermingled with sandy soil, soil blowing is a hazard to young trees or shrubs. Soil blowing and water erosion can be controlled by maintaining a cover of crop residue. Competition for moisture generally is critical. Weeds and grasses can be controlled by shallow cultivation or by applying approved herbicides.

This soil is well suited as a site for low buildings and for roads and streets. The hazard of erosion is slight; however, care should be taken to keep erosion to a minimum during construction of buildings and roads. Caving of sidewalls in shallow excavations is also a hazard. This can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields in this soil do not adequately filter the effluent. Contamination of ground water by the effluent is a hazard. This hazard can be reduced by placing the absorption field above the soil surface in a mound of more suitable filtering material. In places, the soil can be excavated and the absorption field placed in more suitable filtering material.

This soil is in capability subclass IIe.

341A—Arvilla sandy loam, 0 to 2 percent slopes. This somewhat excessively drained, nearly level soil is dominantly on river terraces and outwash plains. In a few areas, it is on the glaciated uplands or the lowland plain. The surface is stony in some areas. Slopes are convex. Most areas are irregular in shape and range from 4 acres to 160 acres.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsoil is dark brown, friable sandy loam about 8 inches thick. The underlying material to a depth of about 30 inches is yellowish brown, calcareous gravelly loamy sand. Next, to a depth of about 35 inches is brownish yellow, calcareous sand, and below this to a depth of about 60 inches is grayish brown and yellowish brown, calcareous gravelly coarse sand. The brownish subsoil is exposed in some areas. In places, the surface layer and subsoil are calcareous.

Included with this soil in mapping are areas of soils that have glacial till at a depth below 40 inches, and a few small areas of Aquolls and Aquents, ponded. Also included are a few small areas of soils near the Minnesota River Valley that are underlain by bedrock, small areas of excessively drained Sioux soils in old stream meanders and on escarpments, and small areas of well drained Fordville soils in slightly concave areas. The included soils make up 3 to 10 percent of the unit.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying material. Surface runoff is slow. Available water capacity is low or very low. The surface layer typically is neutral but is mildly alkaline in a few areas. The content of organic matter is moderate or low, phosphorus is very low, and potassium is low or medium. Roots are restricted by underlying gravelly sand at a depth of 15 to 22 inches.

Most areas of this Arvilla sandy loam are cropped or are used for grazng. If an adequate amount of fertilizer is applied and all crop residue is returned to the soil, row crops can be grown. Corn grows well in years when rainfall is both adequate and timely. Small grain and hay crops are more reliable than most other crops. Droughtiness is the main limitation, but soil blowing can be a serious hazard, especially in spring. Leaving stubble and stalks on the surface during winter helps to reduce soil blowing, traps snow, and conserves moisture. Minimum tillage practices, such as chisel plowing, and the use of a single-row shelterbelt reduce the risk of soil blowing and the loss of moisture through evaporation and transpiration. Wind stripcropping, in which close-growing crops and intertilled crops are grown in alternate narrow bands, also reduces loss of soil and moisture.

This soil is not well suited to many species of trees and shrubs. The mortality rate is high if drought occurs while plants are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and planting and by weed control. Trees on this soil generally grow slowly and tend to have a shorter life span than the same species on soils that are underlain by finer textured material. Young trees or shrubs can be damaged by windblown particles of soil. A cover of grass or of crop residue from corn or small grain reduces the risk of soil blowing.

This soil is well suited as a site for low buildings and for roads and streets. Caving of sidewalls in shallow excavations is a hazard. This can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields in this soil do not adequately filter the effluent. Contamination of ground water by the the effluent is a severe hazard. This hazard can be reduced by placing the absorption field above the soil surface in a mound of more suitable filtering material. In places, the soil can be excavated and the absorption field placed in more suitable filtering material.

This soil is in capability subclass IIIs.

341B—Arvilla sandy loam, 2 to 6 percent slopes. This somewhat excessively drained soil is on stream terraces and outwash plains and on glaciated uplands and the lowland plain. It is gently sloping on the stream terraces and outwash plains and undulating on the glaciated uplands and the lowland plain. Slopes are mainly convex. The surface is stony in some areas. Most areas are irregular in shape and range from 4 acres to 35 acres.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is dark brown, friable sandy loam about 8 inches thick. The underlying material to a depth of about 30 inches is yellowish brown, calcareous gravelly loamy sand; below this to a depth of about 35 inches, it is brownish yellow, calcareous sand; and below that to a depth of about 60 inches, it is grayish brown and yellowish brown, calcareous gravelly coarse sand. In cultivated areas, the surface layer is somewhat lighter in color as a result of erosion and loss of organic matter. In some small areas, the brownish subsoil is exposed. In places, the surface layer and subsoil are calcareous.

Included with this soil in mapping are areas of soils that have glacial till at a depth below 40 inches; small areas of Aquolls and Aquents, ponded; and a few small areas near the Minnesota River Valley that have bedrock outcrops and are underlain by bedrock. Also included are small areas of excessively drained Sioux soils on exposed knobs and escarpments and small areas of the well drained Fordville soils in slightly concave spots and in drainageways. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying material. Surface runoff is slow to medium. Available water capacity is low or very low. The surface layer typically is neutral, but in a few areas, it is mildly alkaline. The content of organic matter is moderate or low, phosphorus is very low, and potassium is low or medium. Roots are restricted by the underlying gravelly sand at a depth of 14 to 20 inches.

Most areas of this Arvilla sandy loam are cropped or are used for grazing. Small grain and meadow crops are moderately suited to this soil. As a result of the low available water capacity, droughtiness is a hazard. Except in years when the rainfall is both adequate and timely, the soil is too droughty for corn. If a meadow crop is grown more than 1 year in a rotation, the available soil moisture can be depleted and become insufficient for corn or small grain during the next year. Erosion is a hazard. Minimizing tillage and returning all crop residue to the soil help to control erosion and conserve moisture in areas where slopes are too irregular for contour farming. Leaving stubble on the surface during winter helps to reduce soil blowing, traps snow, and conserves moisture. A single-row shelterbelt also helps to control erosion and conserve moisture.

This soil is not well suited to many species of trees and shrubs. The mortality rate is high if drought occurs while plants are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and planting and by weed control. Trees on this soil generally grow slowly and tend to have a shorter life span than the same species on soils that are underlain by finer textured material. Young trees and shrubs can be damaged by windblown particles. A cover of grass or of crop residue from corn or small grain reduces the risk of soil blowing.

This soil is well suited as a site for low buildings and for roads and streets. Erosion on this soil is slight; however, care should be taken to keep the erosion to a minimum during construction of buildings and roads.

Caving of sidewalls in shallow excavations is a hazard. This can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields in this soil do not adequately filter the effluent. Contamination of ground water by the effluent is a severe hazard. This hazard can be reduced by placing the absorption field above the soil surface in a mound of more suitable filtering material. In places, the soil can be excavated and the absorption field placed in more suitable filtering material.

This soil is in capability subclass IIIe.

341C—Arvilla sandy loam, 6 to 12 percent slopes. This sloping, somewhat excessively drained soil is on gravelly glaciated uplands and terrace escarpments. A few stones are on the surface and in the soil. Slopes are convex and less than 125 feet long. Individual areas range from 4 acres to 45 acres.

Typically, the surface layer is black sandy loam about 7 inches thick. The subsoil is dark brown, friable sandy loam about 7 inches thick. The underlying material to a depth of about 30 inches is yellowish brown calcareous gravelly loamy sand; below this to a depth of about 35 inches, it is brownish yellow, calcareous sand; and below that to a depth of about 60 inches, it is grayish brown and yellowish brown calcareous gravelly coarse sand. The surface layer in cultivated areas generally is lighter in color and thinner, and in some areas it is calcareous.

Included with this soil in mapping are areas of soils that have glacial till at a depth below 40 inches. Also included are small areas of the excessively drained Sioux soils on the most exposed knobs and parts of side slopes. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying material. Surface runoff is medium, and available water capacity is low or very low. The surface layer typically is neutral, but in some areas it is mildly alkaline. The content of organic matter is moderate or low, phosphorus is very low, and potassium is low or medium. Roots are restricted by the underlying gravelly sand at a depth of 14 to 18 inches.

Most areas of this Arvilla sandy loam are used for grazing or are cropped. Most cultivated areas are too droughty for corn. Hay and small grain are better suited than most other corps. As a result of the low available water capacity, droughtiness is the major hazard. Also, erosion is a severe hazard. Maintaining a winter cover crop, spring plowing, applying liberal amounts of manure, and returning all crop residue to the soil reduce soil blowing and help to conserve moisture. Terraces generally are not built on this soil because it is too shallow over gravelly sand. Waterways should be maintained and in some places need to be reestablished. In waterways where erosion has exposed the gravelly sand, replacing the topsoil promotes the growth of grass. Gullies should be shaped and seeded to form grassed waterways.

This soil is not well suited to many species of trees and shrubs. The mortality in windbreaks is likely to be severe if drought occurs while the trees and shrubs are becoming established. It can be partly overcome by providing special care in site preparation and planting and by weed control. Trees on this soil generally grow slowly and tend to have a shorter lifespan than the same species that are underlain by finer textured material. Young trees or shrubs can be damaged by windblown soil particles. A cover of grass or of crop residue from corn or small grain reduces the risk of soil blowing and water erosion.

This soil is well suited as a site for low buildings and for roads and streets. The hazard of erosion is moderate. Care is needed during construction of buildings and roads to keep erosion to a minimum, and disturbed areas should be revegetated immediately following construction. Caving of sidewalls in shallow excavations is a hazard. The caving can be prevented by sloping the sidewall or by using retaining walls. Septic tank absorption fields in this soil do not adequately filter the effluent. Contamination of ground water by the effluent is a severe hazard. This hazard can be reduced by placing the absorption field above the soil surface in a mound of more suitable filtering material. In places, the soil can be excavated and the absorption field placed in more suitable filtering material. There is also a hazard of effluent from improperly placed septic tank filter fields seeping laterally downslope and surfacing at a lower elevation.

This soil is in capability subclass IVe.

347—Malachy loam. This nearly level, moderately well drained and somewhat poorly drained, calcareous soil is on former streambeds, beaches, and sandbars on the lake plain and on outwash plains. Slopes are slightly convex. Individual areas range from 3 acres to 225 acres.

Typically, the surface soil is loam about 17 inches thick. It is black in the upper part and very dark grayish brown in the lower part. The subsoil is about 10 inches thick. It is dark grayish brown, friable sandy loam. The underlying material to a depth of about 60 inches is dark grayish brown. It is mottled, loamy coarse sand in the upper part and grayish brown, mottled coarse sand in the lower part. All parts of the soil contain free lime. In some areas the surface soil is less than 16 inches thick. In places it is completely leached of free lime, or free lime is at the surface.

Included with this soil in mapping are small areas of Sioux and Arvilla soils that generally have sand and gravel at a shallower depth than this Malachy soil and small areas of McIntosh Variant soils that are underlain by finer textured material. Also included in some areas are soils that have thin bands of silty material in the underlying material, and in places are soils in which the underlying material is silty glacial till. The included soils make up 3 to 10 percent of the map unit.

Permeability is moderate or moderately rapid in the surface soil and subsoil and rapid in the underlying material. Surface runoff is medium to slow, and available water capacity is moderate. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high, phosphorus is very low, and potassium is medium. In most areas, sandy and gravelly material at a depth of 20 to 40 inches restricts the root zone. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas of this Malachy loam are cropped. Except for years in which a long drought occurs, corn, soybeans, small grain, and alfalfa are well suited. Droughtiness is the major hazard. This soil is also subject to soil blowing, especially during winter after fall tillage. Field windbreaks reduce the risk of soil blowing and the loss of moisture through evaporation and transpiration. The main management needs are increasing fertility, maintaining organic matter content, and increasing available water capacity. Leaving crop residue on the surface helps to hold soil moisture, maintains moisture for the next crop, and reduces soil blowing.

The suitability of this soil for trees and shrubs in windbreaks is fair. Available water capacity is moderate, and many trees and shrubs are likely to die if drought occurs while they are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and planting and by weed control. In some areas where the surface layer is sandy loam, soil blowing is a hazard to young trees and shrubs. It can be controlled by maintaining a cover of crop residue. Competition for moisture generally is critical. Weeds and grasses can be controlled by shallow cultivation or by applying approved herbicides.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness. Contamination of ground water by effluent seeping into the high water table is a hazard. Septic tank absorption fields do not function properly when the water table rises nearly to the filter field. Placing the absorption field above the soil surface in a mound of suitable filtering material helps reduce this hazard.

Areas of this soil are well suited as a site for low buildings and for roads and streets. Wetness and the hazard of frost action can cause construction difficulties and can result in damage to roads and streets. This damage can be reduced by artificially draining excess water from the soil and by building above the wet zone. Caving of sidewalls in shallow excavations is a hazard. The caving can be prevented by sloping the sidewalls or by the use of retaining walls.

This soil is in capability subclass IIs.

371—Clontarf sandy loam, 1 to 3 percent slopes. This nearly level, moderately well drained soil is on outwash plains and in sandy areas on the lowland plain. Slopes are slightly concave or plane. Individual areas are irregular in shape and range from 5 acres to 40 acres.

Typically, the surface soil is sandy loam about 13 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is very dark grayish brown, very friable sandy loam about 17 inches thick. It is mottled in the lower part. The underlying material to a depth of about 60 inches is grayish brown, mottled loamy sand and loamy fine sand. In areas northeast of Clarkfield, glacial till or silty water-deposited material is typically at a depth of 40 inches or more.

Included with this soil in mapping are small areas of Fieldon, Egeland, and Sverdrup soils. The Fieldon soils are at a lower elevation than this Clontarf soil, are calcareous throughout, and are poorly drained. The well drained Egeland and Sverdrup soils generally are at a higher elevation and have more convex slopes. In addition, Sverdrup soils have more sand in the surface layer and subsoil. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying material. The available water capacity is moderate, and surface runoff is slow. The surface layer is neutral or slightly acid. The content of organic matter is high, phosphorus is low, and potassium is medium. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas of this Clontarf sandy loam are cropped. Except in years when a long drought occurs, corn, soybeans, small grain, and alfalfa are well suited. This soil is subject to soil blowing, especially during winter after fall tillage. Field windbreaks reduce the risk of soil blowing and the loss of moisture through evaporation and transpiration. The main management needs are increasing fertility, maintaining organic matter content, and increasing available water capacity. Leaving crop residue on the surface helps to hold soil moisture and provides moisture for the next crop. The surface layer is easy to work and can be made into a good seedbed.

The suitability of this soil for trees and shrubs in windbreaks is fair. Available water capacity is moderate, and many trees and shrubs are likely to die if drought occurs while they are becoming established. The mortality rate can be partly overcome by providing special care in site preparation and planting and by weed control. In some areas, soil blowing is a hazard to young trees and shrubs. It can be controlled by maintaining a cover of crop residue. Competition for moisture generally is critical. Weeds and grasses can be controlled by shallow cultivation or by applying approved herbicides.

This soil is poorly suited as a site for sanitary facilities because of the seasonal wetness. Contamination of ground water by effluent seeping into the high water table is a hazard. Septic tank absorption fields do not function properly when the water table rises nearly to the filter field. Placing the absorption field above the soil surface in a mound of suitable filtering material helps reduce this hazard.

Areas of this soil are well suited as sites for low buildings and for roads and streets. Wetness and the hazard of frost action can cause construction difficulties and can result in damage to structures. This damage can be reduced by artificially draining excess water from the soil and by building above the wet zone. Caving of sidewalls in shallow excavations is a hazard. This can be prevented by sloping the sidewalls or by the use of retaining walls.

This soil is in capability subclass IIIs.

402D—Sioux gravelly sandy loam, 2 to 40 percent slopes. This undulating to very steep, excessively drained soil is on terrace escarpments and on gravelly ridges in glaciated uplands. Most areas are stony. Slopes on terrace escarpments are simple, whereas slopes in the uplands are complex. Individual areas range from 4 acres to 25 acres.

Typically, the surface layer is black gravelly sandy loam about 7 inches thick. The next 3 inches is very dark grayish brown, calcareous gravelly loamy sand. The underlying material to a depth of about 60 inches is dark grayish brown, and dark yellowish brown very gravelly coarse sand. Typically, the soil is calcareous throughout, but in a few places, the surface layer is leached of free lime. The surface layer is gravelly loamy coarse sand or gravelly loam in places. Some places are underlain by bedrock, and bedrock outcrops are in a few areas.

Included with this soil in mapping are small areas of soils in which the gravelly underlying material is only a few feet thick over glacial till or silty alluvium. Also included are small areas of Arvilla and Fordville soils, on the less exposed parts of side slopes and escarpments, that are deeper over the gravelly underlying material and are less droughty than this Sioux soil. The included soils make up 5 to 20 percent of the map unit.

Permeability is rapid, and available water capacity is very low or low. This soil absorbs water rapidly. The surface layer is mildly alkaline in most places. The content of organic matter is moderate or low, and phosphorus and potassium are low. The underlying sand and gravel, which is 6 to 12 inches below the surface, severely restricts the root zone.

Areas of this Sioux gravelly sandy loam are generally not cropped. Some small areas are cropped with other, more suitable soils because separate management is not practical. The hazard of drought is very severe because of the very limited available water capacity.

Some areas are used for pasture. Most of these areas have been overgrazed, and the native grass species have declined in vigor and decreased in abundance. The native grasses have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as goldenrod, gumweed, and buckbrush. Proper grazing use, deferred grazing, and a planned grazing system can improve the suitability of this soil for range.

Where this soil is undulating or sloping, it has fair to poor suitability for windbreaks. The hazard of seedling mortality is severe during the first year because available water capacity is low or very low and natural fertility is low. The mortality rate can be reduced by providing special care in site preparation and planting and by weed control. Where this soil is moderately steep or very steep, it is generally very poorly suited to windbreaks. Onsite inspection is needed to determine the suitability of an area for trees and shrubs.

This soil is well suited to building sites in the less sloping areas. Septic tank absorption fields do not adequately filter the effluent. Contamination of streams and underground water is a hazard because of seepage through the rapidly permeable underlying material. Caving of cutbanks in shallow excavations is a hazard, but it can be overcome by enlarging the excavation or by providing retaining walls. Gravel pits are in some areas of this soil.

This soil is in capability subclass VIIs.

421B—Ves loam, 1 to 4 percent slopes. This gently undulating, well drained soil is on low hills that rise 5 to 10 feet above the floor of the lowland plain and on the lower parts of side slopes. Slopes are complex, have convex surfaces, and are about 100 feet long. Individual areas range from 3 acres to several hundred acres.

Typically, the surface soil is black and very dark gray loam about 12 inches thick. The subsoil is about 18 inches thick. It is dark brown and dark yellowish brown, friable clay loam in the upper part and olive brown, calcareous, friable loam in the lower part. The underlying material to a depth of about 60 inches is olive brown, calcareous loam glacial till. Fragments of shale are common in the subsoil and underlying material. Some spots are sandy and gravelly.

Included with this soil in mapping are small areas of more sloping Ves soils and small areas of Seaforth, Storden, Normania, Webster, and Glencoe soils. The moderately well drained, calcareous Seaforth soils are on convex peninsulas at a slightly lower elevation than this Ves soil. The well drained, calcareous Storden soils are on the steepest, most convex parts of hillsides. The moderately well drained Normania soils are in swales, saddles, and other concave areas; the poorly drained Webster soils are in drainageways; and the very poorly drained Glencoe soils are in shallow depressions. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Reaction in the surface layer is neutral in most places. The contents of organic matter and potassium are high, and that of phosphorus is low.

Most areas of this Ves loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is slight. Stones are sometimes pushed to the surface by tillage and by frost action. Tillage is easier if the stones on the surface are removed periodically. The short, complex slopes generally are not well suited to terracing and contour farming. Minimum tillage practices, such as chisel plowing, help to control erosion. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil (fig. 10).

This soil has few characteristics detrimental to the growth and survival of trees in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

The soil is well suited as a site for sanitary facilities and for buildings. It has low strength and is subject to frost heave. These may cause damage to roads and streets built across areas of this soil. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches.

This soil is in capability subclass IIe.

423—Seaforth loam, 1 to 3 percent slopes. This nearly level, moderately well drained, calcareous soil is on the low knolls or islands in wet, flat areas and on the low peninsulas on the lowland plain. Individual areas range from 3 acres to 30 acres but are mostly less than 5 acres.

Figure 10.—Grassed waterway in an area of Ves loam, 1 to 4 percent slopes.

Typically, the surface soil is about 14 inches thick. The upper part of the surface soil is black loam, and the lower part is very dark gray loam that contains many dark grayish brown and grayish brown wormcasts and root channels. The subsoil is grayish brown, friable loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive brown and olive brown, mottled loam. The soil generally is calcareous throughout, but in places the surface layer is leached of free lime. Pockets of gypsum are in the subsoil and underlying material in many areas. In the part of the lowland plain that was covered by glacial Lake Benson, some areas have silty pockets of lake-deposited sediment.

Included with the smaller areas of this soil in mapping, and making up 2 to 5 percent of the map unit, are the poorly drained, calcareous Canisteo soils. These soils are at a slightly lower elevation on the till plain than this Seaforth soil. Included with the larger areas of this soil, and making up 5 to 15 percent of the map unit, are small areas of steeper, well drained Storden soils; very poorly drained Glencoe or Okoboji soils in depressions; well drained Ves soils on the summit of knolls; and Sverdrup and Arvilla soils.

Permeability is moderate, and available water capacity is high. Surface runoff is medium or slow. The surface layer is mildly alkaline or moderately alkaline because the content of lime is high. The content of organic matter is high, phosphorus is very low, and potassium is high. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas of this Seaforth loam are cropped. If adequately fertilized, this soil is suited to all crops commonly grown in the county. In places, a high content of lime in the surface layer causes a fertility imbalance, which can be corrected by liberal applications of potassium and phosphorous fertilizers. Drainage of this soil is not needed, but drainage of the adjoining soils generally makes managing this soil easier. Soil blowing is a hazard. Leaving crop residue on the surface reduces the risk of soil blowing on fall plowed fields during winter and spring.

The suitability of this soil for trees and shrubs in windbreaks is fair. The excessive lime content adversely affects the uptake of plant nutrients. Plants growing on this soil are subject to chlorosis. This condition is best controlled by planting trees and shrubs that can tolerate the high content of lime. Soil blowing on bare knobs can be controlled by maintaining a cover of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is poorly suited as a site for sanitary facilities because of the seasonal wetness. Contamination of ground water by effluent seeping into the water table is a hazard. Septic tank absorption fields do not function properly when the water table rises nearly to the filter field. Building the absorption field above the soil surface in mounds of soil material help keep the absorption field above the wet zone.

This soil has fair suitability as a site for low buildings and for roads and streets. Wetness and frost action can cause construction difficulties and can result in damage to structures. The damage due to wetness or frost action can be reduced by artificially draining excess water from the soil and by building above the wet zone.

This soil is in capability subclass IIs.

434—Perella silty clay loam. This nearly level, poorly drained soil is in low swales, on low flat areas, and on edges of depressions in the lowland plain. Some areas are ponded after snowmelt in the spring or after heavy rains. Slopes are plane or slightly concave. Individual areas are irregular in shape and range from 3 acres to 110 acres.

Typically, the surface soil is black silty clay loam about 20 inches thick. The subsoil is silty clay loam about 13 inches thick. It is very dark gray, mottled, and friable in the upper part and dark grayish brown, mottled, and firm in the lower part. The underlying material to a depth of about 40 inches is light brownish gray, mottled, calcareous silty clay loam. Below this to a depth of about 60 inches is grayish brown, mottled, calcareous silt loam. In some places, the subsoil is clayey. In some drainageways, the surface layer is more than 24 inches thick.

Included with this soil in mapping are small areas of Okoboji, Spicer, and McIntosh soils. The very poorly drained Okoboji soils are in depressions, the poorly drained Spicer soils are at an elevation similar to that of this Perella soil, and the moderately well drained McIntosh soils are on low knolls. In addition, Spicer and McIntosh soils have a calcareous surface layer and subsoil. The included soils make up 3 to 8 percent of the map unit.

Permeability is moderately slow, and available water capacity is high or very high. Surface runoff is slow, or the soil is ponded. The surface layer generally is neutral, but in places it is mildly alkaline. The contents of organic matter and potassium are high, and that of phosphorus is low. The seasonal high water table is at or near the surface in spring and during wet periods in all areas, except those that have been artificially drained.

Most areas of this Perella silty clay loam are cropped. A few are used for grazing or for wild hay. Drainage generally is needed before this soil can be farmed intensively. If drainage is provided, all crops commonly grown in the county, especially corn, are well suited. The soil dries out and warms up slowly in spring. If this soil is tilled when the surface is wet, severe compaction and clodding of the surface layer are likely to occur. Fall tillage permits earlier preparation of a seedbed in spring. Large open areas are subject to soil blowing, if tilth deteriorates because an inadequate amount of crop residue is returned to the soil. Grassed waterways are needed in areas where water flows across the soil.

This soil is moderately suited to trees and shrubs in windbreaks. If adequate subsurface drainage is provided, more species of trees and shrubs can be grown successfully. Site preparation should be completed during the fall before planting because in many years clods form if the soil is tilled in the spring when wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of ponding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil and frost heave can damage roads and streets that are built across areas of this soil. The damage due to frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

437E—Buse loam, 18 to 25 percent slopes. This steep, well drained soil is on ridges and side slopes along streams and drainageways and around the edges of ponds and lakes. A few stones and boulders are on the surface. Shallow, narrow drainageways dissect this soil at irregular intervals. Slopes are convex and simple. Individual areas generally are long and narrow and range from 3 acres to 60 acres.

Typically, the surface layer is very dark gray loam about 8 inches thick. The next 4 inches is very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam and clay loam glacial till. The soil generally is calcareous throughout, but in places part or all of the surface layer does not have free lime. In some places the surface layer is clay loam.

Included with this soil in mapping are small narrow areas of Calco and Du Page soils in the drainageways that dissect this unit. Also included are the moderately well drained Terril soils on the concave parts of foot slopes. Areas of sand and gravel are on some ridges. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately slow, and available water capacity is moderate or high. Surface runoff is very rapid. The surface layer is mildly alkaline in most places. The content of organic matter is moderate, phosphorus is very low, and potassium is medium.

This Buse loam is too steep for cultivated crops. Most areas are used as pasture, and generally have been overgrazed. As a result, the native grass species have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as sage, buckbrush, and goldenrod. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition. Good sites for pond reservoirs are commonly found on this soil.

This soil is too steep for windbreaks but is suitable for other plantings. The hazard of erosion is severe if the surface is disturbed. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees and shrubs. Mortality of trees and shrubs during the first year is slight to severe, depending on the aspect and the slope position. Conditions are less favorable on hot, dry slopes facing south or west. More species of trees and shrubs can be grown on the cooler, more moist slopes facing north or east. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

This steeply sloping soil is generally not used as a site for sanitary facilities. Construction of sanitary facilities and proper placement of septic tank filter fields are difficult on the steep slopes. Also, there is a hazard of effluent seeping laterally downslope and surfacing at a lower elevation. This soil is poorly suited to building sites. The hazard of erosion is severe where buildings or roads are built on the steep slopes. Erosion control measures are needed during and following construction. Mulching the surface, seeding grass, or sodding disturbed areas help to reduce erosion.

This soil is in capability subclass VIe.

437F—Buse loam, 25 to 40 percent slopes. This very steep, well drained soil is on side slopes and ridges along rivers, creeks, and deep drainageways. A few stones and boulders are on the surface and in the soil in most places. Shallow, narrow drainageways dissect this soil at irregular intervals. Slopes are convex, simple, and about 150 feet long. Individual areas are long and narrow and are 3 acres to 100 acres.

Typically, the surface layer is very dark gray loam about 7 inches thick. The next 4 inches is very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam and clay loam glacial till. The soil generally is calcareous throughout, but in places, part or all of the surface layer does not have free lime. In some places, the surface layer is clay loam.

Included with this soil in mapping are narrow areas of Calco and Du Page soils in the drainageways that dissect this unit and moderately well drained Terril soils on the concave parts of foot slopes. Small sandy and gravelly spots are on some of the shoulders of slopes. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderately slow, and available water capacity is moderate or high. Surface runoff is very rapid. The surface layer is mildly alkaline in most places. The content of organic matter is moderate, phosphorus is very low, and potassium is medium.

This Buse loam is too steep for cultivated crops. It is suited to grazing, and most areas have been overgrazed. As a result, native grass species have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as buckbrush, sage, and goldenrod. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition. Potential pond reservoir sites are commonly found on this soil.

The soil is too steep for windbreaks but is suitable for other plantings. The hazard of erosion is severe if the surface is disturbed. Planting sites can be prepared by scalping away the sod for individual trees and shrubs. Mortality of trees and shrubs during the first year is slight to severe, depending on the aspect and slope position. Conditions are less favorable on hot, dry slopes facing south or west. More species of trees and shrubs can be grown on the cooler slopes facing north or east. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

This very steeply sloping soil is generally not used as a site for sanitary facilities. Construction of sanitary facilities and the proper placement of septic tank filter fields are difficult on the very steep slopes. There is a severe hazard of effluent seeping laterally downslope and surfacing at a lower elevation. This soil is poorly suited to building sites. The hazard of erosion is severe where buildings or roads are built on the very steep slopes. Erosion control measures are needed during and following construction. Mulching the surface, seeding grasses, or sodding in disturbed areas help to reduce the hazard of erosion.

This soil is in capability subclass VIIe.

444—Canisteo silty clay loam. This nearly level, poorly drained, calcareous soil is on low flats and on rims of depressions in the lowland plain, along the shoreline of glacial Lake Benson. Elevation is generally less than 1,050 feet. The surface layer has a light colored crust when it dries. Slopes are plane or slightly convex. Individual areas are irregular in shape, and range from 5 acres to several hundred acres.

Typically, the surface soil is silty clay loam about 22 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil is grayish brown, mottled, friable silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled loam glacial till. The soil is calcareous throughout. Between the subsoil and underlying material in many places is a thin sandy layer. The underlying till has a very irregular surface. In some places, the glacial till is exposed or the lake sediment is less than 20 inches thick, and in other places, the lake sediment is more than 40 inches thick. Slightly elevated spots generally have a high content of gypsum.

Included with this soil in mapping are small areas of Okoboji, Webster, Perella, Seaforth, and McIntosh soils. The very poorly drained Okoboji soils are in shallow depressions, the poorly drained Webster and Perella soils are in drainageways and wet flats at a slightly higher elevation than this Canisteo soil, and the moderately well drained Seaforth and McIntosh soils are on islands and low knolls. Also included are small areas of Fieldon and Marysland soils that are underlain by sandy and gravelly material. The included soils make up 10 to 15 percent of the map unit.

Permeability is moderate, surface runoff is slow, and available water capacity is high. The surface layer is mildly alkaline or moderately alkaline. The soil contains an excessive amount of lime, and in some spots it also contains an excessive amount of gypsum. The content of organic matter is high, phosphorus is low or very low, and potassium is medium or high. The seasonal high water table is at a depth of 1 foot to 3 feet.

Most areas of this Canisteo silty clay loam are cropped. Some undrained areas are used for grazing. This soil is well suited to intensive cropping if drainage is adequate and all crop residue is returned. This soil dries out and warms up slowly in spring. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. These nutrients help to correct a fertility imbalance caused by the high lime content. The ground water in some areas contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant tile should be used. Fall tillage permits rapid preparation of a seedbed in spring.

The suitability of this soil for trees and shrubs in windbreaks is fair to poor. Chlorosis occurs in many trees and shrubs on this soil because of the high lime content. This condition is best controlled by planting trees and shrubs that can tolerate the high lime content. Drainage of this soil helps to lower the seasonal high water table and favor deeper rooting. Site preparation should be completed in the fall before planting because in many years working the soil when it is too wet early in spring can cause clodding. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of the seasonal wetness. The water table can be at a depth of 1 foot during wet periods. Contamination of the ground water is a severe hazard. Low strength in this soil, wetness, and frost action can damage roads and streets that are built across areas of this soil. The damage due to wetness and frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches. Damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

446—Normania clay loam, 1 to 3 percent slopes. This nearly level, moderately well drained soil is on the lower, slightly concave parts of side slopes and on the upper parts of drainageways on the lowland plain. Slopes typically are slightly concave, but in large open areas they are plane. Individual areas are irregular in shape and range from 4 acres to 80 acres.

Typically, the surface soil is about 13 inches thick. It is black clay loam in the upper part and very dark grayish brown clay loam that has many black wormcasts in the lower part. The subsoil is about 25 inches thick. It is dark brown and grayish brown, friable clay loam in the upper part and light olive brown, mottled, calcareous, friable loam in the lower part. The underlying material to a depth of about 60 inches is olive brown, mottled, calcareous loam glacial till.

Included with this soil in mapping are small areas of Ves, Seaforth, Terril, Canisteo, and Glencoe soils. The included soils make up 5 to 15 percent of the map unit. The well drained Ves soils and moderately well drained, calcareous Seaforth soils are in slightly convex areas; the moderately well drained Terril soils are on foot slopes and in other areas where the surface layer is more than 24 inches thick; the poorly drained Canisteo soils are in the nearly level, lower lying areas; and the very poorly drained Glencoe soils are in slight depressions. Also included are a few small areas of Sverdrup and Arvilla soils that are underlain by sandy and gravelly material.

Permeability is moderate, and available water capacity is high. Surface runoff is medium or slow. The surface layer is neutral or slightly acid. The contents of organic matter and potassium are naturally high, and that of phosphorus is very low. The seasonal high water table is at a depth of 3 to 6 feet.

Most areas of this Normania clay loam are cropped. This soil is well suited to all crops commonly grown in the county. It has few limitations and can be cropped intensively. Because it is moderately well drained, it does not dry out so quickly in spring as the nearby well drained Ves soils and cannot be worked so early. Leaving crop residue on the surface of fall-plowed fields helps to control soil blowing. An occasional green manure or sod crop helps to maintain good structure and tilth.

This soil is well suited to the trees and shrubs in windbreaks. Texture and drainage characteristics allow for deep penetration of moisture and roots and for uniform distribution of roots. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness. Contamination of the ground water by effluent seeping into the water table is a hazard. Septic tank absorption fields do not function properly when the water table rises nearly to the level of the filter field. Building the absorption field above the soil surface in mounds of soil material keeps the absorption field above the wet zone. Areas of this soil have fair suitability as sites for low buildings and for roads and streets. Wetness and frost action can cause construction difficulties and can damage structures. This damage can be reduced by artificially draining excess water from the soil and by building above the wet zone.

This soil is in capability class I.

574—Du Page loam, occasionally flooded. This nearly level, moderately well drained soil is on the highest parts of flood plains, mostly adjacent to streams. It is subject to occasional flooding. Individual areas range from 5 acres to 200 acres.

Typically, the surface soil is loam about 36 inches thick. It is black in the upper part and very dark gray and calcareous in the lower part. The underlying material to a depth of about 60 inches is dark grayish brown, calcareous loam. In some places, the upper part of the surface layer is leached of free lime. In places, the surface layer is more than 50 inches thick. In some areas, the surface layer is heavy sandy loam, silt loam, or light silty clay loam. In a few areas in the northern part of the Minnesota River Valley, this soil formed in heavy silty clay loam alluvial sediment.

Included with this soil in mapping are small areas of soils that are not subject to overflow and a few areas in the Minnesota River Valley that have Rock outcrop and have bedrock at a depth of less than 40 inches. Also included are small areas of Zumbro, Arvilla, and Sioux soils that have sandy or gravelly underlying material. The included soils make up 1 to 5 percent of the map unit.

Permeability is moderate, available water capacity is high or very high, and surface runoff is slow. The surface layer is mildly alkaline in most places. The contents of organic matter and potassium are high, and that of phosphorus is low. The seasonal high water table is at a depth of 4 to 6 feet.

Most areas of this Du Page loam are cropped. This soil is well suited to all crops commonly grown in the county. It has a few limitations related to wetness or to the hazard of erosion. In some areas, diversions are needed to help control the runoff from adjoining uplands. An occasional crop of legume and grasses helps to keep the surface layer loose and porous and the underlying layers permeable.

The suitability of this soil for trees and shrubs in windbreaks is good. Few soil characteristics are detrimental to the growth and survival of commonly grown trees and shrubs. Texture and drainage characteristics allow for the deep penetration of moisture and roots and for the uniform distribution of roots. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of flooding. Pollution of ground water by sanitary facilities is also a hazard. Low strength in this soil can damage roads and streets that are built across areas of this soil. The damage due to low strength can be reduced by strengthening the soil or by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass IIw.

575—Nishna silty clay, occasionally flooded. This nearly level, poorly drained, calcareous soil is on low parts of flood plains in the Minnesota River Valley and in the overflow channels between Spring Creek and the Yellow Medicine River. In most areas, it is flooded after heavy rains or during snowmelt in spring. Slopes are slightly concave or plane. Individual areas range from 40 acres to several hundred acres.

Typically, the surface soil is black silty clay about 28 inches thick. The subsoil is very dark gray, firm silty clay about 20 inches thick. The underlying material to a depth of about 60 inches is dark gray silty clay loam. The soil generally is calcareous throughout, but in the overflow channels the upper part of the surface layer is leached.

Included with this soil in mapping are small areas of poorly drained Calco and Fulda soils. These soils are at a slightly higher elevation than this Nishna soil. In addition, the Fulda soils have a thinner, noncalcareous surface layer. Also included are small areas of marshes. The included soils make up 5 to 15 percent of this map unit.

Permeability is slow, and available water capacity is moderate. Surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline. In some spots, the soil contains excess lime. The contents of organic matter and potassium are high, and that of phosphorus is low. The seasonal high water table is at a depth of 1 foot to 3 feet in most places.

Most areas of this Nishna silty clay are cropped. Some areas that do not have adequate drainage for cultivated crops are used for grazing or wild hay. This soil is suited to all crops commonly grown in the county. Controlling wetness, reducing soil blowing, and maintaining good tilth on this clayey soil are the main concerns of management. The soil is flooded occasionally, and heavy rains during the growing season can damage crops. In the Minnesota River Valley, open ditches are needed to remove floodwater and to provide outlets for tile drainage systems. In some areas, pumping systems are used to remove tile drainage water. Hard clods are likely to form if the soil is plowed or worked when wet. Fall tillage permits rapid preparation of a seedbed in spring. Leaving the surface rough and some crop residue on the surface reduces the risk of soil blowing. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. These nutrients help to correct the fertility imbalance caused by the high lime content.

The suitability of this soil for the trees and shrubs in windbreaks is fair or poor. The wetness and high content of lime reduce the number of species that can grow well. The soil is too clayey for optimum growth of trees and shrubs. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs in areas of this soil and is best controlled by planting trees and shrubs that can tolerate the lime content. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of flooding. Pollution of ground water by sanitary facilities is also a hazard. Wetness, low strength, and the danger of shrink-swell in this soil can damage roads and streets built across areas of this soil. Damage due to wetness can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength and shrink-swell can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength and is less susceptible to shrink-swell.

This soil is in capability subclass IIIw.

591B—Doland silt loam, 1 to 4 percent slopes. This very gently sloping and gently undulating, well drained soil is on hillsides and on knolls that rise 3 to 10 feet above the bed of glacial Lake Benson. In places where the silty mantle is thin, a few pebbles and stones are on the surface. Slopes are slightly convex and are about 100 to 175 feet long. Individual areas range from 4 acres to 45 acres.

Typically, the surface soil is silt loam about 11 inches thick. It is black in the upper part and very dark gray and black in the lower part. The subsoil is about 12 inches thick. The upper part is dark yellowish brown, friable silt loam, and the lower part is olive brown, calcareous, friable silt loam. The underlying material to a depth of about 60 inches is light olive brown and light brownish gray, calcareous loam glacial till. In a few areas, the surface layer is loam. In some spots, the silt mantle is more than 30 inches thick.

Included with this soil in mapping are small areas of the more sloping, eroded Doland soils and of Ves, Tara, Perella, and Okoboji soils. The eroded Doland soils are on the steepest parts of side slopes. The well drained Ves soils do not have a silt mantle, or the mantle is thin. The moderately well drained, nearly level Tara soils are on slightly concave positions. The poorly drained Perella soils are in drainageways. The very poorly drained Okoboji soils are in depressions. Also included are small areas of Sverdrup and Arvilla soils that have sand and gravel underlying material. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is high or very high. In most places, reaction in the surface layer is neutral. The contents of organic matter and potassium are high, and that of phosphorus is low.

Most areas of this Doland silt loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is slight. Some areas are well suited to terracing and contour farming. Minimum tillage practices, such as chisel plowing, help to control erosion. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. Soil blowing and water erosion can be controlled by maintaining crop residue on the surface. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil has fair suitability as a site for sanitary facilities. It has a slow rate of absorption. Septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rates of specific areas of the soil are desirable. This soil is well suited to building sites. It has low strength and is subject to frost heave. These limitations can cause damage to roads and streets. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches.

This soil is in capability subclass IIe.

591B2—Doland silt loam, 3 to 6 percent slopes, eroded. This gently sloping and undulating, well drained soil is on side slopes. A few stones and pebbles are on the surface in areas where the silt mantle is thin. Slopes are convex and are about 100 to 200 feet long. Individual areas range from 5 acres to 60 acres.

Typically, the surface layer is mixed, very dark gray silt loam and some dark yellowish brown silt loam about 9 inches thick. The subsoil is about 12 inches thick. It is dark yellowish brown, friable silt loam in the upper part and olive brown, calcareous, friable silt loam in the lower part. The underlying material to a depth of about 60 inches is glacial till of light olive brown and light brownish gray, calcareous loam. In some places, the surface layer is loam. In a few small areas, the silt mantle is more than 30 inches thick.

Included with this soil in mapping are small areas of Storden, Ves, Tara, Perella, and Okoboji soils. The well drained, calcareous Storden soils are on the steepest parts of eroded hillsides where the underlying material is exposed. The well drained Ves soils do not have a silt mantle, or the silt mantle is thin. The moderately well drained Tara soils are in concave areas, in swales, saddles, and on foot slopes. The poorly drained Perella soils are in drainageways, and the very poorly drained Okoboji soils are in depressions. Also included are small areas of Sverdrup and Arvilla soils that have sandy and gravelly underlying material. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is high or very high. In most places, reaction in the surface layer is neutral. The content of organic matter is moderate or high, phosphorus is low, and potassium is high.

Most areas of this Doland silt loam are cropped. This soil is well suited to all crops commonly grown in the county. The hazard of erosion is moderate. Areas that have long, smooth slopes are suited to contour farming and terracing. Minimum tillage practices, such as chisel plowing, help to control erosion, particularly in areas that are not suited to contour farming. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall-plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

This soil is well suited to trees and shrubs in windbreaks. Erosion can be controlled by maintaining mulch or crop residue on the surface. In places, windbreaks can be planted on the contour. Weeds can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and harrowing during the summer or fall before planting increases the moisture supply and destroys unwanted vegetation.

This soil has fair suitability as a site for sanitary facilities. It has a slow rate of absorption. Septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of the soil are desirable. This soil is well suited to building sites. It has low strength and is subject to frost heave. These limitations can cause damage to roads and streets. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches.

This soil is in capability subclass IIe.

597—Tara silt loam, 1 to 3 percent slopes. This nearly level, moderately well drained soil is on the lower, slightly concave parts of side slopes and on the upper parts of drainageways in that part of lowland plain formerly covered by glacial Lake Benson. Individual areas mostly are irregular in shape, but are long and narrow wherever they parallel drainageways and side slopes. Each area ranges from 3 acres to 20 acres.

Typically, the surface soil is silt loam about 16 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is about 20 inches thick. It is dark brown and dark grayish brown, friable silt loam in the upper part and dark grayish brown, mottled, friable loam in the lower part. The underlying material to a depth of about 60 inches is olive brown and light brownish gray, mottled, calcareous loam glacial till. In a few areas, the silty material is more than 40 inches thick. In some areas on foot slopes, the surface layer is more than 24 inches thick.

Included with this soil in mapping are small areas of Doland, McIntosh, Spicer, and Okoboji soils. The well drained Doland soils and moderately well drained, calcareous McIntosh soils are in slightly convex areas; the poorly drained Spicer soils are in the lowest lying areas; and the very poorly drained Okoboji soils are in slight depressions. Also included are small areas of Clontarf and Arvilla soils that have sandy and gravelly underlying material. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, and available water capacity is high or very high. Surface runoff is slow. The surface layer is neutral or slightly acid. The contents of organic matter and potassium are naturally high, and that of phosphorus is very low. The seasonal high water table is at a depth of 3 to 5 feet.

Most areas of this Tara silt loam are cropped. This soil is well suited to all crops commonly grown in the county. It has few limitations and can be cropped intensively. Because this soil is moderately well drained, it does not dry out so quickly in spring as the nearby well drained Doland soils and cannot be worked so early. Leaving crop residue on the surface of fall plowed fields helps to control soil blowing. An occasional green manure or sod crop helps to maintain good structure and tilth.

This soil is well suited to the trees and shrubs in windbreaks. Texture and drainage characteristics allow for the deep penetration of moisture and roots and for the uniform distribution of roots. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

This soil is poorly suited as a site for sanitary facilities because of seasonal wetness. Contamination of ground water by effluent seeping into the water table is a hazard. Septic tank absorption fields do not function properly when the water table rises nearly to the filter field. Building absorption fields above the soil surface in mounds of soil material keeps them above the wet zone. Areas of this soil have fair suitability as sites for low buildings and for roads and streets. Wetness and frost action can cause construction difficulties and can damage structures. This damage can be reduced by artificially draining excess water from the soil and by building above the wet zone.

This soil is in capibility class I.

610—Calco silty clay loam, frequently flooded. This nearly level, poorly drained soil is on flood plains on the first bottoms and is frequently flooded. Areas include the main stream channel and old stream channels. Individual areas are long and narrow and range from 5 acres to 900 acres or more.

Typically, the surface soil is silty clay loam about 32 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is very dark gray, mottled silty clay loam alluvium. The soil is calcareous throughout. Pockets of gypsum are in the surface layer and underlying material in some areas. Thin sandy layers are likely to occur anywhere in the profile. In a few areas, the surface layer is clayey.

Included with this soil in mapping are narrow areas of moderately well drained Terril soils on the foot slopes along the sides of the flood plain, small areas of moderately well drained Du Page soils on slightly higher positions, and small areas of marshy soils in oxbows and depressions. Also included are sandy, gravelly, and stony deposits along the streams. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, and available water capacity is high or very high. Surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high, phosphorus is low, and potassium is high. The seasonal high water table is at a depth of 1 foot to 3 feet.

Most areas of this Calco silty clay loam are used for grazing and are not suitable for crops because they are flooded too often or are dissected in too many places by streams or by old meanders. Leveling of stream channels make some areas suitable for crops.

Areas of this soil are well suited to range. Most of the range has been overgrazed, and as a result, the native grasses have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as gumweed, goldenrod, and buckbrush. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition. Potential sites for dugout ponds are plentiful. Most areas of this soil are very poorly suited to trees and shrubs because of frequent overflow.

This soil is generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of flooding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil and wetness can damage roads and streets built across areas of this soil. The damage due to wetness can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass VIw.

876C2—Nutley-Sinai complex, 6 to 12 percent slopes, eroded. This map unit consists of sloping, drained and moderately well drained soils on side slopes. Slopes are convex and about 150 feet long. Individual areas range from 5 acres to 30 acres. The Nutley soils are on the most convex, steepest part of the landscape, whereas the Sinai soils are generally on the lower parts of the hillsides. In most areas, the grayish subsoil of the Nutley soils is exposed. The Nutley soils make up 55 to 75 percent of this map unit, and the Sinai soils make up 25 to 40 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Nutley soil has a very dark gray clay loam surface layer about 7 inches thick that contains a few, small masses of dark grayish brown clay loam. The subsoil is firm silty clay about 16 inches thick. It is dark grayish brown and very dark gray in the upper part and dark grayish brown in the lower part. It contains many wormcasts. The underlying material to a depth of about 60 inches is light olive brown and light yellowish brown silty clay loam. The soil is calcareous throughout.

Typically, the Sinai soil has a very dark gray silty clay surface layer about 9 inches thick. The subsoil is about 8 inches thick. It is very dark grayish brown, friable silty clay loam in the upper part and dark grayish brown, firm, calcareous silty clay in the lower part. The underlying material to a depth of about 60 inches is light olive gray, mottled, calcareous, lake-deposited sediment of silty clay loam. In places, the surface layer is calcareous.

Included with these soils in mapping are small areas of more sloping soils. Also included are small, narrow areas of the moderately well drained Terril soils on the concave parts of foot slopes and drainageways; small areas of well drained Buse soils on side slopes where glacial till is exposed; and a few sandbars and beaches of former ice-walled lakes and perched lakes. The included soils make up 3 to 10 percent of the map unit.

Permeability is slow. Surface runoff is rapid on the Nutley soil and medium on the Sinai soil. Available water capacity is moderate or high. In most places, the surface layer is mildly alkaline in the Nutley soil and neutral in the Sinai soil. The content of organic matter is moderate or low, phosphorus is low, and potassium is medium.

Most areas of this Nutley-Sinai complex are cropped. The steeper areas are used for grazing. If erosion is controlled and fertility maintained, these soils are moderately suited to crops commonly grown in the county. The hazard of further erosion is severe. Grassed waterways are needed in areas where water moves across this soil. If slopes are not suitable for terracing and contour farming, a high level of management and a crop rotation that includes a meadow crop are needed to control runoff and erosion. A high level of management includes maintaining a winter cover crop, heavy applications of manure, return of all crop residue to the soil, and disking instead of plowing for the small grain crop that follows corn in the rotation.

These soils are well suited to most trees and shrubs in windbreaks. The hazard of seedling mortality is moderate during the first year because of the low fertility, excessive lime, and clayey texture of these soils. Erosion can be controlled by planting on the contour or by maintaining a mulch of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and help destroy unwanted vegetation.

These soils have fair suitability for building sites. Erosion is a moderate hazard. Care should be taken to reduce erosion during construction, and disturbed areas should be revegetated immediately after construction. These soils have high shrink-swell potential and low strength. The foundations and footings of buildings should be designed to prevent structural damage caused by shrinking and swelling of the soil. Materials that are less subject to shrink-swell and that have more bearing strength should be used to build the bases of roads and streets. Septic tank absorption fields generally do not function properly in these soils because of the slow rate of absorption. The clayey nature of these soils make working with them difficult during construction.

These soils are in capability subclass IIIe.

878—Calco-Du Page complex. This map unit consists of nearly level, poorly drained and moderately well drained soils on flood plains and in some large drainageways. These soils are subject to flooding. The Du Page soils are generally higher on the landscape than the Calco soils and are dissected by stream channels. Individual areas are long and narrow and range from 10 acres to more than 200 acres. The Calco and Du Page soils each make up 20 to 70 percent of this map unit. These soils are so intricately mixed or in areas so small that to separate them in mapping was not practical.

Typically, the Calco soil has a silty clay loam surface soil about 32 inches thick. The surface soil is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is very dark gray, mottled silty clay loam alluvium. The soil is calcareous throughout.

Typically, the Du Page soil has a calcareous loam surface soil about 36 inches thick. The surface soil is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is dark grayish brown, calcareous loam. In some places, the upper part of the surface layer is leached of free lime. In some areas, the surface layer is silt loam or silty clay loam.

Included with these soils in mapping are small areas of marshy soils in oxbows and stream channels, narrow areas of the moderately well drained Terril soils on the foot slopes along the sides of the flood plain, and small areas of sandy, gravelly, and stony deposits along streams. These included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, and available water capacity is high or very high. Surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high, phosphorus is low, and potassium is medium. The seasonal high water table is at a depth of 1 foot to 3 feet in the Calco soil and 4 to 6 feet in the Du Page soil.

Most areas of this Calco-Du Page complex are used for grazing and are not suitable for crops because they are flooded too often or are too dissected by streams or by old meanders. If the stream channels are leveled, many areas can be made suitable for crops. These soils are well suited to use as rangeland, but most grazed areas have been overgrazed. As a result, the native grass species have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as goldenrod and buckbrush. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition. Suitable sites for dugout ponds are plentiful.

These soils are generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of flooding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil and wetness can damage roads and streets built across areas of this soil. Damage due to wetness can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. Damage due to low strength can be reduced by strengthening the soil or by building the base of roads with material that has greater bearing strength.

These soils are in capability subclass VIw.

883—Zumbro-Du Page complex. This map unit consists of nearly level, moderately well drained and well drained soils in the Minnesota River Valley and in the lower end of the Yellow Medicine River Valley. Individual areas range from 5 acres to 60 acres. These soils are at a similar elevation and are subject to flooding. The Zumbro soils are in the old stream channels that have been filled in by sandy alluvium. Du Page soils are adjacent to these channels. Zumbro sandy loam makes up 60 to 80 percent of this map unit, and Du Page loam makes up 20 to 40 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Zumbro soil has a surface soil about 16 inches thick. The surface soil is black, slightly calcareous sandy loam in the upper part and very dark grayish brown, slightly calcareous loamy sand in the lower part. The subsoil is very dark grayish brown and dark brown, calcareous, loose loamy sand about 34 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, slightly calcareous sand. In places, the underlying material has strata ranging from sand to loam and silt loam. Some areas have gravelly underlying material.

Typically, the Du Page soil has a calcareous loam surface layer about 36 inches thick. The surface layer is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is dark grayish brown, calcareous loam. In some places, the upper part of the surface layer is leached of free lime. In a few areas, the surface layer is silt loam.

Permeability is rapid in the Zumbro soil and moderate in the Du Page soil. Surface runoff is slow. Available water capacity is moderate or low in the Zumbro soil and high or very high in the Du Page soil. The surface layer is mildly alkaline in most places. The content of organic matter is moderate in the Zumbro soil and high in the Du Page soil. In both soils, the content of phosphorus is low and potassium is medium. The seasonal high water table ranges from 4 to 6 feet in the Du Page soils and is more than 6 feet in the Zumbro soils.

Most areas of this Zumbro-Du Page complex are cropped or used for grazing. These soils are suited to all crops commonly grown in the county. They are subject to occasional overflow. In some areas diversions are desirable to help control the runoff from adjoining uplands. The droughtiness of the Zumbro soil is a major concern of management if crops are grown in areas of these soils. Leaving stubble and stalks on the surface during winter helps to trap snow and conserve moisture. Most grazed areas have been overgrazed. As a result, the native grass species have been replaced by less productive grasses, such as Kentucky bluegrass, and by such weeds as goldenrod and buckbrush. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition.

The Zumbro soil is poorly suited to trees and shrubs. The mortality rate in windbreaks is likely to be severe during periods of drought. Trees planted on this soil generally grow slowly and are commonly stunted. Du Page soils are well suited to trees and shrubs in windbreaks. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

These soils are generally not used as a site for sanitary facilities or buildings because of the hazard of flooding. Pollution of ground water by sanitary facilities is also a hazard. Low strength in the Du Page soil can damage roads and streets built across areas of this soil. The damage due to low strength can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength.

These soils are in capability subclass IIIw.

902C2—Barnes-Buse loams, 6 to 12 percent slopes, eroded. This map unit consists of rolling, well drained soils on side slopes. Slopes are convex and range from 100 to 150 feet in length. Individual areas range from 3 acres to 100 acres. Some areas are stony. The Buse soils are on the steepest parts of side slopes, whereas the Barnes soils are on the less sloping parts. The underlying material of the Buse soils is exposed in many places. The Barnes soils make up 40 to 60 percent of this map unit, and the Buse soils make up 30 to 50 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Barnes soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is friable loam about 13 inches thick. It is dark brown in the upper part, brown in the middle part, and olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam glacial till. In places, the surface layer is black and is a few inches thicker than typical.

Typically, the Buse soil has a very dark gray loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam glacial till. In some areas, a 4-inch layer of very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels is below the surface layer. The soil is calcareous throughout.

Included with these soils in mapping are small areas of less sloping Barnes soils and more sloping Buse soils on side slopes. Also included, on knolls and the upper parts of hillsides, are areas where gravelly material is exposed. Areas of the moderately well drained Terril soils are on the concave parts of foot slopes. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is moderate or high. In most places, the surface layer of the Barnes soil is neutral and that of the Buse soil is mildly alkaline. The content of organic matter is moderate in the Barnes soil and low in the Buse soil. In both soils, phosphorus is very low and potassium is medium.

Most areas of these Barnes-Buse loams are cropped. If erosion is controlled and fertility maintained, these soils are moderately suited to crops commonly grown in the county. The hazard of further erosion is moderate to severe. Grassed waterways are needed in areas where runoff collects and crosses these soils. In many areas, the slopes are too irregular for terracing and contour farming. A meadow crop that helps to control runoff and erosion is needed in the rotation. A high level of management is also needed to prevent further erosion. Included in a high level of management are maintaining a winter cover crop, heavy applications of manure, and return of all crop residue to the soil.

These soils are well suited to the trees and shrubs in windbreaks. Trees and shrubs planted on the Buse soil have a high mortality rate and a slow growth rate because of low fertility and excessive lime. Erosion needs to be controlled by planting on the contour or by maintaining a mulch of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

These soils have fair suitability as a site for buildings and sanitary facilities. Erosion is a moderate hazard if plant cover is removed for construction, and erosion control measures should be taken during construction. Covering the surface of the soils with a mulch and seeding grass or sodding disturbed areas following construction reduce the hazard of erosion. These soils have a slow rate of absorption. Septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of the soil are desirable. These soils have low strength and are subject to frost heave. These limitations may cause damage to roads and streets built across areas of these soils. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches.

These soils are in capability subclass IIIe.

904B2—Arvilla-Barnes-Buse complex, 2 to 6 percent slopes, eroded. This map unit consists of undulating, somewhat excessively drained and well drained soils on side slopes on glaciated uplands. Individual areas range from 3 acres to 50 acres. Some areas are stony. The Arvilla soils are on ridges and on tops of hills; Barnes soils are on the lower parts of side slopes; and Buse soils are on the upper, more convex parts of side slopes. The underlying material of the Buse soils is exposed in places. The Arvilla soils make up 30 to 50 percent of this map unit, Barnes soils 25 to 40 percent, and Buse soils 15 to 30 percent. The soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Arvilla soil has a very dark gray sandy loam surface layer about 8 inches thick. The subsoil is dark brown, friable sandy loam about 8 inches thick. The underlying material to a depth of about 30 inches is yellowish brown, calcareous gravelly loamy sand. The next layer to a depth of about 35 inches is brownish yellow, calcareous sand, and below this to a depth of about 60 inches is grayish brown and yellowish brown, calcareous gravelly coarse sand. In places, the underlying material is loamy. In places, the surface layer is darker colored and a few inches thicker than typical.

Typically, the Barnes soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is friable loam about 15 inches thick. It is dark brown in the upper part, brown in the middle part, and olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam glacial till.

Typically, the Buse soil has a very dark gray loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam glacial till. In places a 4-inch layer of very dark grayish brown and dark brown and yellowish brown loam that has many wormcasts and root channels is below the surface layer. The soil is calcareous throughout.

Included with these soils in mapping are small areas of Sioux and Fordville soils. The excessively drained Sioux soils are on the upper parts of knobs and escarpments. The well drained Fordville soils are in slightly concave areas. The included soils make up 3 to 10 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and is rapid in the underlying material of the Arvilla soil. It is moderate in the Barnes and Buse soils. Available water capacity is low or very low in the Arvilla soil and high or moderate in the Buse and Barnes soils. Surface runoff is slow to medium. The surface layer is moderately alkaline to neutral. The content of organic matter is moderate, phosphorus is low, and potassium is low or medium.

Most areas of this Arvilla-Barnes-Buse complex are cropped or are used for grazing. These soils are moderately suited to cropland. The hazard of erosion is moderate. Droughtiness is a moderate limitation on the Arvilla soil because of the low available water capacity. The main management needs are controlling erosion, conserving water, and increasing fertility. In areas where slopes are too irregular for contour farming, minimum tillage and the return of crop residue to the surface of the soil help to control erosion and conserve moisture. Spring plowing helps to control soil blowing and erosion, particularly soil blowing. Leaving stubble on the surface during winter traps snow and conserves moisture. A single-row shelterbelt helps to control erosion and conserve moisture.

The Barnes and Buse soils are well suited to trees and shrubs. The mortality rate of new seedlings can be reduced by providing special care in site preparation and planting and by weed control. Water erosion and soil blowing can be controlled by maintaining a mulch of crop residue. In places, windbreaks can be planted on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

Areas of these soils are well suited to building sites. Erosion is a slight hazard; however, erosion control measures should be taken during construction. The Barnes and Buse soils have low strength and are subject to frost heave. These limitations can cause damage to roads and streets built across areas of these soils. This damage can be reduced by building the base of roads with material that has greater bearing strength. Roads should be designed to prevent water from ponding in ditches. The Barnes and Buse soils have fair suitability for sanitary facilities. Septic tank filter fields placed on these soils should be made large enough to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas are desirable. Septic tank absorption fields are not effective in Arvilla soils because the underlying material is a poor filter. This causes a hazard of contamination to underground water.

These soils are in capability subclass IIIe.

904C—Arvilla-Buse-Barnes complex, 6 to 12 percent slopes. This map unit consists of rolling, somewhat excessively drained and well drained soils on glaciated uplands. Individual areas range from 3 acres to 50 acres. Some areas are stony. The Arvilla soils are on the tops of knobs or ridges, the Buse soils are on the upper parts of side slopes, and the Barnes soils are on the lower parts of side slopes. The underlying material of the Buse soils is exposed in places. The Arvilla soils make up 35 to 50 percent of this map unit, Buse soils 25 to 40 percent, and Barnes soils 15 to 30 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Arvilla soil has a very dark gray sandy loam surface layer about 7 inches thick. The subsoil is dark brown, friable sandy loam about 8 inches thick. The underlying material to a depth of about 30 inches is yellowish brown, calcareous gravelly loamy sand; to a depth of about 35 inches it is brownish yellow, calcareous sand; and below this to a depth of about 60 inches it is grayish brown and yellowish brown, calcareous gravelly coarse sand. The surface layer is darker and a few inches thicker in uncultivated areas.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam glacial till. The soil is calcareous throughout. In some areas, a 4-inch layer of very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels is below the surface layer.

Typically, the Barnes soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is friable loam about 12 inches thick. It is dark brown in the upper part, brown in the middle part, and olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is olive brown, light olive brown, calcareous loam glacial till. The surface layer is black and is a few inches thicker than typical in places.

Included with these soils in mapping are small areas of Sioux and Terril soils. The excessively drained Sioux soils are on the crests of hills where gravelly material is exposed. The moderately well drained Terril soils are on foot slopes and in drainageways. They have a thick, dark colored surface layer. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and is rapid in the underlying material of the

Arvilla soil. It is moderate in the Buse and Barnes soils. Available water capacity is low or very low in the Arvilla soil and high or moderate in the Buse and Barnes soils. Surface runoff is medium. The surface layer is neutral to moderately alkaline. The content of organic matter is moderate, phosphorus is very low, and potassium is low or medium. In the Arvilla soil, roots are restricted by the underlying sand and gravel at a depth of 12 to 18 inches.

Most areas of this Arvilla-Buse-Barnes complex are cropped. Small grain and hay are better suited than most other crops. The hazard of erosion is severe. The hazard of drought is severe on the Arvilla soil. The main management needs are controlling erosion, conserving water, and improving fertility. Spring tillage, heavy applications of manure, and return of all crop residue to the soil are needed. Terraces generally are not built on these soils because the Arvilla soil is shallow over gravelly sand. Some waterways should be maintained and some should be reestablished. If gravelly sand has been exposed by erosion in waterways, the addition of a layer of topsoil promotes the growth of grasses.

The Buse and Barnes soils are better suited to trees than the Arvilla soil. Mortality is likely to be severe on the Arvilla soil if drought occurs while the trees and shrubs are becoming established. Water erosion and soil blowing can be controlled by maintaining a cover of crop residue. In places, windbreaks can be planted on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and help destroy unwanted vegetation.

These soils are well suited to building sites. They have a moderate hazard of erosion, and erosion control measures should be taken during construction. Disturbed areas should be revegetated immediately following contruction. The Barnes and Buse soils have low strength and are subject to frost heave. These limitations can cause damage to roads and streets. This damage can be reduced by building the base of roads with material that has greater bearing strength. Roads should be designed to prevent water from ponding in ditches.

The Barnes and Buse soils have fair suitability for sanitary facilities. They have a slow rate of absorption. Septic tank filter fields placed on these soils should be made large enough to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of the soil are desirable. Septic tank absorption fields are not effective in Arvilla soils because the underlying material is a poor filter. This causes a hazard of contamination to underground water. There is also a hazard of effluent seeping laterally downslope in areas of these soils and surfacing at a lower elevation.

These soils are in capability subclass IVe.

913D—Buse-Barnes loams, 12 to 18 percent slopes. This map unit consists of moderately steep, well drained soils on side slopes and at the heads of drainageways. Slopes are convex and about 150 feet long. In places, the surface is stony. Individual areas range from 3 acres to 15 acres. Buse soils are on the steepest upper parts of hillsides, and Barnes soils are on the upper and lower parts of the hillsides. In some areas, the underlying material of the Buse soil is exposed. The subsoil of the Barnes soil has been exposed on the fringes. The Buse soils make up 55 to 75 percent of the map unit, and the Barnes soils make up 25 to 45 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 8 inches thick. Below this is a 4-inch layer of very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam glacial till. The soil is calcareous throughout.

Typically, the Barnes soil has a very dark gray loam surface layer about 7 inches thick. The subsoil is friable loam about 12 inches thick. It is dark brown in the upper part, brown in the middle part, and olive brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous loam glacial till. The original surface layer has lost organic matter as a result of erosion and cropping. In places, the surface layer is black and is thicker than 7 inches.

Included with these soils in mapping are small areas of less sloping Barnes soils and areas of more sloping Buse soils on side slopes. Also included are small, narrow areas of the moderately well drained Terril soils on the concave parts of foot slopes and drainageways. Some sandy and gravelly deposits are on the crests of slopes. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderate, and available water capacity is high or moderate. Surface runoff is rapid or very rapid. In most places the surface layer of the Buse soil is mildly alkaline and that of the Barnes soil is neutral. The content of organic matter is moderate or low, phosphorus is very low, and potassium is medium.

Most areas of these Buse-Barnes loams are cropped or used for grazing. Hay and small grain are the most suitable crops. These soils have moderate suitability for cropland. Erosion is a very severe hazard and drought is a severe hazard because runoff is rapid on these moderately steep soils. Contour stripcropping, spring plowing, and minimum tillage help to control erosion. Heavy applications of manure help to increase productivity and improve tilth in eroded areas. If stripcropping is not practical, erosion can be controlled by growing hay or pasture crops in rotation. Waterways should be maintained and new ones added in places.

Many areas are used for range. Most of these areas have been overgrazed, and as a result, the native grasses have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as goldenrod, gumweed, and buckbrush. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition. Potential pond reservior sites are common.

These soils are poorly suited to windbreaks but are suitable for other plantings. Erosion is a severe hazard if the surface is disturbed. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees or shrubs. Mortality of trees and shrubs during the first year is largely dependent on the aspect and slope position. Conditions are less favorable on hot, dry slopes facing south or west. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

These soils are poorly suited as a site for sanitary facilities because of the moderately steep slopes. Construction of sanitary facilities and proper placement of septic tank filter fields are difficult on these slopes. Also, there is a hazard of effluent seeping laterally downslope and surfacing at a lower elevation. Areas of these soils have fair suitability for building sites. Erosion is a hazard during and following construction of buildings or roads. Mulching the surface and seeding grass or sodding disturbed areas help reduce the hazard of erosion.

These soils are in capability subclass IVe.

915C2—Forman-Buse complex, 6 to 12 percent slopes, eroded. This map unit consists of sloping, well drained soils on side slopes along drainageways on the Coteau slope. A few stones and boulders are on the surface and in the soil. Shallow drainageways dissect the slopes at irregular intervals. Slopes are convex and are 150 to 200 feet long. Individual areas range from 5 acres to 40 acres. The Forman soils are on the lower parts of the side slopes, and the Buse soils are on the steeper, higher parts. In large areas on many eroded side slopes, the underlying material of the Buse soils is exposed. Forman soils make up 50 to 70 percent of this map unit, and Buse soils make up 30 to 50 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Forman soil has a very dark gray clay loam surface layer about 7 inches thick. The subsoil is firm clay loam about 10 inches thick. It is dark brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown, calcareous clay loam glacial till.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown clay loam glacial till. In places, a 4-inch layer of very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels is between the surface layer and the underlying material. The soil is calcareous throughout.

Included with these soils in mapping are small areas of less sloping Forman soils and areas of more sloping Buse soils on side slopes. Also included are small areas of Terril and Flom soils, which make up 3 to 8 percent of the map unit. The moderately well drained Terril soils are in concave areas at the foot of side slopes. The poorly drained Flom soils are in the narrow drainageways that dissect this unit. Also included next to the flood plain of Canby Creek are small areas of the Sverdrup, Arvilla, Sioux, and Fordville soils. These soils are underlain by sandy and gravelly material. They make up 2 to 15 percent of the map unit.

Permeability is moderately slow. Available water capacity is high or moderate, and surface runoff is rapid. The surface layer of the Forman soil is neutral in most places and that of the Buse soil is mildly alkaline. The content of organic matter is moderate in the Forman soil and low in the Buse soils. In both soils, the content of phosphorus is low and potassium is medium.

Most areas of this Forman-Buse complex are cropped. If erosion is controlled and fertility maintained, these soils are moderately suited to the crops commonly grown in the county. The hazard of further erosion ranges from moderate to severe. Grassed waterways are needed in areas where water collects and crosses this soil. If slopes are too irregular for terracing and contour farming, a rotation that includes a meadow crop is needed to control runoff and erosion. A high level of management is also needed. Included in a high level of management are spring tillage, heavy applications of manure, and return of all crop residue to the soil.

These soils are moderately well suited to trees and shrubs in windbreaks. Trees and shrubs planted on the Buse soil have a higher mortality rate than those planted on the Forman soil because of low fertility and excessive lime. Erosion can be controlled by planting on the contour or by maintaining a mulch of crop residue. Weeds and grasses can be controlled in newly established windbreaks by cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer and fall before planting increase the moisture supply and destroy unwanted vegetation.

These soils have fair suitability as a site for sanitary facilities and buildings. Erosion is a moderate hazard where the plant cover is removed from construction sites. Covering the surface of the soils with a mulch and seeding grass or sodding disturbed areas following construction reduce the hazard of erosion. These soils have a slow rate of absorption. Septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of the soil are desirable. These soils have low strength and are subject to frost heave. These limitations can cause damage to roads and streets. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength. The damage due to frost heave can be reduced by designing the roadbed to prevent water from ponding in ditches.

These soils are in capability subclass IIIe.

915D—Buse-Forman complex, 12 to 18 percent slopes. This map unit consists of moderately steep, well drained soils on side slopes along drainageways on the Coteau slope. In places, the surface is stony. Slopes are convex and are 150 to 200 feet long. Individual areas range from 3 acres to 20 acres. Forman soils are on the upper and lower parts of slopes, dominantly slopes of less than 15 percent. Buse soils are on the steeper upper parts of side slopes. In places, the underlying material of the Buse soil is exposed. Buse soils make up 50 to 70 percent of this map unit, and Forman soils make up 30 to 50 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. Next is very dark grayish brown, dark brown, and yellowish brown loam. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown clay loam glacial till. In places, a 4-inch layer of very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels is between the surface layer and the underlying material.

Typically, the Forman soil has a very dark gray clay loam surface layer about 7 inches thick. The subsoil is firm clay loam about 8 inches thick. It is dark brown in the upper part and brown in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown, calcareous clay loam glacial till.

Included with these soils in mapping are small areas of less sloping Forman soils and areas of more sloping Buse soils. Also included are narrow areas of poorly drained Calco and moderately well drained Du Page soils in the drainageways that dissect this unit and moderately well drained Terril soils on concave foot slopes. These soils make up 5 to 15 percent of the map unit. Included adjacent to the flood plain of Canby Creek are small areas of Sverdrup, Arvilla, Fordville, and Sioux soils. These soils are underlain by gravelly and sandy material, and they make up 2 to 10 percent of the map unit.

Permeability is moderately slow. Available water capacity is high or moderate, and surface runoff is rapid. Typically, the surface layer of the Buse soils is mildly alkaline, and the surface layer of the Forman soils is neutral. In areas where the Forman and Buse soils are closely associated, the soils are mildly alkaline. The content of organic matter is low in the Buse soil and moderate in the Forman soil. In both soils, the content of phosphorus is low and that of potassium is medium.

Most areas of this Buse-Forman complex are cropped or are used for grazing. Hay and small grain are better suited than most other crops. The hazard of erosion is very severe. The hazard of drought is also severe because runoff is rapid on these moderately steep soils. Contour stripcropping, spring plowing, and minimum tillage help to control erosion. Heavy applications of manure increase productivity. If stripcropping is not practical, erosion can be controlled by growing hay or pasture crops in rotation. Waterways should be maintained and in places new ones constructed.

Many areas are used for rangeland, and most of these areas have been overgrazed. As a result, the native grasses have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as goldenrod and buckbrush. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition. Potential pond reservoir sites are common on these soils.

These soils are too steep for windbreaks but are suitable for other plantings. The hazard of erosion is severe if the surface is disturbed. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual planting of trees and shrubs. The mortality rate of trees and shrubs is largely dependent on the aspect and slope position. Conditions are less favorable on hot, dry slopes facing south or west. More species of trees and shrubs can be grown on the cooler, more moist slopes facing north or east. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

These soils are poorly suited as sites for sanitary facilities because of the moderately steep slopes. Construction of sanitary facilities and proper placement of septic tank filter fields are difficult on these slopes. Also, there is a hazard of effluent seeping laterally downslope and surfacing at a lower elevation. Areas of these soils have fair suitability as a site for buildings. Erosion is a hazard during and following construction of buildings or roads on these slopes. Mulching the surface and seeding grass or sodding disturbed areas help reduce the hazard of erosion. The Forman soils also have low strength and are subject to frost heave. The material used for the bases of roads or streets built across areas of these soils should be strengthened or replaced with material that has greater bearing strength. The damage from frost heave can be reduced by designing roads to prevent water from ponding in ditches.

These soils are in capability subclass IVe.

917D—Buse-Sioux complex, 12 to 18 percent slopes. This map unit consists of moderately steep, well drained and excessively drained soils on glaciated uplands. Numerous small stones and pebbles are on the surface of the Sioux soil. Slopes are convex and are about 150 feet long. Individual areas range from 3 acres to 15 acres. The Buse soils are on the more convex upper side slopes. The Sioux soils are on ridges or knobs. Buse loam makes up 40 to 60 percent of this map unit, and the Sioux soils make up 35 to 50 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and light olive brown loam glacial till. The soil is calcareous throughout. In places, a 4-inch layer of very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels is below the surface layer.

Typically, the Sioux soil has a black gravelly sandy loam surface layer about 7 inches thick. The next 3 inches is very dark grayish brown gravelly loamy sand. The underlying material to a depth of about 60 inches is dark grayish brown and dark yellowish brown very gravelly coarse sand. The soil is typically calcareous throughout. In places where the soil has been cropped, the surface layer is very dark gray.

Included with these soils in mapping are small areas of Barnes, Sverdrup, and Terril soils. The well drained Barnes soils are on the lower, convex hillsides; the well drained Sverdrup soils typically are in convex areas above the Barnes soils or in slightly concave areas; and the moderately well drained Terril soils are on concave foot slopes. The included soils make up 10 to 20 percent of the map unit.

Permeability is moderate in the Buse soil and rapid in the Sioux soil. Available water capacity is high or moderate in the Buse soil and very low or low in the Sioux soil. Surface runoff is medium or rapid. In most places, the surface layers of both soils are mildly alkaline in reaction and low or moderate in organic matter. Phosphorus is very low, and potassium is medium or low. The root zone is severely restricted in the Sioux soil by underlying sand and gravel at a depth of 7 to 12 inches.

Most areas of this Buse-Sioux complex are cropped or are used for grazing. These soils are better suited to hay and pasture than to most other crops. They are not suited to corn or other row crops. The hazard of erosion is very severe. The hazard of drought is also very severe on the Sioux soil because available water capacity is limited. If establishing legumes or grasses, small grain should be grown as a nurse crop.

Many areas are used for range. Most of these areas have been overgrazed, and as a result, the native grasses have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass and by such weeds as goldenrod, gumweed, and buckbrush. Proper stocking rates, timely deferment of grazing, uniform distribution of grazing, and a planned grazing system improve the range and keep the range and soil in good condition.

These soils are too steep for windbreaks. The Sioux soil generally is very poorly suited to trees and shrubs in windbreaks. Onsite inspection is needed to determine the suitability of an area for trees and shrubs. The Buse soil is suitable for some individual plantings. The hazard of erosion is severe if the surface is disturbed. Planting sites should be prepared by furrowing on the contour or by scalping away the sod for individual planting of trees or shrubs. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

These soils are poorly suited to sanitary facilities because of the moderately steep slopes. Septic tank absorption fields are difficult to construct on these steep slopes. Also, contamination of ground water supplies by effluent seeping through the rapidly permeable underlying material of the Sioux soils is a hazard. Erosion control measures are needed on these steep slopes during and following construction. Mulching, seeding grasses, or sodding help stabilize the surface and prevent the formation of gullies. Caving of cutbanks during shallow excavations is a hazard on the Sioux soils. This can be prevented by sloping the sidewalls of the excavations or by using retaining walls.

These soils are in capability subclass VIe.

917E—Buse-Sioux complex, 18 to 40 percent slopes. This map unit consists of well drained and excessively drained, steep and very steep soils on side slopes along streams and deep drainageways and on gravelly ridges in the glaciated uplands. Individual areas range from 3 acres to 55 acres. Most areas are very stony. The Buse soils formed in glacial till on the steeper, more convex side slopes. The Sioux soils formed in gravelly glacial outwash on ridges and in glacial outwash in pockets or on knobs. Buse loam and Sioux gravelly sandy loam each make up 40 to 60 percent of this map unit. These soils are so intermingled or in areas so small that to separate them in mapping was not practical.

Typically, the Buse soil has a very dark gray loam surface layer about 7 inches thick. The next 4 inches is very dark grayish brown, dark brown, and yellowish brown loam that has many wormcasts and root channels. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam glacial till. The soil typically is calcareous throughout, but in places, part or all of the surface layer does not have free lime.

Typically, the Sioux soil has a black gravelly sandy loam surface layer about 7 inches thick. The next 3 inches is very dark grayish brown gravelly loamy sand. The underlying material to a depth of about 60 inches is dark grayish brown and dark yellowish brown very gravelly coarse sand. Typically, the soil is calcareous throughout, but in a few places the surface layer is leached of free lime.

Included with these soils in mapping are small areas of Terril and Sverdrup soils. The moderately well drained Terril soils are on the concave part of foot slopes, and the well drained Sverdrup soils are above the shoulders of slopes or in slightly concave areas. The included soils make up 5 to 10 percent of the map unit.

Permeability is moderate in the Buse soil and rapid in the Sioux soil. Available water capacity is moderate or high in the Buse soil and very low or low in the Sioux soil. Surface runoff is very rapid in the Buse soil and medium to rapid in the Sioux soil. The surface layer in both soils typically is mildly alkaline. The content of organic matter is moderate, phosphorus is very low, and potassium is medium or low. The root zone is restricted in the Sioux soil by the underlying sand and gravel at a depth of 7 to 12 inches.

Most areas of this Buse-Sioux complex are used for grazing. These soils are too steep and droughty to be cropped. Some small areas are cropped if they are within tracts of other soils suitable for crops, but crop growth is poor. The hazard of erosion is very severe.

These soils are better suited to range than to most other farm uses. Most areas have been overgrazed. As a result, native grasses have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as buckbrush, gumweed, and goldenrod. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the range and keep the range and the soil in good condition.

Slopes are too steep for windbreaks. The Sioux soil generally is very poorly suited to trees and shrubs. The Buse soil is suitable for other plantings, but onsite inspection is needed to determine the suitability of an area for specific plants. The hazard of erosion is severe if the surface is disturbed. Planting sites can be prepared by scalping away the sod for individual trees or shrubs. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

These soils are generally unsuited to sanitary facilities because of the very steep slopes. Septic tank absorption fields are difficult to construct on the very steep slopes. Also, contamination of underground water supplies by effluent seeping through the rapidly permeable underlying material of the Sioux soils is a severe hazard. Erosion control measures are needed both during and after construction of dwellings, roads, and streets. Mulching, seeding grasses, or sodding help stabilize the surface and prevent the formation of gullies. Caving cutbanks in shallow excavations are a hazard on the Sioux soils. This can be prevented by sloping the sidewalls of the excavations or by using retaining walls.

These soils are in capability subclass VIIe.

923D—Copaston-Rock outcrop complex, 2 to 25 percent slopes. This map unit consists of undulating to steep, well drained Copaston soils that are intermingled with outcrops of rock in the Minnesota River Valley. Slopes are very complex. Most areas are stony. Individual areas range from 6 acres to 600 acres or more. The Copaston soils formed in a mantle of loamy material, which was deposited on the bedrock and among the outcrops of rock. Rock outcrop is grayish and reddish, rugged igneous rock that projects as much as 50 feet above the valley floor. Copaston soils make up 40 to 70 percent of this map unit, and Rock outcrop makes up 15 to 50 percent. The Copaston soils are so intermingled with the Rock outcrop or areas are so small that to separate them in mapping was not practical.

Typically, the Copaston soil has a black loam surface layer about 10 inches thick. The subsoil is about 8 inches thick. It is very dark gray, friable loam in the upper part and very dark gray, calcareous, loose gravelly sandy loam in the lower part. The lower part contains many fragments of igneous rock. Hard igneous bedrock is at a depth of about 18 inches. The thickness of the material over the bedrock typically is 10 to 20 inches but ranges from a few inches to several feet. In some places, the overlying material is sandy loam. In some low lying areas, it is clay loam.

The Rock outcrop part of this unit is Precambrian igneous rock. It is mostly gneiss, but it contains dikes of basalt, which range in width from a few inches to many feet.

Included with this unit in mapping are small areas of well drained Rothsay and Zell soils. Also included are Sioux, Arvilla, Sverdrup, and poorly drained Marysland soils, all of which have sandy and gravelly underlying material. Also included in mapping are small, wet marshes, intermittent waterholes, and wet flats. The included soils and wet areas make up 10 to 20 percent of the map unit.

The Copaston soil has moderate permeability, slow or medium surface runoff, and low available water capacity. Reaction of the surface layer is neutral in most places. The rooting depth of plants is restricted by the shallow depth to bedrock.

This Copaston-Rock outcrop complex is too rocky and shallow to bedrock to be used as cropland. It is better suited to pasture than most other farm uses. Most areas have been overgrazed, and as a result, native grass species have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as buckbrush, sage, and goldenrod. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good condition. The included wet areas are potential sites for stock water pits.

This unit is too shallow and rocky for windbreaks but is suitable for individual plantings on the Copaston soils. Planting sites can be prepared by scalping away the sod for individual trees and shrubs. Mortality of trees and shrubs depends on the thickness of the soil mantle and the slope position. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

This unit has good suitability for most recreational uses. Suitable sites for picnic areas, camp areas, and septic tank absorption fields can be developed on the less sloping areas. Paths and trails for hiking and horseback riding can be developed through this esthetically pleasing landscape.

This unit is poorly suited as a site for sanitary facilities and buildings because of the shallow depth to bedrock. The use of heavy equipment and blasting of bedrock is generally required to install septic tank filter fields and to construct buildings. Also, contamination of ground water by effluent from sanitary facilities seeping through fissures in the bedrock is a hazard. Erosion control measures are needed in construction sites both during and following construction. Mulching the surface, seeding grasses, or sodding disturbed areas following construction help reduce the hazard of erosion. Some areas of this unit are used as rock quarries.

This unit is in capability subclass VIIs.

953C—Arvilla-Storden-Ves complex, 6 to 15 percent slopes. This map unit consists of rolling and hilly, somewhat excessively drained and well drained soils on gravelly ridges on the lowland plain. These ridges are 200 to 300 feet wide, 10 to 25 feet high, and generally run north to south. They are dominantly less than 1/2 mile long, but in places intermittent ridges are several miles long. Individual areas range from 5 acres to 30 acres. The Arvilla soil is on the ridgetops and convex shoulders of side slopes, the Storden soil is on the steep part of side slopes, and the Ves soil is generally on the less sloping parts of summits and side slopes. Arvilla soils and soils similar to Arvilla soils make up about 45 percent of this unit, and Storden and Ves soils make up about 40 percent. These soils are so intermingled or are in areas so small that to map them separately was not practical.

Typically, the Arvilla soil has a black sandy loam surface layer about 8 inches thick. The subsoil is dark brown, friable sandy loam about 8 inches thick. The underlying material to a depth of about 30 inches is yellowish brown gravelly loamy sand. Below this to a depth of about 35 inches is brownish yellow sand, and below this to a depth of about 60 inches is grayish brown and yellowish brown gravelly coarse sand. The soil is calcareous throughout. The surface layer generally is thinner and lighter in color than in cultivated areas. In many places, the gravel deposits are only a few feet thick over glacial till.

Typically, the Storden soil has a dark grayish brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is olive brown and light olive brown loam glacial till. The soil is calcareous throughout.

Typically, the Ves soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is about 17 inches thick. It is dark brown and dark yellowish brown, friable clay loam in the upper part and olive brown, calcareous, friable loam in the lower part. The underlying material to a depth of about 60 inches is olive brown, calcareous loam glacial till.

Included with these soils in mapping are small areas of Fordville, Sioux, and Sverdrup soils. The Fordville soils have a loam mantle that is more than 20 inches thick overlying sand and gravel. Gravelly material is very near the surface on the Sioux soils. Sverdrup soils are underlain by sandy material. The included soils make up 10 to 20 percent of the map unit.

Permeability is moderately rapid in the surface layer and subsoil and rapid in the underlying material of the Arvilla soil. It is moderate in the Storden and Ves soils. Surface runoff is medium to rapid. Available water capacity is low or very low in the Arvilla soil and high in the Storden and Ves soils. The surface layer in these soils is slightly acid to moderately alkaline. The content of organic matter ranges from low to high, phosphorus is very low, and potassium is low or medium. Roots are restricted in the Arvilla soil by the underlying sand and gravel at a depth of 12 to 18 inches.

Most areas of this Arvilla-Storden-Ves complex are cropped or are used for grazing. Small grain and hay are better suited than most other crops. The hazard of erosion is severe. The hazard of drought is severe on the Arvilla soil. The main management needs are controlling erosion, conserving water, and improving fertility. Spring plowing, heavy applications of manure, and return of all crop residue to the soil are needed. Some waterways should be maintained and some reestablished. In areas where gravelly sand in waterways has been exposed by erosion, replacing the top layer promotes the growth of grasses.

Storden and Ves soils are better suited to trees than the Arvilla soil. Mortality of windbreaks planted on the Arvilla soil is likely to be severe if drought occurs while the trees and shrubs are becoming established. Water erosion and soil blowing can be controlled by maintaining a mulch of crop residue and, in places, by planting windbreaks on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

Areas of these soils are well suited to building sites. The hazard of erosion is moderate in construction sites where plant cover has been removed. Erosion control measures should be taken during construction. Covering the surface with mulch and seeding grass or sodding disturbed areas following construction reduce the hazard of erosion. Caving of cutbanks in shallow excavations on the Arvilla soils is a hazard that can be largely overcome by sloping the sidewalls of excavations or by the use of retaining walls. The Ves soils have low strength that can result in damage to roads built across areas of this soil. To overcome the damage due to low strength, the base of roads should be built with material that has more strength.

The Storden and Ves soils have fair suitability for sanitary facilities. There is a hazard of effluent from septic tank absorption fields seeping laterally downslope and surfacing at a lower elevation. The underlying material of Arvilla soils is a poor filter and contamination of underground water supplies is a severe hazard.

These soils are in capability subclass IVe.

954B2—Ves-Storden loams, 3 to 6 percent slopes, eroded. This map unit consists of undulating, well drained soils on convex slopes on hills that rise about 10 feet above the floor of the lowland plain. Individual areas range from 3 acres to several hundred acres. Slopes are 70 to 125 feet long. The Ves soils are on the less sloping parts of the landscape, whereas Storden soils are on the steeper parts. Ves soils make up 50 to 75 percent of this map unit, and Storden soils make up 20 to 40 percent. These soils are so intricately mixed or in areas so small that to separate them in mapping was not practical. In a few areas, this unit is mainly Ves soils. Some of the hilltops have small pockets of sand or gravel. A small area in Posen Township has outcrops of granitic rock.

Typically, the Ves soil has a black loam surface layer about 9 inches thick. It contains small masses of dark grayish brown subsoil. The subsoil is about 17 inches thick. It is dark brown and dark yellowish brown, friable clay loam in the upper part and olive brown, calcareous, friable loam in the lower part. The underlying material to a depth of about 60 inches is olive brown, calcareous loam glacial till. In some areas, such as the lower parts of slopes and in shallow swales, the surface layer is more than 9 inches thick.

Typically, the Storden soil has a dark grayish brown loam surface layer about 9 inches thick. The underlying material to a depth of about 60 inches is olive brown and light olive brown loam glacial till. The soil is calcareous throughout.

Included with these soils in mapping are small areas of Normania, Terril, Seaforth, Webster, Glencoe, Okoboji, Sverdrup, and Arvilla soils. The moderately well drained Normania and Terril soils are in swales and on foot slopes. The moderately well drained, calcareous Seaforth soils are on convex slopes at a slightly lower elevation than the major soils. The poorly drained Webster soils are in drainageways, and the very poorly drained Glencoe and Okoboji soils are in depressions. The Sverdrup and Arvilla soils are on summits and shoulders of slopes. They are underlain by sandy and gravelly material. Also included are small areas of the more sloping Storden and Ves soils on side slopes. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. In most places, the surface layer of the Ves soil is neutral, whereas that of the Storden soil is mildly alkaline. The content of organic matter is moderate in the Ves soil and low in the Storden soil. Both soils have low or very low phosphorus and medium or high potassium.

Most areas of these Ves-Storden loams are cropped. These soils are moderately well suited to all crops commonly grown in the county. The hazard of erosion is moderate. Stones are sometimes pushed to the surface by tillage and by frost action. Tillage is easier if the stones on the surface are removed periodically. The complex slopes generally are not well suited to terracing and contour farming. Minimum tillage practices, such as chisel plowing, help to control erosion. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall-plowed fields during winter and spring. Green manure or sod crops in the rotation help to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses these soils.

Areas of these soils are well suited to trees and shrubs in windbreaks. Trees and shrubs planted in the Storden soil have a higher mortality rate because of low fertility and excessive lime. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation. Erosion can be controlled during site preparation by maintaining crop residue on the surface. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

These soils are well suited as a site for sanitary facilities and buildings. The hazard of erosion where vegetative cover is removed from construction sites is slight; however, erosion control measures should be taken during construction. The Ves soils have low strength that can result in damage to roads built across areas of this soil. The damage due to low strength can be overcome by building the base of roads with material that has more strength than the Ves soils.

These soils are in capability subclass IIe.

954C2—Storden-Ves loams, 5 to 12 percent slopes, eroded. This map unit consists of sloping and rolling, well drained soils on low hills on the lowland plain and on the hillsides surrounding drainageways and closed depressions. Spots of sand or gravel are on some ridgetops. Uncultivated areas generally have a few stones and boulders on the surface. Slopes are convex and are 75 to 150 feet long. Individual areas range from 3 acres to 25 acres. The Ves soils are on the lower, less convex parts of hillsides, whereas the Storden soils are on the steeper, most convex parts. Storden soils make up 35 to 75 percent of this map unit, and Ves soils make up 25 to 50 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Storden soil has a dark grayish brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is olive brown and light olive brown loam glacial till. The soil is calcareous throughout.

Typically, the Ves soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is about

17 inches thick. It is dark brown and dark yellowish brown, friable clay loam in the upper part and olive brown, calcareous, friable loam in the lower part. The underlying material to a depth of about 60 inches is olive brown, calcareous loam glacial till.

Included with these soils in mapping are small areas of less sloping Ves soils and more sloping Storden soils. Also included are small areas of Normania, Terril, and Webster soils. The moderately well drained Normania and Terril soils are in concave areas in the upper end of drainageways and on foot slopes. The poorly drained Webster soils are in shallow drainageways and other low lying areas. The included soils make up 3 to 10 percent of the map unit.

Permeability is moderate, and surface runoff is medium to rapid. Available water capacity is high. The surface layer of the Ves soil is neutral in most places, whereas that of the Storden soil is mildly alkaline or moderately alkaline. The content of organic matter is moderate in the Ves soil and low in the Storden soil. In both soils, phosphorus is low or very low and potassium is medium or high.

Most areas of these Storden-Ves loams are cropped. If erosion is controlled and fertility maintained, these soils are well suited to most crops commonly grown in the county. The hazard of further erosion is moderate to severe. Grassed waterways are needed in some of the swales that cross these areas. In most areas, slopes are too irregular for terracing and contour farming. A crop rotation that includes a meadow crop helps to control runoff and erosion. Also, a high level of management is needed. This management includes spring plowing, heavy applications of manure, return of all crop residue to the soil, and disking instead of plowing for the small grain crop that follows corn in the rotation.

These soils are well suited to trees and shrubs in windbreaks. Trees and shrubs planted on the Storden soil have a higher mortality rate because of low fertility and excessive lime. Erosion can be controlled by planting on the contour or by maintaining a mulch of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and destroy unwanted vegetation.

Areas of these soils have fair suitability for building sites. Erosion is a moderate hazard on construction sites when plant cover is removed. Covering the surface with a mulch and seeding grass or sodding disturbed areas following construction reduce the hazard of erosion. The Ves soils have low strength, and on these soils the base of roads should be built with material that has more strength. Areas of these soils have fair suitability for sanitary facilities. There is a hazard of effluent from septic tank absorption fields seeping laterally downslope and surfacing at a lower elevation.

These soils are in capability subclass IIIe.

954D—Storden-Ves loams, 12 to 18 percent slopes. This map unit consists of moderately steep, well drained soils on side slopes along drainageways, around depressions, and along rivers and creeks. Slopes are convex and are 125 to 175 feet long. A few stones and boulders are on the surface in places. Sandy and gravelly spots are on some ridgetops. Individual areas range from 3 acres to 15 acres. The Storden soils are on the steepest, most convex parts of the landscape, and the Ves soils are on the less sloping parts. In large areas on eroded hillsides, the underlying material of the Storden soils is exposed. Storden soils make up 40 to 80 percent of this map unit, and Ves soils make up 20 to 40 percent. Areas of these soils are so small or so intermingled that to separate them in mapping was not practical.

Typically, the Storden soil has a dark grayish brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is olive brown and light olive brown loam glacial till. The surface layer is darker in places. The soil is calcareous throughout.

Typically, the Ves soil has a very dark gray loam surface layer about 8 inches thick. The subsoil is about 15 inches thick. It is dark brown and dark yellowish brown and brown, friable clay loam in the upper part and olive brown, calcareous, friable loam in the lower part. The underlying material to a depth of about 60 inches is olive brown, calcareous loam glacial till. The surface layer is black in places.

Included with these soils in mapping are small areas of less sloping Ves soils and more sloping Storden soils. Also included are small areas of Webster and Terril soils. The poorly drained Webster soils are in the narrow drainageways that dissect some areas of this unit. The moderately well drained Terril soils are in narrow strips on the concave parts of foot slopes. The included soils make up 2 to 10 percent of the map unit.

Permeability is moderate, available water capacity is high, and surface runoff is rapid. The surface layer of the Storden soil is mildly alkaline and that of the Ves soil is neutral in most places. The content of organic matter is low in the Storden soil and moderate in the Ves soil. In both soils, phosphorus is very low and potassium is medium.

Most areas of these Storden-Ves loams are cropped or are used for grazing. Hay and small grain are better suited than most other crops. The hazard of erosion is very severe, and the hazard of drought is severe. Slopes are too steep for terracing. Contour stripcropping and spring plowing help to control erosion. If stripcropping is not practical, erosion can be controlled by growing hay or pasture crops. Waterways should be maintained, and in places new ones should be added.

These soils are too steep for windbreaks but are suitable for other plantings. The hazard of erosion is severe if the surface is disturbed. Planting sites can be prepared by furrowing on the contour or by scalping away the sod for individual trees or shrubs. Mortality of trees and shrubs during the first year is slight to severe, depending on the aspect and the slope position. Conditions are less favorable on the hot, dry slopes facing south or west. More species of trees and shrubs can be grown on the cooler, more moist slopes facing north or east. Weeds and grasses can be controlled by applying approved herbicides or by hand methods, such as hoeing.

These soils are poorly suited as a site for sanitary facilities because of the moderately steep slopes. Construction of sanitary facilities and proper placement of septic tank filter fields on the slopes are difficult. Also, there is a hazard of effluent seeping laterally downslope and surfacing at a lower elevation. Areas of these soils have fair suitability as a site for buildings. Erosion is a hazard during and following construction of buildings or roads. Mulching the surface and seeding grass or sodding disturbed areas help reduce the hazard of erosion.

These soils are in capability subclass IVe.

969B2—Zell-Rothsay silt loams, 2 to 6 percent slopes, eroded. This map unit consists of gently sloping, well drained soils on side slopes and knolls on lake plains and in bedrock areas and other areas in the Minnesota River Valley. Bedrock outcrops occur in a few places. Slopes are convex and are 100 to 175 feet long. Individual areas range from 3 acres to 40 acres. Zell soils are on the steeper, most convex parts of side slopes and knolls, whereas the Rothsay soils are on the less convex parts. Zell soils make up 60 to 80 percent of this map unit, and Rothsay soils make up 20 to 40 percent. These soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Zell soil has a very dark gray silt loam surface layer about 9 inches thick. The next layer, about 4 inches thick, consists of brown and very dark grayish brown silt loam that contains a few very dark gray wormcasts. The underlying material to a depth of about 21 inches is light olive brown very fine sandy loam. Below this to a depth of about 60 inches is light olive brown and light brownish gray silt loam water-deposited sediment. The soil is calcareous throughout. In some areas the surface layer is loam, and in a few areas it is very fine sandy loam.

Typically, the Rothsay soil has a very dark gray silt loam surface layer about 9 inches thick. It contains small masses of brown subsoil material. The subsoil is silt loam about 24 inches thick. It is brown and dark yellowish brown in the upper part and yellowish brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous silt loam and very fine sandy loam. The surface layer is black in uncultivated areas and has a higher content of organic matter.

Included with these soils in mapping are small areas of more sloping soils and areas of Buse, Storden, McIntosh, Tara, Spicer, and Perella soils. The Buse and Storden soils formed in glacial till and have a few stones and pebbles on the surface. The moderately well drained, calcareous McIntosh soils are on low peninsulas that extend away from areas of this unit, and the moderately well drained Tara soils are in drainageways that dissect this unit. Small pockets of sand and gravel are also included. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate, surface runoff is medium, and available water capacity is high or very high. The surface layer is neutral in the Rothsay soil and mildly alkaline in the Zell soil in most places. The content of organic matter is moderate or low. In both soils, phosphorus is low and potassium is medium.

Most areas of these Zell-Rothsay silt loams are cropped. These soils are well suited to all crops commonly grown in the county. The hazard of erosion is moderate. The long, smooth slopes are generally suited to contour farming and terracing. Minimum tillage also helps to control erosion, particularly in areas not suited to contour farming. Leaving crop residue on the surface and keeping the surface rough reduce the risk of soil blowing on fall-plowed fields during winter and spring. An occasional green manure or sod crop helps to maintain good structure and tilth. Grassed waterways are needed in areas where water collects on and crosses this soil.

These soils are well suited to trees and shrubs in windbreaks. Trees and shrubs planted in the Zell soils have a higher mortality rate because of low fertility and excessive lime. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and reduce seedling mortality. Erosion can be controlled during site preparation by maintaining crop residue on the surface. In places, windbreaks can be planted on the contour. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

These soils are well suited as a site for buildings. The hazard of erosion is slight in areas where vegetative cover is removed from construction sites; however, erosion control measures should be taken during construction. Covering the surface with a mulch and seeding grass or sodding disturbed areas following construction help reduce the hazard of erosion. Septic tank filter fields should be made large enough for the Zell soils to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of this soil are desirable. Low strength in the Zell soils can damage roads and streets built across areas of these soils. This damage can be reduced by building the base of roads with material that has greater bearing strength and less shrink-swell potential. Roads should be designed to prevent water from ponding in ditches.

These soils are in capability subclass IIe.

969C2—Zell-Rothsay silt loams, 6 to 12 percent slopes, eroded. This map unit consists of sloping, well drained soils on side slopes and knolls. Slopes are convex and 100 to 200 feet long. Individual areas range from 5 acres to 40 acres. The Zell soils are on the steepest and most convex surfaces, and the Rothsay soils are on the less convex parts. Zell soils make up 50 to 70 percent of this map unit, and Rothsay soils make up 30 to 50 percent. The two soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Zell soil has a very dark gray silt loam surface layer about 9 inches thick. The underlying material to a depth of about 17 inches is light olive brown very fine sandy loam. Below this to a depth of about 60 inches is light olive brown and light brownish gray, silt loam water-deposited sediment. The soil is calcareous throughout. In some areas, the surface layer is loam, and in a few areas, it is very fine sandy loam.

Typically, the Rothsay soil has a very dark gray silt loam surface layer about 9 inches thick. It contains small masses of brown subsoil material. The subsoil is silt loam about 20 inches thick. It is brown and dark yellowish brown in the upper part and yellowish brown and calcareous in the lower part. The underlying material to a depth of about 60 inches is light olive brown, calcareous silt loam and very fine sandy loam. In cultivated areas, the surface layer is black and generally has a higher content of organic matter.

Included with these soils in mapping are a few small areas of steeper soils. Also included are small areas of Arvilla, Buse, Storden, Sverdrup, Terril, and Perella soils. The Buse and Storden soils formed in glacial till and have a few stones and pebbles on the surface, the somewhat excessively drained Arvilla and well drained Sverdrup soils have sandy and gravelly underlying material, and the moderately well drained Terril soils are in narrow strips on the concave part of foot slopes. The poorly drained Perella soils are in the narrow drainageways that dissect some areas of this unit. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate. Surface runoff is medium to rapid. Available water capacity is high or very high. In most places, the surface layer is mildly alkaline in the Zell soil and neutral in the Rothsay soil. The content of organic matter is low to moderate. In both soils, phosphorus is low or very low and potassium is medium.

Most areas of these Zell-Rothsay silt loams are cropped. If erosion is controlled and fertility maintained, these soils are well suited to the crops commonly grown in the county. The hazard of further erosion is moderate to severe. Grassed waterways are needed in areas where water collects on and crosses this soil. In many areas, the long smooth slopes are well suited to terracing and contour farming. In some areas, slopes are too irregular for terracing and contour farming, and a rotation that includes a meadow crop is needed to control runoff and erosion. Also, a high level of management is needed, including spring tillage, heavy applications of manure, and return of all crop residue to the soil.

These soils are well suited to trees and shrubs in windbreaks. Trees and shrubs planted on the Zell soil have a higher mortality rate because of low fertility and excessive lime. Erosion can be controlled by planting on the contour or by maintaining a mulch of crop residue. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides. If the site for a windbreak is in sod, plowing and disking during the summer or fall before planting increase the moisture supply and reduce seedling mortality.

Areas of these soils have fair suitability as a site for sanitary facilities and buildings. The hazard of erosion is moderate in areas where vegetative cover is removed during construction. Covering the surface with a mulch and seeding grass or sodding disturbed areas following construction help reduce the hazard of erosion. Septic tank filter fields should be made large enough for the soil to properly absorb and filter the effluent. Onsite tests to determine the absorption rate of specific areas of the soil are desirable. Low strength in the Zell soils can cause damage to roads and streets built across areas of this soil. This damage can be reduced by building the base of roads with material that has greater bearing strength. Roads should be designed to prevent water from ponding in ditches.

These soils are in capability subclass IIIe.

1016—Udorthents loamy. This map unit consists mainly of nearly level and gently sloping areas in which the natural soils have been covered, cut away, or removed. Individual areas range from 3 acres to more than 500 acres.

The largest areas are in and around Granite Falls, where much cutting or filling and leveling has occurred. The underlying bedrock has been blasted and removed to install sewerlines, waterlines, and gaslines. Rock outcrops have been blasted and leveled to construct housing and local roads and streets.

Some areas consist of dumps, landfills, and a few gravel pits that have been filled with trash, rocks, and other debris, then covered with soil material and leveled. These areas are cropped or are used for grazing, wildlife habitat, or recreation. Some areas are farmed with the adjoining land. They are low in fertility and need applications of organic matter. The areas are more suitable for cropland if the surface soil is removed, stockpiled, and replaced after the fill is in place. Generally, soil characteristics and quality vary widely. Onsite investigation and soil borings are needed to determine the suitability of these areas for specific uses.

This unit is not assigned to a capability subclass.

1029—Pits, gravel. This map unit consists of open excavations from which gravel has been or is being removed. Areas range from 3 acres to 35 acres. The size, shape, and depth of the pits are influenced by the quality and quantity of gravel. Water is in some of the deeper pits. Many pits are no longer worked because the supply of high-quality gravel has been exhausted. Trees, shrubs, and grasses grow in most abandoned pits.

Most of the pits are within areas of Arvilla, Fordville, and Sioux soils. The surface layer has been stripped and deposited around the edges of the gravel pit. It is a fair or good source of topsoil.

Some gravel pits are on steep side slopes that border the Minnesota River Valley. In most places, they have a thick overburden of glacial till. Small gravel pits of less than 1/2 acre are in pockets of sand and gravel that are on the upper parts of side slopes and on ridges in the glaciated uplands. This gravel is suitable for use on farms.

Most abandoned gravel pits are used by wildlife for cover and nesting. Gravel pits that can be leveled have fair to poor suitability for crops and pasture. Because soil properties vary widely, onsite investigation is needed to determine the suitability of specific areas for most uses.

This unit is not assigned to a capability subclass.

1053—Aquolls and Aquents, ponded. This map unit consists of undrained, closed depressions and ponds that, except in dry years, are generally covered by 1 foot to 3 feet of water. Individual areas are irregular in shape and range from 3 acres to 160 acres. In scattered areas, cattails, reeds, sedges, and other water-tolerant plants grow in the open water.

The soil material in most places is somewhat similar to that of the very poorly drained Glencoe, Okoboji, Barbert, Oldham, Nishna, and Blue Earth soils. Included with this unit in mapping are small areas of poorly drained Vallers, Canisteo, Spicer, and Burr soils along the edges of the unit or on islands. Some areas in the Minnesota River Valley have outcrops of rock or are underlain by bedrock at a shallow depth.

Most areas of Aquolls and Aquents, ponded, are used as wildlife habitat. Suitability for wetland wildlife habitat is good, but extreme wetness limits other uses.

This unit is in capability subclass VIIIw.

1852F—Terril-Swanlake loams, 18 to 70 percent slopes. This map unit consists of steep and very steep, moderately well drained and well drained soils. These soils are on the forested side slopes facing north and east that border the Minnesota River Valley and extend for short distances on side slopes of the streams that empty into the Minnesota River. The side slopes are convex and concave and are 150 to 250 feet long. Individual areas are long and narrow, several miles in length, and extend to several hundred acres. Terril soils are at the foot of the concave parts of side slopes, in slump areas on the convex parts of side slopes, and in drainageways that dissect the side slopes. Swanlake soils are on the steepest, most convex parts of the side slopes. Terril and Swanlake soils each make up about 50 percent of this map unit. The two soils are so intermingled or in areas so small that the separate them in mapping was not practical.

Typically, the Terril soil has a loam surface layer about 30 inches thick. It is black in the upper part and very dark gray in the lower part. The subsoil to a depth of about 60 inches is very dark gray, friable loam. Many places have calcareous loam underlying material at a depth of 30 to 60 inches. In some places, the underlying material contains thin, gravelly, sandy, or cobbly layers.

Typically, the Swanlake soil has a black loam surface layer about 9 inches thick. The next layer is yellowish brown loam about 4 inches thick. It contains many very dark gray wormcasts. The underlying material to a depth of about 60 inches is yellowish brown, brown, and light olive brown loam glacial till. The underlying material has layers of sandy loam or clay loam in some areas. The soil is calcareous throughout. In places, the surface layer is thinner. In places near the Terril soil, the surface layer has been leached of carbonates. In some places, it is as much as 24 inches thick.

Included with these soils in mapping are small areas of Arvilla, Sioux, and Sverdrup soils. The Arvilla, Sioux, and Sverdrup soils have gravelly and sandy underlying material. Also included are a few seep areas on the foot slopes ranging from less than 1 acre to several acres. The included soils make up 2 to 15 percent of this map unit.

Swanlake and Terril soils are moderately permeable. Surface runoff is very rapid. Available water capacity is high. In most places, the surface layer of the Swanlake soil is mildly alkaline and that of the Terril soil is neutral. In both soils the content of organic matter is moderate, phosphorus is low or very low, and potassium is medium or high.

Most areas of these Terril-Swanlake loams are used for grazing. They are too steep for crops and are better suited to pasture and woodland. Most grazed areas have been overgrazed. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good condition.

These soils are too steep for windbreaks. Most areas along the Minnesota River are in native hardwoods, mainly American elm, basswood, green ash, and bur oak. The side slopes, which mostly face north and east, are more favorable for the growth of many species of trees and shrubs. Equipment limitations are severe. The soils are too steep and erodible to permit plowing and planting of fallowed sites. If these areas are fenced and livestock are kept out, the woodland benefits because natural regeneration occurs.

These soils are generally not used as a site for sanitary facilities or buildings because of very steep slopes. Any disturbed areas on these soils should be revegetated as soon as possible.

These soils are in capability subclass VIIe.

1867—Zumbro-Calco complex. This map unit consists of moderately well drained, well drained, and poorly drained soils in old channels and on flood plains of the Minnesota River and some of its tributaries (fig. 11). These areas are frequently flooded. Most areas are so dissected by oxbows and stream channels that cultivation is not practical. Individual areas range from 10 acres to 250 acres or more. Zumbro soils make up 60 to 80 percent of this map unit, and Calco soils make up 20 to 40 percent. The two soils are so intermingled that to separate them in mapping was not practical.

Typically, the Zumbro soil has a surface soil about 16 inches thick. The upper part is black, slightly calcareous sandy loam, and the lower part is very dark grayish brown, slightly calcareous loamy sand. The subsoil is very dark grayish brown and dark brown calcareous, loose loamy sand about 34 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, slightly calcareous sand. In many places, the underlying material is stratified with sandy and loamy material. Some areas have gravelly underlying material.

Typically, the Calco soil has a silty clay loam surface soil about 32 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is very dark gray, mottled silty clay loam. The soil typically is calcareous

Figure 11.—Zumbro-Calco complex on first bottom near the mouth of the Yellow Medicine River.

throughout. In some places, the surface layer has been leached of free lime.

Included with these soils in mapping are small areas of marshy soils in oxbows and stream channels and narrow areas of moderately well drained Terril soils on foot slopes along the sides of flood plains. In places, areas of moderately well drained Du Page soils are on slightly higher positions, and very poorly drained Nishna soils are on the lowest positions. Also included along streams are small deposits of sandy, gravelly, and stony material. The included soils make up 5 to 15 percent of the map unit.

Permeability is rapid in the Zumbro soil and moderate in the Calco soil. Surface runoff is slow. Available water capacity is moderate or low in the Zumbro soil and high or very high in the Calco soil. The surface layer is mildly alkaline in most places. The content of organic matter is moderate in the Zumbro soil and high in the Calco soil. The seasonal high water table ranges in depth from 1 foot to 3 feet in the Calco soil and is at a depth of more than 6 feet in the Zumbro soil.

Most areas of this Zumbro-Calco complex are used for grazing. They are not suitable for crops because they are too often flooded and are dissected by streams or by old meanders. If the stream channels are improved by leveling, some areas can be made suitable for crops.

These soils are well suited to grazing. Most grazed areas have been overgrazed, and as a result the native grass species have declined in vigor and decreased in abundance. They have been replaced by less productive grasses, mainly Kentucky bluegrass, and by such weeds as goldenrod and buckbrush. Proper stocking rates, uniform distribution of grazing, timely deferment of grazing, and a planned grazing system improve the pasture and keep the pasture and the soil in good condition. Potential sites for dugout ponds are plentiful.

Most areas are poorly suited to trees and shrubs because of frequent overflow. Some areas are in native hardwoods, mainly American elm, basswood, cottonwood, and green ash. If these areas are fenced and livestock are kept out, the woodland benefits from natural regeneration.

These soils generally are not used as a site for sanitary facilities or buildings because of the hazard of flooding. Pollution of the water table by sanitary facilities is also a hazard. Low strength in this soil can damage roads and streets built across areas of this soil. Damage due to low strength can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength. Roads should be protected from floodwaters.

These soils are in capability subclass VIw.

1868—Canisteo stony clay loam. This nearly level, poorly drained, calcareous soil is in drainageways on uplands that parallel the Minnesota River Valley. These drainageways are nearly 100 feet above the valley. Many stones and boulders are on the surface and in the soil. Slopes are plane or slightly convex. Individual areas are slightly elongated and range from 5 acres to 60 acres.

Typically, the surface soil is stony clay loam about 20 inches thick. It is black in the upper part and very dark gray and dark gray in the lower part. The subsoil is grayish brown, mottled, friable clay loam about 11 inches thick. The underlying material is olive gray, mottled loam glacial till. The soil is calcareous throughout. Small areas that are slightly elevated generally have a very high content of gypsum. In places, the soil is leached of lime.

Included with this soil in mapping are small areas of moderately well drained, stony Seaforth soils on knolls and on peninsulas that extend into areas of Canisteo soils. Also included are small areas of marshy soils in the lowest parts of drainageways. The included soils make up 5 to 20 percent of the map unit.

Permeability is moderate, surface runoff is slow, and available water capacity is high. The surface layer is mildly alkaline or moderately alkaline. The soil contains an excessive amount of lime, and in spots it also contains an excessive amount of gypsum. The content of organic matter is high, phosphorus is low or very low, and potassium is medium or high. The seasonal high water table is at a depth of 1 foot to 3 feet in spring and during wet periods. The surface layer and subsoil contain numerous stones and boulders, some of which are more than 3 feet in diameter.

Most areas of this Canisteo stony clay loam are used for grazing. This soil is suited to intensive cropping if the stones and boulders are removed and if it is adequately drained and fertilized. The soil dries out and warms up slowly in spring. Tile drains are needed to provide subsurface drainage. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. These nutrients help to correct the fertility imbalance caused by the high lime content. The ground water in some areas contains enough magnesium sulfate to cause disintegration of ordinary cement tile. Clay tile or alkali-resistant tile should be used. Fall plowing permits rapid preparation of a seedbed in spring.

The suitability of this soil for trees and shrubs in windbreaks is moderate to poor even though the stones and boulders are removed. The wetness and the high content of lime reduce the number of species that can grow well. The excessive amount of lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs in areas of this soil because of the high lime content. This condition is best controlled by planting trees and shrubs that can tolerate the high lime content. Drainage lowers the seasonal high water table and allows deeper rooting. Site preparation should be completed in the fall before planting, because in many years, working the soil early in spring when it is too wet can cause clodding. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

This soil is generally not used as a site for sanitary facilities and buildings because of the numerous stones and boulders on the surface of the soil and because of seasonal wetness. The water table can be within a depth of 1 foot during wet periods. Contamination of the water table is a severe hazard. Low strength in this soil, wetness, and frost action can damage roads and streets built across areas of this soil. The damage due to wetness and frost action can be reduced by draining excess water from the soil and by building above the wet zone. Roads should be designed to prevent ponding of water in ditches. The damage due to low strength can be reduced by building the base of roads with material that has greater bearing strength.

This soil is in capability subclass Vw.

1869—Du Page-McIntosh Variant loams. This map unit consists of nearly level, somewhat poorly drained and moderately well drained, calcareous soils. These soils are on slight elevations that rise 1 foot to 2 feet above the floor of the lake plain of glacial Lake Benson. Individual areas range from 4 acres to 1,000 acres or more. The Du Page soils are flooded for short periods after snowmelt in spring or after heavy rains. They generally are next to the streams and have a thicker, dark colored surface layer than McIntosh Variant soils. The McIntosh Variant soils are on plane and slightly convex areas within the lake plain and have a higher content of lime than Du Page soils. Du Page soils make up 50 to 70 percent of this map unit, and McIntosh Variant soils make up 30 to 50 percent. The two soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Du Page soil has a loam surface soil about 36 inches thick. It is black in the upper part and very dark gray and calcareous in the lower part. The underlying material to a depth of about 60 inches is dark grayish brown, calcareous loam. In some places, the upper part of the surface layer is leached of free lime. In some areas, the surface layer is sandy loam or silt loam.

Typically, the McIntosh Variant soil has a black loam surface layer about 9 inches thick. The next layer is very dark gray loam about 4 inches thick. The underlying material extending to a depth of about 43 inches is brown and dark grayish brown, friable loam and silty clay loam. Below this to a depth of about 58 inches is a buried surface layer of black loam. The underlying material to a depth of about 66 inches is olive, mottled loam. The soil is calcareous throughout. In places, the surface layer is leached of free lime. In some places, sandy material is at a depth of 40 to 60 inches.

Included with these soils in mapping are small areas of Burr and Malachy soils. The Malachy soils are in landscape positions similar to those of the major soils, and the Burr soils are in slightly lower positions. Available water capacity is lower in the Malachy soils than in the Du Page and McIntosh Variant soils, and crops are affected by drought sooner. The included soils make up 5 to 15 percent of the map unit.

Permeability is moderate, and available water capacity is high or very high. Surface runoff is slow. The surface layer is mildly alkaline in most places. The content of organic matter is high, phosphorus is low, and potassium is medium or high. The seasonal high water table is at a depth of 2.5 to 6 feet.

Most areas of these Du Page-McIntosh Variant loams are cropped. If adequately fertilized, the soils are well suited to all crops commonly grown in the county. In places, a high content of lime in the surface layer causes a fertility imbalance, which can be corrected by liberal applications of potassium and phosphorous fertilizers. The hazard of soil blowing is moderate. Drainage is not needed in the areas of this unit, but management of this unit is easier if the adjoining soils are drained. Leaving crop residue on the surface in fall-plowed fields reduces the risk of soil blowing during winter and spring.

The suitability of these soils for the trees and shrubs in windbreaks is moderate. An excessive content of lime affects the uptake of plant nutrients. Chlorosis occurs in plants growing on these soils. This condition is best controlled by planting trees and shrubs that can tolerate the high lime content. Soil blowing can be controlled by maintaining a mulch of crop residue. Grasses and weeds can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

Du Page soils generally are not used as a site for sanitary facilities or buildings because of the hazard of flooding. Pollution of ground water by sanitary facilities is also a hazard. Low strength in the Du Page soils and the hazards of wetness and frost heave in both soils can damage roads and streets built across areas of these soils. Damage due to wetness and frost heave can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or by building the base of roads with material that has greater bearing strength and is less susceptible to shrink-swell.

These soils are in capability subclass IIe.

1870—Burr-Calco silty clay loams. This map unit consists of nearly level, poorly drained, calcareous soils at the lower elevations on the lake plain. These soils are subject to occasional flooding. Concentrations of gypsum are in the Burr soils. Individual areas are broad and range from 4 acres to more than 400 acres. In the southern three-quarters of the lake plain, Burr soils make up 70 to 80 percent of the map unit, and Calco soils make up 20 to 30 percent. In the northern one-quarter of the lake plain, Burr soils make up 20 to 40 percent of the map unit, and Calco soils make up 60 to 80 percent. The two soils are so intermingled or are in areas so small that to separate them in mapping was not practical.

Typically, the Burr soil has a surface soil about 30 inches thick. The upper part of the surface soil is black and very dark gray silty clay loam that contains many crystals of gypsum, and the lower part is very dark gray silty clay that contains a few crystals of gypsum. The next layer is dark olive gray, mottled silty clay that contains a few crystals of gypsum. The underlying material to a depth of about 45 inches is olive gray, mottled silty clay loam. Below this to a depth of about 60 inches is olive gray, mottled clay. The soil is calcareous throughout. A few areas have a buried surface layer 30 to 60 inches below the surface. Some places have sandy material 40 to 60 inches below the surface.

Typically, the Calco soil has a silty clay loam surface soil about 32 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material to a depth of about 60 inches is very dark gray, mottled silty clay loam. The soil is calcareous throughout. In some areas, the surface layer is loam or clay loam. This soil has thin sandy layers in places.

Included with these soils in mapping are small areas of Oldham, Malachy, McIntosh Variant, and Marysland soils. The Oldham soils are in slight depressions and are more clayey than the Burr soils. The Malachy and McIntosh Variant soils are at a slightly higher elevation than the Burr soils and are better drained. The Marysland and Malachy soils are underlain by sandy material. The included soils make up 2 to 20 percent of the map unit.

Permeability is moderately slow in the Burr soils and moderate in the Calco soils. Available water capacity is high or very high, and surface runoff is slow. The surface layer is mildly alkaline or moderately alkaline. The content of organic matter is high, phosphorus is low, and potassium is medium or high. The seasonal high water table is at a depth of 1 foot to 3 feet, unless the soil has been artificially drained by drainage tiles.

Most areas of these Burr-Calco silty clay loams are cropped. Some areas that are not adequately drained for cultivated crops are used for grazing or wild hay. These soils are suitable for intensive use if they are adequately drained and fertilized and if all crop residue is returned. Occasionally they are flooded, especially by meltwater during spring runoff. In places, flooding after heavy rains during the growing season damages crops. These soils dry out and warm up slowly in spring. If crop growth is poor after adequate drainage has been provided, liberal applications of potassium and phosphorous fertilizers are needed. These nutrients correct the fertility imbalance caused by the high content of lime. Soybean plants are susceptible to chlorosis, and they turn yellow nearly every spring in areas of Burr soil. This chlorosis can be overcome by drainage and by growing varieties of soybeans that tolerate excessive lime, or by fertilizing and using iron chelates. In places, the ground water contains enough magnesium sulfate to disintegrate ordinary cement tile. Clay tile or alkali-resistant tile should be used. Fall plowing permits rapid preparation of a seedbed in spring.

The suitability of these soils for trees and shrubs in windbreaks is moderate to poor. The wetness and the high lime content reduce the number of species that can grow well. The excessive lime interferes with the uptake of nutrients in many woody plants. Chlorosis occurs in many trees and shrubs on soils that have a high content of lime. This condition is best controlled by planting trees and shrubs that can tolerate the lime content. Drainage lowers the seasonal high water table and allows deeper rooting. Site preparation should be completed in the fall before planting because in many years clods form if the soil is worked early in spring when it is too wet. Weeds and grasses can be controlled in newly established windbreaks by shallow cultivation or by applying approved herbicides.

These soils are generally not used as a site for sanitary facilities or buildings because of wetness and the hazard of flooding. Pollution of the ground water by sanitary facilities is also a hazard. The low strength in these soils and wetness can damage roads and streets built across areas of these soils. Damage due to wetness can be reduced by artificially draining excess water from the soil and by building roads and streets well above the wet zone. The damage due to low strength can be reduced by strengthening the soil or building the base of roads with material that has greater bearing strength.

These soils are in capability subclass IIw.

prime farmland

Prime farmland is one of several kinds of farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the Nation's needs for food and fiber. The supply of this high quality farmland is limited, and the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, must encourage and facilitate the use of prime farmland with wisdom and foresight.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops. If it is properly treated and high level management and acceptable farming methods are used, prime farmland produces high yields with minimal inputs of energy and economic resources, and its use results in the least possible damage to the environment.

Prime farmland may now be in cropland, pastureland, woodland, or other land uses, but not in urban development and built-up land or in water areas. It must either be used for producing food or fiber or be available for these uses.

Prime farmland generally has an adequate and dependable supply of moisture from precipitation or irrigation. It also has a favorable temperature and growing season, and acceptable acidity or alkalinity, few or no rocks, and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and is not flooded during the growing season. Its slope ranges mainly from 0 to 6 percent. For more detailed information on the criteria for prime farmland consult the local staff of the Soil Conservation Service.

About 388,000 acres or about 80 percent of Yellow Medicine County meets the soil requirements for prime farmland. Areas are scattered throughout the county. Nearly all of this prime farmland is used for crops.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which are more erodible, droughty, difficult to cultivate, and generally less productive.

The detailed soil map units that make up prime farmland in Yellow Medicine County are listed in this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Detailed soil map units."

Soils that have a high water table may qualify for prime farmland only if this limitation is overcome by artificial drainage. Onsite evaluation is needed to see if this limitation has been overcome.

The map units that meet the soil requirements for prime farmland are:

6—Aastad clay loam, 0 to 2 percent slopes
33B—Barnes loam, 1 to 4 percent slopes
33B2—Barnes loam, 3 to 6 percent slopes, eroded
36—Flom clay loam (where drained)
85—Calco silty clay loam, occasionally flooded (where drained)
86—Canisteo clay loam (where drained)
94B—Terril loam, 2 to 6 percent slopes
108—McIntosh silt loam, 1 to 3 percent slopes (where drained)
113—Webster clay loam (where drained)
140—Spicer silty clay loam (where drained)
141A—Egeland loam, 0 to 2 percent slopes
141B—Egeland loam, 2 to 6 percent slopes
160—Fieldon fine sandy loam (where drained)
168B—Forman clay loam, 2 to 4 percent slopes
168B2—Forman clay loam, 3 to 6 percent slopes, eroded
184—Hamerly loam, 1 to 3 percent slopes (where drained)
210—Fulda silty clay (where drained)
212—Sinai silty clay, 1 to 3 percent slopes
236—Vallers clay loam (where drained)
246—Marysland clay loam (where drained)
284B—Poinsett clay loam, 2 to 6 percent slopes
290B—Rothsay silt loam, 1 to 4 percent slopes
290B2—Rothsay silt loam, 3 to 6 percent slopes, eroded
338—Waubay clay loam, 1 to 3 percent slopes
339A—Fordville loam, 0 to 2 percent slopes
339B—Fordville loam, 2 to 6 percent slopes
347—Malachy loam
371—Clontarf sandy loam, 1 to 3 percent slopes
421B—Ves loam, 1 to 4 percent slopes
423—Seaforth loam, 1 to 3 percent slopes
434—Perella silty clay loam (where drained)
444—Canisteo silty clay loam (where drained)
446—Normania clay loam, 1 to 3 percent slopes
574—Du Page loam, occasionally flooded
591B—Doland silt loam, 1 to 4 percent slopes
591B2—Doland silt loam, 3 to 6 percent slopes, eroded
597—Tara silt loam, 1 to 3 percent slopes
954B2—Ves-Storden loams, 3 to 6 percent slopes, eroded
969B2—Zell-Rothsay silt loams, 2 to 6 percent slopes, eroded
1869—Du Page-McIntosh Variant loams (where the McIntosh Variant soil is drained)
1870—Burr-Calco silty clay loams (where drained)

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 435,000 acres in the county was used as cropland and pasture in 1967, according to the Minnesota Soil and Water Conservation Needs Inventory. Of this total, 248,000 acres was used for row crops, mainly corn and soybeans; 60,000 acres for close-grown crops, mainly wheat and oats; 33,000 acres for rotation hay and pasture; and 25,000 acres for permanent pasture. The rest was idle cropland.

The soils in Yellow Medicine County have good potential for increased production of food. About 14,000 acres of potentially good cropland is currently used as pasture. In addition to the reserve productive capacity represented by this land, food production could be increased considerably by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

The acreage in crops and pasture is gradually decreasing as more and more land is used for urban development. In 1967, the county had an estimated 17,000 acres of urban and built-up land. The acreage of such land has been growing at the rate of less than 100 acres per year.

Soil erosion is a major problem on about half of the cropland in Yellow Medicine County. It is a hazard on the undulating and steeper soils. Barnes, Buse, Doland, Forman, Poinsett, Rothsay, Storden, and Ves soils are examples.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Erosion is especially damaging on soils in which the root zone is limited and available water capacity is low or moderate, such as in Arvilla, Egeland, Fordville, and Sverdrup soils. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for recreation and for fish and wildlife.

Erosion control provides protective surface cover, reduces runoff, and increases the infiltration rate. A cropping system that keeps a plant cover on the soil for extended periods can hold soil erosion losses to an amount that wil not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, legume and grass forage crops in the cropping system reduce the risk of erosion on sloping soil and provide nitrogen and improve tilth for the crops that follow.

Slopes are so short and irregular that contour tillage or terracing is difficult in most areas of Barnes, Buse, Storden, and Ves soils. In some areas of these soils, cut and fill terraces can be used. In most areas, erosion can be controlled by a cropping system that provides substantial plant cover and keeps tillage to a minimum. Minimizing tillage and leaving crop residue on the surface help to increase the infiltration rate and reduce the hazards of runoff and erosion. These practices can be adapted to most soils in the survey area.

Terraces and diversions reduce the length of slopes and the hazards of runoff and erosion. They are more practical on deep, well drained soils that have regular slopes than on most other soils. Doland, Forman, Poinsett, and Rothsay soils are suitable for terraces. The other soils are less suitable for terraces and diversions because of irregular slopes; steep slopes; excessive wetness in the terrace channels; a sandy subsoil, which would be exposed in terrace channels; or sand and gravel within a depth of 40 inches.

Contour farming and contour stripcropping are other erosion-control measures used in the survey area. They are best adapted to soils with regular slopes.

Soil blowing is a hazard on the Arvilla, Clontarf, and Sverdrup sandy loams and on the Dovray, Fulda, Nishna, and Sinai silty clays. It can damage these soils in a few hours if winds are strong and soils are dry and bare of vegetation or surface mulch. Maintaining plant cover and surface mulch or keeping the surface rough through proper tillage minimizes soil blowing on these soils. All of the soils in the county can be damaged by soil blowing, especially after soybeans are grown. Windbreaks of well suited shrubs and trees, such as Tatarian honeysuckle and green ash, are effective in reducing the risk of soil blowing on sandy and clayey soils.

Information about the design of erosion-control practices for each kind of soil is in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil drainage is the major management need on about a third of the cropland in the county. Some soils are naturally so wet that the production of cultivated crops commonly grown in the area is generally not possible unless artificial drainage has been provided. Examples are the very poorly drained Glencoe, Oldham, Okoboji, Barbert, Dovray, and Blue Earth soils, which make up about 32,000 acres.

Unless artificially drained, poorly drained soils are so wet that in most years crops are damaged. Burr, Calco, Canisteo, Fieldon, Flom, Fulda, Marysland, Nishna, Perella, Spicer, Vallers, and Webster soils are poorly drained. These soils make up about 150,000 acres.

Small areas of the wet soils along drainageways and in swales are commonly included in areas of the moderately well drained Aastad, Tara, Sinai, Waubay, Terril, and Normania soils. Artificial drainage is needed in some of these areas.

The design of surface and subsurface drainage systems varies with the kind of soil. A combination of surface drainage and tile drainage is needed in most areas of the poorly drained and very poorly drained soils used for intensive row cropping. Tile drain lines should be more closely spaced in slowly permeable soils than they are in the more permeable soils. Tile drainage is slow in Barbert, Fulda, Dovray, Nishna, and Oldham soils. Finding adequate outlets for tile drainage systems is difficult in many areas of Burr, Calco, and Nishna soils. Special precautions are needed when the Marysland and Fieldon soils, which are underlain by sandy materials, are drained.

Information about the design of drainage systems for each kind of soil is in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil fertility is naturally medium or high in most soils in the county. Barbert soils are medium acid or slightly acid, and all the other soils are neutral or alkaline.

Crops on most of the soils in the county respond to applications of fertilizer. The soil map units under the heading "Detailed soil map units" specify fertilizer needs of the subsoil. The soils are especially low in phosphorus, but contain ample amounts of lime. The need for fertilizer depends on the kind of soil, its past and present management, and the kind of crop that is grown. Soil tests provide part of the information that is needed in choosing the proper kinds and amounts of fertilizer.

Applications of fertilizer and organic matter generally improve plant growth on the poorly drained to moderately well drained soils in which excess lime causes a fertility imbalance. Examples of poorly drained soils are Burr, Canisteo, Spicer, and Vallers soils, and examples of the moderately well drained and somewhat poorly drained soils are Hamerly, McIntosh, and Seaforth soils.

Soil texture, organic matter content, and lime content affect herbicide use and herbicide carryover. A herbicide program is likely to be most effective when these soil characteristics are considered. They are given in the description of soil map units under "Detailed soil map units."

Soil tilth is important in the germination of seeds and in the infiltration of water into the soil. Soils that have good tilth are granular and porous. Regular additions of crop residue, manure, and other organic matter can improve tilth and increase the infiltration rate.

Many soils in the county are wet or are intermingled with wet soils. Poor tilth is a problem because the soils commonly stay wet until late in spring. If the soils are plowed when wet, they tend to be very cloddy when dry, and good seedbeds are difficult to prepare. Fall plowing generally results in good tilth in spring. However, fall plowing is generally not a good practice if soil blowing is a hazard or if soybeans are grown. It may also increase the hazard of erosion on sloping and steep soils.

Field crops suited to the soils and climate of the county include many that are not now commonly grown. Corn and soybeans are the major row crops. Grain sorghum, sunflowers, beans, sugar beets, and similar crops can be grown if economic conditions are favorable.

Wheat and oats are the most common close-growing crops. Rye, barley, flax, and buckwheat are suited. Seed production is feasible from brome, big bluestem, switchgrass, and indiangrass. Harvesting seed from alfalfa, sweet clover, and red clover is also practical.

Specialty crops grown in the county are vegetables, small fruit, tree fruit, and nursery plants. They are grown mostly by home gardeners. Most vegetables and fruits grow well on soils that have good natural drainage, warm up early in spring, and are protected from wind damage. Supplemental water should be available. The latest information about growing special crops can be obtained from local offices of the Agricultural Extension Service and the Soil Conservation Service.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

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

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

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

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

The major recreational areas in the county are Upper Sioux Agency State Park along the Minnesota River, Oraas County Park on a branch of Spring Creek adjacent to U.S. Highway 59, and Wood Lake County Park on the north shore of Wood Lake. All of the towns have community parks. The potential for development of recreational areas is fair. Areas along the shoreline of some of the lakes and in wooded areas along some of the streams can be further developed into park systems.

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

The soils of Yellow Medicine County provide good habitat for various species of wildlife. Changes in land use, however, have directly reduced the populations of wildlife species. For example, Yellow Medicine County once had a high population of pheasants, but more intensive farming has severely reduced the population. Other small game are Hungarian partridge, rabbit, squirrel, fox, and beaver.

Yellow Medicine County is on the migration route of ducks and geese. Duck populations are also near permanent marshes and some of the 275 ponds and pits that have been constructed. Permanent marshes make up about 3,600 acres in the county. Most of these areas are state owned and assigned to 26 wildlife management units.

The wooded valleys along the major rivers have good populations of deer. Bullheads are in a few of the lakes, but most lakes are too shallow for fish. Northern pike, walleye, crappie, catfish, and perch are in the Minnesota River.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, soybeans, wheat, and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bluegrass, brome, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, ash, chokecherry, black raspberry, wild rose, hawthorn, maple, and willow. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, honeysuckle, cherry, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include Hungarian partridge, pheasant, meadowlark, mourning dove, field sparrow, cottontail, jackrabbit, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include thrushes, woodpeckers, squirrels, red fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 10 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 16.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 16.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69.

The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 16 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by the Minnesota Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); Moisture density, Method A—T99 (AASHTO), D 698 (ASTM).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*7*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquoll (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquoll.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*6*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*7*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Aastad series

The Aastad series consists of moderately well drained soils on uplands. These soils formed in loamy, calcareous glacial till. Permeability is moderately slow. Slope ranges from 0 to 2 percent.

Aastad soils are similar to Waubay soils and are adjacent to Forman and Flom soils. Waubay soils contain more silt and less sand than Aastad soils. Forman soils have a thinner mollic epipedon than Aastad soils, are browner in the B horizon, are more sloping, and are on slightly higher parts of the landscape. Flom soils have lower chroma in the B horizon than Aastad soils, are wetter, and are in shallow drainageways that dissect areas of Aastad soils.

Typical pedon of Aastad clay loam, 0 to 2 percent slopes, about 405 feet east and 105 feet north of the southwest corner sec. 17, T. 114 N., R. 45 W.

Ap—0 to 7 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; massive; slightly sticky; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A3—7 to 12 inches; mixed black (10YR 2/1), very dark gray (10YR 3/1), and very dark grayish brown (2.5Y 3/2) clay loam, dark gray (10YR 4/1) dry; weak fine prismatic structure parting to moderate very fine subangular blocky; firm; about 3 percent coarse fragments; neutral; clear smooth boundary.

B21—12 to 18 inches; mixed very dark grayish brown (2.5Y 3/2) and dark grayish brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) crushed, dark grayish brown (2.5Y 4/2) dry; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; about 3 percent coarse fragments; neutral; clear smooth boundary.

B22—18 to 27 inches; dark grayish brown (2.5Y 4/2) clay loam; common medium faint grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak very fine and fine subangular blocky; firm; about 3 percent coarse fragments; neutral; clear smooth boundary.

C1ca—27 to 35 inches; light olive brown (2.5Y 5/4) clay loam; common fine faint light brownish gray (2.5Y 6/2) mottles; weak very fine and fine subangular blocky structure; friable; about 5 percent coarse fragments; common lime masses; few iron stains; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—35 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; about 5 percent coarse fragments; few lime masses; many iron oxide stains; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 34 inches. The mollic epipedon ranges from 16 to 24 inches in thickness. The solum averages between 28 and 35 percent clay. Coarse fragments in the solum and C horizon commonly range from 2 to 10 percent, by volume, and dominantly are 2 to 25 millimeters in diameter. Mottles that have chroma of 2 or less are in some horizons above a depth of 40 inches.

The A horizon has value of 2 in the upper part and 2 or 3 in the lower part and chroma of 1. Typically, it is 8 to 18 inches thick. The B horizon has hue of 10YR, or it has hue of 2.5Y in the upper part, and has value and chroma of 2 through 4. It is neutral or mildly alkaline. The C horizon typically is clay loam, but it ranges to loam that is high in content of clay.

Arvilla series

The Arvilla series consists of somewhat excessively drained soils on stream terraces, outwash plains, and glacial moraines. These soils formed in a mantle of loamy glacial drift over sandy and gravelly outwash. Permeability is moderately rapid in the subsoil and rapid in the underlying material. Slope ranges from 0 to 15 percent.

Arvilla soils are similar to Sverdrup soils and are near Fordville and Sioux soils. Sverdrup soils have a sandy IIC horizon that contains little or no gravel. Fordville and Arvilla soils are in similar positions on the landscape. Fordville soils are finer textured than Arvilla soils and have a thicker solum. Sioux soils are coarser textured than Arvilla soils and have a thinner solum. They are on the steeper hills and ridges.

Typical pedon of Arvilla sandy loam, 0 to 2 percent slopes, about 2,115 feet north and 210 feet east of the southwest corner sec. 2, T. 114 N., R. 45 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

B2—8 to 16 inches; dark brown (10YR 3/3) sandy loam; weak fine subangular blocky structure; friable; about 8 percent coarse fragments; neutral; clear smooth boundary.

IIC1—16 to 30 inches; yellowish brown (10YR 5/8 and 10YR 5/4) gravelly loamy sand; single grain; loose; about 25 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

IIC2—30 to 35 inches; brownish yellow (10YR 6/6) sand; single grain; loose; about 3 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

IIC3—35 to 60 inches; grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; about 30 percent coarse fragments; many large lime masses; few iron oxide stains; few manganese oxide masses; strong effervescence; mildly alkaline.

The solum is 14 to 22 inches thick. Typically it is sandy loam, but ranges to loam and coarse sandy loam. Coarse fragments commonly range, by volume, from 2 to 10 percent in the solum and from 20 to 30 percent in the IIC horizon. They dominantly are 2 to 30 millimeters in diameter.

The A horizon is 6 to 10 inches thick and is black or very dark gray. The B2 horizon has hue of 2.5Y to 7.5YR, value of 3 or 4, and chroma of 1 through 3. Free lime has accumulated in the upper part of the IIC horizon as crusts on the bottom of pebbles or has been dispersed throughout the horizon.

In map unit 953C—Arvilla-Storden-Ves complex, 6 to 15 percent slopes—the Arvilla soils are calcareous throughout, which is outside the defined range for the series. This difference, however, does not greatly alter the use and behavior of the soils.

Barbert series

The Barbert series consists of very poorly drained soils on uplands and the lowland plain. These soils formed in silty and clayey, stone-free glacial material in shallow, closed depressions and drainageways. Permeability is slow. Slope is 0 to 1 percent.

Barbert soils are near Canisteo soils and are in depressions similar to Glencoe and Okoboji soils. Canisteo soils are calcareous, are less clayey than Barbert soils, and are at a slightly higher elevation. Glencoe and Okoboji soils are less acid in the upper part of the solum and do not have an A2 horizon.

Typical pedon of Barbert silt loam, about 1,400 feet east and 2,500 feet north of the southwest corner sec. 29, T. 115 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.

A2—8 to 13 inches; dark gray (10YR 4/1) silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure; friable; slightly acid; abrupt smooth boundary.

B21t—13 to 21 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; moderate very fine angular blocky structure; firm; thin continuous clay films on peds; slightly acid; gradual smooth boundary.

B22tg—21 to 31 inches; dark grayish brown (2.5Y 4/2) silty clay; few fine distinct yellowish brown (10YR 5/6) mottles; strong very fine angular blocky structure; firm; thin continuous clay films on peds; slightly acid; gradual smooth boundary.

B23tg—31 to 40 inches; olive gray (5Y 5/2) silty clay; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and very fine angular blocky structure; firm; thin continuous clay films on peds; neutral; gradual smooth boundary.

B3g—40 to 54 inches; olive gray (5Y 4/2) silty clay loam; few fine distinct grayish brown (10YR 5/2) and common medium distinct yellowish brown (10YR 5/6) mottles; weak fine and very fine subangular blocky and angular blocky structure; friable; neutral; gradual smooth boundary.

Cg—54 to 60 inches; gray (5Y 5/1) silty clay loam; many fine distinct light olive brown (2.5Y 5/4) mottles; weak very fine and fine subangular blocky structure; friable; neutral.

The thickness of the solum and the depth to free lime range from 35 to 75 inches. The pedon does not have coarse fragments, except in the IIC horizon that formed in glacial till.

The Ap horizon has value of 2 or 3 and chroma of 1. It is commonly 2 or 3 units higher in value when dry. The A2 horizon has value of 4 or 5 and chroma of 1. The A horizon is silt loam or light silty clay loam. The B horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 through 5, and chroma of 1 or 2. The lower values are mostly in the upper part of the B horizon. This horizon is clay, silty clay, or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 through 3. It is silty loam, silty clay loam, or silty clay.

Barnes series

The Barnes series consists of well drained soils on uplands. These soils formed in loamy calcareous glacial till. Permeability is moderate. Slope ranges from 1 to 18 percent.

Barnes soils are similar to Forman and Ves soils and are near Buse and Flom soils. Forman soils contain more clay than Barnes soils. Ves soils have a higher content of shale fragments than Barnes soils and generally have a slightly higher mean annual soil temperature. Buse soils have free carbonates in the A horizon and do not have a B horizon. Flom soils are in shallow drainageways that dissect areas of Barnes soils and are poorly drained.

Typical pedon of Barnes loam, 3 to 6 percent slopes, eroded, about 370 feet east and 300 feet south of the northwest corner sec. 3, T. 114 N., R. 46 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate very fine and fine subangular blocky structure; friable; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

B21—8 to 12 inches; dark brown (10YR 3/3) loam, brown (10YR 4/3) dry; weak and moderate very fine and fine subangular blocky structure; friable; common brown (10YR 4/3) wormcasts; common very dark grayish brown (10YR 3/2) root channels; about 5 percent coarse fragments; neutral; clear irregular boundary.

B22—12 to 17 inches; brown (10YR 4/3) loam; weak very fine subangular blocky structure; friable; dark brown (10YR 3/3) coatings on faces of peds; few yellowish brown (10YR 5/4) wormcasts; common very dark grayish brown (10YR 3/2) root channels; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

B3ca—17 to 23 inches; olive brown (2.5Y 4/4) loam; weak medium prismatic structure parting to moderate fine subangular blocky; friable; about 5 percent coarse fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

C1ca—23 to 31 inches; light olive brown (2.5Y 5/4) loam; weak very fine and fine subangular blocky structure; friable; about 7 percent coarse fragments; many lime masses; few iron oxide stains; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—31 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (2.5Y 5/2) relict mottles; weak fine and medium subangular blocky structure; friable; about 7 percent coarse fragments; many iron oxide stains; strong effervescene; mildly alkaline.

The thickness of the solum and the depth to free lime range from 12 to 23 inches. The mollic epipedon is 7 to 16 inches thick. The control section is loam or light clay loam. The solum and the C horizon commonly are as much as 10 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 25 millimeters in diameter.

The A horizon has value of 2 or 3 and chroma of 1. Typically, it is loam but ranges to sandy loam, clay loam, and silt loam. The B2 horizon has value of 3 through 5 and chroma of 2 through 4. The C horizon has value of 4 or 5 and chroma of 2 through 4.

Blue Earth series

The Blue Earth series consists of very poorly drained, calcareous soils. These soils formed in lake sediment in drained lakes and ponds. Permeability is moderate or moderately slow. Slope is 0 to 1 percent.

Blue Earth, Glencoe, Oldham, and Okoboji soils are in similar positions on the landscape. Glencoe and Okoboji soils have a solum that is leached of free carbonates. They contain less organic matter than Blue Earth soils. Oldham soils are finer textured than Blue Earth soils and contain less organic matter.

Typical pedon of Blue Earth silt loam, about 1,000 feet south and 2 feet west of the northeast corner sec. 10, T. 114 N., R. 39 W.

Lcop—0 to 8 inches; black (N 2/0) silt loam coprogenous earth, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; about 2 percent coarse fragments; common snail shell fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

Lco2—8 to 37 inches; coprogenous earth consisting of layers of black (N 2/0 and 5Y 2/1) silt loam and silty clay loam and very dark gray (5Y 3/1) silty clay loam; few fine faint olive gray (5Y 4/2) mottles; few fine and medium distinct olive (5Y 4/3) mottles; laminated with some parts breaking into platy or subangular blocky fragments; layers are friable or firm; snail shell fragments ranging from fine to common in different parts; layers have slight or strong effervescence and are mildly alkaline or moderately alkaline; clear wavy boundary.

IIC1g—37 to 53 inches; dark gray (5Y 4/1) clay loam; few fine faint olive (5Y 4/3) mottles; massive; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

IIC2g—53 to 60 inches; olive gray (5Y 4/2) loam; common medium faint olive (5Y 5/3) mottles; massive; firm; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of coprogenous earth and the depth to loamy glacial till or silty glacial lacustrine sediment range from 30 to 48 inches. The coprogenous earth commonly is 0 to 10 percent, by volume, snail or clam shells and shell fragments. It ranges from 10 to 25 percent in content of organic matter. It has hue of 10YR through 5Y, value of 2 through 4, and chroma of 1 or 2 or is neutral and has value of 2 or 3. The IIC horizon has hue of 2.5Y or 5Y, value of 3 through 5, and chroma of 1 or 2. It is loam, silt loam, clay loam, or silty clay loam.

Burr series

The Burr series consists of poorly drained, calcareous soils. These soils formed in clayey and silty lacustrine sediment on lake plains. Permeability is moderately slow. Slope ranges from 0 to 2 percent.

Burr soils are similar to Oldham and Calco soils and are near McIntosh Variant, Marysland, and Calco soils. Oldham soils do not have gypsic or calcic horizons at a depth of less than 16 inches and are at a lower elevation in the lake plain. McIntosh Variant soils are at a slightly higher elevation than Burr soils, are less clayey, and are better drained. Marysland soils have a coarser textured C horizon than Burr soils. Calco soils are fine silt. They formed in similar sediment but do not have a gypsic horizon.

Typical pedon of Burr silty clay loam, in an area of Burr-Calco silty clay loams, about 1,850 feet west and 950 feet north of the southeast corner of sec. 25, T. 115 N., R. 45 W.

Apcs—0 to 7 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; sticky; about 16 percent gypsum crystals; strong effervescence; mildly alkaline; abrupt smooth boundary.

A12cacs—7 to 13 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate very fine subangular blocky structure; friable; about 16 percent gypsum crystals; violent effervescence; mildly alkaline; clear wavy boundary.

A13cs—13 to 25 inches; mixed very dark gray (N 3/0) and black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; about 28 percent grayish brown (2.5Y 5/2) gypsum crystals; strong effervescence; mildly alkaline; clear wavy boundary.

A14—25 to 30 inches; very dark gray (N 3/0) silty clay, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; friable; about 3 percent gypsum crystals; strong effervescence; mildly alkaline; clear smooth boundary.

ACg—30 to 35 inches; dark olive gray (5Y 3/2) silty clay; few fine distinct olive brown (2.5Y 4/4) mottles; weak fine subangular blocky structure; friable; about 2 percent gypsum crystals; strong effervescence; mildly alkaline; clear smooth boundary.

C1g—35 to 45 inches; olive gray (5Y 5/2) silty clay loam; common fine distinct olive brown (2.5Y 4/4) mottles; massive; firm; trace of gypsum; few round 1-millimeter manganese oxide concretions; strong effervescence; mildly alkaline; gradual smooth boundary.

C2g—45 to 60 inches; olive gray (5Y 5/2) clay; common medium distinct dark brown (7.5Y 4/4) mottles; massive; firm; trace of gypsum; few 5 to 25 millimeter masses of lime; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 48 inches and commonly coincides with the thickness of the mollic epipedon. Some pedons do not have a calcic horizon. Most pedons are mildly alkaline, but parts of some pedons are moderately alkaline. The control section typically has less than 15 percent fine sand and coarser sand and averages 35 to 45 percent clay. The content of gypsum in the control section typically is 5 to 20 percent but ranges to 30 percent. Some pedons have subhorizons that are as much as 38 percent gypsum. The solum and the C horizon typically are silty clay loam or silty clay, but subhorizons in some pedons range from silt loam or loam to clay. Some pedons have an Ab horizon 6 to 10 inches thick.

Buse series

The Buse series consists of well drained, calcareous soils on uplands. These soils formed in loamy glacial till. Permeability is moderate or moderately slow. Slope ranges from 2 to 40 percent.

Buse soils are similar to Storden soils and are near Barnes and Forman soils. Storden and Buse soils have similar slopes, but Storden soils have a lighter colored surface layer. Barnes and Forman soils have a B horizon and have free carbonates at a greater depth than Buse soils.

Typical pedon of Buse loam, in an area of Buse-Barnes loams, 12 to 18 percent slopes, about 240 feet north and 114 feet west of the southeast corner sec. 17, T. 115 N., R. 46 W.

A1—0 to 8 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

AC—8 to 12 inches; mixed very dark grayish brown (10YR 3/2), dark brown (10YR 4/3), and yellowish brown (10YR 5/4) loam, dark grayish brown (10YR 4/2) crushed, light brownish gray (10YR 6/2) dry; weak fine and medium prismatic structure parting to weak very fine and fine subangular blocky; friable; many wormcasts and root channels; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.

C1ca—12 to 23 inches; yellowish brown (10YR 5/4) loam; weak very fine subangular blocky structure; friable; about 4 percent coarse fragments; many lime masses; few iron oxide stains; violent effervescence; moderately alkaline; clear wavy boundary.

C2—23 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The A1 horizon is 7 to 10 inches thick. It is black or very dark gray. Free lime typically is throughout the A and C horizons, but in some pedons the A horizon is partly or completely free of lime. The A and C horizons are loam or clay loam. They have coarse fragments that commonly range from 2 to 10 percent, by volume. The coarser fragments dominantly are 2 to 25 millimeters in diameter. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 5. The calcium carbonate equivalent ranges from 12 to 30 percent.

Calco series

The Calco series consists of poorly drained soils on flood plains. These soils formed in silty alluvium. Permeability is moderate. Slope ranges from 0 to 2 percent.

Calco soils are similar to Burr soils and are near Du Page and Nishna soils. Burr soils have a high content of gypsum. Du Page soils are fine-loamy. They are at a slightly higher elevation and are better drained than Calco soils. Nishna soils are at a slightly lower elevation than Calco soils.

Typical pedon of Calco silty clay loam, occasionally flooded, about 3,950 feet north and 350 feet west of the southeast corner sec. 33, T. 117 N., R. 40 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak and moderate very fine subangular blocky structure; friable; sticky; slight effervescence; mildly alkaline; clear smooth boundary.

A12—8 to 16 inches; very dark gray (N 3/0) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; many black (N 2/0) wormcasts; slight effervescence; mildly alkaline; gradual smooth boundary.

A13—16 to 32 inches; very dark gray (N 3/0) silty clay loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; few black (N 2/0) wormcasts; few fragments of snail shells; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg—32 to 60 inches; very dark gray (N 3/0) silty clay loam; common medium distinct dark grayish brown (2.5Y 4/2) mottles; massive in some parts and weak very fine subangular blocky structure in other parts; friable; few dark gray (N 4/0) masses of lime; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon commonly ranges from 30 to 60 inches. The control section typically is silty clay loam, but some pedons have subhorizons containing more clay and subhorizons of silt loam.

The A horizon has hue of 10YR or 5Y, value of 2 or 3, and chroma of 1 or is neutral and has value of 2 or 3. A Bg horizon is in some pedons and has hue of 2.5Y or 5Y, value of 3 through 5, and chroma of 1 or is neutral and has value of 3 or 4. The Cg horizon has color and texture similar to those of the A horizon, but it also has sandy or clayey strata.

Canisteo series

The Canisteo series consists of poorly drained, calcareous soils. These soils formed in loamy and silty glacial material on the rims of depressions. Permeability is moderate. Slope ranges from 0 to 2 percent.

Canisteo soils are near Glencoe and Seaforth soils and are similar to Vallers soils. Glencoe soils do not have free lime in the solum, have a thicker A horizon than Canisteo soils, and are at a slightly lower elevation. Seaforth soils are moderately well drained and are slightly upslope from Canisteo soils. Vallers soils contain more lime in the upper part of the solum than Canisteo soils and formed in areas where the mean annual soil temperature is slightly lower.

Typical pedon of Canisteo clay loam, about 1,000 feet south and 200 feet west of the northeast corner sec. 19, T. 113 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; cloddy and weak very fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smoth boundary.

A3—8 to 19 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; common fine distinct gray (5Y 5/1) mottles; moderate very fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

B2g—19 to 33 inches; olive gray (5Y 5/2) clay loam; common medium faint light gray (5Y 6/1) mottles; weak and moderate very fine subangular blocky structure; friable; about 3 percent coarse fragments; few iron oxide stains; strong effervescence; mildly alkaline; gradual wavy boundary.

C1gca—33 to 46 inches; olive gray (5Y 5/2) loam; many medium prominent brown (7.5YR 5/4) mottles; weak very fine and fine subangular blocky structure; friable; about 6 percent coarse fragments; common lime masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C2g—46 to 60 inches; olive gray (5Y 5/2) loam; many coarse prominent strong brown (7.5YR 5/6) mottles; massive; friable; about 8 percent coarse fragments; few lime masses; few manganese oxide stains; strong effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness. It is dominantly clay loam or loam, but the upper part of some pedons has horizons of silt loam or silty clay loam. The pedon is calcareous throughout and is mildly alkaline or moderately alkaline. Typically, the pedon contains 2 to 8 percent, by volume, coarse fragments that are dominantly 2 to 20 millimeters in diameter. Some pedons do not have coarse fragments to a depth of 20 inches. Some upland drainageways that parallel the Minnesota River have many surface stones and boulders.

The A horizon is 8 to 24 inches thick and ranges from black to very dark gray when moist and from very dark gray to gray when dry. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 or has hue of 10YR, value of 4 or 5, and chroma of 1. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 through 4. It is loam or light clay loam.

Clontarf series

The Clontarf series consists of moderately well drained soils. These soils formed in loamy glacial material over sandy sediment on outwash plains and sandy areas in the lowland plain. Permeability is moderately rapid in the loamy material and rapid in the sandy material. Slope ranges from 1 to 3 percent.

Clontarf soils are similar to Malachy soils and are near Egeland, Fieldon, and Sverdrup soils. Malachy soils are calcareous and are on more convex parts of the landscape than Clontarf soils. Egeland soils are well drained and generally are slightly upslope from Clontarf soils. Fieldon soils are slightly downslope from Clontarf soils. The well drained Sverdrup soils contain more sand and are upslope from Clontarf soils.

Typical pedon of Clontarf sandy loam, 1 to 3 percent slopes, about 2,600 feet south and 2,200 feet west of the northeast corner sec. 4, T. 115 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; very friable; less than 1 percent coarse fragments; neutral; clear smooth boundary.

A12—8 to 13 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; very friable; less than 1 percent coarse fragments; neutral; gradual smooth boundary.

B1—13 to 19 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; very friable; less than 1 percent coarse fragments; neutral; gradual smooth boundary.
B2—19 to 30 inches; very dark grayish brown (2.5Y 3/2) sandy loam, grayish brown (2.5Y 5/2) dry; few fine faint dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; very friable; less than 1 percent coarse fragments; neutral; gradual smooth boundary.
IIC1—30 to 50 inches; grayish brown (2.5Y 5/2) loamy sand; common fine faint light olive brown (2.5Y 5/4) mottles; single grain; loose; less than 1 percent coarse fragments; neutral; gradual smooth boundary.
IIC2—50 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand; common medium distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose; less than 1 percent coarse fragments; mildly alkaline.

The thickness of the solum ranges from 20 to 32 inches and commonly coincides with depth to the underlying sandy sediment. The mollic epipedon is 16 to 34 inches thick. The solum is sandy loam, fine sandy loam, or loam. The solum and IIC horizon are 0 to 5 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 5 millimeters in diameter. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. The IIC horizon has value of 4 through 6 and chroma of 2 through 6. It is sand, fine sand, loamy fine sand, or loamy sand.

Copaston series

The Copaston series consists of well drained soils. These soils formed in a mantle of loamy alluvium over bedrock on bottom lands. Permeability is moderate. Slope ranges from 2 to 25 percent.

Copaston soils are similar to Arvilla soils and are near Arvilla, Calco, and Du Page soils. Arvilla soils have sand and gravel at a shallow depth. They are intermingled or are adjacent to Copaston soils on stream terraces. Calco and Du Page soils are on adjacent bottom lands. They formed in thick, calcareous, alluvial deposits.

Typical pedon of Copaston loam, in an area of Copaston-Rock outcrop complex, 2 to 25 percent slopes, about 1,270 feet east and 800 feet south of the northwest corner sec. 29, T. 116 N., R. 39 W.

A1—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; common shiny kaolinite particles; about 6 percent coarse fragments; neutral; clear smooth boundary.
B2—10 to 15 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common shiny kaolinite particles; about 6 percent coarse fragments; neutral; clear irregular boundary.
B3—15 to 18 inches; very dark gray (10YR 3/1) gravelly sandy loam, dark gray (10YR 4/1) dry; few masses of grayish brown (10YR 5/2) kaolinite particles; massive; loose; about 30 percent coarse granitic fragments; slight effervescence; mildly alkaline; abrupt wavy boundary.
R—18 inches; igneous bedrock.

The thickness of the solum and depth to bedrock range from 12 to 20 inches. In some pedons, the lower part of the solum typically has a small amount of free carbonates. Coarse fragments in the solum range from 5 to 30 percent, by volume, and dominantly are 2 to 20 millimeters in diameter. The solum typically is neutral but ranges to mildly alkaline in the lower part. The solum typically is loam and sandy loam but ranges to clay loam. It has value of 2 or 3 and chroma of 1 or 2. Bedrock is Precambrian igneous rock. The boundary between the solum and bedrock is generally abrupt. In some pedons, however, a layer that ranges from a few inches to several feet in thickness overlies the bedrock. This layer consists of rock fragments and kaolinitic material weathered from igneous rock.

Doland series

The Doland series consists of well drained soils on uplands. The solum formed in silty, water- and wind-deposited sediment and in the underlying glacial till or entirely in the silty sediment. Permeability is moderate. Slope ranges from 1 to 6 percent.

Doland soils are similar to Ves, Barnes, and Rothsay soils and are near Tara, Perella, and Okoboji soils. Ves and Barnes soils formed in loamy glacial till and do not have a mantle of silty sediment. Rothsay soils formed in a silty mantle generally over 40 inches thick. Tara soils are downslope from Doland soils on concave parts of slopes and are moderately well drained. Perella soils are in drainageways and wet flat areas. Okoboji soils are in shallow depressions. Perella and Okoboji soils have an aquic soil moisture regime and a thicker mollic epipedon.

Typical pedon of Doland silt loam, 1 to 4 percent slopes, about 2,630 feet north and 180 feet west of the southeast corner sec. 6, T. 116 N., R. 40 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
A3—7 to 11 inches; mixed very dark gray (10YR 3/1) and black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; few dark grayish brown (10YR 4/2) wormcasts; neutral; clear smooth boundary.
B2—11 to 18 inches; dark yellowish brown (10YR 4/4) silt loam; weak coarse prismatic structure parting to weak fine and medium subangular blocky; friable; neutral; clear smooth boundary.

B3ca—18 to 23 inches; olive brown (2.5Y 4/4) silt loam; weak very fine and fine subangular blocky structure; friable; about 2 percent coarse fragments; violent effervescence; moderately alkaline; clear smooth boundary.
IIC1ca—23 to 29 inches; light olive brown (2.5Y 5/4) loam; very weak fine subangular blocky structure; friable; few light brownish gray (2.5Y 6/2) lime masses; about 4 percent coarse fragments; violent effervescence; moderately alkaline; clear smooth boundary.
IIC2—29 to 60 inches; mixed light olive brown (2.5Y 5/4) and light brownish gray (2.5Y 6/2) loam; massive; friable; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to carbonates range from 18 to 28 inches. The sediment over glacial till is 18 to 30 inches thick. The mollic epipedon is 9 to 16 inches thick. The control section is 18 and 27 percent clay and 15 to 25 percent sand coarser than very fine. The solum typically formed in the silty mantle, but in some pedons the lower part of the B horizon formed in glacial till. Typically, the sediment does not have coarse fragments, but in the lower few inches some of the pedons have as much as 5 percent, by volume, coarse fragments. The underlying glacial till contains 2 to 8 percent coarse fragments, by volume, that dominantly are 2 to 20 millimeters in diameter.

The A horizon is silt loam or loam. The B horizon in the upper sediment has texture similar to that of the A horizon. The B2 horizon has value of 4 or 5 and chroma of 2 through 4. A IIB horizon of loam or clay loam is in some pedons. The IIC horizon has value of 4 through 6 and chroma of 2 through 4.

Dovray series

The Dovray series consists of very poorly drained soils. These soils formed in clayey glacial material in closed depressions. Permeability is very slow. Slope is 0 to 1 percent.

Dovray soils are near Fulda soils. They are similar to Okoboji and Oldham soils. Fulda soils are at a slightly higher elevation than Dovray soils and have a thinner mollic epipedon. Okoboji soils are less clayey than Dovray soils. The Oldham soils are calcareous.

Typical pedon of Dovray silty clay, about 1,120 feet south and 60 feet east of the northwest corner sec. 14, T. 114 N., R. 41 W.

Ap—0 to 12 inches; black (N 2/0) silty clay, very dark gray (10YR 3/1) dry; cloddy; very sticky; neutral; abrupt smooth boundary.
A12—12 to 25 inches; black (N 2/0) silty clay, dark gray (10YR 4/1) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate very fine angular blocky structure; firm; neutral; gradual smooth boundary.
B2g—25 to 42 inches; olive gray (5Y 4/2) silty clay; common fine distinct yellowish brown (10YR 5/6) mottles; moderate and strong very fine angular blocky structure; firm; neutral; diffuse smooth boundary.
C1g—42 to 54 inches; mixed dark gray (5Y 4/1) and gray (5Y 5/1) silty clay; common medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; slight effervescence; mildly alkaline; clear smooth boundary.
C2g—54 to 60 inches; olive gray (5Y 5/2) silty clay loam; common coarse distinct yellowish brown (10YR 5/6) mottles; massive; firm; few thin strata of sand; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches and generally is the same as the depth to lime. The solum is typically 40 to 45 percent clay, but clay content ranges from 40 to 60 percent. The A and B horizons are silty clay or clay.

The A horizon typically is black, neutral, and has value of 2. It ranges, however, to hue of 10YR, 2.5Y, or 5Y and has value of 2 and chroma of 1, or in the lower part is neutral and has value of 3. The B horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. The C horizon has a range in color and texture similar to that of the B horizon, but in addition some pedons are silty clay loam. Some pedons have an accumulation of lime in the upper part of the C horizon.

Du Page series

The Du Page series consists of moderately well drained soils. These soils formed in loamy alluvium on flood plains. Permeability is moderate. Slope ranges from 0 to 2 percent.

Du Page soils are near Calco soils. They are similar to the Terril soils on uplands. Calco soils are at a slightly lower elevation than Du Page soils and have a shallower seasonal high water table. Terril soils have a neutral solum formed in local colluvium and are not subject to flooding.

Typical pedon of Du Page loam, occasionally flooded, about 2,630 feet east and 250 feet north of the southwest corner sec. 29, T. 114 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; cloddy and weak very fine and fine subangular blocky structure; friable; mildly alkaline; abrupt smooth boundary.
A12—8 to 22 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.
A13—22 to 36 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; friable; slight

effervescence; moderately alkaline; gradual smooth boundary.

C1—36 to 48 inches; dark grayish brown (10YR 4/2) loam; weak very fine and fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—48 to 60 inches; dark grayish brown (2.5Y 4/2) loam; massive; friable; strong effervescence; moderately alkaline.

The solum typically is 24 to 40 inches thick. Depth to carbonates ranges from 0 to 10 inches.

The A horizon is 24 to 40 inches thick. It has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam or silt loam, but some pedons have layers of sandy loam or loamy sand. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 through 3. The C horizon is similar in texture to the A horizon, but in many pedons it has thin strata that are sandy or gravelly.

Egeland series

The Egeland series consists of well drained soils on sandy outwash plains, stream terraces, and uplands. These soils formed in a loamy mantle over sandy glacial outwash sediment. Permeability is moderately rapid. Slope ranges from 0 to 6 percent.

Egeland soils are similar to Arvilla and Sverdrup soils and are near Arvilla, Sverdrup, and Rothsay soils. Arvilla soils have a sandy and gravelly IIC horizon. Sverdrup soils contain more sand. Arvilla and Sverdrup soils generally are upslope from Egeland soils. Rothsay soils are coarse-silty and in some areas are intermingled with Egeland soils.

Typical pedon of Egeland loam, 2 to 6 percent slopes, about 2,050 feet north and 180 feet west of the southeast corner sec. 21, T. 115 N., R. 45 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; spots of brown (10YR 4/3) loam; neutral; abrupt smooth boundary.

B21—10 to 19 inches; dark yellowish brown (10YR 4/4) loam; weak medium and coarse prismatic structure parting to weak and moderate fine and medium subangular blocky; friable; neutral; gradual smooth boundary.

B22—19 to 32 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak medium and coarse subangular blocky structure; friable; neutral; clear smooth boundary.

C1—32 to 48 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine subangular blocky structure; very friable; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—48 to 60 inches; brown (10YR 5/3) loamy fine sand; single grain; very friable; strong effervescence; moderately alkaline.

The thickness of the solum generally ranges from 16 to 45 inches and coincides with the depth to free lime. The mollic epipedon ranges from 8 to 16 inches in thickness. It extends into the B horizon in some pedons.

The A horizon has value of 2 or 3. It typically is loam but is fine sandy loam in some pedons. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 through 4. It typically is fine sandy loam or sandy loam but is loam in the upper part of some pedons. The B2 horizon is neutral or slightly acid. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 4. It typically is loamy sand or loamy fine sand, but in some pedons it is sandy loam or fine sandy loam or is stratified loamy and sandy material.

Fieldon series

The Fieldon series consists of poorly drained soils that formed in loamy and sandy glacial materials on outwash plains and sandy areas in the lowland plain. Permeability is moderate in the surface layer and subsoil and rapid below the subsoil. Slope ranges from 0 to 2 percent.

Fieldon soils are similar to Marysland soils and are near Clontarf and Sverdrup soils. Marysland soils have more clay in the solum than Fieldon soils. The moderately well drained Clontarf soils are at a slightly higher elevation. The well drained Sverdrup soils contain more sand and are at a higher elevation.

Typical pedon of Fieldon fine sandy loam, about 1,980 feet west and 450 feet south of the northeast corner sec. 3, T. 115 N., R. 41 W.

Ap—0 to 6 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium granular structure; very friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A12—6 to 10 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak to moderate medium granular structure; very friable; slight effervescence; mildly alkaline; clear smooth boundary.

A3—10 to 17 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; very friable; slight effervescence; mildly alkaline; clear smooth boundary.

B2g—17 to 28 inches; dark gray (10YR 4/1) fine sandy loam; few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium and coarse subangular blocky structure; very friable; slight effervescence; mildly alkaline; gradual smooth boundary.

C1g—28 to 42 inches; grayish brown (2.5Y 5/2) loamy fine sand; few fine prominent light olive brown (2.5Y 5/4) mottles; single grain; loose; slight effervescence; mildly alkaline; gradual smooth boundary.

C2g—42 to 50 inches; olive gray (5Y 5/2) loamy fine sand; few medium distinct dark brown (10YR 4/3) mottles; single grain; loose; slight effervescence; mildly alkaline; gradual smooth boundary.

C3g—50 to 60 inches; gray (5Y 5/1) loamy fine sand; common medium distinct dark brown (10YR 4/3) mottles; single grain; loose; thin strata of fine sandy loam; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 36 inches. Free carbonates are in all parts of the pedon. The solum and C horizon are mildly alkaline or moderately alkaline. The mollic epipedon is 14 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or is neutral and has value of 2 or 3. It is fine sandy loam or loam. The B horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 1 through 4. It has few to many mottles in all parts. The B horizon is mostly fine sandy loam, but in some pedons the upper part is loam and the lower part is loamy fine sand. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It mainly is fine sand or loamy fine sand but commonly has strata of fine sandy loam, loam, silt loam, or silty clay loam.

Flom series

The Flom series consists of poorly drained soils on uplands. These soils formed in loamy, calcareous glacial material. Permeability is moderately slow. Slope ranges from 0 to 2 percent.

The Flom soils in Yellow Medicine County have a thicker mollic epipedon than is defined in the range for the Flom series. This difference, however, does not alter the use or behavior of the soils.

Flom soils are similar to Fulda soils and are near Barnes, Waubay, and Vallers soils. Fulda soils are more clayey than Flom soils. Barnes and Waubay soils are upslope from Flom soils and are better drained than those soils. Vallers soils are calcareous throughout the solum.

Typical pedon of Flom clay loam, about 300 feet west and 150 feet south of the northeast corner sec. 25, T. 114 N., R. 46 W.

Ap—0 to 7 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A12—7 to 20 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual smooth boundary.

A3—20 to 28 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; common medium distinct dark grayish brown (2.5Y 4/2) mottles; weak very fine and fine subangular blocky structure; friable; about 4 percent coarse fragments; neutral; clear irregular boundary.

B2g—28 to 42 inches; olive gray (5Y 4/2) clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; firm; about 5 percent coarse fragments; mildly alkaline; clear wavy boundary.

C1g—42 to 50 inches; olive gray (5Y 5/2) clay loam; common medium distinct olive brown (2.5Y 4/4) mottles; massive; friable; about 5 percent coarse fragments; few 5 to 10 millimeter masses of calcium carbonate; few soft manganese oxide pellets; strong effervescence; moderately alkaline; clear smooth boundary.

C2g—50 to 60 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 14 to 48 inches and in most pedons coincides with the depth to free lime. The Flom soils on the Coteau slope are more deeply leached than those formed on the Altamont moraine. The mollic epipedon typically is 15 to 30 inches thick. It reaches a depth of 36 inches in drainageways, swales, and toe slopes. Coarse fragments in the solum and C horizon commonly range from 2 to 10 percent, by volume, and dominantly are 2 to 20 millimeters in diameter.

The A horizon has value of 2 or 3 and chroma of 1 or is neutral and has value of 2 or 3. It is dominantly clay loam but ranges to silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is typically clay loam but ranges to loam or silty clay loam that is high in content of sand. It is friable or firm and ranges from neutral to mildly alkaline. The C horizon is clay loam or loam glacial till, but in some pedons subhorizons are silty clay loam.

Fordville series

The Fordville series consists of well drained soils that formed in loamy glacial outwash over gravelly coarse sand. These soils are on terraces, outwash plains, and gravelly uplands. Permeability is moderate in the upper part and rapid in the lower part. Slope ranges from 0 to 6 percent.

Fordville soils are similar to and near Arvilla and Sverdrup soils. Arvilla and Sverdrup soils have a coarser textured solum than Fordville soils and have less depth to sand and gravelly coarse sand. They are on parts of the landscape similar to the Fordville soils.

Typical pedon of Fordville loam, 0 to 2 percent slopes, about 1,140 feet east and 100 feet south of the northwest corner sec. 34, T. 115 N., R. 45 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A12—7 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak and moderate very fine subangular blocky structure; friable; about 10 percent coarse fragments; neutral; clear smooth boundary.

B21—13 to 19 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to weak very fine subangular blocky; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

B22—19 to 26 inches; mixed very dark grayish brown (10YR 3/2), very dark gray (10YR 3/1), and dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) crushed, dark grayish brown (10YR 4/2) dry; moderate medium and coarse prismatic structure parting to weak fine and medium subangular blocky; friable; about 4 percent coarse fragments; neutral; clear smooth boundary.

IIC1—26 to 31 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; about 20 percent coarse fragments; mildly alkaline; clear smooth boundary.

IIC2—31 to 43 inches; dark brown (10YR 4/3) gravelly coarse sand; single grain; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

IIC3—43 to 60 inches; dark brown (10YR 4/3) gravelly coarse sand; single grain; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and loamy mantle is typically 24 to 30 inches but ranges from 20 to 40 inches. Generally, thickness of the solum coincides with the depth to free lime, but in some pedons lime is in the lower part of the B horizon or has been leached into the gravelly underlying material. The mollic epipedon ranges from 16 to 26 inches in thickness and commonly includes the B2 horizon. Coarse fragments commonly range, by volume, from 2 to 10 percent in the solum and from 20 to 30 percent in the IIC horizon. They dominantly are 2 to 30 millimeters in diameter.

The A horizon is black or very dark gray. It typically is loam, but in some pedons it is silt loam. The B2 horizon has value of 2 through 4 and chroma of 1 through 4. It is loam, silt loam, or clay loam. A B3 horizon, a C horizon, or both of these are in some pedons. The IIC horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It ranges from loamy sand to stratified gravelly coarse sand.

Forman series

The Forman series consists of well drained soils. These soils formed in loamy glacial till on uplands. Permeability is moderately slow. Slope ranges from 2 to 18 percent.

Most of the Forman soils in Yellow Medicine County do not have an argillic horizon because the necessary increase in content of clay for such a horizon is not evident. As a result, these soils are outside the range defined for the Forman series. This difference, however, does not alter the use and behavior of the soil.

Forman soils are similar to Barnes soils and are near Aastad and Flom soils. Barnes soils contain less clay and are more friable than Forman soils. Aastad soils have a thicker A horizon and a more olive colored B horizon than Forman soils. Aastad soils are slightly downslope from Forman soils and are moderately well drained. The poorly drained Flom soils are in shallow drainageways that dissect the Forman soils.

Typical pedon of Forman clay loam, 2 to 4 percent slopes, about 2,570 feet west and 700 feet north of the southeast corner sec. 21, T. 114 N., R. 45 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak to moderate very fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

B21—8 to 15 inches; dark brown (10YR 3/3) clay loam, brown (10YR 4/3) dry; moderate medium and coarse prismatic structure parting to moderate fine and very fine subangular blocky; firm; about 20 percent black (10YR 2/1) wormcasts in the upper part and about 10 percent brown (10YR 4/3) wormcasts in lower part; about 1 percent coarse fragments; neutral; clear smooth boundary.

B22—15 to 21 inches; brown (10YR 4/3) clay loam; moderate medium and coarse prismatic structure parting to weak fine and medium subangular blocky; firm; about 1 percent coarse fragments; neutral; clear irregular boundary.

C1ca—21 to 34 inches; mixed dark yellowish brown (10YR 4/4) and grayish brown (2.5Y 5/2) clay loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; few masses of lime; about 1 percent coarse fragments; violent effervescence; moderately alkaline; clear irregular boundary.

C2—34 to 47 inches; mixed dark yellowish brown (10YR 4/4) and grayish brown (2.5Y 5/2) clay loam; massive; friable; few stains of iron oxide; about 1 percent coarse fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

C3—47 to 60 inches; mixed grayish brown (2.5Y 5/2) and dark yellowish brown (10YR 4/4) clay loam; massive; friable; common iron oxide stains; common manganese oxide stains on faces of fractures; about 2 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free lime range from 15 to 26 inches. The mollic epipedon ranges from 9 to 16 inches in thickness. Both the solum and the

C horizon are clay loam or loam. The solum and C horizon are from 0 to 10 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 25 millimeters in diameter.

The A horizon has value of 2 or 3 and chroma of 1. The B horizon has hue of 10YR, which grades to 2.5Y in the lower part of some pedons, value of 3 or 4, and chroma of 1 through 3. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is mildly alkaline or moderately alkaline.

Fulda series

The Fulda series consists of poorly drained soils. These soils formed in silty and clayey glacial lacustrine sediment, mainly on ice-walled lake plains. Permeability is slow. Slope ranges from 0 to 2 percent.

Fulda soils are similar to Perella soils and are near Sinai and Dovray soils. Sinai soils are at a slightly higher elevation than Fulda soils and are better drained. Dovray soils are in depressions and are very poorly drained. Perella soils contain less clay than Fulda soils.

Typical pedon of Fulda silty clay, about 1,700 feet west and 190 feet north of the southeast corner sec. 34, T. 114 N., R. 46 W.

Ap—0 to 7 inches; black (N 2/0) silty clay, very dark gray (10YR 3/1) dry; cloddy and moderate very fine subangular blocky structure; friable, sticky; neutral; abrupt smooth boundary.

A12—7 to 14 inches; black (N 2/0) silty clay, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; neutral; clear smooth boundary.

A3g—14 to 19 inches; very dark gray (N 3/0) silty clay, very dark grayish brown (2.5Y 3/2) crushed, dark gray (10YR 4/1) dry; few fine distinct olive gray (5Y 4/2) mottles; moderate very fine subangular blocky structure; neutral; clear irregular boundary.

B2g—19 to 28 inches; dark grayish brown (2.5Y 4/2) silty clay; common fine faint grayish brown (2.5Y 5/2) mottles; moderate very fine and fine subangular blocky structure; firm; many tongues of very dark gray (N 3/0); neutral; clear irregular boundary.

C1g—28 to 36 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium faint light olive brown (2.5Y 5/4) mottles; massive; friable; few very dark gray (N 3/0) tongues in upper part; few fine masses of lime; few iron oxide stains; slight effervescence; mildly alkaline; gradual smooth boundary.

C2g—36 to 60 inches; gray (5Y 5/1) silty clay loam; common medium distinct olive (5Y 5/4) mottles; massive; friable; many iron oxide stains; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 50 inches. The depth to free carbonates generally is 20 to 30 inches. The mollic epipedon is 14 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or is neutral and has value of 2 or 3. It is silty clay loam or silty clay. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It typically is silty clay or clay, but in some pedons is silty clay loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is silty clay loam or silty clay, but in some pedons it is clay loam.

Glencoe series

The Glencoe series consists of very poorly drained soils that formed in loamy glacial material in shallow, closed depressions. Permeability is moderately slow. Slope is 0 to 1 percent.

Glencoe soils are near Canisteo soils. They are similar to Dovray and Okoboji soils. Canisteo soils are calcareous, have a thinner mollic epipedon than Glencoe soils, and are at a slightly higher elevation. Dovray and Okoboji soils are more clayey.

Typical pedon of Glencoe clay loam, about 2,160 feet west and 115 feet north of the southeast corner sec. 1, T. 114 N., R. 42 W.

Ap—0 to 7 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; cloddy and weak fine subangular blocky structure; firm; neutral; abrupt smooth boundary.

A12—7 to 16 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; moderate very fine and fine angular and subangular blocky strcuture; firm; neutral; gradual smooth boundary.

A13—16 to 25 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate very fine subangular blocky structure; firm; strong vertical cleavage; few iron oxide stains; about 1 percent coarse fragments; neutral; gradual smooth boundary.

A3g—25 to 33 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak very fine subangular blocky structure; firm; strong vertical cleavage; common iron oxide stains; about 1 percent coarse fragments; neutral; gradual smooth boundary.

B2g—33 to 44 inches; dark grayish brown (2.5Y 4/2) clay loam; common medium distinct yellowish brown (10YR 5/6 and 10YR 5/4) mottles; weak medium subangular blocky structure; friable; few thin tongues of A horizon materials; few iron oxide masses; about 3 percent coarse fragments; neutral; gradual smooth boundary.

Cg—44 to 60 inches; olive gray (5Y 5/2) clay loam; common fine distinct olive brown (2.5Y 4/4) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum is 36 to 54 inches, and commonly coincides with the depth to free lime. The solum is commonly clay loam or silty clay loam but ranges to loam. Coarse fragments, by volume, in the solum are 0 to 5 percent and are 2 to 8 percent in the C horizon. They dominantly are 2 to 15 millimeters in diameter.

The A horizon ranges from 24 to 42 inches in thickness. It has hue of 10YR through 5Y, value of 2 or 3, and chroma of 1, or it is neutral and has value of 2 or 3. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. The C horizon has hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is loam or clay loam.

Hamerly series

The Hamerly series consists of somewhat poorly drained and moderately well drained calcareous soils. These soils formed in loamy glacial till on glaciated uplands. Permeability is moderately slow. Slope ranges from 1 to 3 percent.

The Hamerly soils in Yellow Medicine County do not have a calcic horizon within a depth of 16 inches. This difference, however, does not alter the use or behavior of the soils.

Hamerly soils are similar to Seaforth soils and are near Vallers and Aastad soils. Seaforth and Hamerly soils have similar convex slopes, but Seaforth soils have a slightly higher mean annual soil temperature. Vallers soils are downslope from Hamerly soils and are poorly drained. Aastad soils do not have free carbonates in the solum and have more distinct horizons than Hamerly soils. Hamerly and Aastad soils are in similar positions on the landscape, but Aastad soils are in areas that are plane or more concave.

Typical pedon of Hamerly loam, 1 to 3 percent slopes, about 150 feet west and 2,570 feet north of the southeast corner sec. 18, T. 115 N., R. 46 W.

A11—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

A12—8 to 15 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

AC—15 to 19 inches; mixed very dark gray (10YR 3/1) and olive brown (2.5Y 4/4) loam, dark grayish brown (10YR 4/2) crushed, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.

C1ca—19 to 35 inches; mixed olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/4) loam; weak fine subangular blocky structure; friable; few lime masses; about 5 percent coarse fragments; violent effervescence; mildly alkaline; clear smooth boundary.

C2ca—35 to 48 inches; light olive brown (2.5Y 5/4) loam; few fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; common lime masses; about 5 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

C3—48 to 60 inches; olive brown (2.5Y 4/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; massive; friable; few iron oxide stains; few manganese oxide stains; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The pedon is 1 to 10 percent, by volume, coarse fragments that dominantly are 2 to 25 millimeters in diameter.

The A horizon is 6 to 18 inches thick and has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1. The A and C horizons are loam or clay loam. They are mildly alkaline or moderately alkaline. An AC horizon is not in some pedons. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 through 4.

Malachy series

The Malachy series consists of moderately well drained and somewhat poorly drained, calcareous soils on lake plains and outwash plains. These soils formed in loamy glacial lacustrine sediment over sandy sediment. Permeability is moderate or moderately rapid in the solum and rapid in the underlying material. Slope ranges from 0 to 2 percent.

Malachy soils are similar to Clontarf soils and are near McIntosh Variant, Burr, and Marysland soils. Clontarf soils do not have free lime in the control section and are on more concave parts of the landscape than Malachy soils. Burr and Marysland soils are at a slightly lower elevation than Malachy soils and have a shallower seasonal high water table. In addition, Burr soils have a finer textured solum and C horizon. McIntosh Variant soils are fine loamy.

Typical pedon of Malachy loam, about 2,550 feet east and 100 feet south of the northwest corner sec. 35, T. 115 N., R. 45 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; less than 3 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

A3—9 to 17 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; less than 3 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

B2—17 to 27 inches; dark grayish brown (2.5Y 4/2) sandy loam; weak medium and coarse subangular blocky structure; friable; less than 3 percent coarse fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

IIC1—27 to 39 inches; dark grayish brown (2.5Y 4/2) loamy coarse sand; common fine faint light olive brown (2.5Y 5/4) mottles; single grain; loose; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC2—39 to 60 inches; grayish brown (2.5Y 5/2) coarse sand; common medium distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose; about 15 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to loamy fine sand or coarser sand range from 20 to 40 inches. The solum is dominantly loam, but it can also be sandy loam and fine sandy loam. The mollic epipedon is 16 to 24 inches thick. Coarse fragments, by volume, are as much as 10 percent in the solum and as much as 20 percent in the IIC horizon. They dominantly are 2 to 15 millimeters in diameter.

The A horizon has value of 2 or 3 and chroma of 1 or 2 in the lower part. The B horizon has hue of 10YR or 2.5Y, value of 3 through 6, and chroma of 2 through 4. The IIC horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 through 6. It ranges from loamy sand to coarse sand.

Marysland series

The Marysland series consists of poorly drained, calcareous soils in low areas on the lake plain, on stream deltas, and in overflow channels between some of the streams that cross the lowland plain. These soils formed in loamy lacustrine sediment overlying sandy material. Permeability is moderate in the loamy material and rapid in the sandy material. Slope ranges from 0 to 2 percent.

Most of the Marysland soils in Yellow Medicine County have a gypsic horizon and are coarse loamy. These characteristics are outside the defined range for the series. These differences, however, do not alter the use and behavior of the soils.

Marysland soils are similar to Fieldon soils and are near the Burr and Malachy soils. Fieldon soils have more sand and less clay in the solum. Burr soils have a finer textured IIC horizon than Marysland soils. Malachy soils are at a slightly higher elevation than Marysland soils and are better drained.

Typical pedon of Marysland clay loam, about 2,280 feet south and 260 feet east of the northwest corner sec. 18, T. 115 N., R. 45 W.

Ap—0 to 7 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; moderate very fine granular structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

A12cacs—7 to 14 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; about 25 percent gypsum; violent effervescence; moderately alkaline; clear smooth boundary.

A13ca—14 to 20 inches; very dark (10YR 3/1) clay loam, gray (10YR 5/1) dry; weak very fine and fine subangular blocky structure; friable; violent effervescence; moderately alkaline; clear irregular boundary.

C1g—20 to 28 inches; dark grayish brown (2.5Y 4/2) loam; common medium distinct olive gray (5Y 5/2) mottles; very weak to weak very fine and fine subangular blocky structure; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

IIC2—28 to 60 inches; grayish brown (2.5Y 5/2) gravelly coarse sand; many medium distinct dark yellowish brown (10YR 4/4) mottles; single grain; loose; about 20 percent coarse fragments; slight effervescence; mildly alkaline.

The mollic epipedon typically is 12 to 20 inches thick. The loamy outwash material ranges from 20 to 40 inches in thickness. It is as much as 10 percent, by volume, coarse fragments, mostly in the lower part. Some pedons do not have gypsum.

The A horizon has hue of 10YR through 5Y, value of 2 or 3, and chroma of 1 or less or is neutral and has value of 2 or 3. It is loam, clay loam, or sandy clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It has texture similar to that of the A horizon, but the range includes fine sandy loam or sandy loam in the lower part. The IIC horizon is fine sand, sand, or coarse sand or is stratified sand and gravel. It contains as much as 30 percent, by volume, coarse fragments that are dominantly 2 to 15 millimeters in diameter.

McIntosh series

The McIntosh series consists of moderately well drained and somewhat poorly drained soils on uplands. These soils formed in silty, calcareous, water-deposited sediment and the underlying loamy glacial till. Permeability is moderate. Slope ranges from 1 to 3 percent.

McIntosh soils in Yellow Medicine County contain more sand and less clay than is defined in the range for the series. This difference, however, does not alter the use and behavior of the soils.

McIntosh soils are similar to McIntosh Variant and Seaforth soils and are near Doland, Tara, and Spicer soils. McIntosh Variant soils formed in lacustrine and alluvial sediment on lake plains. Seaforth soils formed in glacial till. Doland soils are well drained and are upslope from McIntosh soils. Tara soils are moderately well drained, but they do not contain lime in the upper part of the solum. Spicer soils are poorly drained and are downslope from McIntosh soils.

Typical pedon of McIntosh silt loam, 1 to 3 percent slopes, 1,620 feet south and 75 feet west of the northeast corner sec. 6, T. 116 N., R. 40 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

AC—9 to 14 inches; very dark grayish brown (10YR 3/2) silt loam; weak very fine and fine subangular blocky structure; friable; many yellowish brown (10YR 5/4) wormcasts; slight effervescence, strong in spots; mildly alkaline; clear irregular boundary.

C1ca—14 to 24 inches; light olive brown (2.5Y 5/4) silt loam; weak fine subangular blocky structure; friable; violent effervescence; moderately alkaline; clear irregular boundary.

IIC2ca—24 to 29 inches; light olive brown (2.5Y 5/4) loam; weak fine subangular blocky structure; friable; about 3 percent coarse fragments, mostly fine gravel and a few fragments of shale; violent effervescence; moderately alkaline; gradual smooth boundary.

IIC3—29 to 38 inches; light olive brown (2.5Y 5/4) loam; common fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; about 3 percent coarse fragments, mostly fine gravel and a few fragments of shale; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC4—38 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; massive; friable; few reddish iron oxide stains and accumulations; about 3 percent coarse fragments, mostly shale; strong effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 7 to 16 inches. The thickness of the silty mantle and depth to glacial till range from 24 to 40 inches. Some pedons have a sandy loam or coarser textured layer as much as 5 inches thick between the silty mantle and the till. The upper part of the sediment typically does not have coarse fragments, but the lower few inches of the sediment in some pedons contain as much as 5 percent, by volume. The underlying glacial till is 2 to 10 percent, by volume, coarse fragments that are dominantly 2 to 20 millimeters in diameter. The pedon contains free carbonates throughout and is mildly alkaline or moderately alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. It typically is silt loam but ranges to silty clay loam or loam that has a high content of very fine sand. The Cca horizon has hue of 10YR, value of 4 to 6, and chroma of 1 to 3 or hue of 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is silt loam or silty clay loam. The IIC horizon has hue of 2.5Y, value of 5 or 6, and chroma of 3 through 6. Except for the coarser textured layer, which is at the base of the sediment in the upper part of some pedons, the IIC horizon is loam or clay loam.

McIntosh Variant

The McIntosh Variant consists of somewhat poorly drained calcareous soils on lake plains. These soils formed in loamy and silty lacustrine sediment mixed with loamy alluvium. Permeability is moderate. Slope ranges from 0 to 2 percent.

McIntosh Variant soils are similar to McIntosh and Seaforth soils and are near Burr and Marysland soils. McIntosh soils formed in a mantle of silty sediment over glacial till on uplands. They do not have an A1b horizon. Seaforth soils formed in loamy glacial till on the lowland plain. Burr and Marysland soils are at a slightly lower elevation on the lake plain and are poorly drained. In addition, Marysland soils have a sandy IIC horizon.

Typical pedon of McIntosh Variant loam, in an area of Du Page-McIntosh Variant loams, 2,600 feet east and 250 feet north of the southwest corner sec. 18, T. 114 N., R. 44 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; slight effervescence; moderately alkaine; abrupt smooth boundary.

AC—9 to 13 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; slight effervescence; moderately alkaline; clear smooth boundary.

C1ca—13 to 25 inches; brown (10YR 5/3) loam, light gray (10YR 7/2) dry; weak and moderate very fine subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

C2g—25 to 30 inches; dark grayish brown (10YR 4/2) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; weak and moderate fine subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

C3g—30 to 43 inches; dark grayish brown (2.5Y 4/2) silty clay loam; common medium faint grayish brown (2.5Y 5/2) mottles; moderate very fine subangular and angular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

A1b—43 to 58 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; slight effervescence; moderately alkaline; gradual smooth boundary.

C4—58 to 66 inches; olive (5Y 5/3) loam; common medium prominent dark yellowish brown (10YR 4/4) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum or the depth to a buried A horizon ranges from 34 to 48 inches. The mollic epipedon is 7 to 16 inches thick. The pedon is mildly alkaline or moderately alkaline. Some pedons contain gypsum crystals.

The Ap or A1 horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1. It typically is loam but ranges to silt loam, clay loam, or light silty clay loam. It contains 1 to 10 percent carbonates. The A1b horizon is silty clay loam, silty clay, clay loam, loam, or silt loam. The A1b horizon is not present in some pedons. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is loam, silt loam, or silty clay loam. The C1ca horizon contains 15 percent to more than 30 percent carbonates.

Nishna series

The Nishna series consists of poorly drained soils on flood plains. These soils formed in clayey and silty sediment. Permeability is slow. Slope is 0 to 1 percent.

Most of the Nishna soils in Yellow Medicine County have carbonates at a slightly greater depth than is defined in the range for the Nishna series. This difference, however, does not alter the use or behavior of the soils.

Nishna soils are similar to Oldham soils and are near Calco and Du Page soils. Oldham soils are in drained basins of shallow lakes and ponds on uplands and lake plains and are very poorly drained. Calco soils are fine silty and are on slightly higher parts of flood plains. Du Page soils are fine loamy, are on the highest parts of flood plains, and are moderately well drained.

Typical pedon of Nishna silty clay, occasionally flooded, about 1,200 feet east and 250 feet south of the northwest corner sec. 19, T. 114 N., R. 41 W.

Ap—0 to 7 inches; black (N 2/0) silty clay, black (10YR 2/1) dry; moderate very fine subangular blocky structure; friable; mildly alkaline; abrupt smooth boundary.

A12—7 to 14 inches; black (N 2/0) silty clay, black (10YR 2/1) dry; moderate and strong very fine angular and subangular blocky structure; firm; mildly alkaline; clear smooth boundary.

A13—14 to 28 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate very fine angular and subangular blocky structure; firm; slight effervescence; mildly alkaline; gradual smooth boundary.

B2g—28 to 35 inches; very dark gray (5Y 3/1) silty clay, dark gray (10YR 4/1) dry; weak to moderate very fine angular and subangular blocky structure; firm; slight effervescence; mildly alkaline; gradual smooth boundary.

B3g—35 to 48 inches; very dark gray (5Y 3/1) silty clay, dark gray (5Y 4/1) crushed, gray (10YR 6/1) dry; weak very fine subangular blocky structure; firm; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg—48 to 60 inches; dark gray (5Y 4/1) silty clay loam; massive; firm; few soft lime accumulations; strong effervescence; moderately alkaline.

Thickness of the solum and thickness of the mollic epipedon range from about 30 to 48 inches. Free carbonates are at the surface or within a depth of 16 inches. The control section is typically silty clay or silty clay loam. Typically, the solum is mildly alkaline or moderately alkaline, but the plow layer is neutral in some pedons.

The A horizon typically is black (10YR 2/1, 5Y 2/1, or N 2/0). In most pedons, the B horizon has colors similar to those of the A horizon but is commonly very dark gray. The C horizon has hue of 2.5Y or 5Y, value of 3 or 4, and chroma of 1 or less. Mottles that have high chroma and value are present is some pedons below a depth of 36 inches.

Normania series

The Normania series consists of moderately well drained soils on the lowland plain. These soils formed in loamy glacial till. Permeability is moderate. Slope ranges from 1 to 3 percent.

Normania soils are similar to Tara soils and are near Canisteo and Ves soils. Tara soils formed in a mantle of silty sediment overlying glacial till. They have more silt and less sand in the control section than Normania soils. Canisteo soils are slightly downslope from Normania soils, have a calcareous solum, and are poorly drained. Ves soils are upslope from Normania soils, have a thinner A horizon, and are well drained.

Typical pedon of Normania clay loam, 1 to 3 percent slopes, about 2,240 feet west and 250 feet south of the northeast corner of sec. 12, T. 115 N., R. 42 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium granular structure; friable; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

A3—8 to 13 inches; very dark grayish brown (10YR 3/2) clay loam, very dark gray (10YR 3/1) crushed, dark gray (10YR 4/1) dry; weak and moderate very fine subangular blocky structure; hard, friable; about 25 percent black (10YR 2/1) wormcasts; about 2 percent coarse fragments; neutral; clear smooth boundary.

B21—13 to 18 inches; dark brown (10YR 4/3) clay loam, dark grayish brown (2.5Y 4/2) crushed; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; hard, friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

B22—18 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct dark yellowish brown

(10YR 4/4) mottles; weak medium prismatic structure parting to weak and moderate fine and medium subangular blocky; hard, friable; about 5 percent coarse fragments; common shale fragments; neutral; clear smooth boundary.

B3ca—28 to 38 inches; light olive brown (2.5Y 5/4) loam; common fine faint grayish brown (2.5Y 5/2) mottles; weak moderate subangular blocky structure; friable; about 8 percent coarse fragments; common soft coarse masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

C—38 to 60 inches; olive brown (2.5Y 4/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; massive; friable; about 5 percent coarse fragments; few soft coarse masses of lime; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 40 inches. The depth to free lime typically is 24 to 30 inches, but it ranges from 18 to 36 inches. The mollic epipedon is 10 to 20 inches thick and generally coincides with the thickness of the A horizon. The solum and C horizon typically are loam or clay loam, but some pedons have subhorizons of silt loam, sandy clay loam, or sandy loam. The solum and C horizon are 3 to 8 percent, by volume, coarse fragments. The coarse fragments are dominantly 2 to 20 millimeters in diameter. Shale fragments are common to abundant.

The A horizon has value of 2 or 3 and chroma of 1 but ranges to chroma of 2 in the lower part. The B2 horizon has value of 3 or 4 and chroma of 2 through 4. The C horizon typically has hue of 2.5Y but has hue of 5Y in the lower part in some pedons. It has value of 4 through 6 and chroma of 1 through 4.

Nutley series

The Nutley series consists of well drained, calcareous soils on uplands. These soils formed in calcareous, clayey and silty lake sediment. Permeability is slow. Slope ranges from 6 to 12 percent.

Nutley soils in Yellow Medicine County contain more silt than is defined in the range for the series. This difference, however, does not alter the use and behavior of the soils.

Nutley soils are similar to Buse soils and are near Sinai and Poinsett soils. Buse soils are less clayey than Nutley soils, having formed in loamy glacial till. Sinai soils have a solum leached of free carbonates and are on the more gentle upper and lower parts of side slopes. Poinsett soils have less steep slopes and contain less clay in the control section.

Typical pedon of Nutley clay loam, in an area of Nutley-Sinai complex, 6 to 12 percent slopes, eroded, about 1,700 feet west and 25 feet north of the southeast corner sec. 19, T. 115 N., R. 46 W.

Ap—0 to 7 inches; mixed 90 percent very dark gray (10YR 3/1) and 10 percent dark grayish brown (10YR 4/2) clay loam, very dark gray (10YR 3/1) crushed, gray (10YR 5/1) dry; massive; hard; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; boundary not discernable because of worm activity.

B1—7 to 13 inches; mixed 60 percent dark grayish brown (10YR 4/2) and 40 percent very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) crushed, light brownish gray (10YR 6/2) dry; moderate very fine subangular blocky structure; firm; many wormcasts; strong effervescence; mildly alkaline; boundary not discernable because of worm activity.

B2ca—13 to 23 inches; dark grayish brown (10YR 4/2) silty clay; moderate medium prismatic structure parting to weak or moderate fine and very fine angular blocky; firm; few soft 5 to 25 millimeters lime masses; violent effervescence; mildly alkaline; gradual smooth boundary.

C1ca—23 to 31 inches; light olive brown (2.5Y 5/4) silty clay loam; weak medium subangular blocky structure; friable; few soft 5 to 25 millimeter lime masses; few 5 millimeter iron oxide pipestems; varving common; violent effervescence; mildly alkaline; clear smooth boundary.

C2—31 to 50 inches; light olive brown (2.5Y 5/4) silty clay loam; massive; friable; varving common; thin manganese oxide coatings on fracture faces; common iron oxide stains; strong effervescence; mildly alkaline; gradual smooth boundary.

C3—50 to 60 inches; light yellowish brown (2.5Y 6/4) silty clay loam; common medium faint light olive brown (2.5Y 5/6) relict mottles; massive; friable; varving common; few lime masses; strong effervescence; moderately alkaline.

The solum ranges from 14 to 26 inches in thickness. The mollic epipedon is 6 to 14 inches thick. The control section is silty clay or silty clay loam and ranges between 35 and 45 percent clay. Coarse fragments typically are only in the A horizon and are less than 5 percent, by volume. The coarse fragments are dominantly 2 to 10 millimeters in diameter.

The A horizon typically is clay loam but ranges to silty clay loam and silty clay. It has value of 2 or 3 and chroma of 1 or less. An A3 horizon is present in some pedons. The B2 horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2. A B3ca horizon is present in some pedons. The C horizon has value of 4 through 6 and chroma of 2 through 4. It is silty clay loam or silty clay.

Okoboji series

The Okoboji series consists of very poorly drained soils in depressions and swales on uplands. These soils formed in silty and clayey glacial materials. Permeability is moderately slow. Slope is 0 to 1 percent.

Okoboji soils are similar to Glencoe and Dovray soils. They are near Canisteo and Perella soils. Glencoe soils contain more sand in the control section than Okoboji soils, and Dovray soils contain more clay. Poorly drained Canisteo and Perella soils are at a slightly higher elevation than Okoboji soils and have a thinner mollic epipedon. In addition, Canisteo soils are calcareous.

Tyical pedon of Okoboji silty clay loam, about 2,075 feet east and 115 feet north of the southwest corner sec. 18, T. 113 N., R. 39 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak very fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A12—10 to 18 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate very fine and fine angular and subangular blocky structure; firm; neutral; clear wavy boundary.

A3—18 to 34 inches; very dark gray (N 3/0) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct light olive brown (2.5Y 5/6) mottles; weak and moderate very fine and fine angular and subangular blocky structure; firm; neutral; clear irregular boundary.

B2g—34 to 45 inches; olive gray (5Y 4/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; weak very fine subangular blocky structure; firm; few iron oxide stains; neutral; gradual irregular boundary.

Cg—45 to 60 inches; olive gray (5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; common iron oxide stains; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum typically ranges from 40 to 60 inches, and that of the mollic epipedon ranges from 24 to 48 inches. Depth to free lime ranges from 24 to 50 inches. The solum typically is silty clay loam, but subhorizons of silt loam and silty clay are present. The control section has 35 to 40 percent clay.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or less or is neutral and has value of 2 or 3. The B horizon has hue of 2.5Y or 5Y, value of 3 through 5, and chroma of 2 or less. The C horizon has colors similar to those of the B horizon.

Oldham series

The Oldham series consists of very poorly drained, calcareous soils in the drained basins of shallow lakes and ponds on uplands and lake plains. These soils formed in silty and loamy lake-deposited sediment. Permeability is moderately slow or slow. Slope is 0 to 1 percent.

Oldham soils are similar to Fulda and Nishna soils and are near the Canisteo and Vallers soils. Fulda soils do not have lime in the solum and have a thinner mollic epipedon than Oldham soils. Nishna soils formed in alluvium in low places on flood plains. Canisteo and Vallers soils have a thinner mollic epipedon and are less clayey. In addition, Canisteo and Vallers soils formed in glacial till.

Typical pedon of Oldham silty clay loam, about 600 feet north and 50 feet east of the southwest corner sec. 28, T. 114 N., R. 46 W.

A1—0 to 17 inches; very dark gray (N 3/0) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine granular structure; friable; many fragments of snail shells and masses of gypsum; strong effervescence; moderately alkaline; gradual smooth boundary.

B2—17 to 31 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine and fine subangular blocky structure; friable; few fragments of snail shells; slight effervescence; moderately alkaline; gradual smooth boundary.

B3g—31 to 43 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; common medium distinct dark olive gray (5Y 3/2) mottles; weak medium and coarse subangular blocky structure; friable; few fragments of snail shells; slight effervescence; moderately alkaline; gradual smooth boundary.

C1g—43 to 57 inches; very dark gray (5Y 3/1) clay loam, gray (10YR 5/1) dry; common medium faint dark olive gray (5Y 3/2) mottles; massive; friable; few fragments of snail shells; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2g—57 to 60 inches; dark gray (5Y 4/1) clay loam; common medium faint dark olive gray (5Y 3/2) mottles; massive; friable; few masses of soft white lime; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum is 30 to 48 inches, and the thickness of the mollic epipedon is 24 to 60 inches or more. The pedon is calcareous throughout and is mildly alkaline or moderately alkaline.

The A and B horizons are silty clay loam or silty clay. They have hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or less or are neutral and have value of 2 or 3. The Cg horizon has hue of 2.5Y or 5Y, value of 3 through 5, and chroma of 1 or 2. It is silty clay loam, silt loam, clay loam, or silty clay. In some pedons, a IIC horizon of calcareous loam or clay loam glacial till is at a depth of more than 40 inches. The underlying glacial till contains 2 to 8 percent, by volume, coarse fragments that are dominantly 2 to 15 millimeters in diameter.

Perella series

The Perella series consists of poorly drained soils on the lowland plain. These soils formed in silty glacial lacustrine sediment. Permeability is moderately slow. Slope ranges from 0 to 2 percent.

The Perella soils are similar to Spicer and Fulda soils and are near Okoboji soils. Spicer soils have free carbonates throughout the solum. Fulda soils have more clay in the solum and C horizon than Perella soils. Okoboji soils are in depressions. They do not have free lime in the solum and have a thicker mollic epipedon than Perella soils.

Typical pedon of Perella silty clay loam, about 1,900 feet east and 650 feet south of the northwest corner sec. 26, T. 115 N., R. 40 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A12—9 to 20 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B1—20 to 23 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; moderate very fine angular and subangular blocky structure; friable; neutral; clear smooth boundary.

B2g—23 to 33 inches; dark grayish brown (2.5Y 4/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate very fine angular blocky and subangular blocky structure; firm; neutral; gradual wavy boundary.

C1gca—33 to 40 inches; light brownish gray (2.5Y 6/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; friable; violent effervescence; moderately alkaline; gradual smooth boundary.

C2g—40 to 60 inches; grayish brown (2.5Y 5/2) silt loam; many coarse distinct brownish yellow (10YR 6/6) mottles; massive; friable; varved; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to carbonates range from 18 to 36 inches. The mollic epipedon is 14 to 24 inches thick. Both the solum and the C horizon typically are silty clay loam or silt loam, but some pedons have subhorizons of silty clay.

The A horizon has hue of 10YR or is neutral. It has value of 1 through 3 and chroma of 1. The Bg horizon has hue of 2.5Y or 5Y, value of 2 through 4, and chroma of 1 through 3. The Cg horizon has hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 1 or 2.

Poinsett series

The Poinsett series consists of well drained soils on ice-walled lake plains on uplands. These soils formed in silty and loamy glacial lacustrine sediment. Permeability is moderate. Slope ranges from 2 to 6 percent.

Poinsett soils are similar to Rothsay soils and are near Waubay and Sinai soils. Rothsay soils are on similar parts of the landscape but contain more silt and less clay than Poinsett soils. The moderately well drained Waubay and Sinai soils are downslope in more concave parts of the landscape and have thicker mollic epipedons than Poinsett soils. In addition, Sinai soils contain more clay.

Typical pedon of Poinsett clay loam, 2 to 6 percent slopes, about 1,260 feet west and 725 feet north of the southeast corner sec. 30, T. 115 N., R. 46 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak and moderate very fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A3—9 to 13 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; about 30 percent wormcasts of dark brown (10YR 3/3); slightly acid; clear irregular boundary.

B21—13 to 18 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; about 10 percent wormcasts of very dark gray (10YR 3/1); slightly acid; clear smooth boundary.

B22—18 to 28 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium prismatic structure parting to weak fine and medium subangular blocky; friable; neutral; clear smooth boundary.

C1ca—28 to 34 inches; yellowish brown (10YR 5/4) silt loam; weak fine and medium subangular blocky structure; friable; few masses of lime; few stains of iron oxide; violent effervescence; mildly alkaline; clear smooth boundary.

C2—34 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; few fine distinct light brownish gray (2.5Y 6/2) relict mottles; massive; friable; few reddish pipestems; few stains of iron oxide; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free lime range from 14 to 30 inches. The mollic epipedon is 8 to 16 inches thick. The A horizon and upper part of the B horizon typically are clay loam that is less than 15 percent fine sand or coarser material. Below this commonly is silt loam or silty clay loam that has thin lamellae of very fine sand and fine sand. Some pedons have loam or clay loam glacial till below a depth of 40 inches.

The A horizon has value of 2 or 3 and chroma of 1.5 or less. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 through 4. The C horizon has hue of 2.5Y or 10YR, value of 4 through 6, and chroma of 2 through 4.

Rothsay series

The Rothsay series consists of well drained soils on uplands. These soils formed in silty, calcareous sediment deposited by water and wind. Permeability is moderate. Slope ranges from 1 to 12 percent.

Rothsay soils are similar to and are near Doland, Poinsett, Tara, and Zell soils. Doland soils are fine loamy and generally upslope from Rothsay soils. Poinsett and Tara soils contain more clay than Rothsay soils. Tara soils also have a thicker mollic epipedon and are moderately well drained. Poinsett soils are on the same parts of the landscape as Rothsay soils. Zell soils are on the most convex, steepest parts of slopes and have a thin, light colored, calcareous surface layer.

Typical pedon of Rothsay silt loam, 3 to 6 percent slopes, eroded, 1,000 feet east and 75 feet north of the southwest corner sec. 22, T. 115 N., R. 45 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam; dark gray (10YR 4/1) dry; weak fine granular structure; few masses of brown (10YR 4/3); friable; neutral; abrupt smooth boundary.

B1—9 to 18 inches; brown (10YR 4/3) silt loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

B2—18 to 24 inches; dark yellowish brown (10YR 4/4) silt loam; moderate coarse prismatic structure parting to weak fine subangular blocky; friable; neutral; clear irregular boundary.

B3ca—24 to 33 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; very friable; violent effervescence; mildly alkaline; gradual smooth boundary.

C1ca—33 to 49 inches; light olive brown (2.5Y 5/4) silt loam; massive; very friable; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—49 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam; massive; very friable; strong effervescence; moderately alkaline.

The thickness of solum ranges from 15 to 36 inches, and depth to free lime ranges from 15 to 30 inches. The mollic epipedon is 7 to 16 inches thick. Both the solum and C horizon are silt loam, loam, or very fine sandy loam.

The A horizon is black or very dark gray. The B2 horizon has value of 3 through 5 and chroma of 2 through 4. The C horizon typically has hue of 2.5Y but has hue of 10YR in some pedons. It has value of 5 or 6 and chroma of 2 through 4.

Seaforth series

The Seaforth series consists of moderately well drained, calcareous soils on the lowland plain. These soils formed in loamy glacial till. Permeability is moderate. Slope ranges from 1 to 3 percent.

Seaforth soils are near Canisteo and Ves soils. They are similar to Hamerly soils. Canisteo soils are downslope from Seaforth soils and are poorly drained. Ves soils are upslope from Seaforth soils and are well drained. Hamerly and Seaforth soils are in similar positions on the landscape, but Hamerly soils have a lower mean annual soil temperature.

Typical pedon of Seaforth loam, 1 to 3 percent slopes, about 670 feet east and 155 feet north of the southwest corner sec. 8, T. 114 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; cloddy; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A3—9 to 14 inches; very dark gray (10YR 3/1) loam, very dark gray (10YR 3/1) dry; very dark grayish brown (2.5Y 3/2) crushed; moderate very fine and fine subangular blocky structure; friable; common dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) wormcasts and root channels; about 8 percent coarse fragments; violent effervescence; moderately alkaline; clear irregular boundary.

B2ca—14 to 24 inches; grayish brown (2.5Y 5/2) loam; weak very fine and fine subangular blocky structure; friable; about 4 percent coarse fragments; common lime masses; violent effervescence; moderately alkaline; gradual smooth boundary.

C1ca—24 to 44 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; very weak fine subangular blocky structure; friable; about 8 percent coarse fragments; common lime masses; few iron oxide masses; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—44 to 60 inches; olive brown (2.5Y 4/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; friable; about 8 percent coarse fragments; common iron oxide masses; violent effervescence; moderately alkaline.

The solum is 20 to 28 inches thick. The solum and the C horizon typically are loam or clay loam, but some pedons have subhorizons of silt loam, sandy clay loam, or sandy loam. The solum and the C horizon are generally mildly alkaline or moderately alkaline. They contain 3 to 8 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 20 millimeters in diameter. Fragments of shale are common or many.

The A horizon ranges from 7 to 16 inches in thickness. It has value of 2 or 3 and chroma of 1 or 2. In most pedons, the A3 horizon has colors similar to those of the B horizon. The B horizon typically has hue of 2.5Y, value of 4 or 5, and chroma of 2 through 4. Less commonly it has hue of 10YR. The C horizon typically has hue of 2.5Y but in some pedons has hue of 5Y or 10YR. It has value of 4 or 5 and chroma of 2 through 4.

Sinai series

The Sinai series consists of moderately well drained soils on ice-walled lake plains on uplands. These soils formed in clayey and silty glacial lacustrine sediment. Permeability is slow. Slope ranges from 1 to 3 percent.

Sinai soils are similar to Waubay soils and are near Fulda and Poinsett soils. Waubay soils contain more silt and less clay. Fulda soils are at a lower elevation than Sinai soils and are poorly drained. Poinsett soils are at a higher elevation than Sinai soils, have a thinner mollic epipedon, a more brownish B horizon, and contain more silt and less clay.

Typical pedon of Sinai silty clay, 1 to 3 percent slopes, about 340 feet east and 60 feet south of the northwest corner sec. 34, T. 114 N., R. 46 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; cloddy; weak very fine subangular blocky structure; sticky; slightly acid; abrupt smooth boundary.

A12—8 to 13 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable, sticky; slightly acid; clear smooth boundary.

A3—13 to 17 inches; mixed black (10YR 2/1) and very dark gray (10YR 3/1) silty clay loam; very dark gray (10YR 3/1) dry; moderate and strong very fine and fine subangular blocky structure; friable; neutral; clear irregular boundary.

B21—17 to 21 inches; very dark grayish brown (2.5Y 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak and moderate medium and coarse prismatic structure parting to moderate very fine and fine angular blocky; friable; few very dark gray (10YR 3/1) and dark grayish brown (2.5Y 4/2) wormcasts; few patchy clay films; mildly alkaline; clear wavy boundary.

B22—21 to 25 inches; dark grayish brown (2.5YR 4/2) silty clay; few fine distinct yellowish brown (10YR 5/8) mottles; weak and moderate very fine and fine subangular and angular blocky structure; firm; few very dark gray (N 3/0) and very dark grayish brown (2.5Y 3/2) wormcasts; slight effervescence; mildly alkaline; clear wavy boundary.

C1ca—25 to 45 inches; light olive gray (5Y 6/2) silty clay; common medium prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; firm; few soft lime masses; few manganese oxide masses; violent effervescence; moderately alkaline; gradual wavy boundary.

C2—45 to 60 inches; light olive gray (5Y 6/2) silty clay; many coarse prominent yellowish brown (10YR 5/8) mottles; massive; firm; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 17 to 34 inches. The mollic epipedon is 16 to 25 inches thick. The control section commonly is 35 to 50 percent clay.

The A horizon has value of 2 or 3 and chroma of 1. The B2 horizon has hue of 10YR or 2.5Y, value of 2 through 4, and chroma of 1 through 3. The A and B horizons are typically silty clay but range to silty clay loam. The C horizon has the same textures as the A horizon, but in addition it ranges to silt loam, clay loam, or loam below a depth of 40 inches.

Sioux series

The Sioux series consists of excessively drained soils on terrace escarpments and upland ridges. These soils formed in gravelly and sandy glacial outwash material. Permeability is rapid. Slope ranges from 2 to 40 percent.

Sioux soils are similar to Buse soils and are near Arvilla and Fordville soils. Buse soils formed in loam glacial till, but are similar to Sioux soils in having a weakly expressed profile. Arvilla and Fordville soils have a thicker solum than Sioux soils. Also, Fordville soils have a finer textured solum.

Typical pedon of Sioux gravelly sandy loam, in an area of Buse-Sioux complex, 18 to 40 percent slopes, about 2,700 feet south and 300 feet west of the northeast corner sec. 29, T. 115 N., R. 46 W.

A1—0 to 7 inches; black (10YR 2/1) gravelly sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; about 20 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

AC—7 to 10 inches; very dark grayish brown (10YR 3/2) gravelly loamy sand, dark grayish brown (10YR 4/2) dry; very weak fine granular structure; very friable; about 25 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

C1—10 to 20 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand; single grain; loose; about 50 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2—20 to 60 inches; dark yellowish brown (10YR 4/4) very gravelly coarse sand; single grain; loose; about 35 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 6 to 12 inches and coincides with the depth to sand and gravel. Depth to free carbonates ranges from 0 to 10 inches. Coarse fragments in the A and AC horizons are 20 to 35 percent, by volume. They are 35 to 60 percent in the C horizon. The coarse fragments dominantly are 2 to 30 millimeters in diameter.

The A horizon ranges from gravelly loamy sand to gravelly loam and from black to very dark gray. The AC horizon has value of 3 or 4 and chroma of 1 through 3. The C horizon generally has hue of 10YR but ranges to hue of 7.5YR and 2.5YR. It has value of 4 through 6 and chroma of 2 through 4. The percentages of sand, gravel, and cobbles in the C horizon are variable.

Spicer series

The Spicer series consists of poorly drained, calcareous soils in swales and flat areas of the lowland plain. These soils formed in silty glacial lacustrine sediment. They generally are at an elevation of less than 1,050 feet. Permeability is moderate. Slope ranges from 0 to 2 percent.

The Spicer soils are similar to Burr and Canisteo soils and are near Okoboji soils. Burr soils generally contain more gypsum and lime in the upper part of the solum and have a thicker mollic epipedon than Spicer soils. Canisteo soils have more sand in the solum and C horizon. Okoboji soils are in depressions. They do not have free lime in the solum and have a thicker mollic epipedon than Spicer soils.

Typical pedon of Spicer silty clay loam, about 150 feet east and 150 feet north of the southwest corner sec. 16, T. 116 N., R. 41 W.

Ap—0 to 7 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

A12—7 to 13 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine granular structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

A3—13 to 22 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

B2g—22 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine and medium subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

B3g—32 to 38 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; very friable; thin strata of very fine sandy loam; strong effervescence; moderately alkaline; clear smooth boundary.

Cg—38 to 60 inches; olive gray (5Y 5/2) silt loam; common large prominent reddish brown (5YR 4/4) mottles; massive; friable; few accumulations of iron and manganese oxide; weak horizontal cleavage; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 22 to 48 inches. The mollic epipedon ranges from 12 to 24 inches in thickness. The solum and C horizon are silty clay loam, silt loam, or loam high in content of very fine sand.

The A horizon is neutral or has hue of 10YR, value of 2 or 3, and chroma of 1. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2.

Storden series

The Storden series consists of well drained soils on the lowland plain. These soils formed in loamy glacial till. Permeability is moderate. Slope ranges from 3 to 40 percent.

Storden soils are similar to Buse and Seaforth soils and are near Ves soils. Buse soils have a slightly lower mean annual soil temperature than Storden soils and have a mollic epipedon. Seaforth soils are on lower parts of the landscape than Storden soils and have an aquic moisture regime. Ves soils have a darker colored, noncalcareous A horizon.

Typical pedon of Storden loam, in an area of Ves-Storden loams, 3 to 6 percent slopes, eroded, about 165 feet east and 130 feet north of the southwest corner sec. 6, T. 115 N., R. 40 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak very fine and fine subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1—9 to 15 inches; olive brown (2.5Y 4/4) loam; weak and moderate very fine subangular blocky structure; friable; about 5 percent coarse fragments; common shale fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—15 to 26 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 3 percent coarse fragments; few threads of lime; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—26 to 60 inches; olive brown (2.5Y 4/4) loam; massive; friable; about 5 percent coarse fragments; common shale fragments; strong effervescence; mildly alkaline.

The thickness of the solum commonly is 6 to 10 inches and coincides with the thickness of the A1 horizon. All horizons have free carbonates and are mildly alkaline or moderately alkaline. The control section has 2 to 10 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 25 millimeters in diameter.

The Ap horizon mainly has value of 4 or 5 and chroma of 2 or 3; value is 2 to 3 in a few masses. It has slight or strong effervescence. A weakly expressed B horizon 2 to 4 inches thick is in some pedons. This horizon has hue of 10YR, value of 4, and chroma of 3 or 4. It has slight effervescence. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 6. It has strong or violent effervescence.

Sverdrup series

The Sverdrup series consists of well drained soils on lowland plains, lake plains, and uplands. These soils formed in loamy glacial material over sandy sediment. Permeability is moderately rapid in the glacial material and rapid in the sandy sediment.

Sverdrup soils are similar to Egeland soils and are near Arvilla and Fordville soils. Egeland soils contain more clay than Sverdrup soils. Arvilla soils have a gravelly and sandy IIC horizon. Fordville soils are finer textured in the solum, have a thicker solum, and have a gravelly and sandy IIC horizon.

Typical pedon of Sverdrup fine sandy loam, 2 to 6 percent slopes, about 2,000 feet north and 200 feet west of the southeast corner sec. 17, T. 115 N., R. 45 W.

Ap—0 to 8 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

B2—8 to 18 inches; dark brown (10YR 4/3) fine sandy loam; weak coarse prismatic structure; friable; few very dark gray wormcasts in the upper part; few shale fragments in the lower part; slightly acid; abrupt wavy boundary.

B3—18 to 26 inches; yellowish brown (10YR 5/4) fine sand; single grain; loose; neutral; clear wavy boundary.

C1—26 to 35 inches; brown (10YR 5/3) fine sand; single grain; loose; slight effervescence; mildly alkaline; clear wavy boundary.

C2—35 to 48 inches; light yellowish brown (10YR 6/4) fine sand; single grain; loose; slight effervescence; moderately alkaline; gradual smooth boundary.

C3—48 to 60 inches; mixed light brownish gray (10YR 6/2) and light yellowish brown (10YR 6/4) fine sand; single grain; loose; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free lime vary within short horizontal distances. Depths are typically 20 to 30 inches but range from 15 to 40 inches. The depth to loamy fine sand or coarse sand ranges from 14 to 24 inches.

The A horizon is sandy loam or fine sandy loam and ranges from 10 to 15 inches in thickness. The A horizon has value of 1 and chroma of 2 or 3. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 4. The B horizon ranges from fine sandy loam to loamy sand in the upper part to fine sand in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4.

Swanlake series

The Swanlake series consists of well drained soils on river bluffs. These soils formed in loamy glacial till under prairie vegetation that has been replaced by forest vegetation. Permeability is moderate. Slope ranges from 18 to 70 percent.

Swanlake soils are similar to Buse soils and are near Terril and Storden soils. Buse soils are in the western part of the county. They are at a higher elevation and have lower mean annual soil temperature than Swanlake soils. The moderately well drained Terril soils are on foot slopes, in drainageways, and in slump areas on slopes. They have a thicker mollic epipedon than Swanlake soils. The well drained Storden soils do not have a mollic epipedon and generally are on parts of side slopes that are not covered by forest vegetation.

Typical pedon of Swanlake loam, in an area of Terril-Swanlake loams, 18 to 70 percent slopes, about 3,400 feet east and 1,500 feet north of the southwest corner sec. 3, T. 116 N., R. 40 W.

A1—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; about 20 percent yellowish brown (10YR 5/4) wormcasts; about 3 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

AC—9 to 13 inches; yellowish brown (10YR 5/4) loam; very dark grayish brown (10YR 3/2) crushed; dark grayish brown (10YR 4/2) crushed, dry; weak very fine and fine subangular blocky structure; friable; about 40 percent very dark gray (10YR 3/1) wormcasts; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear irregular boundary.

C1ca—13 to 22 inches; yellowish brown (10YR 5/4) loam; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; some evidence of lime on ped surfaces; violent effervescence; moderately alkaline; gradual smooth boundary.

C2ca—22 to 33 inches; brown (10YR 5/3) loam; weak fine and medium subangular blocky structure; friable; about 6 percent coarse fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

C3—33 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 8 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 14 inches thick. Carbonates typically are at the surface but in some pedons are leached to a depth of 10 inches. Coarse fragments range from 2 to 10 percent, by volume, and dominantly are 2 to 25 millimeters in diameter.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It has 0 to 5 percent carbonates. The AC horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 3 through 5. The C horizon has value of 5 and chroma of 4 through 6. It has 10 to 20 percent carbonates.

Tara series

The Tara series consists of moderately well drained soils on uplands. These soils formed in silty, water- and wind-deposited sediment and in the underlying loamy glacial till. Permeability is moderate. Slope ranges from 1 to 3 percent.

Tara soils are similar to Waubay soils and are near Spicer and Doland soils. Waubay soils formed in thicker deposits of silty sediment than Tara soils. Spicer soils are slightly downslope from Tara soils, have a calcareous solum, and are poorly drained. Doland soils are upslope from Tara soils, have a thinner A horizon, and are well drained.

Typical pedon of Tara silt loam, 1 to 3 percent slopes, about 300 feet south and 75 feet east of the northwest corner sec. 9, T. 116 N., R. 40 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A3—8 to 16 inches; very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) dry; moderate very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—16 to 20 inches; dark brown (10YR 3/3) silt loam, very dark grayish brown (10YR 3/2) crushed, brown (10YR 4/3) crushed and dry; weak fine prismatic structure parting to moderate very fine and fine subangular blocky; friable; few masses of very dark gray (10YR 3/1) and dark grayish brown (10YR 4/3); neutral; gradual smooth boundary.

B21—20 to 28 inches; mixed dark grayish brown (10YR 4/2) and dark brown (10YR 3/3) silt loam, brown (10YR 4/3) crushed; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; neutral; gradual smooth boundary.

B22—28 to 36 inches; dark grayish brown (2.5Y 4/2) loam; few fine faint grayish brown (2.5Y 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; about 2 percent coarse fragments; neutral; gradual smooth boundary.

IIC1—36 to 41 inches; olive brown (2.5Y 4/4) loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; few reddish iron oxide masses; slight effervescence; mildly alkaline; gradual wavy boundary.

IIC2g—41 to 60 inches; light brownish gray (2.5Y 6/2) loam; many coarse distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 6 percent coarse fragments; few calcium carbonate masses; few reddish iron oxide masses; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 38 inches. The thickness of the silt mantle ranges from 25 to 40 inches. Typically, it is silt loam, but some pedons have horizons that are loam and have less than 15 percent sand coarser than very fine sand. Most of the solum is in the silty mantle, but in some pedons the B horizon extends into the loamy underlying material. Typically, the silty mantle does not contain coarse fragments, but in the lower few inches in some pedons it contains up to 3 percent, by volume, coarse fragments. The underlying glacial till contains 2 to 8 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 20 millimeters in diameter. The mollic epipedon is 16 to 30 inches thick.

The B horizon has hue of 10YR or 2.5Y in the upper part and hue of 2.5Y in the lower part. It has value of 3 and 4 and chroma of 2 or 3. The C horizon has value of 4 through 6 and chroma of 2 through 4.

Terril series

The Terril series consists of moderately well drained soils on foot slopes on uplands. These soils formed in loamy, local colluvial and alluvial sediment. Permeability is moderate. Slope ranges from 2 to 40 percent.

The Terril soils in Yellow Medicine County have a darker, thicker mollic epipedon than is defined as the range for the series. This difference, however, does not alter the use or behavior of the soils.

Terril soils are near Buse, Storden, and Swanlake soils. They are similar to Du Page soils. Buse, Storden, and Swanlake soils generally are steeper and are above Terril soils on the landscape. In addition, these soils have a thin, calcareous A horizon. Du Page soils are on flood plains and have carbonates at or near the surface.

Typical pedon of Terril loam, 6 to 12 percent slopes, about 2,250 feet north and 1,320 feet east of the southwest corner sec. 29, T. 115 N., R. 38 W.

A11—0 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; about 4 percent coarse fragments; neutral; gradual smooth boundary.

A12—13 to 24 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak and moderate very fine and fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

A3—24 to 30 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak and moderate very fine subangular blocky structure; friable; about 10 percent coarse fragments; neutral; clear smooth boundary.

B21—30 to 38 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate very fine and fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; diffuse smooth boundary.

B22—38 to 60 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral.

The solum ranges from about 3 to 5 feet in thickness. Loamy material similar to that of the solum generally extends to a depth of 6 feet or more. Coarse fragments range from 2 to 10 percent, by volume, and dominantly are 2 to 20 millimeters in diameter. The pedon is commonly free of carbonates to a depth of at least 50 inches, except where glacial till is above this depth.

Total thickness of the A horizon ranges from 24 to 36 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is typically loam, but in some pedons is silt loam that is high in sand or is light clay loam. It is slightly acid or neutral. The B horizon has value of 3 or 4 and chroma of 1 through 4. Most commonly it is loam but in some pedons is light clay loam. It is neutral or slightly acid.

Vallers series

The Vallers series consists of poorly drained, calcareous soils on uplands. These soils formed in loamy glacial material. Permeability is moderately slow. Slope ranges from 0 to 2 percent.

Vallers soils are similar to Canisteo soils and are near Flom and Okoboji soils. Canisteo soils have a slightly higher mean annual soil temperature than Vallers soils. Flom and Vallers soils are in similar positions on the landscape. Flom soils are noncalcareous in the upper part of the solum. Okoboji soils are in depressions. They have a thicker mollic epipedon than Vallers soils and have a solum that has been leached of free carbonates.

Typical pedon of Vallers clay loam, about 240 feet west and 160 feet north of southeast corner sec. 16, T. 114 N., R. 46 W.

Ap—0 to 7 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak and moderate fine subangular blocky structure; friable; violent effervescence; moderately alkaline; abrupt smooth boundary.

A12ca—7 to 16 inches; black (10YR 2/1) and very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) and gray (10YR 5/1) dry; weak very fine and fine subangular blocky structure; friable; few grayish brown (2.5Y 5/2) wormcasts; violent effervescence; moderately alkaline; clear smooth boundary.

C1gca—16 to 23 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common very dark gray (10YR 3/1) root channels; few iron oxide stains; violent effervescence; moderately alkaline; clear smooth boundary.

C2gca—23 to 42 inches; olive gray (5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; about 3 percent coarse fragments; few lime concretions; common iron oxide stains; violent effervescence; mildly alkaline; gradual wavy boundary.

C3g—42 to 60 inches; olive gray (5Y 5/2) clay loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 4 percent coarse fragments; few large lime concretions; common iron oxide stains; strong effervescence; mildly alkaline.

The control section typically contains 2 to 8 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 20 millimeters in diameter, but in some pedons the upper part of the control section does not contain coarse fragments.

The mollic epipedon ranges from 10 to 24 inches in thickness. The A horizon typically is 10 to 16 inches thick and has hue of 10YR to 5Y or is neutral. It has value of 2 or 3 and chroma of 1 or 0. Typically, the A horizon is clay loam or silty clay loam; less commonly it is loam. An ACca horizon is present in some pedons. The Cca horizon has hue of 10YR, 2.5Y, or 5Y; value of 3 through 6; and chroma of 1 or 2; or it is neutral and has value of 4 through 6. The part of the C horizon below the Cca horizon has hue of 2.5Y or 5Y, value of 4 through 7, and chroma of 1 through 3. It is loam or clay loam.

Ves series

The Ves series consists of well drained soils on the lowland plain. These soils formed in loamy glacial till. Permeability is moderate. Slope ranges from 1 to 12 percent.

Ves soils are similar to Barnes soils and are near Canisteo, Seaforth, and Storden soils. Barnes soils have a slightly lower mean annual soil temperature than Ves soils. Canisteo and Seaforth soils have a calcareous solum. They are at a lower elevation than Ves soils and are not so well drained. Storden soils have a calcareous, lighter colored A horizon than Ves soils and have a weakly expressed solum.

Typical pedon of Ves loam, in an area of Ves-Storden loams, 3 to 6 percent slopes, eroded, about 2,640 feet west and 160 feet north of the southeast corner sec. 31, T. 113 N., R. 39 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; about 10 percent dark grayish brown (10YR 4/2) loam; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

B1—9 to 12 inches; dark brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; friable; common very dark gray (10YR 3/1) wormcasts; about 3 percent coarse fragments; neutral; clear irregular boundary.

B2—12 to 21 inches; dark yellowish brown (10YR 4/4) clay loam; weak and moderate medium and coarse prismatic structure parting to weak fine and medium subangular blocky; hard, friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

B3ca—21 to 26 inches; olive brown (2.5Y 4/4) loam; weak fine and medium subangular blocky structure;

friable; about 5 percent coarse fragments; common lime masses; violent effervescence; moderately alkaline; diffuse smooth boundary.

C1ca—26 to 38 inches; olive brown (2.5Y 4/4) loam; massive; friable; about 5 percent coarse fragments; few lime masses and few iron oxide masses; violent effervescence; moderately alkaline; gradual smooth boundary.

C2—38 to 60 inches; olive brown (2.5Y 4/4) loam; few fine faint grayish brown (2.5Y 5/2) mottles; massive; friable; about 5 percent coarse fragments; many iron oxide masses; strong effervescence; mildly alkaline.

The solum ranges from 18 to 40 inches in thickness. It typically is loam or clay loam, but has subhorizons of silt loam, sandy clay loam, or sandy loam in a few pedons. Depth to free carbonates is typically 18 to 25 inches, but the depth ranges from 14 to 33 inches. The solum and C horizon are 3 to 8 percent, by volume, coarse fragments. The coarse fragments dominantly are 2 to 20 millimeters in diameter. Shale fragments are common. The mollic epipedon is 8 to 20 inches thick.

The Ap or A1 horizon is typically black or very dark gray. The A horizon commonly is neutral but ranges from mildly alkaline to slightly acid. The B2 horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 3 or 4. Typically, it is neutral but ranges to mildly alkaline in places. The B3ca and C1ca horizons have few to many soft masses, seams, or filaments of lime. They are mildly alkaline or moderately alkaline. The C horizon typically is light olive brown or olive brown.

Waubay series

The Waubay series consists of moderately well drained soils on ice-walled lake plains on uplands. These soils formed in silty and loamy glacial lacustrine sediment. Permeability is moderate. Slope ranges from 1 to 3 percent.

Waubay soils are similar to Tara soils and are near Poinsett and Sinai soils. Tara soils, which formed partially in loam or clay loam glacial till, have more sand in the lower part of the control section than Waubay soils. The well drained Poinsett soils are on higher, more convex parts of the landscape than Waubay soils. Sinai soils are at a similar elevation but are more clayey than Waubay soils.

Typical pedon of Waubay clay loam, 1 to 3 percent slopes, about 1,100 feet south and 200 feet west of the northeast corner sec. 28, T. 114 N., R. 46 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A12—8 to 15 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; neutral; clear smooth boundary.

A3—15 to 25 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; few dark grayish brown (10YR 4/2) wormcasts; neutral; clear irregular boundary.

B21—25 to 33 inches; dark grayish brown (2.5Y 4/2) silty clay loam; weak medium prismatic structure parting to weak fine subangular blocky; friable; few very dark grayish brown (2.5Y 3/2) wormcasts; neutral; gradual smooth boundary.

B22—33 to 40 inches; dark grayish brown (2.5Y 4/2) silt loam; common medium faint olive brown (2.5Y 4/4) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; mildly alkaline; clear smooth boundary.

C1gca—40 to 49 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; common masses of lime; few stains of iron oxide; about 4 percent coarse fragments; violent effervescence; mildly alkaline; gradual smooth boundary.

IIC2g—49 to 60 inches; grayish brown (2.5Y 5/2) loam; many medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; few masses of lime; many stains of iron oxide; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free lime ranges from 24 to 45 inches. The mollic epipedon is 16 to 25 inches thick. It extends into the upper part of the B2 horizon in some pedons. The surface layer and stratified layers in the C horizon are as much as 8 percent coarse fragments, by volume, that are dominantly 2 to 10 millimeters in diameter.

The A horizon has value of 2 or 3 and chroma of 1.5 or less. The B2 horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. A B3ca horizon is present in some pedons. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 2 through 4.

Webster series

The Webster series consists of poorly drained soils on the lowland plain. These soils formed in loamy glacial sediment. Permeability is moderate. Slope ranges from 0 to 2 percent.

Webster soils are similar to Flom soils and are near Canisteo, Glencoe, and Normania soils. Flom soils have a slightly lower mean annual soil temperature than Webster soils. Canisteo soils are more calcareous than Webster soils and are closely associated with wet, flat, interdepressional areas. Glencoe soils have a thicker mollic epipedon than Webster soils. They are in shallow depressions. Normania soils are upslope from Webster soils and are moderately well drained.

Typical pedon of Webster clay loam, about 2,000 feet east and 565 feet south of the northwest corner sec. 17, T. 113 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; cloddy and weak fine subangular blocky structure; firm; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A12—10 to 14 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak and moderate very fine and fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear irregular boundary.

A3—14 to 19 inches; mixed very dark gray (10YR 3/1), very dark grayish brown (2.5Y 3/2), and dark grayish brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) crushed, dark grayish brown (2.5Y 4/2) dry; weak and moderate very fine subangular blocky structure; friable; about 6 percent coarse fragments; few iron oxide stains; neutral; clear irregular boundary.

B2g—19 to 26 inches; dark grayish brown (2.5Y 4/2) loam; common medium faint grayish brown (2.5Y 5/2) mottles; weak and moderate fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; few iron oxide stains; common very dark gray (10YR 3/1) wormcasts; neutral; gradual wavy boundary.

C1g—26 to 40 inches; olive gray (5Y 5/2) loam; common fine distinct olive brown (2.5Y 4/4) mottles; very weak very fine subangular blocky structure; friable; about 4 percent coarse fragments; many shale fragments; many masses of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

C2g—40 to 60 inches; olive gray (5Y 5/2) loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum generally ranges from 24 to 30 inches. Typically, it coincides with the depth to free lime, but in some pedons the B3 horizon contains free carbonates. Coarse fragments in the solum and C horizon commonly range from 2 to 20 millimeters in diameter.

The Ap or A2 horizons are black. They are neutral or have hue of 10YR, value of 2, and chroma of 1. These horizons are clay loam or silty clay loam. The B2 horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. Its texture is similar to that of the A horizon. The C horizon has color range similar to that of the B horizon, but in some pedons it has chroma of 3 and value as high as 6. It is commonly loam, but in some pedons it is heavy sandy loam or clay loam.

Zell series

The Zell series consists of well drained soils on uplands. These soils formed dominantly in silty, calcareous sediment deposited by water and wind. Permeability is moderate. Slope ranges from 2 to 12 percent.

Zell soils are similar to Buse soils and are near Rothsay and Tara soils. Buse soils formed in glacial till and contain more clay and sand but less silt than Zell soils. The well drained Rothsay soils and moderately well drained Tara soils have a thicker mollic epipedon and a more strongly expressed B horizon, and they do not have free carbonates in the A horizon. Rothsay soils are on the gentle, less exposed parts of convex slopes. Tara soils are in swales, foot slopes, and other concave positions.

Typical pedon of Zell silt loam, in an area of Zell-Rothsay silt loams, 2 to 6 percent slopes, eroded, about 4,400 feet east and 2,000 feet south of the northwest corner sec. 24, T. 116 N., R. 40 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

AC—9 to 13 inches; mixed brown (10YR 4/3) and very dark grayish brown (10YR 3/2) silt loam; weak fine subangular blocky structure; friable; few wormcasts of very dark gray (10YR 3/1); strong effervescence; moderately alkaline; clear smooth boundary.

C1—13 to 21 inches; light olive brown (2.5Y 5/4) very fine sandy loam; few fine distinct yellowish brown (10YR 5/6) relict mottles; massive; friable; few threads of soft lime; strong effervescence; moderately alkaline; clear wavy boundary.

C2ca—21 to 29 inches; light olive brown (2.5Y 5/4) silt loam; few medium distinct yellowish brown (10YR 5/6) relict mottles; massive; friable; common masses of lime; common fine continuous pores; violent effervescence; moderately alkaline; clear wavy boundary.

C3—29 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; common medium distinct dark yellowish brown (10YR 4/4) relict mottles; massive; friable; laminated; few fine discontinuous pores; few accumulations of manganese oxide; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 8 to 16 inches and coincides with the thickness of the mollic epipedon. The solum and C horizon are commonly silt loam but in places are very fine sandy loam or loam. In some pedons the lower part of the C horizon has lenses of finer or coarser textures.

The A horizon has value of 2 or 3 and chroma of 1.5 or less. The AC horizon has hue of 2.5Y or 10YR, value of 3 through 5, and chroma of 2 through 4. The C horizon has value of 4 through 6 and chroma of 2 through 4.

Zumbro series

The Zumbro series consists of moderately well drained and well drained soils on bottom lands and low stream terraces. These soils formed dominantly in calcareous sandy alluvium. Permeability is rapid. Slope ranges from 0 to 2 percent.

Zumbro soils are similar to Sverdrup soils and are near Calco and Du Page soils. Sverdrup soils have a mollic epipedon less than 16 inches thick. Calco soils are at a lower elevation than Zumbro soils and are poorly drained. Du Page soils are at an elevation similar to that of Calco soils and have similar natural drainage, but they have a higher content of clay than Zumbro soils.

Typical pedon of Zumbro sandy loam, in an area of Zumbro-Du Page complex, about 3,750 feet north and 330 feet east of the southwest corner sec. 35, T. 115 N., R. 39 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A3—10 to 16 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; very friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

B2—16 to 35 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak very fine and fine subangular blocky structure; loose; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

B3—35 to 50 inches; banded dark brown (10YR 4/3) and very dark grayish brown (10YR 3/2) loamy sand, very dark grayish brown (10YR 3/2) crushed, grayish brown (10YR 5/2) dry; single grain; loose; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

C—50 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; common snail shell fragments; about 7 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 30 to 55 inches in thickness. The depth to free carbonates is 0 to 20 inches. The solum and C horizon contain less than 5 percent free carbonates. Coarse fragments are less than 10 percent, by volume. The coarse fragments dominantly are 2 to 10 millimeters in diameter. The average texture of the control section is loamy fine sand or loamy sand.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 3 or 4 and chroma of 2 through 4. The C horizon has value of 4 through 6, and chroma of 2 through 5. It is typically sand or fine sand but ranges to coarse sand. Some pedons have thin gravelly layers.

formation of the soils

Soil forms through the physical and chemical weathering of deposited or accumulated geological material. The characteristics of the soil at any given point are determined by the interaction of five factors: the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plants and animals living on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material. The following paragraphs relate the factors of soil formation to the soils in the survey area.

parent material

The soils of Yellow Medicine County formed mostly in glacial till or in material sorted out of the till by the action of water. About 70 percent formed in glacial till, 7 percent in alluvium and colluvium, 6 percent in or over sandy and gravelly outwash, and 17 percent wholly or partly in lacustrine sediment (fig. 12). The Des Moines lobe of the Wisconsin glaciation is the most recent glacier that covered the county (*4, 8*). The following paragraphs describe the parent material as it occurs within major geomorphic areas in the county.

Altamont moraine. This recessional moraine of the Des Moines lobe is in the western part of the county. The landscape is undulating and rolling. Most of the till is loam. Barnes, Buse, Flom, and Vallers soils are the major soils formed in this till.

The Altamont moraine is characterized by ice-walled lake plains. These distinctive landforms are of two types, one that formed in a stable environment and one that formed in an unstable environment (*3*).

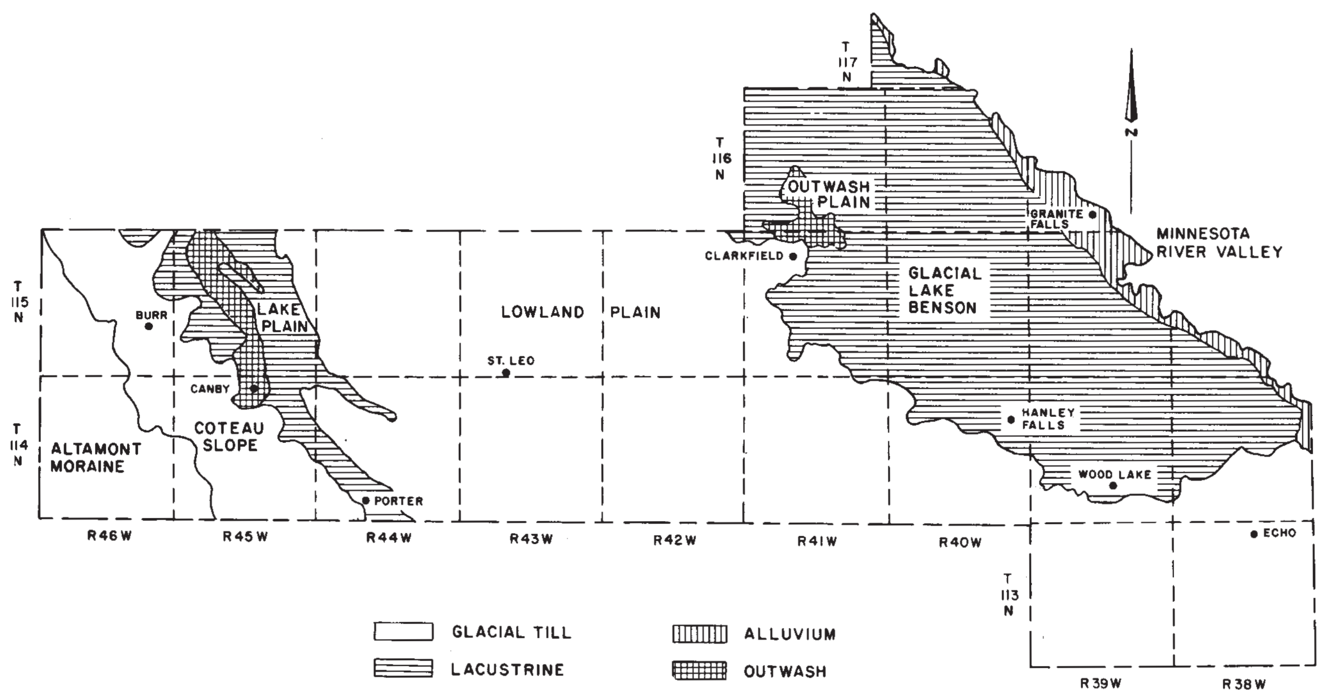

Figure 12.—Parent material and the major geomorphic areas in Yellow Medicine County.

The ice-walled lake plain that formed in a stable environment consists of nearly level and gently sloping soils on flat-topped hills. Areas range from 20 to 150 acres and, typically, are on the highest part of the landscape. The hilltops are covered with stratified clayey and silty sediment. This sediment was deposited in lake basins formed over thick deposits of superglacial till that covered blocks of stagnant glacial ice. The ice melted slowly to form the perched plains of the ice-walled lakes. Fulda, Sinai, Waubay, and Poinsett soils are the major soils.

The ice-walled lake plain that formed in an unstable environment consists of gently sloping to moderately steep soils on hills and ridges. These soils range from gravelly and sandy to silty and clayey. They formed in ice-blocked basins where the superglacial till on glacial ice was thin and the ice melted rapidly. As a result, the topography of the glacier underwent continuous change. Much superglacial till slumped or flowed into the lakes, and silt-laden glacial rivers carried much sand and gravel into the lake margins. Waves sorted and redistributed the mudflow and slump material, carrying the fines out into the lake and leaving the sand and gravel fraction on the beach along with the sand and gravel brought there by the rivers. Thus, the sediment is gravelly on the beaches and ranges to clayey near the center of the lake. The Sioux, Arvilla, and Sverdrup soils formed in the sandy and gravelly sediment on the outer edges of this ice-walled lake plain. Next are Rothsay and Zell soils formed in coarse silty sediment. Grading towards the lake center are Poinsett soils formed in fine silty sediment. Near the center of the lake plain on nearly level hilltops and sloping hillsides are clayey Sinai and Nutley soils.

Coteau slope. The Coteau slope is the first slope on the northeast flank of the Coteau des Prairies. In Yellow Medicine County it is 4 to 6 miles wide and extends across the west end of the county from the north to south. It is between the Altamont Moraine to the southwest and an ice marginal lake plain to the northeast. It increases in elevation at the rate of about 75 feet per mile. At intervals of half a mile to a mile, it is dissected by nearly parallel drainageways 25 to 50 feet deep. The Coteau slope resembles a stairway; the large areas of nearly level Aastad soils are the steps and the areas of undulating and rolling Forman soils are the risers (*4*).

The glacial till in this area is the most clayey material in the county. It is clay loam or loam that is high in content of clay. Forman and Aastad soils formed in this till. Very few areas of sandy and gravelly soils are evident.

Ice marginal lake plain. This geomorphic area is along the northeast side of the Coteau des Prairies and is 1 mile to 2 miles wide. It formed between the Coteau slope and the melting glacial ice. Most of the original lacustrine sediment was silty clay loam and silty clay, but in many places these deposits have been covered by alluvium deposited by the rivers and creeks flowing out of the steeper areas of the Côteau slope. The alluvium ranges from loamy to sandy and gravelly. The major soils formed in alluvium are the Du Page and Calco soils. McIntosh Variant soils formed in the lacustrine and alluvial sediment; the Burr soils formed in the clayey and silty sediment; and the Marysland and Malachy soils formed in the loamy, sandy, and gravelly sediment.

Outwash plains. Major outwash plains are near Canby and Clarkfield. The southern part of the Canby outwash plain has gravelly material and the northern part has sandy material. The gravelly material was carried from the Altamont moraine by Canby Creek and deposited on the nearly level ice marginal lake plain. Deltas and beaches were formed on the ice marginal lake plain by the sandy material. The Clarkfield outwash plain consists mostly of sandy sediment that probably was deposited as beaches and deltas of glacial Lake Benson. Outwash material also was deposited on small discontinuous terraces along most of the major streams and in pockets or in layers over the glacial till on uplands throughout the county. The major soils formed in gravelly outwash sediment are Arvilla, Sioux, and Fordville soils. Egeland and Sverdrup soils formed in sandy outwash sediment.

Lowland plain. The lowland plain is a glacial ground moraine or till plain that extends east from the lake plain to the Minnesota River. This till plain consists almost entirely of irregularly shaped low knolls, most of which rise 1 foot to 10 feet above the floor of the till plain. The till, which is the youngest in the county, is loam containing many unweathered gray and green shale fragments. Seaforth, Normania, and Ves soils formed in this material.

Glacial lake plain. A shallow temporary glacial lake, Glacial Lake Benson, covered the lowland plain in the eastern part of the county (*4*). The shoreline elevation is about 1,050 feet. The silty glacial lake sediment is thickest in the low areas on the lowland plain. Spicer, Perella, and Okoboji soils formed in the thick deposits of sediment. Exposed are irregularly shaped knolls of glacial till. In the northeast corner, the streamlined hills have a thin mantle of silty sediment. Doland, McIntosh, and Tara soils formed in the thin mantle of lake sediment that overlies the glacial till.

Flood plains. Alluvial material has been deposited along rivers and creeks and in the high overflow channels between some of the rivers and creeks. This sediment is silty clay loam or loam. It is dark colored, calcareous, and several feet thick in most places. Calco and Du Page soils formed in alluvial material.

In some areas on flood plains, especially in the overflow channels, the alluvial material is clayey. Nishna soils formed in these areas.

climate

Yellow Medicine County has a subhumid, continental climate characterized by cold winters and hot summers.

The climate has a pronounced effect on soil formation. Freezing of the soil during winter slows the soil-forming processes. Alternate freezing and thawing, especially in spring, play a part in the development of soil structure. Freezing and thawing also help to disintegrate parts of the glacial debris, and frost heaving helps to mix the soil material. Differences in soil temperature reflect the interaction of climate and elevation on soils in the county. Mean annual soil temperature of soils on the lowland plain is higher than that of soils on the Coteau des Prairies at a higher elevation (see fig. 1). Rainfall affects the leaching of lime, and solum thickness is largely determined by the depth to which free lime has been leached.

To a large extent, climate was responsible for the growth of prairie vegetation. As a result of this plant cover, the soils have a dark surface layer. Prairie vegetation and cool temperatures promote the accumulation of organic matter, and most of the soils in the county have a high organic matter content. More details about the climate are given in the section "General nature of the county."

plant and animal life

The native vegetation of Yellow Medicine County consisted mainly of tall and mid prairie grasses, depending on the soil, the drainage, and other site factors. Prairie cordgrass, reedgrass, switchgrass, and sedges grew on wet sites. Bluestem, green needlegrass, porcupinegrass, Canada wildrye, indiangrass, needleandthread, and sideoats grama grew on the better drained sites. A variety of flowers flourished on the native prairies, including aster, goldenrod, sunflower, blazingstar, clover, roses, lilies, harebell, phlox, and gentian.

Soil formation in Yellow Medicine County was started by the growth of plants in freshly deposited glacial till. Plant roots loosen soil and bring minerals up from the parent material. Decay of the plants returns organic matter and plant nutrients to the soil.

Earthworms affect soil formation. They eat decomposed plant matter, and their burrows help channel air and water through the soil. Subsurface horizons of many soils contain wormcasts of surface and subsoil material. Burrowing animals also mix soil material from various horizons and bring fresh parent material to the surface.

Man also influences soil formation. Farming has increased the action of some of the soil forming processes. Erosion of the surface layer has accelerated on some of the sloping soils, and some of the lower lying soils have gained deposits of eroded material. The strong granular structure of the surface layer has been weakened or destroyed in many of these soils. The surface layer of most well drained soils has become browner or grayer as a result of being mixed with the subsoil and receiving less organic matter. Leaching of many soils has been slowed as a result of increased runoff and reduced infiltration. Man's activities, particularly in altering drainage conditions, maintaining fertility, and changing the kinds of vegetation, continue to have important effects on soil formation.

relief

Yellow Medicine County is mostly an undulating plain, and its slopes range from nearly level to very steep. Relief is the most important factor causing the formation of different soils in uniform parent material. Soils in which the horizons are distinct formed where the slope is gentle and drainage is good. Steep soils show little evidence of mature soil formation, mostly because runoff is excessive. Excessive runoff reduces the amount of water that can leach the soil and the amount that plants can use. Many steep soils, therefore, are droughty, have indistinct horizons, and support a poor cover of plants.

Topographic position is a key to the kind of soil and the soil drainage class at any point on the landscape. For example, the locations of Storden, Ves, Normania, Webster, and Glencoe soils, which make up the Ves drainage sequence, can generally be predicted. Each of these soils occupies a distinctive part of the landscape. Moving down from the highest point, the well drained, steep Storden soils are on convex side slopes; the well drained, gently undulating Ves soils are on the more gentle convex slopes and on hilltops; and the moderately well drained, nearly level Normania soils are at a lower elevation than Ves soils or in plane or slightly concave, nearly level areas surrounded by Ves soils. The poorly drained Webster soils are in drainageways and on nearly level, wet flats; and the very poorly drained Glencoe soils are in depressions.

time

The time required for soil formation depends to a large extent on the influence of the other soil forming factors. In areas where relief and drainage are favorable, enough time has elapsed for soils to have mature profiles. Steep soils have immature or thin profiles because the soil forming processes have not been effective. Soils formed in alluvium along streams are immature or weakly developed because the material is young. Fresh deposits are added to the alluvium almost annually and prevent distinct, mature horizons from developing.

In the geological sense, all of the soils in the county are very young. In most parts of the county, soil forming processes have been active about 8,000 to 12,000 years.

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references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 1487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Clayton, L. and T. Freers. 1967. Glacial geology of the Missouri Coteau and adjacent areas. N.D. Geol. Surv. Misc. Ser. 30, 170 pp., illus.

(4) Matsch, Charles L. 1972. Quaternary geology of southwestern Minnesota. *In* Geology of Minnesota, pp. 548-560, Minn. Geol. Surv.

(5) Thiel, George A. 1965. Geology and underground waters of southern Minnesota. Minn. Geol. Surv. Bull. 31, 506 pp., illus.

(6) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(7) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(8) Wright, Jr., H.E. 1972. Quaternary history of Minnesota. *In* Geology of Minnesota, pp. 515-547, Minn. Geol. Surv.

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glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms. The Lco horizon is a limnic layer that contains many fecal pellets.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. In this survey area, the terms describing the content of organic matter in the upper 10 inches of the soil are:

	Percent
Low	Less than 2
Moderate	2 to 4
High	4 to 8
Very high	More than 8

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Superglacial till. Water saturated, highly plastic or fluid till distributed on and under stagnant glacial ice.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by melt water streams, in a glacial lake or other body of still water in front of a glacier.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-74 at Canby]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	22.3	2.3	12.4	50	-27	0	.56	.17	.87	2	5.2
February---	28.9	8.4	18.7	55	-23	0	1.00	.28	1.57	3	8.7
March------	39.1	19.3	29.2	70	-14	23	1.33	.50	1.99	4	8.6
April------	57.3	33.3	45.3	87	14	50	2.63	1.46	3.58	6	3.4
May--------	70.9	45.4	58.2	94	24	270	3.32	1.69	4.63	7	.1
June-------	81.2	56.1	68.7	100	37	561	3.91	1.84	5.59	7	.0
July-------	86.2	60.6	73.5	100	45	729	3.95	1.93	5.59	5	.0
August-----	84.9	58.9	72.0	100	42	682	2.91	1.37	4.16	5	.0
September--	74.0	48.5	61.3	96	29	344	2.05	.79	3.06	4	.0
October----	63.1	38.8	51.0	88	16	155	1.54	.43	2.41	3	.8
November---	42.9	23.5	33.2	72	-5	0	1.07	.45	1.56	3	3.6
December---	28.4	10.0	19.2	54	-22	0	.98	.32	1.50	3	7.1
Year-----	56.6	33.8	45.2	102	-28	2,814	25.25	20.36	29.86	52	37.5

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-74 at Canby]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 3	May 14	May 23
2 years in 10 later than--	April 27	May 9	May 19
5 years in 10 later than--	April 17	April 29	May 11
First freezing temperature in fall:			
1 year in 10 earlier than--	October 4	September 26	September 14
2 years in 10 earlier than--	October 9	October 1	September 20
5 years in 10 earlier than--	October 18	October 11	September 30

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-74 at Canby]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	163	146	126
8 years in 10	170	152	132
5 years in 10	184	163	142
2 years in 10	197	175	152
1 year in 10	204	180	157

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
6	Aastad clay loam, 0 to 2 percent slopes	6,600	1.4
31E	Storden loam, 18 to 25 percent slopes	220	*
31F	Storden loam, 25 to 40 percent slopes	750	0.2
33B	Barnes loam, 1 to 4 percent slopes	1,400	0.3
33B2	Barnes loam, 3 to 6 percent slopes, eroded	6,900	1.4
35	Blue Earth silt loam	1,500	0.3
36	Flom clay loam	8,900	1.8
85	Calco silty clay loam, occasionally flooded	6,800	1.4
86	Canisteo clay loam	57,500	11.8
94B	Terril loam, 2 to 6 percent slopes	2,200	0.5
94C	Terril loam, 6 to 12 percent slopes	310	0.1
108	McIntosh silt loam, 1 to 3 percent slopes	1,900	0.4
113	Webster clay loam	27,600	5.7
114	Glencoe clay loam	12,200	2.5
127A	Sverdrup fine sandy loam, 0 to 2 percent slopes	600	0.1
127B	Sverdrup fine sandy loam, 2 to 6 percent slopes	1,500	0.3
127C	Sverdrup sandy loam, 6 to 12 percent slopes	200	*
134	Okoboji silty clay loam	13,700	2.8
137	Dovray silty clay	450	0.1
140	Spicer silty clay loam	18,800	3.9
141A	Egeland loam, 0 to 2 percent slopes	1,800	0.4
141B	Egeland loam, 2 to 6 percent slopes	3,400	0.7
160	Fieldon fine sandy loam	700	0.1
168B	Forman clay loam, 2 to 4 percent slopes	6,600	1.4
168B2	Forman clay loam, 3 to 6 percent slopes, eroded	19,900	4.1
184	Hamerly loam, 1 to 3 percent slopes	760	0.2
210	Fulda silty clay	420	0.1
212	Sinai silty clay, 1 to 3 percent slopes	300	0.1
236	Vallers clay loam	1,500	0.3
246	Marysland clay loam	6,900	1.4
276	Oldham silty clay loam	1,400	0.3
284B	Poinsett clay loam, 2 to 6 percent slopes	460	0.1
290B	Rothsay silt loam, 1 to 4 percent slopes	650	0.1
290B2	Rothsay silt loam, 3 to 6 percent slopes, eroded	450	0.1
319	Barbert silt loam	2,600	0.5
338	Waubay clay loam, 1 to 3 percent slopes	300	0.1
339A	Fordville loam, 0 to 2 percent slopes	3,000	0.6
339B	Fordville loam, 2 to 6 percent slopes	650	0.1
341A	Arvilla sandy loam, 0 to 2 percent slopes	3,500	0.7
341B	Arvilla sandy loam, 2 to 6 percent slopes	2,300	0.5
341C	Arvilla sandy loam, 6 to 12 percent slopes	270	0.1
347	Malachy loam	1,100	0.2
371	Clontarf sandy loam, 1 to 3 percent slopes	450	0.1
402D	Sioux gravelly sandy loam, 2 to 40 percent slopes	230	*
421B	Ves loam, 1 to 4 percent slopes	53,000	10.9
423	Seaforth loam, 1 to 3 percent slopes	12,700	2.6
434	Perella silty clay loam	1,700	0.4
437E	Buse loam, 18 to 25 percent slopes	720	0.1
437F	Buse loam, 25 to 40 percent slopes	2,700	0.6
444	Canisteo silty clay loam	19,200	4.0
446	Normania clay loam, 1 to 3 percent slopes	15,000	3.1
574	Du Page loam, occasionally flooded	4,400	0.9
575	Nishna silty clay, occasionally flooded	2,800	0.6
591B	Doland silt loam, 1 to 4 percent slopes	1,800	0.4
591B2	Doland silt loam, 3 to 6 percent slopes, eroded	1,200	0.2
597	Tara silt loam, 1 to 3 percent slopes	1,100	0.2
610	Calco silty clay loam, frequently flooded	2,700	0.6
876C2	Nutley-Sinai complex, 6 to 12 percent slopes, eroded	220	*
878	Calco-Du Page complex	6,300	1.3
883	Zumbro-Du Page complex	220	*
902C2	Barnes-Buse loams, 6 to 12 percent slopes, eroded	3,900	0.8
904B2	Arvilla-Barnes-Buse complex, 2 to 6 percent slopes, eroded	520	0.1
904C	Arvilla-Buse-Barnes complex, 6 to 12 percent slopes	780	0.2
913D	Buse-Barnes loams, 12 to 18 percent slopes	550	0.1
915C2	Forman-Buse complex, 6 to 12 percent slopes, eroded	4,400	0.9
915D	Buse-Forman complex, 12 to 18 percent slopes	550	0.1
917D	Buse-Sioux complex, 12 to 18 percent slopes	400	0.1
917E	Buse-Sioux complex, 18 to 40 percent slopes	320	0.1
923D	Copaston-Rock outcrop complex, 2 to 25 percent slopes	2,800	0.6
953C	Arvilla-Storden-Ves complex, 6 to 15 percent slopes	2,600	0.5

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
954B2	Ves-Storden loams, 3 to 6 percent slopes, eroded	77,100	15.8
954C2	Storden-Ves loams, 5 to 12 percent slopes, eroded	11,900	2.5
954D	Storden-Ves loams, 12 to 18 percent slopes	630	0.1
969B2	Zell-Rothsay silt loams, 2 to 6 percent slopes, eroded	750	0.2
969C2	Zell-Rothsay silt loams, 6 to 12 percent slopes, eroded	680	0.1
1016	Udorthents, loamy	900	0.2
1029	Pits, gravel	400	0.1
1053	Aquolls and Aquents, ponded	2,800	0.6
1852F	Terril-Swanlake loams, 18 to 70 percent slopes	1,500	0.3
1867	Zumbro-Calco complex	600	0.1
1868	Canisteo stony clay loam	310	0.1
1869	Du Page-McIntosh Variant loams	4,000	0.8
1870	Burr-Calco silty clay loams	8,100	1.7
	Water areas greater than 40 acres in size	3,200	0.7
	Total	485,120	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Spring wheat	Grass-legume hay	Brome-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Bu	Ton	AUM*	AUM*
6------------------------ Aastad	85	32	80	47	4.0	6.0	---
31E---------------------- Storden	---	---	---	---	1.8	2.7	2.0
31F---------------------- Storden	---	---	---	---	---	---	1.5
33B---------------------- Barnes	75	28	75	39	3.5	5.2	---
33B2--------------------- Barnes	65	25	70	36	3.3	5.0	---
35----------------------- Blue Earth	75	30	70	35	3.5	5.2	---
36----------------------- Flom	80	30	80	40	4.0	6.0	---
85----------------------- Calco	80	30	75	38	3.8	5.7	4.2
86----------------------- Canisteo	85	32	75	38	4.0	6.0	3.0
94B---------------------- Terril	80	30	80	40	4.0	6.0	4.2
94C---------------------- Terril	70	28	70	30	3.2	4.8	3.8
108---------------------- McIntosh	80	30	75	40	4.0	6.0	---
113---------------------- Webster	90	34	80	40	4.0	6.0	4.2
114---------------------- Glencoe	85	34	75	40	3.5	5.2	---
127A--------------------- Sverdrup	40	18	50	23	2.7	4.0	---
127B--------------------- Sverdrup	35	15	40	18	2.3	3.5	---
127C--------------------- Sverdrup	25	10	30	10	1.3	2.0	---
134---------------------- Okoboji	85	30	75	40	3.5	5.2	3.3
137---------------------- Dovray	75	30	70	38	3.5	5.2	---
140---------------------- Spicer	85	32	75	38	4.0	6.0	---
141A--------------------- Egeland	53	24	55	30	3.0	4.5	---

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Spring wheat	Grass-legume hay	Brome-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Bu	Ton	AUM*	AUM*
141B-----------------------Egeland	45	24	45	25	2.5	3.8	---
160-----------------------Fieldon	60	25	65	30	3.0	4.5	3.0
168B-----------------------Forman	80	30	80	40	3.8	5.7	---
168B2-----------------------Forman	70	27	75	36	3.6	5.4	---
184-----------------------Hamerly	70	25	75	38	3.6	5.4	---
210-----------------------Fulda	80	30	75	40	4.0	6.0	---
212-----------------------Sinai	80	30	80	40	3.8	5.7	---
236-----------------------Vallers	75	28	75	40	4.0	6.0	3.7
246-----------------------Marysland	60	25	70	35	3.3	5.0	---
276-----------------------Oldham	75	30	70	35	3.5	5.2	---
284B-----------------------Poinsett	75	28	75	39	3.6	5.4	---
290B-----------------------Rothsay	85	32	80	38	4.1	6.1	3.0
290B2-----------------------Rothsay	75	29	75	35	3.8	5.7	---
319-----------------------Barbert	85	32	75	38	3.5	5.2	---
338-----------------------Waubay	80	30	80	43	3.8	5.7	---
339A-----------------------Fordville	49	24	60	30	3.0	4.5	---
339B-----------------------Fordville	45	20	45	25	2.6	3.9	---
341A-----------------------Arvilla	35	17	45	20	2.3	3.5	---
341B-----------------------Arvilla	30	14	35	17	1.7	2.5	---
341C-----------------------Arvilla	20	10	25	10	1.2	1.8	---
347-----------------------Malachy	55	22	55	25	3.0	4.5	---
371-----------------------Clontarf	60	25	60	30	3.0	4.5	---
402D-----------------------Sioux	---	---	---	---	---	---	---
421B-----------------------Ves	85	33	80	38	4.1	6.1	3.0

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Spring wheat	Grass-legume hay	Brome-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Bu	Ton	AUM*	AUM*
423 Seaforth	80	30	75	40	4.0	6.0	---
434 Perella	90	34	80	40	4.0	6.0	---
437E Buse	---	---	---	---	1.5	2.3	1.2
437F Buse	---	---	---	---	---	---	1.0
444 Canisteo	85	32	75	38	4.0	6.0	3.0
446 Normania	90	35	85	45	4.2	6.3	---
574 Du Page	75	32	80	40	4.0	6.0	---
575 Nishna	70	32	70	38	3.6	5.4	3.7
591B Doland	85	32	80	38	4.1	6.1	---
591B2 Doland	75	29	75	35	3.8	5.7	---
597 Tara	90	35	80	45	4.2	6.3	---
610 Calco	---	---	---	---	---	---	3.0
876C2 Nutley-Sinai	40	18	60	28	2.6	3.9	---
878 Calco-Du Page	---	---	---	---	---	---	---
883 Zumbro-Du Page	45	20	45	25	2.5	3.8	---
902C2 Barnes-Buse	50	19	60	30	2.8	4.2	---
904B2 Arvilla-Barnes-Buse	40	18	50	25	2.5	3.8	---
904C Arvilla-Buse-Barnes	25	12	35	15	2.0	3.0	---
913D Buse-Barnes	30	---	40	20	2.3	3.5	---
915C2 Forman-Buse	55	20	60	30	3.0	4.5	---
915D Buse-Forman	35	---	40	20	2.5	3.8	---
917D Buse-Sioux	20	---	25	10	1.2	3.0	---
917E Buse-Sioux	---	---	---	---	---	---	---

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Spring wheat	Grass-legume hay	Brome-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Bu	Ton	AUM*	AUM*
923D---------------------- Copaston-Rock outcrop	---	---	---	---	---	---	---
953C---------------------- Arvilla-Storden-Ves	25	12	35	15	2.0	3.3	---
954B2--------------------- Ves-Storden	75	29	75	35	3.9	5.7	3.1
954C2--------------------- Storden-Ves	60	23	60	30	3.5	4.8	2.9
954D---------------------- Storden-Ves	40	---	40	20	2.6	3.9	2.6
969B2--------------------- Zell-Rothsay	70	27	70	33	3.8	5.7	---
969C2--------------------- Zell-Rothsay	55	21	55	27	3.0	4.5	---
1016**. Udorthents							
1029**. Pits							
1053---------------------- Aquolls and Aquents	---	---	---	---	---	---	---
1852F--------------------- Terril-Swanlake	---	---	---	---	---	---	---
1867---------------------- Zumbro-Calco	---	---	---	---	---	---	2.3
1868---------------------- Canisteo	---	---	---	---	---	---	2.5
1869---------------------- Du Page-McIntosh Variant	75	30	65	40	3.8	5.7	---
1870---------------------- Burr-Calco	81	31	75	40	4.0	6.0	3.4

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
6----------------- Aastad	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, Siberian crabapple, blue spruce, eastern redcedar.	Common hackberry, green ash.	Golden willow, eastern cottonwood, Siberian elm.
31E, 31F. Storden					
33B, 33B2--------- Barnes	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash, honeylocust.	Siberian elm.
35---------------- Blue Earth	---	Medium purple willow, redosier dogwood, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, white spruce, eastern redcedar.	Green ash---------	Eastern cottonwood, golden willow, Siberian elm.
36---------------- Flom	Lilac, silver buffaloberry.	Siberian peashrub, tall purple willow, Tatarian honeysuckle.	Common hackberry, ponderosa pine, blue spruce, Siberian crabapple.	Golden willow, green ash.	Eastern cottonwood.
85---------------- Calco	Redosier dogwood	Lilac, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, eastern redcedar.	Common hackberry, green ash.	Eastern cottonwood.
86---------------- Canisteo	---	Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Russian-olive, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood, Siberian elm.
94B, 94C---------- Terril	---	Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Common hackberry, bur oak, eastern white pine, ponderosa pine, green ash.	Silver maple.
108--------------- McIntosh	---	Lilac, Siberian peashrub, Tatarian honeysuckle, American plum.	Eastern redcedar, white spruce, blue spruce, Siberian crabapple.	Green ash, Russian-olive.	Eastern cottonwood, Siberian elm.
113--------------- Webster	---	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Siberian crabapple, Amur maple, green ash, eastern white pine, white spruce.	Silver maple, golden willow.	Eastern cottonwood.
114--------------- Glencoe	---	Redosier dogwood, medium purple willow, northern white-cedar, Tatarian honeysuckle.	Siberian crabapple, eastern white pine, Amur maple, white spruce.	Green ash, silver maple, golden willow.	Eastern cottonwood.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
127A, 127B, 127C-- Sverdrup	Tatarian honeysuckle.	Lilac, Siberian peashrub, silver buffaloberry, eastern redcedar, Siberian crabapple, common chokecherry, American plum.	Green ash, bur oak, Russian-olive, ponderosa pine.	---	---
134--------------- Okoboji	---	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Siberian crabapple, Amur maple, eastern white pine, white spruce.	Silver maple, golden willow, green ash.	Eastern cottonwood.
137--------------- Dovray	Silver buffaloberry, lilac.	Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, blue spruce, ponderosa pine, Siberian crabapple, common hackberry.	Golden willow, green ash.	Eastern cottonwood.
140--------------- Spicer	---	Medium purple willow, Tatarian honeysuckle, redosier dogwood, Siberian peashrub, American plum.	Russian-olive, white spruce, eastern redcedar.	Green ash---------	Eastern cottonwood, golden willow, Siberian elm.
141A, 141B-------- Egeland	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, lilac, American plum.	Green ash, common hackberry, ponderosa pine, Russian-olive, Siberian crabapple.	Siberian elm, honeylocust.	---
160--------------- Fieldon	---	Northern white-cedar, lilac, tall purple willow, American plum, Tatarian honeysuckle, redosier dogwood.	White spruce, Amur maple.	Green ash, golden willow.	Eastern cottonwood, silver maple.
168B, 168B2------- Forman	---	Siberian peashrub, American plum, eastern redcedar, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash, honeylocust.	Siberian elm.
184--------------- Hamerly	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
210--------------- Fulda	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Common hackberry, Siberian crabapple, blue spruce, eastern redcedar, ponderosa pine.	Golden willow, green ash.	Eastern cottonwood.
212--------------- Sinai	---	Siberian crabapple, Tatarian honeysuckle, American plum, Siberian peashrub, lilac.	Honeylocust, ponderosa pine, common hackberry, Russian-olive, eastern redcedar.	Siberian elm, green ash.	---

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
236 Vallers	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, common hackberry, Siberian crabapple, Black Hills spruce, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
246 Marysland	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Ponderosa pine, Siberian crabapple, common hackberry, eastern redcedar, Black Hills spruce.	Golden willow, green ash.	Eastern cottonwood.
276 Oldham	Lilac, silver buffaloberry.	Tatarian honeysuckle, Siberian peashrub.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
284B Poinsett	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Bur oak, blue spruce, ponderosa pine, Russian-olive, Siberian crabapple.	Honeylocust, green ash.	Siberian elm.
290B, 290B2 Rothsay	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, red pine, Russian-olive, bur oak, Siberian crabapple.	Green ash, honeylocust.	Siberian elm.
319 Barbert	---	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	White spruce, Amur maple, eastern white pine, Siberian crabapple.	Golden willow, green ash, silver maple.	Eastern cottonwood.
338 Waubay	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
339A, 339B Fordville	Lilac	Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, common chokecherry, Tatarian honeysuckle.	Honeylocust, green ash, ponderosa pine.	Siberian elm	---
341A, 341B, 341C Arvilla	Lilac	Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Tatarian honeysuckle, common chokecherry.	Honeylocust, green ash, ponderosa pine.	Siberian elm	---

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
347. Malachy	---	Silver buffaloberry, Tatarian honeysuckle, lilac, Siberian peashrub, American plum.	Eastern redcedar, blue spruce, Siberian crabapple.	Russian-olive, green ash.	Eastern cottonwood, Siberian elm.
371. Clontarf	---	Eastern redcedar, Tatarian honeysuckle, Siberian peashrub, lilac, American plum.	Green ash, common hackberry, ponderosa pine, Russian-olive, Siberian crabapple.	Siberian elm, honeylocust.	---
402D. Sioux					
421B. Ves	---	Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.
423. Seaforth	---	Northern white-cedar, Tatarian honeysuckle, lilac.	Eastern redcedar, blue spruce, American plum.	Ponderosa pine, laurel willow, green ash, Russian-olive.	Eastern cottonwood, Siberian elm.
434. Perella	Silver buffaloberry, lilac.	Siberian peashrub, Tatarian honeysuckle.	Common hackberry, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood.
437E, 437F. Buse					
444. Canisteo	---	Siberian peashrub, redosier dogwood, Tatarian honeysuckle.	Russian-olive, blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood, Siberian elm.
446. Normania	---	Tatarian honeysuckle.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple, Siberian crabapple.	Scotch pine, green ash, bur oak, common hackberry.	Eastern cottonwood, silver maple.
574. Du Page	---	Lilac, Tatarian honeysuckle.	Amur maple, white spruce, northern white-cedar, Siberian crabapple.	Green ash, common hackberry, bur oak, eastern white pine, ponderosa pine.	Silver maple.
575. Nishna	Redosier dogwood, gray dogwood.	Lilac, Tatarian honeysuckle, Siberian peashrub.	Russian-olive, eastern redcedar.	Green ash, eastern white pine, common hackberry.	Eastern cottonwood.
591B, 591B2. Doland	---	Lilac, eastern redcedar, Siberian peashrub, American plum.	Blue spruce, bur oak, Siberian crabapple, ponderosa pine, Russian-olive.	Honeylocust, green ash.	Siberian elm.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
597, 610.					
Tara	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, blue spruce, Siberian crabapple, eastern redcedar.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
610. Calco					
876C2*:					
Nutley	---	Siberian crabapple, Tatarian honeysuckle, American plum, Siberian peashrub, lilac.	Honeylocust, ponderosa pine, common hackberry, Russian-olive, eastern redcedar.	Siberian elm, green ash.	---
Sinai	---	Siberian crabapple, Tatarian honeysuckle, American plum, Siberian peashrub, lilac.	Honeylocust, ponderosa pine, common hackberry, Russian-olive, eastern redcedar.	Siberian elm, green ash.	---
878*:					
Calco	Redosier dogwood	Lilac, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, eastern redcedar.	Common hackberry, eastern white pine, green ash.	Eastern cottonwood.
Du Page	---	Lilac, Tatarian honeysuckle.	Amur maple, white spruce, northern white-cedar, Siberian crabapple.	Green ash, common hackberry, bur oak, eastern white pine, ponderosa pine.	Silver maple.
883*:					
Zumbro	Golden currant	Eastern redcedar, Russian-olive, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster.	Common hackberry, white spruce, bur oak, eastern white pine, green ash.	---	---
Du Page	---	Lilac, Tatarian honeysuckle.	Amur maple, white spruce, northern white-cedar, Siberian crabapple.	Green ash, common hackberry, bur oak, eastern white pine, ponderosa pine.	Silver maple.
902C2*:					
Barnes	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash, honeylocust.	Siberian elm.
Buse	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, common hackberry, Russian-olive, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash, honeylocust.	---	---

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
904B2*:					
Arvilla	Lilac	Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Tatarian honeysuckle, common chokecherry.	Honeylocust, green ash, ponderosa pine.	Siberian elm	---
Barnes	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash, honeylocust.	Siberian elm.
Buse	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, common hackberry, Russian-olive, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash, honeylocust.	---	---
904C*:					
Arvilla	Lilac	Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Tatarian honeysuckle, common chokecherry.	Honeylocust, green ash, ponderosa pine.	Siberian elm	---
Buse	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, common hackberry, Russian-olive, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash, honeylocust.	---	---
Barnes	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash, honeylocust.	Siberian elm.
913D*:					
Buse.					
Barnes.					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
915C2*:					
Forman	---	Siberian peashrub, American plum, eastern redcedar, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash, honeylocust.	Siberian elm.
Buse	American plum, silver buffaloberry.	Eastern redcedar, Rocky Mountain juniper, common hackberry, Russian-olive, Siberian peashrub, Tatarian honeysuckle.	Ponderosa pine, Siberian elm, green ash, honeylocust.	---	---
915D*:					
Buse.					
Forman	---	Siberian peashrub, American plum, eastern redcedar, lilac.	Blue spruce, ponderosa pine, Russian-olive, Siberian crabapple, bur oak.	Green ash, honeylocust.	Siberian elm.
917D*, 917E*:					
Buse.					
Sioux.					
923D*:					
Copaston.					
Rock outcrop.					
953C*:					
Arvilla	Lilac	Russian-olive, Siberian crabapple, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Tatarian honeysuckle, common chokecherry, silver buffaloberry.	Honeylocust, green ash, ponderosa pine.	Siberian elm	---
Storden	---	Tall purple willow, Tatarian honeysuckle, Siberian peashrub, northern white-cedar.	Eastern redcedar, white spruce.	Green ash, Russian-olive, golden willow.	Eastern cottonwood, Siberian elm.
Ves	---	Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
954B2*:					
Ves	---	Tatarian honeysuckle, lilac, silver buffaloberry.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.
Storden	---	Tall purple willow, Tatarian honeysuckle, Siberian peashrub, northern white-cedar.	Eastern redcedar, white spruce.	Green ash, Russian-olive, golden willow.	Eastern cottonwood, Siberian elm.
954C2*:					
Storden	---	Tall purple willow, Tatarian honeysuckle, Siberian peashrub, northern white-cedar, silver buffaloberry.	Eastern redcedar, white spruce.	Green ash, Russian-olive, golden willow.	Eastern cottonwood, Siberian elm.
Ves	---	Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.
954D*:					
Storden.					
Ves	---	Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, Black Hills spruce, Amur maple.	Scotch pine, green ash, common hackberry, bur oak.	Silver maple, eastern cottonwood.
969B2*, 969C2*:					
Zell	American plum, silver buffaloberry.	Russian-olive, common hackberry, eastern redcedar, Rocky Mountain juniper, Siberian peashrub, Tatarian honeysuckle.	Siberian elm, honeylocust, green ash, ponderosa pine.	---	---
Rothsay	---	Eastern redcedar, Siberian peashrub, American plum, lilac.	Blue spruce, red pine, Russian-olive, bur oak, Siberian crabapple.	Green ash, honeylocust.	Siberian elm.
1016*. Udorthents					
1029*. Pits					
1053*:					
Aquolls.					
Aquents.					

See footnote at end of table.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
1852F*:					
Terril	---	Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple.	Common hackberry, bur oak, eastern white pine, ponderosa pine, green ash.	Silver maple.
Swanlake.					
1867*:					
Zumbro	Golden currant	Eastern redcedar, Russian-olive, silver buffaloberry, Siberian crabapple, Tatarian honeysuckle, Peking cotoneaster.	Common hackberry, white spruce, bur oak, eastern white pine, green ash.	---	---
Calco	Redosier dogwood	Lilac, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, eastern redcedar.	Common hackberry, eastern white pine, green ash.	Eastern cottonwood.
1868. Canisteo					
1869*:					
Du Page	---	Lilac, Tatarian honeysuckle.	Amur maple, white spruce, northern white-cedar, Siberian crabapple.	Green ash, common hackberry, bur oak, eastern white pine, ponderosa pine.	Silver maple.
McIntosh Variant	---	American plum, Siberian peashrub, lilac.	Eastern redcedar, Siberian crabapple, blue spruce, ponderosa pine.	Golden willow, green ash, common hackberry.	Eastern cottonwood, Siberian elm.
1870*:					
Burr	Silver buffaloberry, lilac.	Tatarian honeysuckle, Siberian peashrub.	Blue spruce, ponderosa pine, Siberian crabapple, eastern redcedar.	Golden willow, green ash.	Eastern cottonwood, Siberian elm.
Calco	Redosier dogwood	Lilac, Tatarian honeysuckle, Siberian peashrub, American plum.	Russian-olive, eastern redcedar.	Common hackberry, eastern white pine, green ash.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
6-----Aastad	Slight	Slight	Slight	Slight	Slight.
31E-----Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
31F-----Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
33B, 33B2-----Barnes	Slight	Slight	Moderate: slope.	Slight	Slight.
35-----Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
36-----Flom	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: excess humus, wetness.	Moderate: wetness.	Moderate: wetness.
85-----Calco	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: floods, wetness.
86-----Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
94B-----Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
94C-----Terril	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
108-----McIntosh	Slight	Slight	Slight	Slight	Slight.
113-----Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114-----Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
127A-----Sverdrup	Slight	Slight	Slight	Slight	Moderate: droughty.
127B-----Sverdrup	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
127C-----Sverdrup	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
134-----Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, erodes easily.	Severe: ponding.
137-----Dovray	Severe: ponding, too clayey, percs slowly.	Severe: ponding, too clayey, percs slowly.	Severe: ponding, too clayey, percs slowly.	Severe: too clayey, ponding.	Severe: too clayey, ponding.
140-----Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
141A-----Egeland	Slight	Slight	Slight	Slight	Slight.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
141B Egeland	Slight	Slight	Moderate: slope.	Slight	Slight.
160 Fieldon	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
168B, 168B2 Forman	Slight	Slight	Moderate: slope.	Slight	Slight.
184 Hamerly	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
210 Fulda	Severe: floods, wetness, too clayey.	Severe: wetness, too clayey.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
212 Sinai	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: percs slowly, slope.	Moderate: too clayey.	Severe: too clayey.
236 Vallers	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
246 Marysland	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
276 Oldham	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
284B Poinsett	Slight	Slight	Moderate: slope.	Slight	Slight.
290B, 290B2 Rothsay	Slight	Slight	Moderate: slope.	Slight	Slight.
319 Barbert	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
338 Waubay	Slight	Slight	Moderate: slope.	Slight	Slight.
339A Fordville	Slight	Slight	Slight	Slight	Slight.
339B Fordville	Slight	Slight	Moderate: slope.	Slight	Slight.
341A Arvilla	Slight	Slight	Slight	Slight	Moderate: droughty.
341B Arvilla	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
341C Arvilla	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
347 Malachy	Slight	Slight	Slight	Slight	Slight.
371 Clontarf	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
402D Sioux	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.	Severe: droughty, slope.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
421B Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
423 Seaforth	Slight	Slight	Moderate: slope.	Slight	Slight.
434 Perella	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
437E Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
437F Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
444 Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
446 Normania	Slight	Slight	Moderate: slope.	Slight	Slight.
574 Du Page	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
575 Nishna	Severe: floods, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
591B, 591B2 Doland	Slight	Slight	Moderate: slope.	Slight	Slight.
597 Tara	Slight	Slight	Moderate: slope.	Slight	Slight.
610 Calco	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
876C2*:					
Nutley	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: droughty, slope.
Sinai	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Severe: slope.	Moderate: too clayey.	Severe: too clayey.
878*:					
Calco	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
Du Page	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
883*:					
Zumbro	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
Du Page	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
902C2*:					
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
902C2*:					
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
904B2*:					
Arvilla	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Barnes	Slight	Slight	Moderate: slope.	Slight	Slight.
Buse	Slight	Slight	Moderate: slope.	Slight	Slight.
904C*:					
Arvilla	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Barnes	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
913D*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
915C2*:					
Forman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Buse	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
915D*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Forman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
917D*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Sioux	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.	Severe: droughty, slope.
917E*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sioux	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Severe: slope.	Severe: droughty, slope.
923D*:					
Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight	Severe: thin layer.
Rock outcrop.					

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
953C*:					
Arvilla	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
954B2*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
954C2*:					
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
954D*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
969B2*:					
Zell	Slight	Slight	Moderate: slope.	Slight	Slight.
Rothsay	Slight	Slight	Moderate: slope.	Slight	Slight.
969C2*:					
Zell	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Rothsay	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
1016*. Udorthents					
1029*. Pits					
1053*: Aquolls.					
Aquents.					
1852F*:					
Terril	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1867*:					
Zumbro	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.

See footnote at end of table.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1867*:					
Calco	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
1868 Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: large stones, wetness.
1869*:					
Du Page	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
McIntosh Variant	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Slight.
1870*:					
Burr	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
Calco	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: floods, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
6-----------------Aastad	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
31E, 31F----------Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
33B, 33B2---------Barnes	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
35-----------------Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
36-----------------Flom	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
85-----------------Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
86-----------------Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
94B----------------Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
94C----------------Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
108----------------McIntosh	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.
113----------------Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
114----------------Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
127A, 127B---------Sverdrup	Fair	Fair	Fair	Fair	Fair	Poor	Very poor.	Fair	Fair	Poor.
127C---------------Sverdrup	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
134----------------Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
137----------------Dovray	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
140----------------Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
141A, 141B---------Egeland	Fair	Fair	Good	Fair	Very poor.	Very poor.	Very poor.	Fair	Fair	Very poor.
160----------------Fieldon	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
168B, 168B2--------Forman	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
184----------------Hamerly	Good	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
210----------------- Fulda	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Fair.
212----------------- Sinai	Fair	Fair	Good	Fair	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
236----------------- Vallers	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
246----------------- Marysland	Good	Good	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
276----------------- Oldham	Good	Good	Good	Poor	Poor	Good	Good	Good	Poor	Good.
284B---------------- Poinsett	Good	Good	Good	Good	Very poor.	Poor	Very poor.	Good	Very poor.	Very poor.
290B, 290B2--------- Rothsay	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Poor.
319----------------- Barbert	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Fair.
338----------------- Waubay	Good	Good	Good	Good	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
339A---------------- Fordville	Good	Good	Good	Poor	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
339B---------------- Fordville	Good	Good	Good	Poor	Very poor.	Very poor.	Very poor.	Good	Very poor.	Very poor.
341A, 341B---------- Arvilla	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
341C---------------- Arvilla	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
347----------------- Malachy	Fair	Fair	Good	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
371----------------- Clontarf	Fair	Fair	Good	Good	Good	Poor	Poor	Fair	Good	Poor.
402D---------------- Sioux	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
421B---------------- Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
423----------------- Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
434----------------- Perella	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
437E, 437F---------- Buse	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
444----------------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
446----------------- Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
574----------------- Du Page	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
575----------------- Nishna	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
591B, 591B2-------- Doland	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
597----------------- Tara	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
610----------------- Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
876C2*:										
Nutley------------	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
Sinai-------------	Fair	Fair	Good	Fair	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
878*:										
Calco-------------	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
Du Page-----------	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
883*:										
Zumbro------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
Du Page-----------	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
902C2*:										
Barnes------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Buse--------------	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
904B2*:										
Arvilla-----------	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Barnes------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Buse--------------	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
904C*:										
Arvilla-----------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Buse--------------	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Barnes------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
913D*:										
Buse--------------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Barnes------------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
915C2*:										
Forman	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Buse	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
915D*:										
Buse	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Forman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
917D*:										
Buse	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Sioux	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
917E*:										
Buse	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Sioux	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
923D*:										
Copaston	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Rock outcrop.										
953C*:										
Arvilla	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
954B2*:										
Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Storden	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
954C2*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
954D*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

See footnote at end of table.

TABLE 8.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
969B2*:										
Zell	Fair	Fair	Fair	Poor	Very poor.	Very poor.	Very poor.	Fair	Very poor.	Very poor.
Rothsay	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Poor.
969C2*:										
Zell	Poor	Fair	Fair	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.	Very poor.
Rothsay	Good	Good	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Poor.
1016*. Udorthents										
1029*. Pits										
1053*:										
Aquolls.										
Aquents.										
1852F*:										
Terril.										
Swanlake.										
1867*:										
Zumbro	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
1868 Canisteo	Poor	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
1869*:										
Du Page	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
McIntosh Variant	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
1870*:										
Burr	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
6: Aastad	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
31E, 31F: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
33B: Barnes	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
33B2: Barnes	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
35: Blue Earth	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
36: Flom	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
85: Calco	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Moderate: floods, wetness.
86: Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
94B: Terril	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
94C: Terril	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
108: McIntosh	Moderate: wetness.	Slight	Moderate: wetness, shrink-swell.	Slight	Severe: frost action.	Slight.
113: Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
114: Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
127A: Sverdrup	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
127B: Sverdrup	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
127C: Sverdrup	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
134: Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
137 Dovray	Severe: ponding.	Severe: shrink-swell, ponding, low strength.	Severe: shrink-swell, ponding.	Severe: shrink-swell, ponding, low strength.	Severe: ponding, low strength, shrink-swell.	Severe: too clayey, ponding.
140 Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
141A Egeland	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
141B Egeland	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
160 Fieldon	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
168B Forman	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, frost action.	Slight.
168B2 Forman	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.	Slight.
184 Hamerly	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action.	Moderate: wetness.
210 Fulda	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: wetness, too clayey.
212 Sinai	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.
236 Vallers	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
246 Marysland	Severe: cutbanks cave, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: frost action.	Moderate: wetness.
276 Oldham	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
284B Poinsett	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: frost action, low strength.	Slight.
290B Rothsay	Slight	Slight	Slight	Slight	Severe: frost action.	Slight.
290B2 Rothsay	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.	Slight.
319 Barbert	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
338 Waubay	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
339A: Fordville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
339B: Fordville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
341A: Arvilla	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
341B: Arvilla	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
341C: Arvilla	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
347: Malachy	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
371: Clontarf	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Moderate: droughty.
402D: Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
421B: Ves	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
423: Seaforth	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
434: Perella	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Moderate: wetness.
437E, 437F: Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
444: Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
446: Normania	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
574: Du Page	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods.
575: Nishna	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, shrink-swell, wetness.	Severe: floods, low strength, shrink-swell.	Severe: too clayey.
591B: Doland	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
591B2: Doland	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
597: Tara	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
610: Calco	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Severe: floods.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
876C2*:						
Nutley	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: droughty, slope.
Sinai	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.
878*:						
Calco	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Severe: floods.
Du Page	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods.
883*:						
Zumbro	Severe: cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
Du Page	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods.
902C2*:						
Barnes	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Buse	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
904B2*:						
Arvilla	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Barnes	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Buse	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
904C*:						
Arvilla	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Buse	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Barnes	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
913D*:						
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
915C2*:						
Forman	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Buse	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
915D*:						
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Forman	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: frost action, slope, low strength.	Moderate: slope.
917D*, 917E*:						
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sioux	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
923D*:						
Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: thin layer.
Rock outcrop.						
953C*:						
Arvilla	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
954B2*:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
954C2*:						
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
954D*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
954D*:						
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
969B2*:						
Zell	Slight	Slight	Slight	Moderate: slope.	Severe: low strength, frost action.	Slight.
Rothsay	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.	Slight.
969C2*:						
Zell	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Rothsay	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
1016*. Udorthents						
1029*. Pits						
1053*:						
Aquolls.						
Aquents.						
1852F*:						
Terril	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1867*:						
Zumbro	Severe: cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Calco	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Severe: floods.
1868 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: large stones, wetness.
1869*:						
Du Page	Moderate: wetness, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods.
McIntosh Variant	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action.	Slight.
1870*:						
Burr	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods, frost action.	Moderate: wetness, floods.
Calco	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Moderate: floods, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
6------------------ Aastad	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
31E, 31F------------ Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
33B, 33B2----------- Barnes	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
35------------------ Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
36------------------ Flom	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
85------------------ Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
86------------------ Canisteo	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
94B----------------- Terril	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
94C----------------- Terril	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
108----------------- McIntosh	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
113----------------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
114----------------- Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
127A, 127B---------- Sverdrup	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
127C---------------- Sverdrup	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
134----------------- Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
137----------------- Dovray	Severe: percs slowly, ponding.	Slight-----------	Severe: too clayey, ponding.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
140----------------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
141A, 141B: Egeland	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
160: Fieldon	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
168B, 168B2: Forman	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
184: Hamerly	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
210: Fulda	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
212: Sinai	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
236: Vallers	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
246: Marysland	Severe: wetness, poor filter.	Severe: seepage, floods, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
276: Oldham	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
284B: Poinsett	Moderate: percs slowly.	Moderate: slope, seepage.	Slight	Slight	Good.
290B, 290B2: Rothsay	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
319: Barbert	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
338: Waubay	Moderate: wetness, percs slowly.	Moderate: seepage, slope, wetness.	Moderate: too clayey.	Slight	Fair: too clayey.
339A, 339B: Fordville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: small stones, too sandy, seepage.
341A, 341B: Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
341C: Arvilla	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
347----------------- Malachy	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
371----------------- Clontarf	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
402D---------------- Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
421B---------------- Ves	Slight-----------	Moderate: seepage, slope, excess humus.	Slight-----------	Slight-----------	Good.
423----------------- Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
434----------------- Perella	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
437E, 437F---------- Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
444----------------- Canisteo	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
446----------------- Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
574----------------- Du Page	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage, wetness.	Severe: floods.	Good.
575----------------- Nishna	Severe: floods, percs slowly, wetness.	Severe: floods.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, hard to pack, wetness.
591B, 591B2--------- Doland	Moderate: percs slowly.	Moderate: seepage, slope, excess humus.	Slight-----------	Slight-----------	Good.
597----------------- Tara	Severe: wetness.	Severe: wetness.	Moderate: wetness.	Slight-----------	Fair: wetness.
610----------------- Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
876C2*:					
Nutley--------------	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
Sinai---------------	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
878*:					
Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Du Page	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage, wetness.	Severe: floods.	Good.
883*:					
Zumbro	Severe: floods, poor filter.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy, thin layer.
Du Page	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage, wetness.	Severe: floods.	Good.
902C2*:					
Barnes	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Buse	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
904B2*:					
Arvilla	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Barnes	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Buse	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
904C*:					
Arvilla	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Buse	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Barnes	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
913D*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Barnes	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
915C2*:					
Forman	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
915C2*:					
Buse	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
915D*:					
Buse	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Forman	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: slope, too clayey.
917D*, 917E*:					
Buse	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Sioux	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
923D*:					
Copaston	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
Rock outcrop.					
953C*:					
Arvilla	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
954B2*:					
Ves	Slight	Moderate: seepage, slope, excess humus.	Slight	Slight	Good.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
954C2*:					
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
954D*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
969B2*:					
Zell	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Rothsay	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
969C2*:					
Zell	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Rothsay	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
1016*. Udorthents					
1029*. Pits					
1053*: Aquolls.					
Aquents.					
1852F*:					
Terril	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1867*:					
Zumbro	Severe: floods, poor filter.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy, thin layer.
Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
1868 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
1869*:					
Du Page	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage, wetness.	Severe: floods.	Good.
McIntosh Variant	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
1870*:					
Burr	Severe: floods, wetness, percs slowly.	Severe: wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, hard to pack, wetness.
Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
6 Aastad	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
31E Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
31F Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
33B, 33B2 Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
35 Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
36 Flom	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
85 Calco	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
86 Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
94B Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
94C Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
108 McIntosh	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
113 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
114 Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
127A, 127B Sverdrup	Good	Probable	Improbable: too sandy.	Fair: thin layer.
127C Sverdrup	Good	Probable	Improbable: too sandy.	Fair: slope, thin layer.
134 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
137 Dovray	Poor: wetness, shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
140 Spicer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
141A, 141B Egeland	Good	Probable	Improbable: too sandy.	Good.
160 Fieldon	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
168B, 168B2 Forman	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
184 Hamerly	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
210 Fulda	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
212 Sinai	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
236 Vallers	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
246 Marysland	Fair: wetness.	Probable	Probable	Fair: area reclaim, small stones, thin layer.
276 Oldham	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
284B Poinsett	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
290B, 290B2 Rothsay	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
319 Barbert	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
338 Waubay	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
339A, 339B Fordville	Good	Probable	Probable	Fair: thin layer.
341A, 341B, 341C Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
347 Malachy	Good	Probable	Improbable: too sandy.	Fair: thin layer.
371 Clontarf	Good	Probable	Improbable: too sandy.	Fair: thin layer.
402D Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
421B Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
423 Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
434 Perella	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
437E Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
437F Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
444 Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
446 Normania	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
574 Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
575 Nishna	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
591B, 591B2 Doland	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
597 Tara	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
610 Calco	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
876C2*:				
Nutley	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Sinai	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
878*:				
Calco	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
883*:				
Zumbro	Good	Probable	Improbable: too sandy.	Good.
Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
902C2*:				
Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
902C2*:				
Buse	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
904B2*:				
Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Buse	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
904C*:				
Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
Buse	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Barnes	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
913D*:				
Buse	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Barnes	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
915C2*:				
Forman	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Buse	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
915D*:				
Buse	Fair: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Forman	Fair: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
917D*:				
Buse	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Sioux	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
917E*:				
Buse	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Sioux	Poor: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
923D*:				
Copaston	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Rock outcrop.				
953C*:				
Arvilla	Good	Probable	Probable	Poor: small stones, area reclaim.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
954B2*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
954C2*:				
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
954D*:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
969B2*:				
Zell	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Rothsay	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
969C2*:				
Zell	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Rothsay	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
1016*. Udorthents				

See footnote at end of table.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1029*. Pits				
1053*: Aquolls.				
Aquents.				
1852F*: Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Swanlake	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1867*: Zumbro	Good	Probable	Improbable: too sandy.	Good.
Calco	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1868 Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones.
1869*: Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
McIntosh Variant	Fair: low strength, thin layer, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1870*: Burr	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Calco	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
6 Aastad	Slight	Moderate: piping, wetness.	Deep to water	Favorable	Favorable	Favorable.
31E, 31F Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
33B Barnes	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
33B2 Barnes	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
35 Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
36 Flom	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
85 Calco	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
86 Canisteo	Severe: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
94B Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
94C Terril	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
108 McIntosh	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Favorable	Favorable	Favorable.
113 Webster	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
114 Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding	Ponding	Wetness.
127A Sverdrup	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, droughty.	Too sandy, soil blowing.	Droughty.
127B Sverdrup	Severe: seepage.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Too sandy, soil blowing.	Droughty.
127C Sverdrup	Severe: seepage, slope.	Severe: piping, seepage.	Deep to water	Soil blowing, slope, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.
134 Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness, erodes easily.
137 Dovray	Slight	Severe: hard to pack, ponding, excess humus.	Percs slowly, ponding.	Ponding, slow intake, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
140 Spicer	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
141A Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Favorable	Too sandy	Favorable.
141B Egeland	Severe: seepage.	Severe: piping, seepage.	Deep to water	Slope	Too sandy	Favorable.
160 Fieldon	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
168B, 168B2 Forman	Moderate: slope.	Severe: piping.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
184 Hamerly	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
210 Fulda	Slight	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
212 Sinai	Slight	Moderate: hard to pack.	Deep to water	Slow intake, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
236 Vallers	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
246 Marysland	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
276 Oldham	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
284B Poinsett	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Erodes easily	Erodes easily.
290B Rothsay	Severe: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
290B2 Rothsay	Severe: seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
319 Barbert	Slight	Severe: hard to pack, ponding.	Ponding, percs slowly, frost action.	Ponding, percs slowly.	Ponding, percs slowly.	Wetness, percs slowly.
338 Waubay	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
339A Fordville	Severe: seepage.	Severe: seepage.	Deep to water	Favorable	Too sandy	Favorable.
339B Fordville	Severe: seepage.	Severe: seepage.	Deep to water	Slope	Too sandy	Favorable.
341A Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
341B Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
341C------------- Arvilla	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
347-------------- Malachy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable------	Too sandy------	Favorable.
371-------------- Clontarf	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
402D------------- Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
421B------------- Ves	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
423-------------- Seaforth	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Favorable------	Favorable.
434-------------- Perella	Moderate: seepage.	Severe: piping, ponding.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness--------	Wetness, percs slowly.
437E, 437F-------- Buse	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
444-------------- Canisteo	Severe: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
446-------------- Normania	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Favorable------	Erodes easily	Erodes easily.
574-------------- Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Floods---------	Favorable------	Favorable.
575-------------- Nishna	Slight---------	Severe: hard to pack, wetness.	Floods, percs slowly.	Slow intake, wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
591B------------- Doland	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Favorable------	Favorable.
591B2------------ Doland	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Favorable------	Favorable.
597-------------- Tara	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
610-------------- Calco	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness--------	Wetness.
876C2*:						
Nutley-----------	Severe: slope.	Moderate: hard to pack.	Deep to water	Droughty, percs slowly.	Slope, percs slowly.	Slope, droughty, percs slowly.
Sinai------------	Moderate: slope.	Moderate: hard to pack.	Deep to water	Slow intake, percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
878*:						
Calco------------	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness--------	Wetness.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
878*:						
Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Floods	Favorable	Favorable.
883*:						
Zumbro	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, floods.	Too sandy, soil blowing.	Favorable.
Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Floods	Favorable	Favorable.
902C2*:						
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Buse	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
904B2*:						
Arvilla	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
Barnes	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Buse	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
904C*:						
Arvilla	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Buse	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
913D*:						
Buse	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Barnes	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
915C2*:						
Forman	Severe: slope.	Severe: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
915D*:						
Buse	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Forman	Severe: slope.	Severe: piping.	Deep to water	Percs slowly, slope.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
917D*, 917E*:						
Buse	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Sioux	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, rooting depth, slope.	Slope, too sandy.	Slope, droughty, rooting depth.
923D*:						
Copaston	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Rock outcrop.						
953C*:						
Arvilla	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
954B2*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
954C2*, 954D*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
969B2*:						
Zell	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Rothsay	Severe: seepage.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
969C2*:						
Zell	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Rothsay	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
1016*. Udorthents						
1029*. Pits						
1053*:						
Aquolls.						
Aquents.						

See footnote at end of table.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
1852F*:						
Terril	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
Swanlake	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
1867*:						
Zumbro	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, floods.	Too sandy, soil blowing.	Favorable.
Calco	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
1868 Canisteo	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Large stones, wetness.
1869*:						
Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Floods	Favorable	Favorable.
McIntosh Variant	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
1870*:						
Burr	Slight	Severe: wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
Calco	Moderate: seepage.	Severe: wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
6----------------- Aastad	0-12	Clay loam--------	CL	A-7	0-5	95-100	90-100	80-95	60-80	40-50	15-25
	12-27	Clay loam--------	CL	A-7	0-5	95-100	85-100	75-95	50-75	40-50	15-25
	27-60	Clay loam, loam	CL	A-6, A-7	0-5	90-100	85-100	75-95	55-75	35-50	12-25
31E, 31F--------- Storden	0-6	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
33B, 33B2-------- Barnes	0-8	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	8-17	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	17-60	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
35--------------- Blue Earth	0-8	Silt loam--------	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	8-37	Silty clay loam, clay loam, silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
	37-60	Clay loam, loam, silty clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	80-100	70-95	35-50	11-20
36--------------- Flom	0-28	Clay loam--------	OL, CL-ML, CL	A-4, A-6, A-7	0	95-100	95-100	80-100	60-90	20-50	5-20
	28-42	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-50	10-30
	42-60	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-98	80-95	60-90	20-50	10-30
85--------------- Calco	0-32	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	32-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
86--------------- Canisteo	0-19	Clay loam--------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	19-33	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	33-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
94B, 94C--------- Terril	0-30	Loam-------------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	30-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
108-------------- McIntosh	0-14	Silt loam--------	CL-ML, CL, ML	A-4, A-7, A-6	0	100	100	85-100	70-95	20-50	3-25
	14-24	Silt loam, silty clay loam, loam.	ML, CL, CL-ML	A-4, A-6	0	100	95-100	90-100	70-90	20-40	2-15
	24-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	95-100	90-100	80-95	60-80	30-40	7-15
113-------------- Webster	0-19	Clay loam--------	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	19-26	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	26-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
114-------------- Glencoe	0-33	Clay loam--------	OL, OH, MH, ML	A-7	0	100	95-100	85-98	75-90	45-60	10-20
	33-44	Loam, clay loam, silty clay loam.	CL	A-7, A-6	0	100	95-100	85-98	75-90	35-50	15-25
	44-60	Loam, clay loam	CL	A-6, A-7	0	98-100	90-98	80-98	70-85	35-50	15-25
127A, 127B------- Sverdrup	0-8	Fine sandy loam	SM	A-4	0	100	95-100	60-70	35-50	---	NP
	8-18	Loam, fine sandy loam, loamy sand.	ML, SM	A-2, A-4	0	100	95-100	50-75	30-70	<30	NP-5
	18-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-90	2-10	---	NP
127C------------- Sverdrup	0-7	Sandy loam-------	SM	A-4	0	100	95-100	60-70	35-50	---	NP
	7-17	Loam, fine sandy loam, loamy sand.	ML, SM	A-2, A-4	0	100	95-100	50-75	30-70	<30	NP-5
	17-60	Sand, fine sand	SP, SP-SM	A-3, A-2	0	100	95-100	50-90	2-10	---	NP

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
134--------------- Okoboji	0-34	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	34-45	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	45-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
137--------------- Dovray	0-25	Silty clay-------	CH, MH, OH	A-7	0	100	100	95-100	85-95	50-75	25-40
	25-42	Clay, silty clay	CH, MH	A-7	0	100	95-100	90-100	85-95	50-80	25-40
	42-60	Clay, silty clay, silty clay loam.	CH, MH, CL, ML	A-7	0	100	95-100	80-100	70-95	40-75	20-40
140--------------- Spicer	0-13	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	13-38	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	38-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
141A, 141B------- Egeland	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0	100	100	85-100	50-80	25-40	5-15
	10-48	Sandy loam, fine sandy loam, loam.	SM, SM-SC	A-2, A-4	0	95-100	85-100	70-95	15-50	<30	NP-7
	48-60	Loamy sand, loamy fine sand, loamy very fine sand.	SM, SP-SM, SM-SC	A-2, A-4	0	95-100	85-100	70-90	10-45	<25	NP-5
160--------------- Fieldon	0-17	Fine sandy loam	SM, SM-SC	A-4	0	100	100	70-85	35-50	<20	NP-5
	17-28	Fine sandy loam, very fine sandy loam, loam.	ML, SM	A-4	0	100	100	70-90	35-60	<30	NP-5
	28-60	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-3	0	100	100	75-85	5-35	---	NP
168B, 168B2------ Forman	0-8	Clay loam--------	CL	A-6	0-5	95-100	90-100	90-100	70-80	25-40	10-25
	8-21	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-15
	21-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-15
184--------------- Hamerly	0-15	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-90	20-40	5-25
	15-35	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
	35-60	Loam, clay loam	CL, CL-ML	A-4, A-6, A-7	0-5	95-100	90-100	80-95	60-75	20-45	5-25
210--------------- Fulda	0-19	Silty clay-------	OH, CH, CL, MH	A-7, A-6	0	100	100	95-100	85-95	30-70	10-35
	19-28	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	90-100	90-95	45-70	25-50
	28-60	Silty clay loam, silty clay.	CH, CL, MH, ML	A-7	0	100	90-100	90-100	85-95	40-70	15-30
212--------------- Sinai	0-13	Silty clay-------	CL, CH, MH	A-7	0	100	100	95-100	90-100	45-70	20-35
	13-17	Silty clay, silty clay loam, clay.	CL, CH, MH	A-7	0	100	100	95-100	90-100	45-70	20-35
	17-25	Silty clay, silty clay loam, clay.	CL, CH, MH	A-7	0	100	100	95-100	90-100	45-70	20-35
	25-60	Stratified silty clay to silt loam.	CL, CH	A-7	0	100	100	95-100	80-95	40-65	15-35
236--------------- Vallers	0-16	Clay loam--------	OL, CL, ML	A-6, A-7	0	95-100	95-100	95-100	85-95	30-50	11-20
	16-23	Clay loam, silty clay loam, sandy clay loam.	CL	A-6	0	95-100	90-97	80-95	50-80	30-40	11-20
	23-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-97	85-95	60-75	20-40	5-20
246--------------- Marysland	0-20	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	85-95	50-80	30-50	10-25
	20-28	Loam, clay loam, sandy clay loam.	CL, SC	A-6	0	90-100	85-100	80-95	45-80	20-40	10-20
	28-60	Stratified fine sand to gravelly coarse sand.	SP-SM, SM	A-1, A-2, A-3	0	70-95	50-90	35-70	5-20	---	NP

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
276-------------- Oldham	0-17	Silty clay loam	CL, CH, MH, ML	A-7	0	100	95-100	90-100	85-100	40-60	15-25
	17-43	Silty clay loam, clay loam.	CL, CH, MH, ML	A-7	0	100	95-100	85-100	85-100	40-60	15-25
	43-60	Silty clay loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	95-100	85-100	70-100	25-45	5-20
284B------------- Poinsett	0-13	Clay loam--------	CL	A-6, A-7	0	100	100	95-100	75-95	35-50	10-25
	13-28	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	95-100	95-100	75-100	30-50	10-25
	28-60	Silt loam, silty clay loam, clay loam.	CL	A-6, A-7	0	100	95-100	95-100	75-100	30-50	10-25
290B, 290B2------ Rothsay	0-9	Silt loam--------	ML	A-4	0	95-100	95-100	90-100	85-100	20-40	NP-10
	9-24	Silt loam, very fine sandy loam, loam.	ML	A-4	0	95-100	95-100	90-100	80-100	20-40	NP-10
	24-60	Silt loam, loam, very fine sandy loam.	ML	A-4	0	95-100	95-100	90-100	80-90	20-40	NP-10
319-------------- Barbert	0-13	Silt loam--------	ML	A-4, A-7, A-6	0	100	100	90-100	90-100	35-50	5-20
	13-40	Clay, silty clay	CH, MH	A-7	0	100	100	90-100	90-100	50-80	20-50
	40-60	Silty clay loam, silt loam, silty clay.	CH, CL	A-7	0	100	100	95-100	65-100	40-60	15-35
338-------------- Waubay	0-8	Clay loam--------	CL	A-6, A-7	0	100	100	95-100	80-100	35-50	12-25
	8-25	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	95-100	85-100	35-50	10-25
	25-40	Silt loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	95-100	85-100	30-45	5-20
	40-60	Silt loam, loam	ML, CL	A-4, A-6, A-7	0	100	100	90-100	70-95	30-45	5-20
339A, 339B------- Fordville	0-13	Loam-------------	ML, CL	A-4, A-6, A-7	0	100	100	70-85	55-75	30-45	5-20
	13-26	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	95-100	70-95	55-80	30-45	5-20
	26-60	Gravelly loamy sand, gravelly sand, gravelly coarse sand.	SW, SW-SM, SM	A-1	0	65-85	45-70	15-40	0-15	<25	NP-5
341A, 341B, 341C- Arvilla	0-16	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
	16-60	Gravelly coarse sand, sand, gravelly loamy sand.	SP-SM, GP, SP, GP-GM	A-1	0	35-95	25-90	10-50	0-10	---	NP
347-------------- Malachy	0-17	Loam-------------	ML	A-4	0	100	95-100	80-95	50-75	25-35	1-10
	17-27	Loam, fine sandy loam, sandy loam.	SM, ML, SC, CL	A-4	0	100	95-100	60-95	35-75	15-35	NP-10
	27-60	Fine sand, coarse sand, loamy coarse sand.	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	30-80	5-35	<20	NP
371-------------- Clontarf	0-13	Sandy loam-------	SM	A-2, A-4	0	100	95-100	60-85	25-50	<30	NP-7
	13-30	Sandy loam, loam	SM, ML	A-2, A-4	0	100	95-100	60-95	20-60	<30	NP-7
	30-60	Sand, loamy fine sand, loamy sand.	SP-SM, SM	A-2, A-3	0	100	95-100	50-80	5-35	<20	NP

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
402D-------------- Sioux	0-7	Gravelly sandy loam.	SM, GM	A-4, A-2	0-5	60-90	50-80	45-70	25-50	20-35	NP-7
	7-10	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	10-60	Very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
421B-------------- Ves	0-12	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	12-24	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	24-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
423-------------- Seaforth	0-14	Loam-------------	ML, OL	A-7, A-6, A-4	0-5	95-100	90-100	80-100	60-80	35-45	8-15
	14-24	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-100	80-95	55-80	30-40	8-15
	24-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
434-------------- Perella	0-20	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-95	25-50	10-30
	20-33	Silt loam, silty clay loam, silty clay.	CL, CL-ML, CH	A-4, A-7, A-6	0	100	100	95-100	80-95	25-60	5-40
	33-60	Silt loam, silt, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-95	25-50	3-28
437E, 437F------- Buse	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
444-------------- Canisteo	0-22	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	22-32	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	32-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
446-------------- Normania	0-13	Clay loam--------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	13-28	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
	28-60	Loam-------------	CL	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
574-------------- Du Page	0-36	Loam-------------	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
	36-60	Sandy loam, loam, gravelly sandy clay loam.	CL	A-4, A-6, A-7	0	85-100	85-100	65-100	55-95	25-45	7-20
575-------------- Nishna	0-48	Silty clay-------	CH, MH	A-7	0	100	100	95-100	90-100	55-65	25-35
	48-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	60-70	30-40
591B, 591B2------ Doland	0-11	Silt loam--------	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	11-23	Silt loam--------	ML, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	2-12
	23-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0	90-100	85-98	80-90	55-80	20-40	6-20
597-------------- Tara	0-16	Silt loam--------	OL, ML	A-4, A-6	0	100	100	90-100	70-90	30-40	2-12
	16-36	Silt loam, loam	ML, CL-ML	A-4, A-6	0	100	100	85-100	60-90	20-40	2-12
	36-60	Loam-------------	CL, CL-ML	A-6, A-4	0-2	95-100	85-100	80-90	55-80	20-40	6-20
610-------------- Calco	0-32	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	32-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
876C2*:											
Nutley----------	0-7	Clay loam--------	CH, CL	A-7	0	100	100	95-100	80-100	45-60	20-30
	7-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	85-100	50-70	25-40
Sinai-----------	0-9	Silty clay-------	CL, CH, MH	A-7	0	100	100	95-100	90-100	45-70	20-35
	9-17	Silty clay, silty clay loam, clay.	CL, CH, MH	A-7	0	100	100	95-100	90-100	45-70	20-35
	17-60	Stratified silty clay to silt loam.	CL, CH	A-7	0	100	100	95-100	80-95	40-65	15-35

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
878*:											
Calco-----------	0-32	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	32-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
Du Page---------	0-36	Loam-------------	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
	36-60	Sandy loam, loam, gravelly sandy clay loam.	CL	A-4, A-6, A-7	0	85-100	85-100	65-100	55-95	25-45	7-20
883*:											
Zumbro----------	0-10	Sandy loam-------	SM	A-4	0	100	95-100	70-95	35-50	<20	NP
	10-50	Loamy sand, loamy fine sand.	SM	A-2	0	100	95-100	60-95	15-30	<20	NP
	50-60	Sand, fine sand, coarse sand.	SP, SM, SP-SM	A-2, A-3	0	90-100	75-100	50-80	4-20	<20	NP
Du Page---------	0-36	Loam-------------	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
	36-60	Sandy loam, loam, gravelly sandy clay loam.	CL	A-4, A-6, A-7	0	85-100	85-100	65-100	55-95	25-45	7-20
902C2*:											
Barnes----------	0-8	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	8-21	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	21-60	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
Buse------------	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-15
	8-60	Loam-------------	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-15
904B2*:											
Arvilla---------	0-16	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
	16-60	Gravelly coarse sand, gravelly loamy sand, sand.	SP-SM, GP, SP, GP-GM	A-1	0	35-95	25-90	10-50	0-10	---	NP
Barnes----------	0-8	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	8-23	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	23-60	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
Buse------------	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-15
	8-60	Loam-------------	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-15
904C*:											
Arvilla---------	0-15	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
	15-60	Gravelly coarse sand, sand, gravelly loamy sand.	SP-SM, GP, SP, GP-GM	A-1	0	35-95	25-90	10-50	0-10	---	NP
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-60	20-40	3-15
	7-60	Loam-------------	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-15
Barnes----------	0-7	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	7-19	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	19-60	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
913D*:											
Buse------------	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-15
	8-60	Loam-------------	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-15
Barnes----------	0-7	Loam-------------	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-100	35-90	20-40	5-15
	7-19	Loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	95-100	90-100	80-95	35-80	25-40	5-15
	19-60	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	55-80	25-40	5-15
915C2*:											
Forman----------	0-7	Clay loam--------	CL	A-6	0-5	95-100	90-100	90-100	70-80	25-40	10-25
	7-17	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-15
	17-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-15
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
915D*:											
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-20
	7-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-20
Forman----------	0-7	Clay loam--------	CL	A-6	0-5	95-100	90-100	90-100	70-80	25-40	10-25
	7-15	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-15
	15-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	60-80	25-40	5-15
917D*, 917E*:											
Buse------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	55-80	20-40	3-15
	7-60	Loam-------------	CL, CL-ML	A-4, A-6	0	90-100	85-95	70-90	60-80	25-40	5-15
Sioux-----------	0-7	Gravelly sandy loam.	SM, GM	A-4, A-2	0-5	60-90	50-80	45-70	25-50	20-35	NP-7
	7-10	Gravelly loam, gravelly sandy loam, gravelly loamy sand.	SM, GM	A-4, A-2, A-1	0-5	60-90	50-80	45-70	15-50	20-35	NP-7
	10-60	Sand and gravel, very gravelly coarse sand.	GM, GP, SM, SP	A-1	0	25-75	10-60	5-35	0-25	<25	NP-5
923D*:											
Copaston--------	0-15	Loam-------------	SM, ML	A-4	0	95-100	90-100	65-80	45-60	30-40	NP-10
	15-18	Gravelly sandy loam, sandy loam, loam.	SM	A-2, A-4	0-5	95-100	70-100	55-75	25-50	<35	NP-10
	18	Unweathered bedrock.									
Rock outcrop.											
953C*:											
Arvilla---------	0-16	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	60-80	30-45	10-30	NP-10
	16-60	Gravelly coarse sand, sand, gravelly loamy sand.	SP-SM, GP, SP, GP-GM	A-1	0	35-95	25-90	10-50	0-10	---	NP
Storden---------	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Ves-------------	0-8	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	8-20	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	20-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15

See footnote at end of table.

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
954B2*:											
Ves	0-9	Loam	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	9-21	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	21-60	Loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Storden	0-9	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
954C2*, 954D*:											
Storden	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Ves	0-8	Loam	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	8-21	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	21-60	Loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
969B2*, 969C2*:											
Zell	0-9	Silt loam	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
	9-60	Silt loam, very fine sandy loam, loam.	CL, ML	A-4, A-6	0	100	95-100	85-100	80-100	30-40	5-15
Rothsay	0-9	Silt loam	ML	A-4	0	95-100	95-100	90-100	85-100	20-40	NP-10
	9-24	Silt loam, very fine sandy loam, loam.	ML	A-4	0	95-100	95-100	90-100	80-100	20-40	NP-10
	24-60	Silt loam, loam, very fine sandy loam.	ML	A-4	0	95-100	95-100	90-100	80-90	20-40	NP-10
1016*. Udorthents											
1029*. Pits											
1053*: Aquolls.											
Aquents.											
1852F*:											
Terril	0-30	Loam	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	30-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
Swanlake	0-9	Loam	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	9-33	Loam	CL-ML, CL	A-4, A-6	0	90-100	85-98	70-90	50-70	20-35	5-15
	33-60	Loam	ML, CL, SM, SC	A-4, A-6	0	70-95	65-90	60-85	40-70	20-35	3-15
1867*:											
Zumbro	0-10	Sandy loam	SM	A-4	0	100	95-100	70-95	35-50	<20	NP
	10-50	Loamy sand, loamy fine sand.	SM	A-2	0	100	95-100	60-95	15-30	<20	NP
	50-60	Sand, fine sand, coarse sand.	SP, SM, SP-SM	A-2, A-3	0	90-100	75-100	50-80	4-20	<20	NP
Calco	0-32	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	32-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
1868 Canisteo	0-20	Stony clay loam	OL, CL	A-7	5-25	98-100	95-100	85-95	60-90	40-50	15-20
	20-31	Clay loam, loam	CL	A-6, A-7	0-20	98-100	90-100	85-95	65-85	35-50	15-25
	31-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	80-95	60-75	30-40	10-20
1869*:											
Du Page	0-36	Loam	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
	36-60	Sandy loam, loam, gravelly sandy clay loam.	CL	A-4, A-6, A-7	0	85-100	85-100	65-100	55-95	25-45	7-20

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
1869*:											
McIntosh Variant	0-13	Loam	OL, CL, CL-ML	A-4, A-6, A-7	0	100	95-100	85-95	55-70	25-45	5-15
	13-43	Loam, silty clay loam, silt loam.	CL-ML, CL	A-4, A-6, A-7	0	100	95-100	85-95	60-85	25-45	5-20
	43-60	Stratified loam to silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	95-100	80-95	65-85	25-45	5-20
1870*:											
Burr	0-7	Silty clay loam	OH, CL, CH	A-7	0	100	95-100	85-95	75-90	40-60	15-30
	7-30	Silty clay loam, silty clay.	CL, CH	A-7	0	100	90-100	80-95	75-90	40-60	15-30
	30-60	Stratified silt loam to clay.	CL, CH	A-7, A-6	0	100	95-100	80-95	65-90	35-55	15-30
Calco	0-32	Silty clay loam	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	32-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
6---------------- Aastad	0-12	28-35	1.35-1.45	0.2-0.6	0.17-0.19	6.1-7.8	<2	Moderate	0.24	5	6	4-6
	12-27	28-35	1.45-1.60	0.2-0.6	0.15-0.19	6.6-7.8	<2	Moderate	0.24			
	27-60	24-35	1.55-1.65	0.2-0.6	0.14-0.16	7.4-8.4	<2	Moderate	0.32			
31E, 31F--------- Storden	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-4
	6-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
33B, 33B2-------- Barnes	0-8	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.6-7.8	<2	Low--------	0.28	5	6	2-5
	8-17	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low--------	0.28			
	17-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<4	Low--------	0.37			
35--------------- Blue Earth	0-8	18-32	0.20-0.80	0.6-6.0	0.18-0.24	7.4-8.4	<2	Moderate	0.28	5	5	10-16
	8-37	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	<2	Low--------	0.28			
	37-60	18-32	1.30-1.60	0.2-2.0	0.14-0.16	7.4-8.4	<2	Moderate	0.28			
36--------------- Flom	0-28	22-35	1.30-1.45	0.2-2.0	0.18-0.24	6.1-7.8	<2	Moderate	0.28	5	6	5-8
	28-42	24-35	1.45-1.60	0.2-0.6	0.15-0.19	6.6-8.4	<2	Moderate	0.28			
	42-60	24-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.28			
85--------------- Calco	0-32	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	<2	High-------	0.28	5	7	5-7
	32-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.28			
86--------------- Canisteo	0-19	22-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.24	5	4L	4-8
	19-33	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.32			
	33-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low--------	0.32			
94B, 94C--------- Terril	0-30	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low--------	0.24	5	6	4-5
	30-60	27-32	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low--------	0.32			
108-------------- McIntosh	0-14	18-35	1.35-1.50	0.6-2.0	0.18-0.24	7.4-8.4	<2	Moderate	0.28	5	4L	4-7
	14-24	18-35	1.40-1.50	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28			
	24-60	18-35	1.30-1.60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.28			
113-------------- Webster	0-19	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	<2	Moderate	0.24	5	6	6-7
	19-26	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32			
	26-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Moderate	0.32			
114-------------- Glencoe	0-33	25-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	6	5-10
	33-44	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.28			
	44-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	<2	Moderate	0.28			
127A, 127B------- Sverdrup	0-8	10-18	1.35-1.50	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.20	3	3	2-4
	8-18	6-18	1.40-1.55	2.0-6.0	0.10-0.18	6.1-7.8	<2	Low--------	0.20			
	18-60	0-10	1.50-1.65	6.0-20	0.02-0.12	6.6-8.4	<2	Low--------	0.15			
127C------------- Sverdrup	0-7	10-18	1.35-1.50	2.0-6.0	0.13-0.15	6.1-7.3	<2	Low--------	0.20	3	3	2-4
	7-17	6-18	1.40-1.55	2.0-6.0	0.10-0.18	6.1-7.8	<2	Low--------	0.20			
	17-60	0-10	1.50-1.65	6.0-20	0.02-0.12	7.4-8.4	<2	Low--------	0.15			
134-------------- Okoboji	0-34	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	<2	High-------	0.37	5	4	5-15
	34-45	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	<2	High-------	0.37			
	45-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.28			
137-------------- Dovray	0-25	40-60	1.20-1.30	0.06-0.6	0.13-0.16	6.1-7.8	<2	High-------	0.28	5	4	5-15
	25-42	40-60	1.20-1.30	<0.2	0.10-0.14	6.6-7.8	<2	High-------	0.28			
	42-60	25-60	1.20-1.60	<0.6	0.10-0.18	6.6-8.4	<2	High-------	0.28			
140-------------- Spicer	0-13	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	<2	Moderate	0.28	5	4L	4-8
	13-38	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	<2	Moderate	0.28			
	38-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	<2	Low--------	0.28			
141A, 141B------- Egeland	0-10	15-25	1.20-1.30	0.6-2.0	0.18-0.20	5.6-7.3	<2	Low--------	0.28	5	5	1-4
	10-48	10-18	1.30-1.45	2.0-6.0	0.09-0.15	6.1-7.8	<2	Low--------	0.20			
	48-60	5-10	1.40-1.65	2.0-6.0	0.08-0.10	6.6-8.4	<2	Low--------	0.20			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
160--------------	0-17	10-18	1.30-1.50	2.0-6.0	0.15-0.17	7.4-8.4	<2	Low--------	0.28	5	3	4-7
Fieldon	17-28	10-18	1.35-1.55	0.6-2.0	0.15-0.17	7.4-8.4	<2	Low--------	0.28			
	28-60	0-10	1.40-1.60	6.0-20	0.05-0.07	7.4-8.4	<2	Low--------	0.28			
168B, 168B2------	0-8	27-34	1.20-1.40	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.28	4	6	2-8
Forman	8-21	24-34	1.30-1.50	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.28			
	21-60	18-34	1.30-1.50	0.06-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37			
184--------------	0-15	18-35	1.20-1.60	0.6-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	4-7
Hamerly	15-35	18-35	1.20-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.28			
	35-60	18-35	1.30-1.60	0.2-2.0	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
210--------------	0-19	30-50	1.20-1.30	0.06-0.6	0.14-0.22	6.6-7.3	<2	High------	0.28	5	4	5-10
Fulda	19-28	35-60	1.20-1.35	0.06-0.6	0.13-0.16	6.6-8.4	<2	High------	0.28			
	28-60	30-50	1.20-1.40	0.2-0.6	0.16-0.19	7.4-8.4	<2	High------	0.28			
212--------------	0-13	40-60	1.15-1.30	<0.2	0.13-0.16	6.1-7.3	<2	High------	0.28	5	4	4-7
Sinai	13-17	35-60	1.20-1.40	<0.2	0.17-0.19	6.6-7.8	<2	High------	0.28			
	17-25	35-60	1.20-1.40	<0.2	0.11-0.17	7.4-8.4	<2	High------	0.28			
	25-60	30-50	1.35-1.40	<0.2	0.11-0.17	7.4-8.4	<2	High------	0.43			
236--------------	0-16	28-35	1.20-1.35	0.2-0.6	0.18-0.22	7.4-8.4	<4	Moderate	0.28	5	4L	5-8
Vallers	16-23	18-35	1.40-1.55	0.2-0.6	0.15-0.19	7.4-8.4	<4	Moderate	0.28			
	23-60	18-35	1.50-1.70	0.2-0.6	0.17-0.19	7.4-8.4	<4	Low--------	0.28			
246--------------	0-20	18-30	1.20-1.30	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.28	4	4L	5-8
Marysland	20-28	18-30	1.35-1.50	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.28			
	28-60	1-5	1.55-1.65	>6.0	0.02-0.07	7.9-8.4	<2	Low--------	0.15			
276--------------	0-17	35-45	1.15-1.30	0.06-0.6	0.13-0.19	6.6-8.4	<4	High------	0.28	5	4L	4-9
Oldham	17-43	35-45	1.25-1.40	0.06-0.6	0.14-0.20	7.4-8.4	<4	High------	0.28			
	43-60	20-40	1.30-1.50	0.06-0.6	0.14-0.20	7.4-8.4	<2	Moderate	0.43			
284B-------------	0-13	27-30	1.25-1.35	0.6-2.0	0.19-0.22	6.1-7.3	<2	Moderate	0.32	5	6	2-6
Poinsett	13-28	20-32	1.20-1.35	0.6-2.0	0.18-0.21	6.1-7.8	<2	Moderate	0.43			
	28-60	20-32	1.20-1.35	0.6-2.0	0.18-0.21	7.4-8.4	<2	Moderate	0.43			
290B, 290B2------	0-9	10-18	1.20-1.40	0.6-2.0	0.22-0.24	6.6-7.3	<2	Low--------	0.32	5	5	3-6
Rothsay	9-24	10-18	1.20-1.40	0.6-2.0	0.17-0.22	6.6-7.8	<2	Low--------	0.43			
	24-60	10-18	1.20-1.40	0.6-6.0	0.20-0.22	7.4-8.4	<2	Low--------	0.43			
319--------------	0-13	18-35	1.20-1.60	0.6-2.0	0.22-0.24	5.1-6.5	<2	Moderate	0.28	5	6	3-8
Barbert	13-40	45-60	1.20-1.35	0.06-0.2	0.10-0.14	5.1-7.3	<2	High------	0.28			
	40-60	25-50	1.25-1.45	0.2-0.6	0.16-0.19	6.6-7.8	<2	High------	0.28			
338--------------	0-8	27-34	1.20-1.30	0.6-2.0	0.19-0.22	6.1-7.3	<2	Moderate	0.28	5	6	4-8
Waubay	8-25	20-30	1.35-1.45	0.6-2.0	0.18-0.21	6.6-7.8	<2	Moderate	0.43			
	25-40	20-30	1.35-1.45	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.43			
	40-60	20-30	1.40-1.50	0.6-2.0	0.16-0.18	7.4-8.4	<4	Moderate	0.43			
339A, 339B-------	0-13	18-25	1.20-1.30	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.24	4	6	4-7
Fordville	13-26	18-30	1.25-1.40	0.6-2.0	0.18-0.21	6.1-7.8	<2	Moderate	0.24			
	26-60	0-5	1.60-1.80	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
341A, 341B, 341C-	0-16	6-18	1.40-1.60	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low--------	0.20	3	3	1-4
Arvilla	16-60	2-10	1.40-1.60	>6.0	0.02-0.05	7.4-8.4	<2	Low--------	0.10			
347--------------	0-17	10-22	1.25-1.40	0.6-2.0	0.20-0.22	7.4-7.8	<2	Low--------	0.20	4	5	4-6
Malachy	17-27	10-18	1.35-1.50	0.6-6.0	0.12-0.19	7.4-7.8	<2	Low--------	0.20			
	27-60	2-10	1.45-1.65	6.0-20	0.02-0.07	7.4-8.4	<2	Low--------	0.20			
371--------------	0-13	10-18	1.35-1.55	2.0-6.0	0.13-0.18	6.1-7.3	<2	Low--------	0.20	4	3	4-6
Clontarf	13-30	10-18	1.45-1.60	2.0-6.0	0.12-0.19	6.1-7.8	<2	Low--------	0.20			
	30-60	5-10	1.55-1.70	6.0-20	0.05-0.09	6.6-7.8	<2	Low--------	0.15			
402D-------------	0-7	10-20	1.30-1.50	2.0-6.0	0.10-0.15	6.6-8.4	<2	Low--------	0.20	2	8	1-3
Sioux	7-10	10-20	1.20-1.50	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20			
	10-60	0-10	1.60-1.75	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
421B	0-12	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low	0.24	5	6	4-6
Ves	12-24	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	24-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
423	0-14	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.28	5	4L	4-6
Seaforth	14-24	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.28			
	24-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.28			
434	0-20	27-39	1.20-1.40	0.2-2.0	0.18-0.23	6.6-7.8	<2	Moderate	0.28	5	7	4-8
Perella	20-33	18-45	1.30-1.50	0.06-2.0	0.15-0.22	6.6-7.8	<2	Moderate	0.28			
	33-60	18-34	1.30-1.60	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.28			
437E, 437F	0-7	18-35	1.40-1.50	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	2-3
Buse	7-60	18-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
444	0-22	18-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.32	5	4L	4-8
Canisteo	22-32	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.32			
	32-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low	0.32			
446	0-13	22-32	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.24	5	6	4-8
Normania	13-28	22-32	1.30-1.40	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	28-60	22-27	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
574	0-36	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	<2	Moderate	0.28	5	6	4-6
Du Page	36-60	18-27	1.45-1.65	0.6-2.0	0.10-0.20	7.4-8.4	<2	Low	0.28			
575	0-48	36-44	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	<2	High	0.37	5	4	4-8
Nishna	48-60	38-46	1.35-1.40	0.06-0.2	0.11-0.13	7.4-8.4	<2	High	0.28			
591B, 591B2	0-11	18-27	1.30-1.45	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.32	5	6	2-6
Doland	11-23	18-27	1.35-1.50	0.6-2.0	0.17-0.22	6.1-8.4	<2	Low	0.32			
	23-60	18-30	1.45-1.70	0.6-2.0	0.14-0.19	6.6-8.4	<2	Low	0.32			
597	0-16	18-30	1.40-1.50	0.6-2.0	0.20-0.24	6.1-7.3	<2	Low	0.28	5	6	4-8
Tara	16-36	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-7.8	<2	Low	0.28			
	36-60	18-27	1.35-1.60	0.6-2.0	0.15-0.19	7.4-8.4	<2	Low	0.37			
610	0-32	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	<2	High	0.28	5	7	5-7
Calco	32-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.28			
876C2*:												
Nutley	0-7	35-40	1.25-1.35	0.06-0.2	0.16-0.19	7.4-8.4	<2	High	0.28	5	4	1-4
	7-60	35-60	1.35-1.50	<0.2	0.08-0.15	7.4-8.4	<2	High	0.28			
Sinai	0-9	40-60	1.15-1.30	<0.2	0.13-0.16	6.1-7.3	<2	High	0.28	5	4	2-4
	9-17	35-60	1.20-1.40	<0.2	0.17-0.19	6.6-7.8	<2	High	0.28			
	17-60	30-50	1.35-1.40	<0.2	0.11-0.17	7.4-8.4	<2	High	0.43			
878*:												
Calco	0-32	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	<2	High	0.28	5	7	5-7
	32-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.28			
Du Page	0-36	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	<2	Moderate	0.28	5	6	4-6
	36-60	18-27	1.45-1.65	0.6-2.0	0.10-0.20	7.4-8.4	<2	Low	0.28			
883*:												
Zumbro	0-10	5-18	1.35-1.45	2.0-6.0	0.13-0.16	5.6-7.8	<2	Low	0.17	5	3	2-4
	10-50	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	<2	Low	0.17			
	50-60	0-5	1.55-1.65	6.0-20	0.05-0.08	6.1-7.8	<2	Low	0.17			
Du Page	0-36	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	<2	Moderate	0.28	5	6	4-6
	36-60	18-27	1.45-1.65	0.6-2.0	0.10-0.20	7.4-8.4	<2	Low	0.28			
902C2*:												
Barnes	0-8	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.6-7.8	<2	Low	0.28	5	6	2-4
	8-21	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low	0.28			
	21-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<4	Low	0.37			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
902C2*:												
Buse------------	0-8	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L	1-2
	8-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low--------	0.37			
904B2*:												
Arvilla---------	0-16	6-18	1.40-1.60	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low--------	0.20	3	3	2-4
	16-60	2-10	1.40-1.60	>6.0	0.02-0.05	7.4-8.4	<2	Low--------	0.10			
Barnes----------	0-8	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.6-7.8	<2	Low--------	0.28	5	6	2-4
	8-23	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low--------	0.28			
	23-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<4	Low--------	0.37			
Buse------------	0-8	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L	2-3
	8-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low--------	0.37			
904C*:												
Arvilla---------	0-15	6-18	1.40-1.60	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low--------	0.20	3	3	2-4
	15-60	2-10	1.40-1.60	>6.0	0.02-0.05	7.4-8.4	<2	Low--------	0.10			
Buse------------	0-7	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L	2-3
	7-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low--------	0.37			
Barnes----------	0-7	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.6-7.8	<2	Low--------	0.28	5	6	2-4
	7-19	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low--------	0.28			
	19-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<4	Low--------	0.37			
913D*:												
Buse------------	0-8	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L	1-3
	8-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low--------	0.37			
Barnes----------	0-7	18-27	1.40-1.50	0.6-2.0	0.18-0.24	6.6-7.8	<2	Low--------	0.28	5	6	2-4
	7-19	18-27	1.50-1.60	0.6-2.0	0.15-0.19	6.6-7.8	<2	Low--------	0.28			
	19-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<4	Low--------	0.37			
915C2*:												
Forman----------	0-7	27-34	1.20-1.40	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.28	4	6	2-4
	7-17	24-34	1.30-1.50	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.28			
	17-60	18-34	1.30-1.50	0.06-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37			
Buse------------	0-7	18-35	1.40-1.50	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	1-2
	7-60	18-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
915D*:												
Buse------------	0-7	18-35	1.40-1.50	0.2-2.0	0.17-0.22	6.6-8.4	<2	Moderate	0.28	5	4L	1-2
	7-60	18-35	1.55-1.65	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
Forman----------	0-7	27-34	1.20-1.40	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.28	4	6	2-4
	7-15	24-34	1.30-1.50	0.6-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.28			
	15-60	18-34	1.30-1.50	0.06-0.6	0.14-0.19	7.4-8.4	<4	Moderate	0.37			
917D*, 917E*:												
Buse------------	0-7	18-27	1.40-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.28	5	4L	1-3
	7-60	18-27	1.50-1.60	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low--------	0.37			
Sioux-----------	0-7	10-20	1.30-1.50	2.0-6.0	0.10-0.15	6.6-8.4	<2	Low--------	0.20	2	8	1-3
	7-10	10-20	1.20-1.50	2.0-6.0	0.10-0.15	7.4-8.4	<2	Low--------	0.20			
	10-60	0-10	1.60-1.75	6.0-20	0.03-0.06	7.4-8.4	<2	Low--------	0.10			
923D*:												
Copaston--------	0-15	14-20	1.30-1.45	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low--------	0.28	2	5	4-6
	15-18	14-20	1.40-1.60	0.6-6.0	0.15-0.17	5.6-7.8	<2	Low--------	0.28			
	18	---	---	---	---	---	---	-----------	----			
Rock outcrop.												
953C*:												
Arvilla---------	0-16	6-18	1.40-1.60	2.0-6.0	0.13-0.15	6.6-7.8	<2	Low--------	0.20	3	3	2-4
	16-60	2-10	1.40-1.60	>6.0	0.02-0.05	7.4-8.4	<2	Low--------	0.10			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
953C*:												
Storden----------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-2
	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Ves--------------	0-8	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low--------	0.24	5	6	4-6
	8-20	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	20-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
954B2*:												
Ves--------------	0-9	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low--------	0.24	5	6	2-4
	9-21	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	21-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Storden----------	0-9	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-2
	9-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
954C2*, 954D*:												
Storden----------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-2
	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Ves--------------	0-8	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low--------	0.24	5	6	2-4
	8-21	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	21-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
969B2*, 969C2*:												
Zell-------------	0-9	10-18	1.15-1.30	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low--------	0.32	5	4L	1-3
	9-60	10-18	1.25-1.40	0.6-2.0	0.15-0.20	7.4-8.4	<2	Low--------	0.43			
Rothsay----------	0-9	10-18	1.20-1.40	0.6-2.0	0.22-0.24	6.6-7.3	<2	Low--------	0.32	5	5	3-4
	9-24	10-18	1.20-1.40	0.6-2.0	0.17-0.22	6.6-7.8	<2	Low--------	0.43			
	24-60	10-18	1.20-1.40	0.6-6.0	0.20-0.22	7.4-8.4	<2	Low--------	0.43			
1016*. Udorthents												
1029*. Pits												
1053*: Aquolls.												
Aquents.												
1852F*:												
Terril-----------	0-30	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low--------	0.24	5	6	3-4
	30-60	27-32	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low--------	0.32			
Swanlake---------	0-9	18-27	1.25-1.45	0.6-2.0	0.18-0.22	7.4-7.8	<2	Low--------	0.28	5	4L	2-4
	9-33	18-27	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
	33-60	18-27	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
1867*:												
Zumbro-----------	0-10	5-18	1.35-1.45	2.0-6.0	0.13-0.16	5.6-7.8	<2	Low--------	0.17	5	3	2-4
	10-50	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	<2	Low--------	0.17			
	50-60	0-5	1.55-1.65	6.0-20	0.05-0.08	6.1-7.8	<2	Low--------	0.17			
Calco------------	0-32	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	<2	High-------	0.28	5	7	5-7
	32-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.28			
1868------------- Canisteo	0-20	18-35	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.24	5	8	4-8
	20-31	18-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.32			
	31-60	18-35	1.45-1.65	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low--------	0.32			
1869*:												
Du Page----------	0-36	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	<2	Moderate	0.28	5	6	4-6
	36-60	18-27	1.45-1.65	0.6-2.0	0.10-0.20	7.4-8.4	<2	Low--------	0.28			

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
1869*:												
McIntosh Variant	0-13	18-27	1.10-1.20	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	4-8
	13-43	18-35	1.20-1.30	0.6-2.0	0.16-0.19	7.4-8.4	<2	Moderate	0.28			
	43-60	18-35	1.20-1.40	0.6-2.0	0.17-0.19	7.4-8.4	<2	Moderate	0.28			
1870*:												
Burr------------	0-7	30-40	1.00-1.10	0.2-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.32	5	4L	4-8
	7-30	35-45	1.10-1.25	0.2-0.6	0.18-0.22	7.4-8.4	<2	Moderate	0.32			
	30-60	30-45	1.20-1.30	0.2-0.6	0.16-0.22	7.4-8.4	<2	Moderate	0.32			
Calco-----------	0-32	28-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	<2	High------	0.28	5	7	5-7
	32-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
6------------------ Aastad	B	None---------	---	---	3.0-6.0	Apparent	Mar-Jun	>60	Moderate----	High-----	Low.
31E, 31F---------- Storden	B	None---------	---	---	>6.0	---	---	>60	Moderate----	Low------	Low.
33B, 33B2--------- Barnes	B	None---------	---	---	>6.0	---	---	>60	Moderate----	Moderate	Low.
35---------------- Blue Earth	B/D	None---------	---	---	+2-1.0	Apparent	Jan-Dec	>60	High--------	High-----	Low.
36---------------- Flom	B/D	None to rare	---	---	1.0-3.0	Apparent	Nov-Jun	>60	High--------	High-----	Low.
85---------------- Calco	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
86---------------- Canisteo	C/D	None---------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	High--------	High-----	Low.
94B, 94C---------- Terril	B	None---------	---	---	>6.0	---	---	>60	Moderate----	Moderate	Low.
108--------------- McIntosh	B	None---------	---	---	3.0-6.0	Apparent	Apr-Nov	>60	High--------	High-----	Low.
113--------------- Webster	B/D	None---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
114--------------- Glencoe	B/D	None---------	---	---	+1-1.0	Apparent	Oct-Jun	>60	High--------	High-----	Low.
127A, 127B, 127C-- Sverdrup	B	None---------	---	---	>6.0	---	---	>60	Low---------	Low------	Low.
134--------------- Okoboji	B/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	High--------	High-----	Low.
137--------------- Dovray	C/D	None---------	---	---	+2-1.0	Apparent	Jan-Dec	>60	Moderate----	High-----	Low.
140--------------- Spicer	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jun	>60	High--------	High-----	Low.
141A, 141B-------- Egeland	B	None---------	---	---	>6.0	---	---	>60	Low---------	Moderate	Low.
160--------------- Fieldon	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jun	>60	High--------	High-----	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
168B, 168B2: Forman	B	None	---	---	>6.0	---	---	>60	Moderate	High	Low.
184: Hamerly	C	None	---	---	2.0-4.0	Apparent	Apr-Jun	>60	High	High	Low.
210: Fulda	C/D	Rare	---	---	0-1.0	Apparent	Mar-Jun	>60	High	High	Low.
212: Sinai	C	None	---	---	>6.0	---	---	>60	Low	High	High.
236: Vallers	C	None to rare	---	---	1.0-2.5	Apparent	Nov-Jun	>60	High	High	Low.
246: Marysland	B/D	Rare	---	---	1.0-2.5	Apparent	Nov-Jul	>60	High	High	Low.
276: Oldham	C/D	None	---	---	+2-1.0	Apparent	Oct-Jun	>60	High	Moderate	High.
284B: Poinsett	B	None	---	---	>6.0	---	---	>60	High	High	Low.
290B, 290B2: Rothsay	B	None	---	---	>6.0	---	---	>60	High	Low	Low.
319: Barbert	D	None	---	---	+1-1.0	Perched	Nov-Jun	>60	High	High	Low.
338: Waubay	B	None	---	---	4.0-6.0	Perched	Oct-Jun	>60	High	High	Low.
339A, 339B: Fordville	B	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.
341A, 341B, 341C: Arvilla	A	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.
347: Malachy	B	None	---	---	3.0-5.0	Apparent	Nov-Apr	>60	High	Low	Low.
371: Clontarf	B	None	---	---	3.0-5.0	Apparent	Nov-Jun	>60	Moderate	Low	Low.
402D: Sioux	A	None	---	---	>6.0	---	---	>60	Low	Low	Low.
421B: Ves	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
423: Seaforth	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	>60	High	High	Low.
434: Perella	B/D	None	---	---	0-1.0	Apparent	Apr-Jul	>60	High	High	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
437E, 437F: Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
444: Canisteo	C/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	>60	High	High	Low.
446: Normania	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	>60	High	Moderate	Low.
574: Du Page	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	Moderate	Low	Low.
575: Nishna	C/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	Moderate	High	Low.
591B, 591B2: Doland	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
597: Tara	B	None	---	---	3.0-5.0	Perched	Mar-Jun	>60	High	High	Moderate.
610: Calco	B/D	Frequent	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High	High	Low.
876C2**:											
Nutley	C	None	---	---	>6.0	---	---	>60	Moderate	High	Low.
Sinai	C	None	---	---	>6.0	---	---	>60	Low	High	High.
878**:											
Calco	B/D	Frequent	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High	High	Low.
Du Page	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	Moderate	Low	Low.
883**:											
Zumbro	A	Occasional	Brief	Apr-Jun	>6.0	---	---	>60	Low	Low	Low.
Du Page	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	Moderate	Low	Low.
902C2**:											
Barnes	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
904B2**:											
Arvilla	A	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.
Barnes	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
904C**:											
Arvilla	A	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
904C**:											
Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
913D**:											
Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Barnes	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
915C2**:											
Forman	B	None	---	---	>6.0	---	---	>60	Moderate	High	Low.
Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
915D**:											
Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Forman	B	None	---	---	>6.0	---	---	>60	Moderate	High	Low.
917D**, 917E**:											
Buse	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Sioux	A	None	---	---	>6.0	---	---	>60	Low	Low	Low.
923D**:											
Copaston	D	None	---	---	>6.0	---	---	12-20	Moderate	Low	Low.
Rock outcrop.											
953C**:											
Arvilla	A	None	---	---	>6.0	---	---	>60	Low	Moderate	Low.
Storden	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
954B2**:											
Ves	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
Storden	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
954C2**, 954D**:											
Storden	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
969B2**, 969C2**:											
Zell	B	None	---	---	>6.0	---	---	>60	High	High	Moderate.
Rothsay	B	None	---	---	>6.0	---	---	>60	High	Low	Low.
1016**:											
Udorthents											

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months	Depth		Uncoated steel	Concrete
					Ft			In			
1029**: Pits											
1053**: Aquolls.											
Aquents.											
1852F**: Terril	B	None	---	---	>6.0	---	---	>60	Moderate	Moderate	Low.
Swanlake	B	None	---	---	>6.0	---	---	>60	Moderate	Low	Low.
1867**: Zumbro	A	Frequent	Brief	Apr-Jun	>6.0	---	---	>60	Low	Low	Low.
Calco	B/D	Frequent	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High	High	Low.
1868 Canisteo	D	None	---	---	1.0-3.0	Apparent	Oct-Jul	>60	High	High	Low.
1869**: Du Page	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	Moderate	Low	Low.
McIntosh Variant	B	None	---	---	2.5-4.0	Apparent	Mar-Jun	>60	High	High	Low.
1870**: Burr	D	Occasional	Very brief	Mar-Jun	1.0-3.0	Apparent	Mar-Jun	>60	High	High	High.
Calco	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	High	High	Low.

* Plus sign under "High water table--Depth" indicates ponding.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX TEST DATA

[Dashes indicate data were not available. NP means nonplastic]

Soil name, report number, horizon, and depth in inches	Classification		Grain size distribution								Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
											Pct		Lb/ft3	Pct
Canisteo clay loam:[1] (S76MN-173-006)														
Ap------- 0 to 8	A-7-6(14)	ML	100	99	98	92	75	59	36	30	46	18	--	--
B2g------19 to 33	A-7-6(14)	CL	100	99	97	92	74	56	40	32	42	20	--	--
C1gca----33 to 46	A-6(09)	CL	100	99	96	87	64	56	32	27	38	17	--	--
Egeland loam:[2] (S76MN-173-007)														
Ap------- 0 to 10	A-4(01)	ML	100	100	99	93	54	31	20	15	30	5	--	--
B22------19 to 32	A-4(00)	CL-ML	100	100	100	99	54	31	16	11	25	5	--	--
C2-------48 to 60	A-4(00)	SM	100	100	100	99	37	--	9	4	--	NP	--	--
Flom clay loam:[3] (S76MN-173-005)														
Ap------- 0 to 8	A-7-6(09)	ML	100	100	99	92	63	48	32	27	42	16	--	--
B2g------13 to 20	A-7-6(12)	CL	100	99	98	92	70	57	39	29	41	18	--	--
C2g------30 to 60	A-7-6(14)	CL	100	99	97	90	69	57	40	32	41	23	--	--
Normania clay loam:[4] (S76MN-173-001)														
Ap------- 0 to 8	A-7-6(12)	ML	100	100	100	96	84	56	37	29	41	13	--	--
B22------18 to 28	A-7-6(15)	CL	100	100	98	92	71	53	39	35	47	21	--	--
C2-------38 to 60	A-6(10)	CL	100	97	92	83	63	43	31	29	40	19	--	--
Spicer silty clay loam:[5] (S76MN-173-004)														
Ap------- 0 to 9	A-7-6(21)	ML	100	100	100	99	90	60	41	38	49	20	--	--
B2-------21 to 42	A-7-6(25)	CL	100	100	100	99	92	66	43	40	47	25	--	--
C--------48 to 60	A-6(10)	CL	100	100	100	99	85	54	29	20	34	12	--	--
Vallers clay loam:[6] (S76MN-173-003)														
Ap------- 0 to 7	A-7-5(07)	ML	100	99	97	90	67	48	32	27	43	11	--	--
C1gca----16 to 23	A-6(09)	CL	100	98	95	88	66	52	37	30	39	15	--	--
C3g------42 to 60	A-6(07)	CL	100	96	93	81	62	49	33	27	30	16	--	--

See footnotes at end of table.

TABLE 16.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain size distribution								Liquid limit	Plasticity index	Moisture density	
			Percentage passing sieve--					Percentage smaller than--						
	AASHTO	Unified	3/8 inch	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
											Pct		Lb/ft3	Pct
Ves loam:[7] (S76MN-173-002)														
Ap------- 0 to 9	A-6(07)	ML	100	99	97	88	61	41	25	17	40	13	--	--
B2-------12 to 21	A-6(07)	CL	100	99	97	91	64	44	30	27	38	14	--	--
C2-------38 to 60	A-6(06)	CL	100	99	95	87	61	41	25	19	34	13	--	--

[1]Canisteo clay loam: 4 miles south and 2 miles west of Wood Lake, about 1,000 feet south and 200 feet west of northeast corner sec. 19, T. 113 N., R. 39 W.

[2]Egeland loam: 3 miles north of Canby, about 2,050 feet north and 180 feet west of southeast corner sec. 21, T. 115 N., R. 45 W.

[3]Flom clay loam: 7.5 miles west and 3.9 miles north of Canby, about 2,430 feet east and 560 feet south of northwest corner sec. 17, T. 115 N., R. 46 W.

[4]Normania clay loam: 2.5 miles west of Clarkfield, about 2,240 feet west and 250 feet south of northeast corner sec. 12, T. 115 N., R. 42 W.

[5]Spicer silty clay loam: 5 miles north and 1 mile east of Wood Lake, about 600 feet south and 80 feet west of northeast corner sec. 3, T. 114 N., R. 39 W.

[6]Vallers clay loam: 6 miles west and 2 miles south of Canby, about 240 feet west and 160 feet north of southeast corner sec. 16, T. 114 N., R. 46 W.

[7]Ves loam: 7 miles south and 2.5 miles west of Wood Lake, about 2,640 feet east and 160 feet north of southeast corner sec. 31, T. 113 N., R. 39 W.

TABLE 17.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Aastad	Fine-loamy, mixed Pachic Udic Haploborolls
Aquents	Haplaquents
Aquolls	Haplaquolls
Arvilla	Sandy, mixed Udic Haploborolls
Barbert	Fine, montmorillonitic, mesic Typic Argialbolls
Barnes	Fine-loamy, mixed Udic Haploborolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Burr	Fine, mesic Typic Calciaquolls
Buse	Fine-loamy, mixed Udorthentic Haploborolls
Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clontarf	Coarse-loamy, mixed Pachic Udic Haploborolls
Copaston	Loamy, mixed, mesic Lithic Hapludolls
Doland	Fine-loamy, mixed Udic Haploborolls
Dovray	Fine, montmorillonitic, frigid Cumulic Haplaquolls
Du Page	Fine-loamy, mixed, mesic Cumulic Hapludolls
Egeland	Coarse-loamy, mixed Udic Haploborolls
Fieldon	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
*Flom	Fine-loamy, mixed, frigid Typic Haplaquolls
Fordville	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Udic Haploborolls
*Forman	Fine-loamy, mixed Udic Argiborolls
Fulda	Fine, montmorillonitic, frigid Typic Haplaquolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
*Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Malachy	Coarse-loamy, mixed Pachic Udic Haploborolls
*Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
*McIntosh	Fine-silty, frigid Aeric Calciaquolls
McIntosh Variant	Fine-loamy, mesic Aeric Calciaquolls
*Nishna	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
*Nutley	Fine, montmorillonitic Udertic Haploborolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Oldham	Fine, montmorillonitic (calcareous), frigid Cumulic Haplaquolls
Perella	Fine-silty, mixed, frigid Typic Haplaquolls
Poinsett	Fine-silty, mixed Udic Haploborolls
Rothsay	Coarse-silty, mixed Udic Haploborolls
Seaforth	Fine-loamy, mixed, mesic Aquic Calciustolls
Sinai	Fine, montmorillonitic Pachic Udic Haploborolls
Sioux	Sandy-skeletal, mixed Udorthentic Haploborolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Sverdrup	Sandy, mixed Udic Haploborolls
Swanlake	Fine-loamy, mixed, mesic Entic Hapludolls
Tara	Fine-silty, mixed Pachic Udic Haploborolls
*Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Udorthents	Loamy, mixed Udorthents
Vallers	Fine-loamy, frigid Typic Calciaquolls
Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Waubay	Fine-silty, mixed Pachic Udic Haploborolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Zell	Coarse-silty, mixed Udorthentic Haploborolls
Zumbro	Sandy, mixed, mesic Entic Hapludolls

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