United States Department of Agriculture

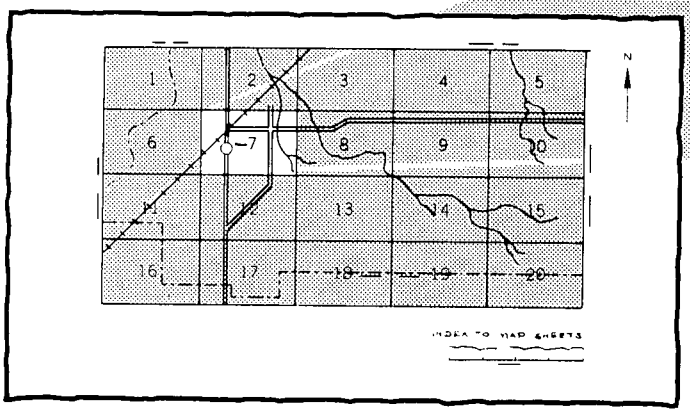
Soil Conservation Service

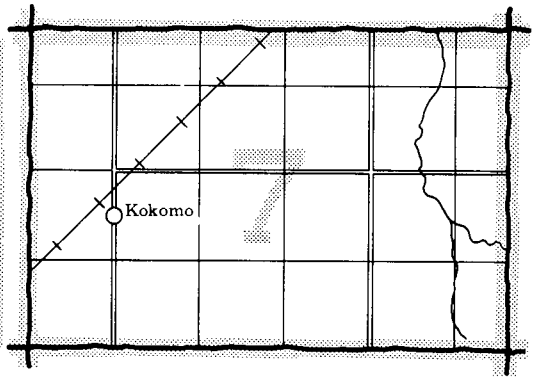
In cooperation with Minnesota Agricultural Experiment Station

Soil Survey of Martin County, Minnesota

HOW TO USE

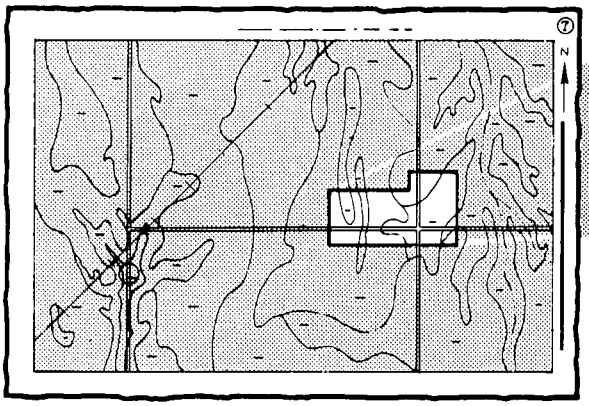
1. Locate your area of interest on the "Index to Map Sheets"

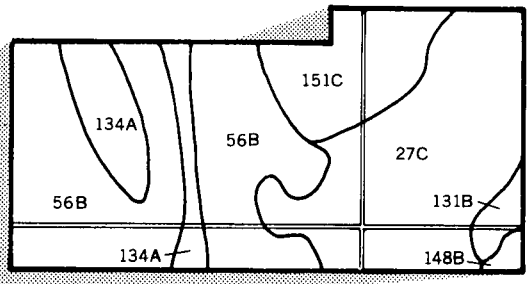




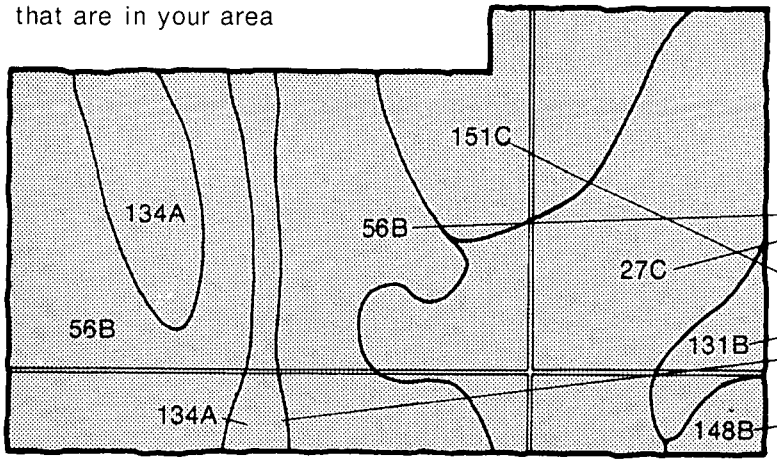
2. Note the number of the map sheet and turn to that sheet.

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





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

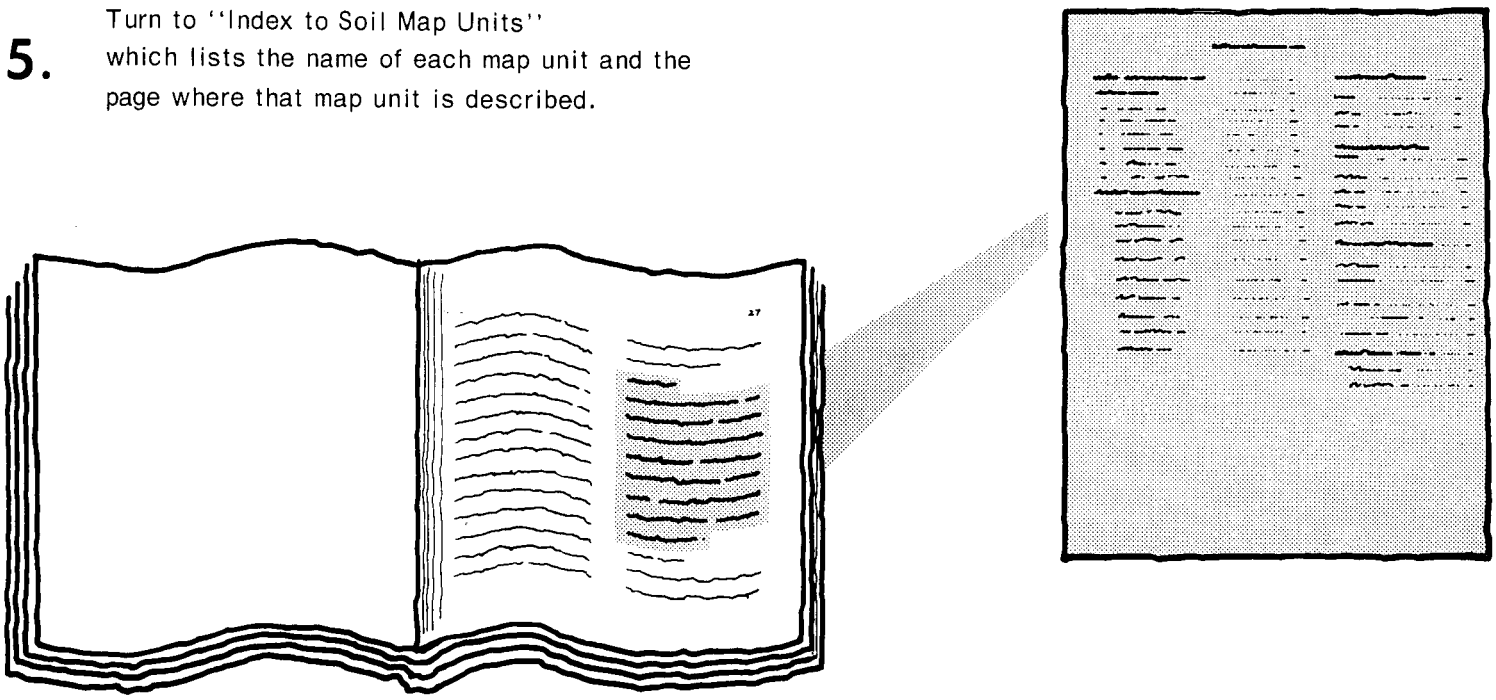


Symbols

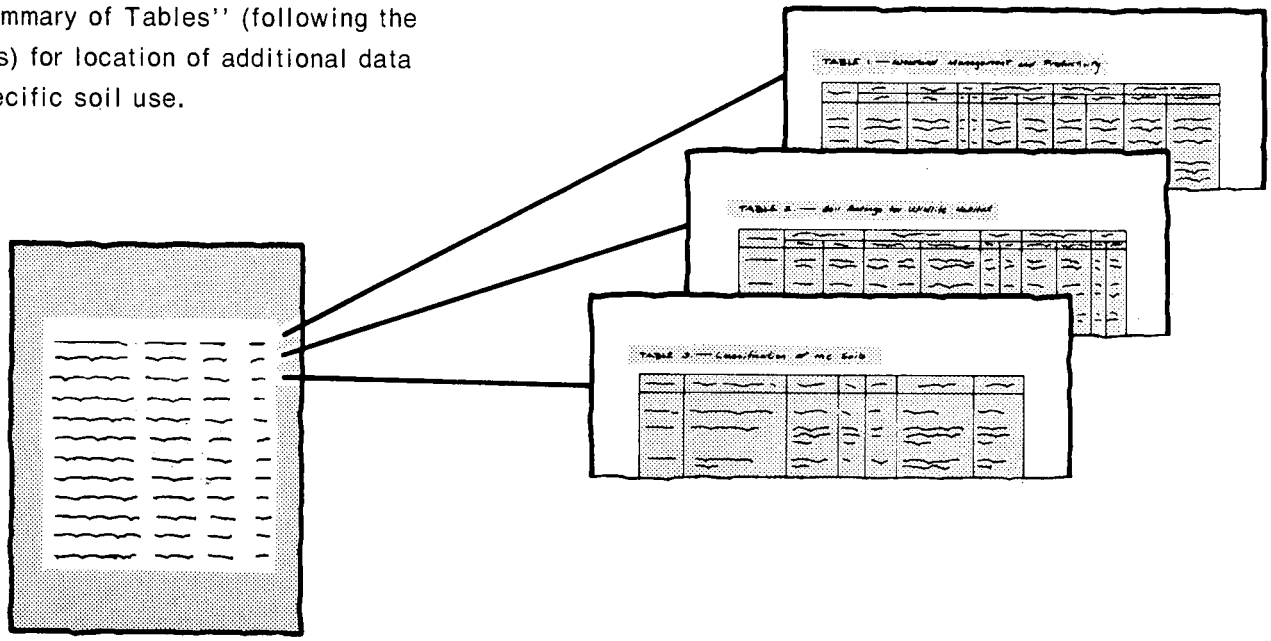
27C
56B
131B
134A
148B
151C

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. The U.S. Department of Agriculture, Soil Conservation Service, administers the federal part of this national program. This soil survey is a joint effort of the Soil Conservation Service and the Minnesota Agricultural Experiment Station in cooperation with the Agricultural Extension Service, the Minnesota Board of Water and Soil Resources, and the Martin County Soil and Water Conservation District. The survey was partly funded by the Legislative Commission for Minnesota Resources and by Martin County. 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, handicap, or age.

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. 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 Martin County Soil and Water Conservation District.

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: Farmstead windbreaks and trees along a stream channel in an area of Canisteo and Clarion soils.

Contents

Soil Series

Issued May 1989

Index to Map Units

Summary of Tables

Foreword

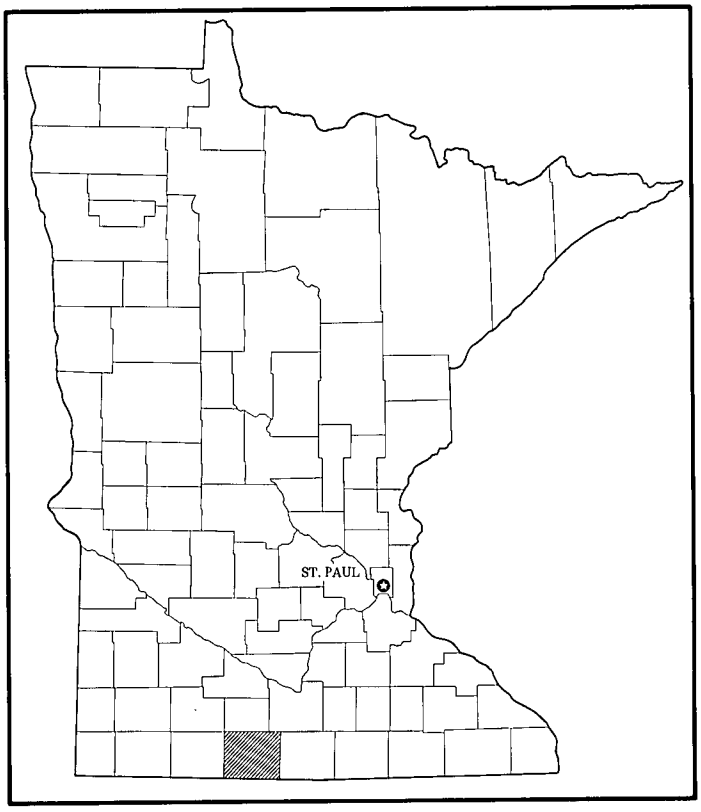
This soil survey contains information that can be used in land-planning programs in Martin County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact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

This soil survey is designed for many different users. Farmers, 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 ensure 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.

Gary R. Nordstrom
State Conservationist
Soil Conservation Service



Location of Martin County in Minnesota.

Soil Survey of Martin County, Minnesota

By Kenneth D. Matzdorf, Soil Conservation Service

Fieldwork by Kenneth D. Matzdorf, Carroll E. Oskvig, Richard O. Paulson, Robert W. Anderson, and Marc P. Diers, Soil Conservation Service, and Catherine J. Krupinski and Scott A. Navratil, Minnesota Agricultural Experiment Station

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

MARTIN COUNTY is in the south-central part of Minnesota, along the Iowa border. Fairmont, the county seat, is about 100 miles east of the South Dakota border and about 10 miles north of the Iowa border. The total area of the county is approximately 449,920 acres.

Martin County was established in 1856. It was named after Henry Martin of Wallinford, Connecticut, who owned land in the area. Many settlers moved out of the county in 1862, when Indian uprisings resulted from insensitivity to the native occupants. The Homestead Act of 1864 attracted many people to the county. The population was 5,259 in 1880; 16,936 in 1900; and 24,656 in 1940. It reached a high of 26,986 in 1960 and then declined to 24,687 by 1980.

General Nature of the County

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

Transportation Facilities and Markets

The major thoroughfare crossing Martin County is Interstate 90. Other thoroughfares are County Highways 8, 26, 27, 38, 44, 50, 52, and 54 and Minnesota Highways 4, 15, and 263. One railroad serves the county.

Livestock generally are trucked to Estherville, Austin, Worthington, or South St. Paul. Grain elevators are located in most of the towns in the county. Soybeans are processed at Mankato or sold out of state. Corn generally is sold to the elevators, but some is used as feed for livestock. Grain is transported by truck or rail.

Farming

About 96 percent of the acreage in Martin County is farmland. The farms are decreasing in number and increasing in size. The number decreased from a high of 2,557 in 1939 to 1,500 in 1980. The size increased from 175 acres in 1939 to 300 acres in 1980 (*6*).

Corn and soybeans are the major crops. The major kind of livestock is hogs. Some beef cattle and a few dairy cows are raised on the farms.

Physiography, Relief, and Drainage

The landscape of Martin County was strongly affected by the last glacial period, which is known as the New Ulm phase of the Des Moines lobe. The topography is characterized by gently undulating slopes. Small hills or ridges are interspersed with broad lowland areas that have many depressions.

The northeastern part of the county is a lacustrine plain, which formed when the area was covered by Glacial Lake Minnesota (*5*). Sandy outwash plains and terraces are along present and old stream channels throughout the county and in a small area in the east-central part. The rest of the county is a glacial till plain characterized by nearly circular hills that have nearly level tops. The hills range from a few to several hundred

acres in size. Most are in the northwestern and central parts of the county.

Elevation is highest, 1,410 feet above sea level, in the southwest corner of the county. It is 1,120 feet above sea level in the southeast corner and 1,270 feet above sea level in the northwest corner. The lowest elevation, 1,050 feet above sea level, is in an area in the northeastern part where a drainage ditch leaves the county.

The southwestern part of Martin County is drained by the East Fork of the Des Moines River, which flows in a southeast direction in the county. The other major drainage system centers around Elm Creek, which flows through the county from west to east. This creek and several smaller streams drain into the Blue Earth River, in Faribault County.

A notable feature in Martin County is three chains of lakes thought to be part of a major drainage system that flowed south before the last glacial period. As the last glacier melted, soil material partially filled this valley, forming the present chains of lakes (*12*). The central chain, made up of 20 lakes in Martin County, was the main channel. The east and west chains probably were tributaries of the main channel.

Climate

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

Martin County is cold in winter. Summers are quite hot but are characterized by occasional cool spells. Precipitation frequently occurs as snow during the winter. It occurs chiefly as showers during the warmer months, when warm, moist air moves in from the south. The showers commonly are heavy. The total annual rainfall generally is adequate for corn, soybeans, and small grain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Fairmont in the period 1951 to 1980. 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 temperature is 8 degrees. The lowest temperature on record, which occurred at Fairmont on January 21, 1970, is -33 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred at Fairmont on July 28, 1955, is 101 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.

The total annual precipitation is about 29 inches. Of this, nearly 22 inches, or about 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 18 inches. The heaviest 1-day rainfall during the period of record was 4.79 inches at Fairmont on July 19, 1963. Thunderstorms occur on about 38 days each year. Tornadoes and severe thunderstorms strike occasionally. They are local in extent and of short duration and cause sparse damage in scattered areas. Hail falls in scattered small areas during the warmer part of the year.

The average seasonal snowfall is nearly 42 inches. The greatest snow depth at any one time during the period of record was 33 inches. On the average, 54 days of the year have at least 1 inch of snow on the ground. The number of such 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 sun shines 65 percent of the time possible in summer and 40 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in spring.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil

scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another 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 association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Canisteo-Clarion Association

Nearly level to rolling, poorly drained and well drained, loamy soils on till plains

This association is on till plains that have short, irregular slopes and circular, flat-topped hills. Drainage tile has been installed in most areas of the Canisteo soils. Slopes range from 0 to 12 percent.

This association makes up about 51 percent of the county. It is about 38 percent Canisteo soils, 27 percent Clarion soils, and 35 percent minor soils.

Canisteo soils are nearly level and are on the rims of depressions and on lowlands. They are poorly drained and calcareous. Typically, they have a surface soil of black clay loam about 23 inches thick. The subsoil is dark grayish brown, mottled clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled loam.

Clarion soils are undulating and rolling and are on convex summits, back slopes, and shoulder slopes. They are well drained. Typically, they have a surface soil of black loam about 14 inches thick. The subsoil is dark brown and dark yellowish brown loam about 19 inches thick. The underlying material to depth of about 60 inches is yellowish brown, mottled loam.

Minor in this association are the Glencoe, Okoboji, Webster, Delft, Nicollet, Swanlake, and Storden soils. The very poorly drained Glencoe and Okoboji soils are in depressions. The poorly drained Webster soils are in the slightly higher landscape positions. The poorly drained Delft soils are in drainageways and on foot slopes. The moderately well drained or somewhat poorly drained Nicollet soils are on back slopes. The well drained Swanlake and Storden soils are on shoulder slopes.

About 95 percent of this association is used for cultivated crops. The main crops are corn and soybeans. A minor acreage is used for small grain or alfalfa. A few areas are used for specialty crops, such as sweet corn, peas, and sunflowers. If drained, the association is well suited to crop production. Wetness is the main limitation in areas of the poorly drained Canisteo soils, and erosion is a hazard in the uplands. The Canisteo soils have a high content of lime, which may cause a fertility imbalance.

2. Canisteo-Glencoe Association

Nearly level, poorly drained and very poorly drained, loamy soils on till plains and moraines

This association is on lowlands that have nearly circular or elongated depressions. Most areas are drained by tile lines, which empty into drainage ditches. Slopes range from 0 to 2 percent.

This association makes up about 21 percent of the county. It is about 35 percent Canisteo soils, 30 percent Glencoe soils, and 35 percent minor soils.

Canisteo soils are on the rims of depressions and on the lowlands between the depressions. They are poorly drained and calcareous. Typically, they have a surface soil of black clay loam about 23 inches thick. The subsoil is dark grayish brown, mottled clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled loam.

Glencoe soils are mainly in the depressions but also are in drainageways. They are frequently ponded. They are very poorly drained and noncalcareous. Typically, the surface layer is black clay loam about 15 inches thick. The subsurface layer is black and very dark gray, mottled clay loam about 26 inches thick. The subsoil to a depth of about 60 inches is gray and olive gray, mottled silty clay loam.

Minor in this association are the Webster, Harps, Nicollet, Clarion, and Swanlake soils. The poorly drained Webster soils are in drainageways. The poorly drained

Harps soils are on the rims of depressions. The moderately well drained or somewhat poorly drained Nicollet soils are on back slopes. The well drained Clarion and Swanlake soils are on uplands.

About 92 percent of this association is drained and is used for cultivated crops. Corn and soybeans are the principal crops. A minor acreage is used for small grain or alfalfa. A few areas are used for specialty crops, such as sweet corn, peas, and sunflowers. If drained, the association is well suited to cropland. Wetness is the main limitation, and soil blowing is a hazard. The Glencoe soils are frequently ponded for brief or long periods in the spring or after heavy rainfall. The Canisteo soils become powdery if overworked and are subject to soil blowing. They have a high content of lime, which may cause a fertility imbalance.

Field or farmstead windbreaks are effective in controlling soil blowing. The trees that are suited to wet sites and are tolerant of a high content of lime grow best. Weed control is needed when seedlings are becoming established.

3. Clarion-Delft-Storden Association

Nearly level to steep, well drained and poorly drained, loamy soils on till plains and moraines

This association is on uplands interspersed with drainageways. The uplands consist of eroded ridges. Colluvial and alluvial material is deposited in the drainageways and on foot slopes. Slopes typically are 6 to 18 percent but range from 1 to 25 percent.

This association makes up about 15 percent of the county. It is about 27 percent Clarion soils, 22 percent Delft soils, 16 percent Storden soils, and 35 percent minor soils (fig. 1).

Clarion soils are gently sloping to steep and are on summits and on some back slopes. They are well drained. Typically, they have a surface soil of black loam about 14 inches thick. The subsoil is dark brown and dark yellowish brown loam about 19 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled loam.

Delft soils are nearly level and are on foot slopes and in drainageways. They are poorly drained. Typically, they have a surface layer of black loam about 9 inches thick. The subsurface layer is black and very dark gray loam about 35 inches thick. The subsoil is dark grayish brown, mottled, friable loam about 10 inches thick. The

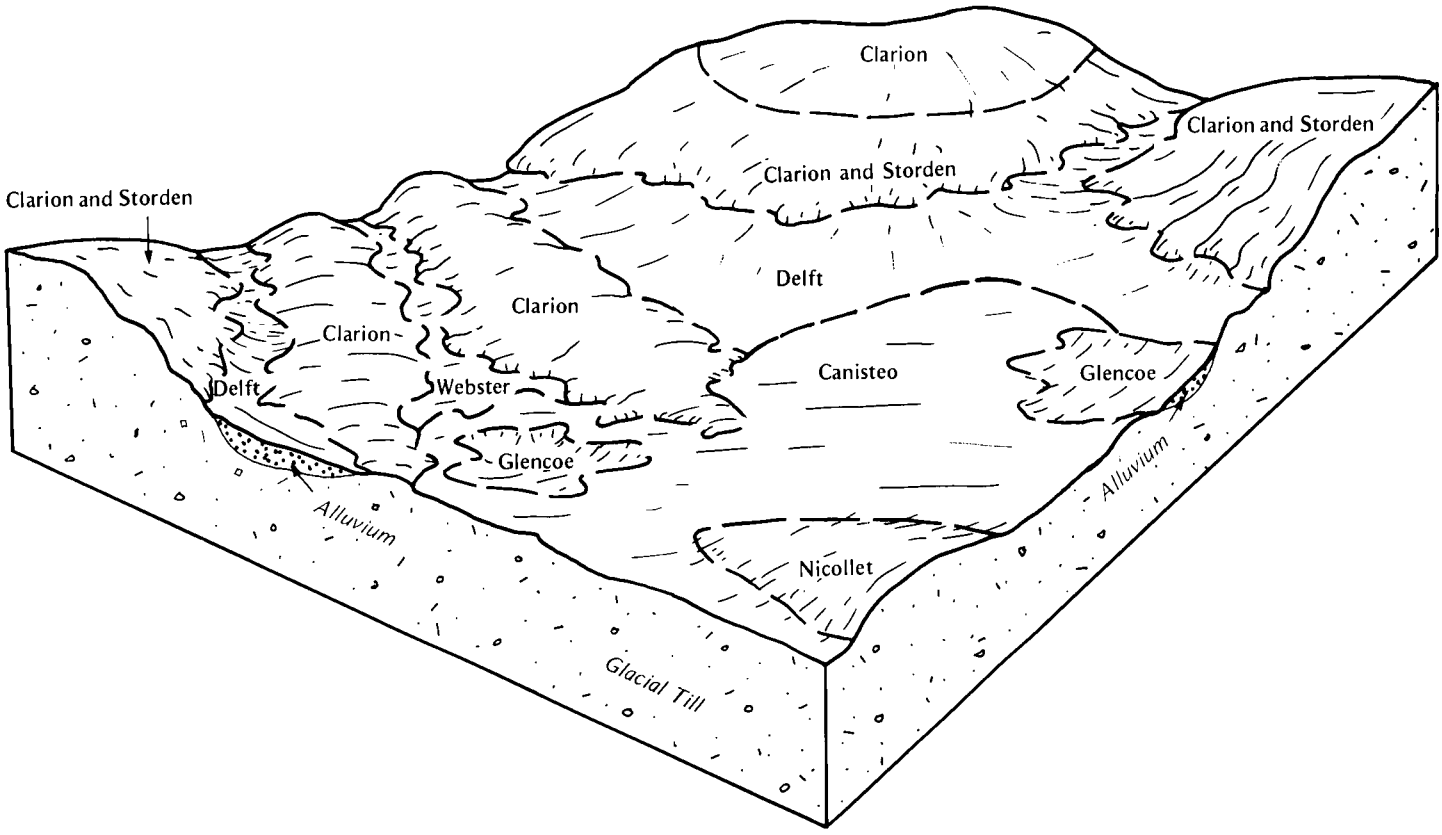


Figure 1.—Pattern of soils and parent material in the Clarion-Delft-Storden association.

underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam.

Storden soils are gently sloping to steep and are on shoulder slopes. They are well drained. Typically, they have a surface layer of dark brown and brown, calcareous loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam.

Minor in this association are the Glencoe, Canisteo, Webster, Terril, Nicollet, Dickinson, and Estherville soils. The very poorly drained Glencoe soils are in depressions. The poorly drained Canisteo and Webster soils are on low flats. The moderately well drained or somewhat poorly drained Terril and Nicollet soils are on back slopes. The somewhat excessively drained or well drained Dickinson and Estherville soils are on ridges.

About 80 percent of this association is used for cultivated crops. The rest is used for permanent pasture or supports trees or native vegetation. The principal crops are corn and soybeans. A minor acreage is used for small grain. The association is fairly well suited to cropland. The Clarion and Storden soils are subject to water erosion. Wetness is the main limitation in areas of the Delft soils.

4. Spicer-Truman-Kingston Association

Nearly level to moderately steep, poorly drained to well drained, silty soils on lake plains and moraines

This association generally occurs as irregularly shaped, gently sloping areas on lake plains and moraines. Some areas are nearly level, and moderately steep areas are adjacent to the major drainageways and streams. Most low areas are drained by tile. Slopes range from 0 to 18 percent.

This association makes up about 2 percent of the county. It is about 30 percent Spicer soils, 23 percent Truman soils, 13 percent Kingston soils, and 34 percent minor soils (fig. 2).

Spicer soils are nearly level and are on lowlands and the rims of depressions. They are poorly drained and calcareous. Typically, they have a surface layer of black

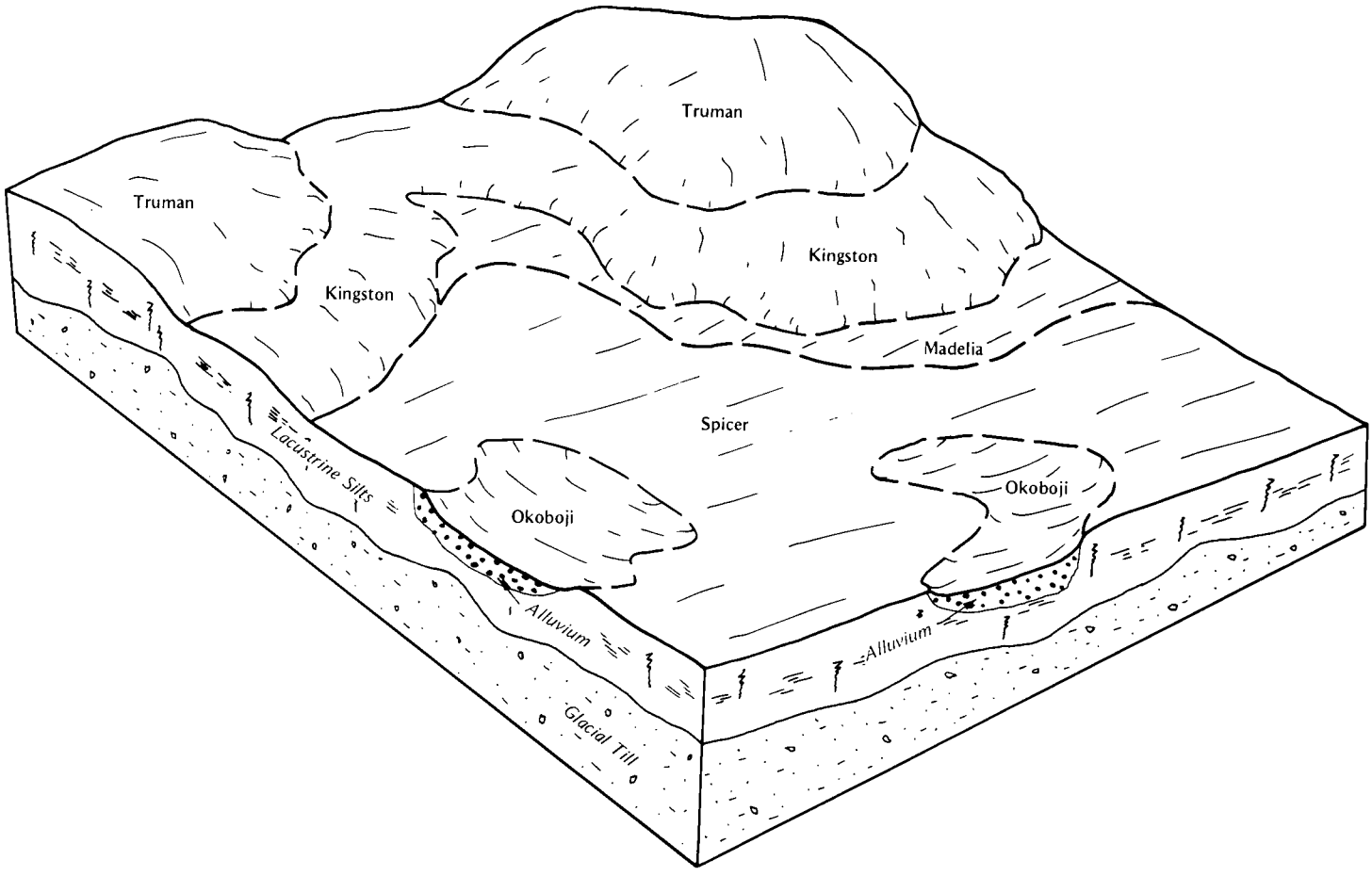


Figure 2.—Pattern of soils and parent material in the Spicer-Truman-Kingston association.

silty clay loam about 10 inches thick. The subsurface layer is very dark gray silty clay loam about 14 inches thick. The subsoil is grayish brown silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is brownish gray and olive gray silty clay loam.

Truman soils are gently sloping to moderately steep and are on shoulder slopes and summits. They are well drained. Typically, they have a surface layer of black silt loam about 9 inches thick. The subsurface layer is very dark brown silt loam about 8 inches thick. The subsoil is dark yellowish brown and brown silt loam about 16 inches thick. The underlying material to a depth of about 60 inches is brownish yellow, calcareous silt loam.

Kingston soils are nearly level and are on back slopes and the lower summits. They are moderately well drained or somewhat poorly drained. Typically, they have a surface layer of black silt loam about 11 inches thick. The subsurface layer is black silty clay loam about 7 inches thick. The subsoil is dark grayish brown and yellowish brown silty clay loam about 20 inches thick. The underlying material to a depth of about 60 inches is light olive brown, calcareous silt loam.

Minor in this association are the very poorly drained Okoboji soils in depressions, the poorly drained Madelia soils on the lower back slopes and in drainageways, and the well drained Ocheyedan soils on summits and shoulder slopes.

About 95 percent of this association is cropland. A minor acreage is used for pasture or hay. The principal crops are corn, soybeans, and small grain. The association is well suited to cropland. The poorly drained soils are drained by tile. Soil blowing and water erosion are hazards on the Truman soils.

5. Waldorf-Fostoria-Ocheyedan Association

Nearly level and gently sloping, poorly drained, somewhat poorly drained, and well drained, silty and loamy soils on lake plains, till plains, and uplands

This association is on glacial lake plains and on till plains and uplands mantled with loamy material. Most areas of the poorly drained Waldorf soils are drained by tile. Slopes range from 0 to 5 percent.

This association makes up about 2 percent of the county. It is about 35 percent Waldorf soils, 20 percent Fostoria soils, 15 percent Ocheyedan soils, and 30 percent minor soils.

Waldorf soils are nearly level and are on lowlands and in drainageways. They are poorly drained. Typically, they have a surface soil of black silty clay loam about 24 inches thick. The subsoil is dark gray, mottled silty clay about 12 inches thick. The underlying material to a depth of about 60 inches is light brownish gray, mottled, calcareous silty clay loam.

Fostoria soils are nearly level and are on the lower summits and on gentle rises. They are somewhat poorly drained. Typically, they have a surface soil of black and very dark grayish brown clay loam about 19 inches thick. The subsoil is about 21 inches of dark grayish brown clay loam and grayish brown silt loam. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam.

Ocheyedan soils are gently sloping and are on summits and back slopes. They are well drained. Typically, they have a surface soil of black, very dark gray, and brown loam about 22 inches thick. The subsoil is brown silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous silt loam.

Minor in this association are the Brownton, Okoboji, Collinwood, Truman, and Clarion soils. The very poorly drained Brownton soils are on the rims of depressions and in low areas. The very poorly drained Okoboji soils are in the depressions. The moderately well drained Collinwood soils are on the lower summits. The well drained Truman and Clarion soils are on moraines and till plains.

About 95 percent of this association is used for cultivated crops. Corn and soybeans are the principal crops. A minor acreage is used for small grain or alfalfa. The association is well suited to cropland. Wetness and erosion are the main management concerns. Because of restricted permeability, the interval between tile drains in poorly drained areas should be as little as 50 feet.

6. Lemond-Litchfield-Estherville Association

Nearly level to moderately steep, poorly drained to somewhat excessively drained, loamy soils on outwash plains, terraces, and moraines

This association is in broad areas of glacial outwash. Most of the lowlands are drained by tile. Slopes range from 0 to 18 percent.

This association makes up about 2 percent of the county. It is about 35 percent Lemond soils, 20 percent Litchfield soils, 15 percent Estherville soils, and 30 percent minor soils (fig. 3).

Lemond soils are nearly level and are on lowlands and the rims of depressions. They are poorly drained and calcareous. Typically, they have a surface layer of black sandy loam about 10 inches thick. The subsurface layer is black and very dark gray sandy loam about 10 inches thick. The subsoil is dark gray sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is olive gray and grayish brown, mottled sand.

Litchfield soils are nearly level and are on low summits and on back slopes. They are moderately well drained or somewhat poorly drained. Typically, they have a surface layer of very dark gray sandy loam about 12 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is about 21 inches of dark grayish brown very fine sandy loam and yellowish brown, mottled loamy sand. The underlying

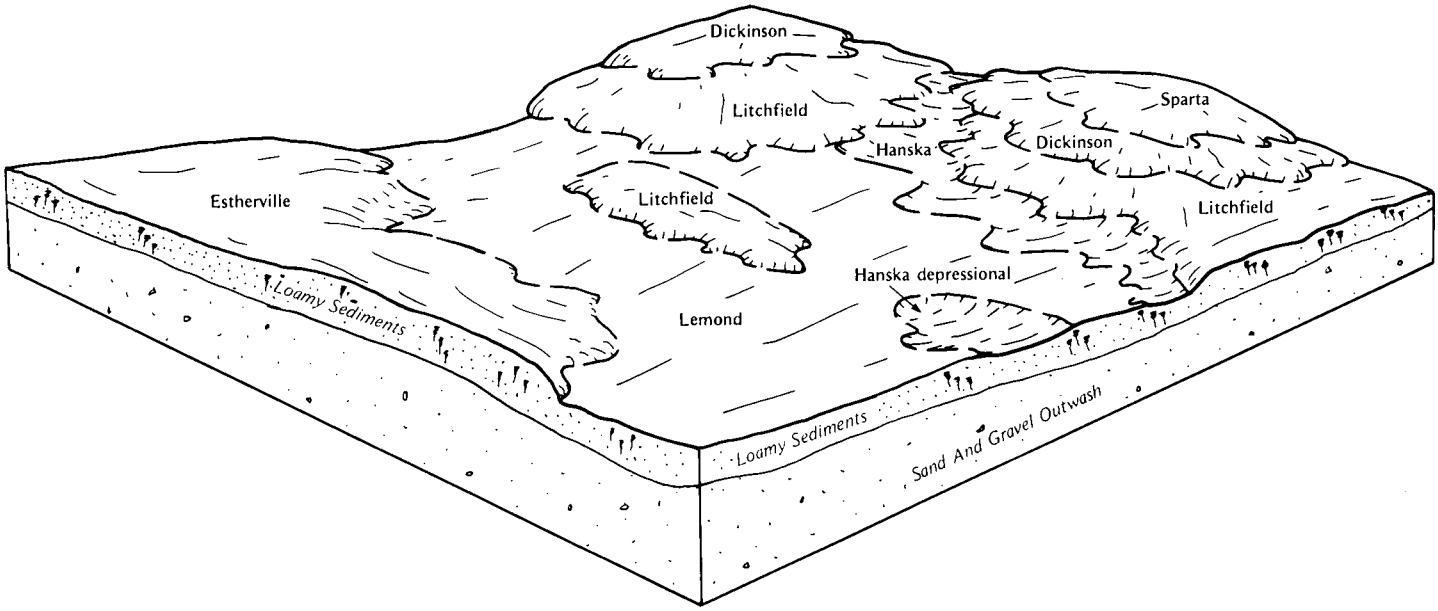


Figure 3.—Pattern of soils and parent material in the Lemond-Litchfield-Estherville association.

material to a depth of about 60 inches is grayish brown sand.

Estherville soils are gently sloping to moderately steep and are in elongated areas on uplands. They are well drained or somewhat excessively drained. Typically, they have a surface layer of black sandy loam about 9 inches thick. The subsurface layer is very dark brown sandy loam about 4 inches thick. The subsoil is about 9 inches of brown sandy loam and dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand.

Minor in this association are the Sparta, Clarion, Dickinson, Hanska, and Biscay soils. The excessively drained Sparta soils are on uplands. The well drained Clarion soils are in areas on shoulder slopes where glacial till is exposed. The well drained or somewhat excessively drained Dickinson soils are in convex areas on outwash plains and some stream terraces. The poorly drained Hanska and Biscay soils are on foot slopes and in drainageways and depressions.

About 90 percent of this association is farmed. The main crops are small grain, but corn and soybeans also are grown. The association is fairly well suited to cropland. The main management concerns are soil blowing on all the major soils, droughtiness in the Litchfield and Estherville soils, and wetness in the Lemond soils. The poorly drained Lemond soils are generally drained by tile.

7. Coland-Clarion-Delft Association

Nearly level to steep, poorly drained and well drained, loamy soils on flood plains and till plains

This association is on flood plains, on the adjacent uplands along streams, and in upland drainageways. The flood plains are either occasionally or frequently flooded. In areas where streams have been straightened or dikes have been constructed, the hazard of flooding is reduced. Drainage tile has been installed, but suitable outlets are not available in all areas. Slopes range from 0 to 25 percent.

This association makes up about 7 percent of the county. It is about 33 percent Coland soils, 18 percent Clarion soils, 14 percent Delft soils, and 35 percent minor soils (fig. 4).

Coland soils are nearly level and are on flood plains. They are poorly drained. Typically, they have a surface layer of black loam about 8 inches thick. The next 36 inches is black clay loam. The underlying material to a depth of about 60 inches is dark gray, mottled clay loam.

Clarion soils are gently sloping to steep and are on till plains. They are well drained. Typically, they have a surface soil of black loam about 14 inches thick. The subsoil is dark brown and dark yellowish brown loam about 19 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam.

Delft soils are nearly level and are on foot slopes and in drainageways on till plains. They are poorly drained. Typically, they have a surface soil of black and very dark gray loam about 44 inches thick. The subsoil is dark

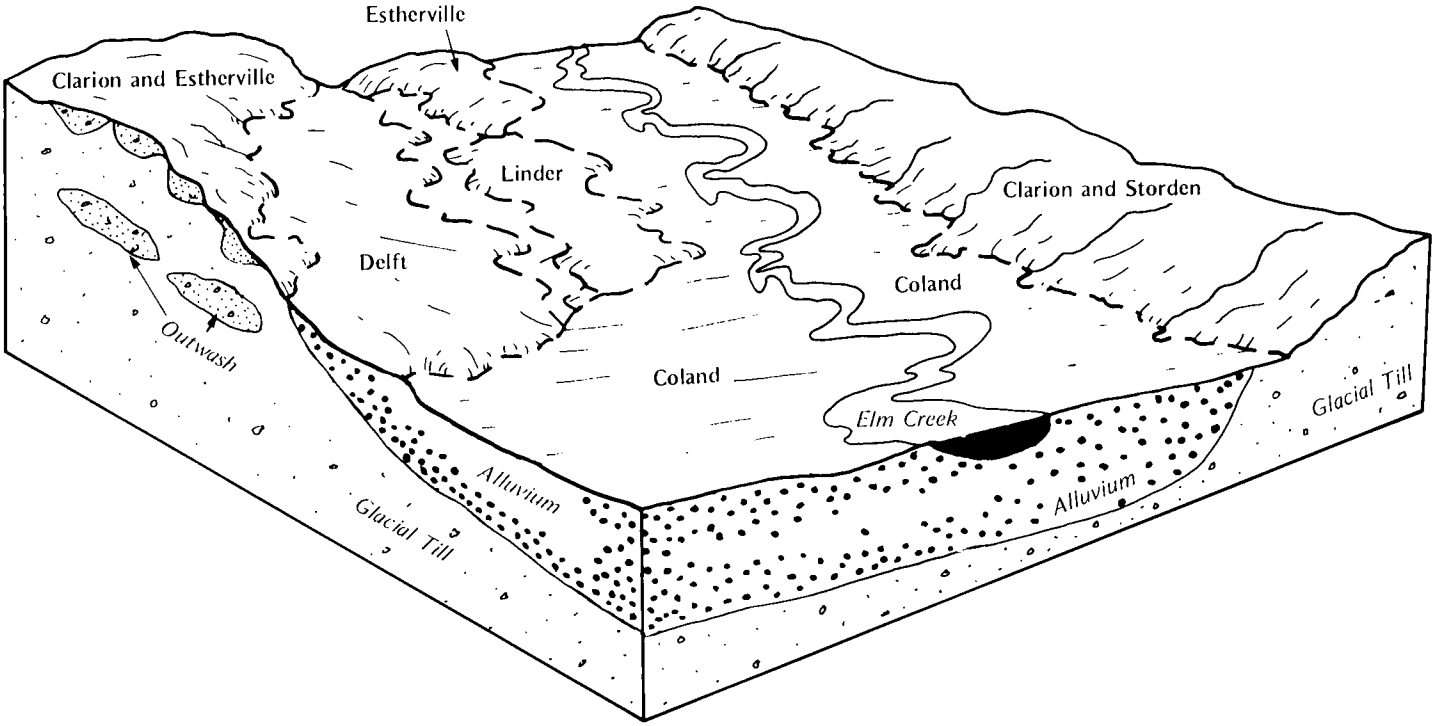


Figure 4.—Pattern of soils and parent material in the Coland-Clarion-Delft association.

grayish brown, mottled loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam.

Minor in this association are the Spillville, Terril, Storden, Linder, Millington, and Estherville soils. The moderately well drained or somewhat poorly drained Spillville soils are on slight rises on the flood plains. The moderately well drained Terril soils are on foot slopes. The well drained Storden soils are on shoulder slopes. The somewhat poorly drained Linder soils are on terraces. The poorly drained Millington soils are on flood plains. The well drained or somewhat excessively drained Estherville soils are on the higher terraces.

About 75 percent of this association is cultivated. The rest is used for permanent pasture, for hay, or for trees or is idle land. The main crops are corn, soybeans, and small grain. Erosion is a hazard on uplands, and flooding is a hazard on bottom land.

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, Coland loam, frequently flooded, is a phase of the Coland series.

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

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, 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. Clarion-Estherville-Storden complex, 6 to 12 percent slopes, eroded, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Palms and Okoboji soils, ponded, is an undifferentiated group in this survey area.

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.

Soil Descriptions

8B—Sparta loamy fine sand, 1 to 6 percent slopes. This gently sloping, excessively drained soil is in slightly convex and nearly plane areas on outwash plains and stream terraces. Individual areas are narrow and elongated and range from 5 to 20 acres in size.

Typically, the surface layer is black loamy fine sand about 10 inches thick. The subsurface layer is very dark gray and very dark grayish brown loamy fine sand about 4 inches thick. The subsoil is dark brown and dark yellowish brown loamy fine sand about 16 inches thick. The underlying material to a depth of about 60 inches is dark brown fine sand. In places the surface layer is fine sandy loam. In a few areas the soil is coarser textured throughout.

Included with this soil in mapping are small areas of the well drained Farrar soils on shoulder slopes. These soils contain less sand than the Sparta soil. Also included are the moderately well drained or somewhat poorly drained Litchfield and poorly drained Hanska soils in the lower areas. Included soils make up 5 to 15 percent of the map unit.

Permeability is rapid in the Sparta soil, and the available water capacity is low. Organic matter content and natural fertility also are low. Surface runoff is slow. The surface layer is strongly acid to neutral.

Most areas are used as cropland. This soil is poorly suited to small grain, grasses, and legumes. If cultivated crops are grown, drought and soil blowing are hazards. Winter cover crops and a system of conservation tillage that leaves crop residue on the surface help to control erosion and conserve moisture. Short-season crops are less likely to be damaged by drought than other crops. Returning crop residue to the soil or adding other organic material improves fertility.

A cover of pasture plants or hay is effective in controlling soil blowing. Pasture rotation and restricted use during dry periods help to keep the pasture in good condition.

This soil is poorly suited to the trees grown as field and farmstead windbreaks. Droughtiness is a limitation, but it can be overcome by planting trees that are adapted to dry conditions. Weed control and periodic watering help to establish seedlings.

The land capability classification is IVs.

27B—Dickinson fine sandy loam, 1 to 6 percent slopes. This gently sloping, well drained or somewhat excessively drained soil is in convex areas on outwash plains and some stream terraces. Individual areas are elongated or irregularly shaped and range from 5 to 25 acres in size.

Typically, the surface layer is black fine sandy loam about 14 inches thick. The subsurface layer is black and very dark grayish brown fine sandy loam about 5 inches thick. The subsoil is brown sandy loam about 15 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown fine sand. In some places the depth to loamy fine sand or coarser textured material is less than 20 inches. In other places coarse fragments are below a depth of 40 inches.

Included with this soil in mapping are small areas of the well drained Clarion soils on shoulder slopes and back slopes and the poorly drained Hanska soils in drainageways. Clarion soils contain less sand than the Dickinson soil. Included soils make up 3 to 10 percent of the map unit.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the lower part. The available water capacity is moderate. Organic matter content is low, and natural fertility is medium. Surface runoff also is medium. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to all of the crops commonly grown in the county. If cultivated crops are grown, drought and soil blowing are hazards (fig. 5). A system of conservation tillage that leaves crop residue on the surface helps to control soil blowing. Short-season varieties of row crops, small grain, and legumes are less likely to be damaged by drought than other varieties.

A cover of pasture plants or hay is effective in controlling soil blowing. Restricted use during dry periods and pasture rotation help to keep the pasture in good condition.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are adapted to dry sites. Watering during dry periods and weed control help to establish seedlings.

The land capability classification is IIe.

35—Blue Earth mucky silty clay loam. This nearly level, very poorly drained soil is in drained depressions on glacial lakebeds. It is subject to ponding. It also is subject to rare flooding, which lasts for brief periods in the spring. Individual areas are circular and range from 25 to 200 acres in size.

Typically, the surface layer is black mucky silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is very dark gray and dark olive gray, mottled mucky silty clay loam and clay loam. The soil is calcareous throughout. In some areas the surface layer contains more organic matter.

Included with this soil in mapping are small areas of the poorly drained Lemond and somewhat poorly drained Linder soils. These soils are on the edges of the depressions. They make up 2 to 5 percent of the map unit.

Permeability is moderate in the Blue Earth soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is ponded or very slow. A seasonal high water table is 2 feet above to 1 foot below the surface. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If drained, this soil is fairly well suited to corn, soybeans, grasses, and alfalfa. The high water table and a fertility imbalance caused by the high content of lime are the main limitations. Tile drains can lower the water table, but ditches commonly are needed to provide suitable outlets for tile lines. A good fertility program that includes applications of phosphorus and potassium is needed. The high content of lime and organic matter reduces the effectiveness of preemergence herbicides. Soil blowing is a hazard unless the fields are protected. A system of conservation tillage that leaves crop residue on the surface reduces this hazard.

If this soil is used for pasture or hay, the wetness is a problem. Grazing during wet periods can result in compaction and poor tilth. Restricted use during these periods helps to keep the pasture in good condition.

This soil is poorly suited to field and farmstead windbreaks. Trees and shrubs established in or around these lakebeds are effective in controlling soil blowing. The species selected for planting should be those that can withstand the wetness and the high content of lime.

Figure 5.—Soil blowing in an area of Dickinson fine sandy loam, 1 to 6 percent slopes.

Controlling weeds by applications of herbicide or by cultivation increases the rate of seedling survival.

The land capability classification is IIIw.

37B—Farrar fine sandy loam, 1 to 6 percent slopes. This gently sloping, well drained soil is in convex areas on glacial uplands. Individual areas are narrow and elongated and range from 5 to 20 acres in size.

Typically, the surface layer is black fine sandy loam about 10 inches thick. The subsurface layer is black and very dark brown fine sandy loam about 4 inches thick. The subsoil is about 16 inches thick. The upper part is very dark grayish brown fine sandy loam, and the lower part is dark yellowish brown loam. The underlying material to a depth of about 60 inches is light olive brown and yellowish brown, mottled, calcareous loam. In places sandy loam is at a depth of more than 40 inches. In a few places glacial till is within 18 inches of the surface. In some areas the loamy mantle is underlain by silty sediments.

Included with this soil in mapping are small areas of the well drained or somewhat excessively drained Estherville and moderately well drained or somewhat poorly drained Nicollet and Litchfield soils. Estherville soils contain more sand than Farrar soil. They are in landscape positions similar to those of the Farrar soil.

Nicollet and Litchfield soils are in the lower positions. Included soils make up 5 to 10 percent of the map unit.

Permeability is moderately rapid in the upper part of the Farrar soil and moderate in the lower part. The available water capacity is high. Organic matter content is low, and natural fertility is medium. Surface runoff also is medium. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion and soil blowing are hazards. They can be controlled by a system of conservation tillage that leaves crop residue on the surface.

This soil is well suited to field and farmstead windbreaks. Droughtiness may be a limitation until the tree roots reach the underlying material. The trees and shrubs selected for planting should be those that are suited to dry sites. Weed control and periodic watering help to establish seedlings.

The land capability classification is IIe.

39B—Wadena loam, 1 to 6 percent slopes. This gently sloping, well drained soil is in convex areas on outwash plains. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black loam about 13 inches thick. The subsurface layer is very dark brown loam about 7 inches thick. The subsoil is about 18 inches thick. It is dark yellowish brown. The upper part is loam, and the lower part is sandy loam. The underlying material to a depth of about 60 inches is grayish brown and dark yellowish brown, calcareous sand. In some areas the loamy mantle has more sand. In other areas glacial till is within 40 inches of the surface.

Included with this soil in mapping are small areas of the somewhat excessively drained or well drained Dickinson soils. These soils are in landscape positions similar to those of the Wadena soil. They have less clay in the surface layer than the Wadena soil. Also included are the poorly drained Hanska and Biscay soils in the lower areas. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the upper part of the Wadena soil and very rapid in the lower part. The available water capacity is low or moderate. Organic matter content is moderate or high, and natural fertility is medium. Surface runoff also is medium. The surface layer is slightly acid or neutral.

Most areas are used as cropland. This soil is well suited to all of the crops commonly grown in the county. If cultivated crops are grown, drought and erosion are hazards. Short-season crops are less likely to be damaged by drought than other crops. A system of conservation tillage that leaves crop residue on the surface helps to control erosion and runoff and conserves moisture.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand occasional periods of drought in late summer and in fall. Weed control helps to establish seedlings.

The land capability classification is IIe.

41B—Estherville sandy loam, 1 to 6 percent slopes. This gently sloping, well drained or somewhat excessively drained soil is in convex and nearly plane areas on outwash plains. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark brown sandy loam about 4 inches thick. The subsoil is about 9 inches of brown sandy loam and dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly coarse sand. In some areas glacial till is within 40 inches of the surface. In a few areas the soil has no coarse fragments.

Included with this soil in mapping are small areas of the well drained or somewhat excessively drained Dickinson soils. These soils are in landscape positions similar to those of the Estherville soil. They have few or no coarse fragments and contain less sand than the Estherville soil. Also included are small areas of the well drained Clarion and Storden soils on the higher parts of the landscape. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. The available water capacity is low. Organic matter content is moderate, and natural fertility is medium. Surface runoff is slow. The surface layer is medium acid to neutral.

Most areas are used for small grain, legumes, or grasses. Some are used for corn or soybeans. This soil is only fairly well suited to cultivated crops because of the low available water capacity and the hazard of erosion. Winter cover crops and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Returning crop residue to the soil or adding other organic material improves fertility and increases the available water capacity.

A cover of pasture plants or hay is effective in controlling erosion. Pasture rotation and restricted use during dry periods help to keep the pasture in good condition.

This soil is poorly suited to the trees grown as field and farmstead windbreaks. Droughtiness is a limitation, but it can be overcome by planting trees that are suited to dry sites. Weed control and periodic watering help to establish seedlings. Once established, windbreaks are effective in controlling soil blowing.

The land capability classification is IIIs.

41C—Estherville sandy loam, 6 to 12 percent slopes. This sloping, well drained or somewhat

excessively drained soil is in convex areas on outwash plains. Individual areas are long and narrow and range from 5 to 20 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark gray sandy loam about 5 inches thick. The subsoil is about 8 inches of dark yellowish brown sandy loam and loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown, calcareous gravelly coarse sand. In some areas the gravelly material is at or near the surface. In a few places the soil has no coarse fragments.

Included with this soil in mapping are small areas of the well drained or somewhat excessively drained Dickinson soils. These soils are in landscape positions similar to those of the Estherville soil. They have little or no gravel and contain less sand than the Estherville soil. Also included are small areas of the well drained Clarion and Swanlake soils on the higher parts of the landscape. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. The available water capacity is low. Organic matter content is moderate, and natural fertility is low. Surface runoff is medium. The surface layer is medium acid to neutral.

Most areas are used for small grain, grasses, or legumes. This soil is poorly suited to cultivated crops because of the low available water capacity and the hazard of erosion. A system of conservation tillage that leaves crop residue on the surface helps to control runoff and erosion and conserves moisture. Growing winter cover crops, returning crop residue to the soil, and adding manure improve fertility.

A cover of pasture plants or hay is effective in controlling erosion. Pasture rotation and restricted use during dry periods help to keep the pasture in good condition.

This soil is poorly suited to many of the trees grown as field and farmstead windbreaks. Droughtiness is a limitation, but it can be overcome by planting trees and shrubs that are suited to dry sites. Weed control and periodic watering help to establish seedlings. Once established, windbreaks are effective in controlling soil blowing.

The land capability classification is IVs.

84—Brownton silty clay. This nearly level, poorly drained soil is in slightly convex and nearly plane areas on glacial lake plains. Individual areas are irregular in shape and range from 10 to 75 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsurface layer also is black silty clay about 10 inches thick. The subsoil is mottled clay about 20 inches thick. The upper part is dark gray, and the lower part is olive gray. The underlying material to a depth of about 60 inches is olive gray, mottled silty clay loam. The soil is calcareous throughout. In some places the dark surface soil is more than 24 inches thick. In other places the subsoil contains less clay. In a few areas gypsum crystals are at or near the surface.

Included with this soil in mapping are small areas of the very poorly drained Okoboji soils in depressions and the poorly drained Waldorf soils in drainageways. The included soils are not calcareous throughout. They make up 2 to 12 percent of the map unit.

Permeability is slow in the Brownton soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1.0 to 2.5 feet. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If drained, this soil is well suited to all of the crops commonly grown in the county. The wetness and the slow permeability are limitations. Tile drains lower the water table. A good fertility program is needed because a high content of lime restricts the availability of phosphorus, iron, and some other plant nutrients. Soybeans may exhibit iron chlorosis, or "yellowing." Fall tillage allows the soil to warm up more rapidly in the spring, but it increases the hazard of erosion. Ridge planting reduces this hazard. Excessive tillage can break down soil structure and thus increase the susceptibility to soil blowing. Field windbreaks and a system of conservation tillage that leaves crop residue on the surface help to control soil blowing.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand the wetness and the high content of lime. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate.

The land capability classification is IIw.

86—Canisteo clay loam. This nearly level, poorly drained soil is on the convex rims of depressions and in slightly convex to slightly concave areas on till plains. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 14 inches thick. The subsoil is dark grayish brown, mottled clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled loam. The soil is calcareous throughout. In some areas the dark surface soil is more than 24 inches thick. In other areas there is a buildup of carbonates near the surface. In some places gypsum crystals are at or near the surface. In other places the soil has sandy or silty sediments.

Included with this soil in mapping are small areas of the very poorly drained Glencoe soils in depressions and the poorly drained Webster soils in drainageways. The

included soils are not calcareous throughout. They make up 10 to 15 percent of the map unit.

Permeability is moderate in the Canisteo soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains help to lower the water table. Soybeans often exhibit iron chlorosis, or "yellowing," (fig. 6). A good fertility program is needed because the high content of lime restricts the availability of phosphorus, iron, and other plant nutrients. Fall tillage allows the soil to warm up more rapidly in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

This soil is fairly well suited to field and farmstead windbreaks. Excessive tillage during site preparation can break down soil structure and increase the susceptibility to soil blowing. The trees and shrubs selected for planting should be those that can withstand the wetness and the high content of lime. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate. Once established, windbreaks are effective in controlling soil blowing.

The land capability classification is IIw.

94B—Terril loam, 2 to 6 percent slopes. This gently sloping, moderately well drained soil is on foot slopes and alluvial fans in the uplands. Individual areas are long and narrow and range from 5 to 25 acres in size.

Typically, the surface layer is black loam about 15 inches thick. The subsurface layer is very dark brown clay loam about 21 inches thick. The subsoil to a depth of about 60 inches is very dark grayish brown, brown,

Figure 6.—Iron chlorosis, or "yellowing," in an area of Canisteo clay loam used for soybeans.

dark brown, and dark yellowish brown loam. It is mottled in the lower part. In some areas the soil has more sand, and in other areas it has more silt. In a few places calcareous glacial till is within 40 inches of the surface.

Included with this soil in mapping are small areas of the well drained Clarion and Swanlake soils in the higher landscape positions and the poorly drained Webster soils in drainageways. Included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the Terril soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is medium. The surface layer is slightly acid or neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface.

This soil is well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are adapted to moderately wet sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation. Once established, windbreaks are effective in controlling soil blowing.

The land capability classification is IIe.

96—Collinwood silty clay. This nearly level, moderately well drained or somewhat poorly drained soil is in slightly convex and nearly plane areas on glacial lake plains. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is black silty clay about 9 inches thick. The subsurface layer is very dark grayish brown silty clay about 6 inches thick. The subsoil is about 20 inches of dark grayish brown and grayish brown clay and silty clay. It is mottled in the lower part. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous silty clay loam. In places glacial till is within 40 inches of the surface. In a few areas the surface soil and subsoil contain less clay.

Included with this soil in mapping are small areas of the well drained Truman soils on the higher parts of the landscape and the poorly drained Waldorf soils on the lower parts and in drainageways. Truman soils contain less clay than the Collinwood soil. Included soils make up 2 to 10 percent of the map unit.

Permeability is moderately slow or slow in the Collinwood soil, and the available water capacity is moderate or high. Organic matter content and natural fertility are high. Surface runoff is medium. The depth to a seasonal high water table is 2 to 5 feet. The surface layer is medium acid to neutral.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. It becomes compacted and cloddy if it is tilled when wet. Fall tillage allows the soil to warm up sooner in the spring.

This soil is well suited to farmstead and field windbreaks. The trees and shrubs selected for planting should be those that are adapted to moderately wet sites. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate.

The land capability classification is IIw.

101B—Truman silt loam, 1 to 6 percent slopes. This undulating, well drained soil is in convex areas on glacial lake plains. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is very dark brown and dark brown silt loam about 8 inches thick. The subsoil is silt loam about 16 inches thick. The upper part is brown and dark yellowish brown, and the lower part is yellowish brown and dark yellowish brown and is calcareous. The underlying material to a depth of about 60 inches is brownish yellow, mottled, calcareous silt loam. In some areas carbonates are closer to the surface. In a few areas the soil has a loamy mantle. In places it has a higher content of fine sand.

Included with this soil in mapping are small areas of the well drained Bold soils on shoulder slopes. These soils are calcareous throughout and contain more silt than the Truman soil. Also included are the moderately well drained or somewhat poorly drained Kingston and poorly drained Madelia and Spicer soils in the lower areas. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Truman soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is medium. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to control runoff and erosion.

This soil is well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are adapted to dry sites. Controlling weeds by applications of herbicide or by cultivation helps to establish seedlings.

The land capability classification is IIe.

102B—Clarion loam, 1 to 6 percent slopes. This undulating, well drained soil is on summits and shoulder slopes on till plains. Individual areas are elongated or irregular in shape and range from 5 to 75 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 4 inches thick. The subsoil is loam about 19 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The underlying material to a

depth of about 60 inches is yellowish brown, calcareous loam. It is mottled in the lower part. In some areas the soil has sandy or silty sediments in the surface soil or subsoil.

Included with this soil in mapping are small areas of the well drained Storden and Swanlake soils on shoulder slopes, the poorly drained Canisteo and Webster soils on the lower parts of the landscape or in drainageways, and the moderately well drained or somewhat poorly drained Nicollet soils on the lower parts of the landscape. Storden and Swanlake soils are calcareous throughout. Included soils make up 5 to 10 percent of the map unit.

Permeability is moderate in the Clarion soil, and the available water capacity is high. Organic matter content is moderate, and natural fertility is high. Surface runoff is medium. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface helps to control runoff and erosion.

This soil is well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are adapted to dry sites. Weed control helps to establish seedlings.

The land capability classification is IIe.

106B—Lester loam, 2 to 6 percent slopes. This undulating, well drained soil is on summits and shoulder slopes on till plains near the chains of lakes. Individual areas are elongated or irregularly shaped and range from 5 to 50 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer also is black loam. It is about 10 inches thick. The subsoil is clay loam about 22 inches thick. The upper part is dark yellowish brown and has thin clay coatings, and the lower part is yellowish brown and has moderately thick clay coatings. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous clay loam and loam. In some areas there is no clay buildup in the subsoil.

Included with this soil in mapping are small areas of the poorly drained Webster soils in drainageways, the moderately well drained or somewhat poorly drained Nicollet soils on the lower parts of the landscape, and the well drained Swanlake soils on shoulder slopes. Swanlake soils are calcareous throughout. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Lester soil, and the available water capacity is high. Organic matter content is moderate, and natural fertility is high. Surface runoff is medium. The surface layer is medium acid or slightly acid.

Many areas are used for building site development. Areas along the central chain of lakes are forested. A few areas are farmed. This soil is well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface. Growing grasses and legumes for pasture or hay also is effective in controlling erosion. Returning crop residue to the soil improves tilth.

This soil is well suited to the trees and shrubs grown as field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to dry sites and acid soils. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIe.

106C—Lester loam, 6 to 12 percent slopes. This rolling, well drained soil is on shoulder slopes on till plains near the chains of lakes. Individual areas are long and narrow and range from 5 to 25 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsurface layer is very dark grayish brown loam about 6 inches thick. The subsoil is clay loam about 20 inches thick. The upper part is brown and has moderately thick clay coatings, and the lower part is yellowish brown and has thin clay coatings. The underlying material to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown and calcareous in the lower part. In some areas the soil has carbonates closer to the surface and has no clay coatings.

Included with this soil in mapping are small areas of the poorly drained Webster soils in drainageways, the moderately well drained or somewhat poorly drained Nicollet soils on the lower parts of the landscape, and the well drained Storden and Swanlake soils on shoulder slopes. Storden and Swanlake soils are calcareous throughout. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Lester soil, and the available water capacity is high. Organic matter content is moderate, and natural fertility is high. Surface runoff is rapid. The surface layer is medium acid or slightly acid.

Most areas are used for cultivated crops or building site development. This soil is fairly well suited to all of the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. Farming on the contour and leaving crop residue on the surface greatly reduce this hazard.

Growing grasses and legumes for pasture or hay is effective in controlling erosion. Grazing in very wet areas causes compaction, excessive runoff, and poor tilth. Pasture rotation and restricted use during wet periods help to keep the pasture in good condition.

Some areas are wooded. This soil is well suited to woodland. Seedlings survive and grow well if competing vegetation is controlled or removed. No major hazards or limitations affect planting or harvesting.

The land capability classification is IIIe.

112—Harps clay loam. This nearly level, poorly drained soil is on the convex rims around depressions on till plains. Individual areas are elongated or irregularly shaped and range from 5 to 25 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is very dark gray clay loam about 5 inches thick. The subsoil is about 19 inches thick. It is mottled. The upper part is olive gray clay loam, and the lower part is olive gray and light olive gray loam. The underlying material to a depth of about 60 inches is light olive gray and light gray loam. The soil is calcareous throughout. In some areas the upper 20 inches has few or no carbonates.

Included with this soil in mapping are small areas of the very poorly drained Glencoe and Okoboji soils in depressions and the somewhat poorly drained Crippin soils on slight rises. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the Harps soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is moderately alkaline.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. The wetness caused by the high water table in the spring is a limitation. Tile drains lower the water table. Soybeans often exhibit iron chlorosis, or "yellowing." A good fertility program is needed because the high content of lime restricts the uptake of iron, phosphorus, and other plant nutrients. Fall tillage allows the soil to warm up sooner in the spring, but it increases the hazard of soil blowing. Ridge planting reduces this hazard.

This soil is fairly well suited to field and farmstead windbreaks. If excessively tilled during site preparation, it becomes powdery and more susceptible to soil blowing. The trees and shrubs selected for planting should be those that are suited to moist sites and that can tolerate the high content of lime. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation. Once established, windbreaks are effective in controlling soil blowing.

The land capability classification is IIw.

113—Webster clay loam. This nearly level, poorly drained soil is on the lower foot slopes and in drainageways on glacial till plains. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is black clay loam about 11 inches thick. The subsurface layer is very dark gray clay loam about 8 inches thick. The subsoil is dark grayish brown, mottled clay loam about 15 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled, calcareous loam. In some areas the dark surface soil is more than 24 inches thick.

Included with this soil in mapping are small areas of the poorly drained Canisteo, very poorly drained Glencoe, and moderately well drained or somewhat poorly drained Nicollet soils. Canisteo soils are calcareous throughout. They are in low areas around the depressions. Glencoe soils are in the depressions. Nicollet soils are on the slightly higher parts of the landscape. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Webster soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow. The depth to a seasonal high water table is 1 to 2 feet. The surface layer is neutral.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains help to lower the water table. The soil becomes compacted and cloddy if it is tilled when wet. Fall tillage allows the soil to warm up sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Weed control increases the seedling survival rate.

The land capability classification is IIw.

114—Glencoe clay loam. This nearly level, very poorly drained soil is in depressions and drainageways on glacial moraines. It is ponded for brief or long periods in the spring and is subject to rare flooding. Individual areas commonly are circular and range from 5 to 40 acres in size.

Typically, the surface layer is black clay loam about 15 inches thick. The subsurface layer is black and very dark gray, mottled clay loam about 26 inches thick. The subsoil to a depth of about 60 inches is gray and olive gray, mottled silty clay loam. In a few places the dark surface soil is less than 24 inches thick. In some areas the soil has more clay and less sand.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Harps soils on the rims of the depressions and the poorly drained Webster soils on the slightly higher parts of the landscape. Also included, in some of the depressions, are small areas of the very poorly drained Palms soils, which formed in muck. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate or moderately slow in the Glencoe soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow to ponded. A seasonal high water table is 1 foot above to 1 foot below the surface. The surface layer is slightly acid to mildly alkaline.

Most areas are used as cropland. If drained, this soil is fairly well suited to the crops commonly grown in the county. The high water table is a limitation, and ponding

is a hazard in the spring and after heavy rainfall or prolonged periods of rainfall. Tile drains reduce the wetness. Ditches are needed in some areas to provide suitable outlets for drainage systems. Fall tillage allows the soil to warm up sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

If this soil is used for pasture or hay, the wetness is a problem. Ponding can damage or kill seedlings and can restrict access. Grazing in wet areas can result in compaction and poor tilth. Restricted use during wet periods helps to keep the pasture in good condition.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand the wetness. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate.

The land capability classification is IIIw.

118—Crippin loam. This nearly level, somewhat poorly drained soil is on the summits of low rises on ground moraines. Individual areas are long and narrow and range from 5 to 15 acres in size.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 6 inches thick. The subsoil is dark grayish brown loam about 12 inches thick. The underlying material to a depth of about 60 inches is olive brown, mottled loam. The soil is calcareous throughout. In many places the subsurface layer is brighter colored. In a few places the slope is more than 3 percent.

Included with this soil in mapping are small areas of the poorly drained Harps soils on the rims of depressions and the well drained Clarion and Swanlake soils in the higher landscape positions. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Crippin soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium or high. Surface runoff is slow. The depth to a seasonal high water table is 2 to 4 feet. The surface layer is neutral to moderately alkaline.

Most areas are used as cropland. This soil is well suited to all of the crops commonly grown in the county. If cultivated crops are grown, a good fertility program is needed because of the high content of lime. Returning crop residue to the soil improves tilth.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand the wetness and the high content of lime. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is I.

128B—Grogan silt loam, 1 to 6 percent slopes. This gently sloping, well drained soil is in convex areas on lake plains. Individual areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black silt loam about 10 inches thick. The subsurface layer is very dark brown silt loam about 8 inches thick. The subsoil is brown silt loam about 20 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous, stratified very fine sandy loam and silt loam. In some areas the soil has more sand, and in a few areas it has more silt.

Included with this soil in mapping are small areas of the well drained Ocheyedan and Clarion soils on shoulder slopes and the poorly drained Madelia soils in drainageways. The included soils contain more clay than the Grogan soil. They make up 3 to 10 percent of the map unit.

Permeability is moderately rapid in the Grogan soil, and the available water capacity is high. Organic matter content is moderate, and natural fertility is medium. Surface runoff is slow. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface.

This soil is well suited to field and farmstead windbreaks, which are effective in controlling erosion and windblown snow. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIe.

130—Nicollet clay loam. This nearly level, moderately well drained or somewhat poorly drained soil is on back slopes and the lower summits on till plains. Individual areas are oblong or long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is very dark gray clay loam about 7 inches thick. The subsoil is dark grayish brown and grayish brown, mottled clay loam about 19 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some areas the soil has more silt. In a few places it has a clay buildup in the subsoil.

Included with this soil in mapping are small areas of the well drained Clarion soils in the higher landscape positions and the poorly drained Webster soils in drainageways. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Nicollet soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow. A seasonal high water table is at a depth of 2.5 to 5.0 feet. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. It can be cropped intensively. Returning crop residue to the soil and restricting fieldwork during wet periods help to prevent excessive compaction and improve tilth.

This soil is well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are adapted to moderately wet sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is I.

134—Okoboji silty clay loam. This nearly level, very poorly drained soil is in depressions on till plains and lake plains. It is commonly ponded for brief periods in the spring. Individual areas are circular and range from 10 to 60 acres in size.

Typically, the surface layer is black silty clay loam about 12 inches thick. The subsurface layer also is black silty clay loam. It is about 16 inches thick. The subsoil is olive gray, mottled silty clay loam about 14 inches thick. The underlying material to a depth of about 60 inches is olive gray, calcareous clay loam and silt loam. In some areas the surface layer contains peat. In other areas glacial till is within 40 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Harps soils on the rims of the depressions and the very poorly drained Palms soils near the center of the depressions. Palms soils formed in muck. Included soils make up 2 to 10 percent of the map unit.

Permeability is moderately slow in the Okoboji soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow to ponded. A seasonal high water table is 1 foot above to 1 foot below the surface. The surface layer is neutral or mildly alkaline.

Most areas are used as cropland. If drained, this soil is fairly well suited to the crops commonly grown in the county. The wetness and the ponding are problems. Tile drains can lower the water table, but ditches may be needed to provide suitable outlets. Fall tillage allows the soil to warm up sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites and that can withstand the brief periods of ponding. Seedlings survive and grow best if weeds are controlled by herbicides or by cultivation.

The land capability classification is IIIw.

136—Madelia silty clay loam. This nearly level, poorly drained soil is on the lower foot slopes and in drainageways on glacial lake plains. Individual areas are irregular in shape and range from 10 to 60 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer also is black silty clay loam. It is about 13 inches thick. The subsoil is olive gray silty clay loam about 15 inches thick. It is calcareous in the lower part. The underlying material to a depth of about 60 inches is olive and light olive gray, calcareous silt loam. In many areas the dark surface soil is more than 24 inches thick. In a few places the soil has less silt and more sand. In some areas it has coarse fragments.

Included with this soil in mapping are small areas of the poorly drained Spicer soils on the rims of depressions and the moderately well or somewhat poorly drained Kingston soils in the slightly higher landscape positions. Spicer soils are calcareous throughout. Included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the Madelia soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow. The depth to a seasonal high water table is 1.0 to 2.5 feet. The surface layer is slightly acid or neutral.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains lower the water table. The soil becomes compacted and cloddy if it is tilled when wet. Fall tillage allows the soil to warm up sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIw.

140—Spicer silty clay loam. This nearly level, poorly drained soil is on the rims of depressions and on slightly concave to slightly convex lowlands on lake plains. Individual areas are irregular in shape and range from 5 to 75 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark gray and dark grayish brown silty clay loam about 14 inches thick. The subsoil is grayish brown silty clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is light brownish gray and olive gray, mottled silty clay loam. The soil is calcareous throughout. In a few areas the dark surface soil is more than 24 inches thick. In some areas it contains more clay. In a few places the surface layer is not calcareous.

Included with this soil in mapping are small areas of the very poorly drained Okoboji soils in depressions, the poorly drained Madelia soils in drainageways, and the somewhat poorly or moderately well drained Kingston soils on the higher parts of landscape. The included soils are not calcareous throughout. They make up 5 to 15 percent of the map unit.

Permeability is moderate in the Spicer soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains have been installed in most areas. A good fertility program is needed because the high content of lime reduces the uptake of phosphorus and iron. Soybeans often exhibit iron chlorosis, or "yellowing." Fall tillage allows the soil to warm up sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

This soil is fairly well suited to field and farmstead windbreaks. Excessive tillage can break down soil structure and thus increase the susceptibility to soil blowing. The trees and shrubs selected for planting should be those that are suited to wet sites and that can tolerate the high content of lime. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation. Once established, windbreaks are effective in controlling soil blowing.

The land capability classification is IIw.

181—Litchfield sandy loam. This nearly level, moderately well drained or somewhat poorly drained soil is on low rises and some back slopes on outwash plains and stream terraces. Individual areas are irregular in shape and range from 5 to 35 acres in size.

Typically, the surface layer is very dark gray sandy loam about 12 inches thick. The subsurface layer is very dark grayish brown and dark brown sandy loam about 4 inches thick. The subsoil is about 21 inches thick. The upper part is dark grayish brown and brown, stratified fine sandy loam and loamy sand. The lower part is dark grayish brown and yellowish brown, mottled loamy sand. The underlying material to a depth of about 60 inches is grayish brown, mottled sand. It is calcareous in the lower part. In a few places the surface layer contains less sand. In some areas the soil contains gravel.

Included with this soil in mapping are small areas of the well drained or somewhat excessively drained Dickinson soils in the higher landscape positions, the poorly drained Hanska soils in drainageways, and the poorly drained Lemond soils on the lower parts of the landscape. Included soils make up 5 to 10 percent of the map unit.

Permeability is moderately rapid in the Litchfield soil, and the available water capacity is low or moderate. Organic matter content is moderate, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 2.5 to 5.0 feet. The surface soil is slightly acid or neutral.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. If cultivated crops are grown, soil blowing is a hazard and droughtiness is a limitation in summer and fall. Also, restricted fertility may be a problem. Applications of fertilizer should be based on the results of soil tests. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss. Planting short-season varieties of row crops, small grain, and legumes conserves moisture.

This soil is fairly well suited to field and farmstead windbreaks. Species selection may be difficult because the soil is wet in spring and dry in summer and fall. Trees and shrubs grow better if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification IIs.

197—Kingston silt loam. This nearly level, moderately well drained or somewhat poorly drained soil is on back slopes and the lower summits on lake plains. Individual areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is black silt loam about 11 inches thick. The subsurface layer is black silty clay loam about 7 inches thick. The subsoil is about 20 inches thick. The upper part is very dark grayish brown and yellowish brown silty clay loam. The lower part is light olive brown, mottled, calcareous silt loam. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam. In places the soil is underlain by glacial till.

Included with this soil in mapping are small areas of the well drained Bold soils on shoulder slopes, the poorly drained Madelia soils in drainageways, and the poorly drained Spicer soils on the lower parts of the landscape. Included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the Kingston soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is medium. The depth to a seasonal high water table is 2.5 to 5.0 feet. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. It can be cropped intensively. If cultivated crops are grown, soil blowing is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface.

This soil is well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to moderately wet sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is I.

227—Lemond sandy loam. This nearly level, poorly drained soil is in slightly convex to slightly concave areas on outwash plains. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is black and very dark gray sandy loam about 10 inches thick. The subsoil is dark gray, mottled sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is olive gray and grayish brown, mottled sand. The soil is calcareous throughout. In some areas it has less sand in the surface layer and is underlain by glacial till.

Included with this soil in mapping are small areas of the very poorly drained Hanska soils in depressions, the poorly drained Hanska and Webster soils in drainageways, and the moderately well drained or somewhat poorly drained Litchfield soils on the higher parts of the landscape. The included soils are not calcareous throughout. They make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Lemond soil and rapid in the lower part. The available water capacity is moderate. Organic matter content is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains lower the water table. Soybeans may exhibit iron chlorosis, or "yellowing." A good fertility program is needed because the high content of lime restricts the availability of phosphorus and iron.

This soil is fairly well suited to field and farmstead windbreaks, which are effective in controlling soil blowing. The trees and shrubs selected for planting should be those that are suited to moist sites and that can tolerate the high content of lime. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate.

The land capability classification is IIw.

229—Waldorf silty clay loam. This nearly level, poorly drained soil is in slightly concave and nearly plane areas on glacial lake plains. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black and very dark gray silty clay loam about 14 inches thick. The subsoil is dark gray silty clay about 12 inches thick. The underlying material to a depth of about 60 inches is light brownish gray, mottled, calcareous silty clay loam. In some areas glacial till is within 40 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Brownton soils on the rims of depressions, the very poorly drained Okoboji soils in the depressions, and the moderately well drained or somewhat poorly drained Collinwood soils on the higher parts of the landscape. Brownton soils are calcareous throughout. Included soils make up 3 to 12 percent of the map unit.

Permeability is moderately slow in the Waldorf soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow. A seasonal high water table is within a depth of 3 feet. The surface layer is slightly acid or neutral.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains have been installed in most areas. They commonly are spaced 50 to 80 feet apart because of the high content of clay and the moderately slow permeability. Tilling when the soil is wet results in compaction and poor tilth. Fall tillage allows the soil to warm up sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

This soil is fairly well suited to farmstead and field windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate.

The land capability classification is IIw.

247—Linder loam. This nearly level, somewhat poorly drained soil is on low rises on outwash plains and stream terraces. Individual areas are oblong or long and narrow and range from 5 to 40 acres in size.

Typically, the surface layer is black loam about 11 inches thick. The subsurface layer is very dark gray and very dark grayish brown loam about 4 inches thick. The subsoil is dark grayish brown and grayish brown, mottled sandy loam about 14 inches thick. The upper part of the underlying material is dark grayish brown loamy coarse sand. The lower part to a depth of about 60 inches is dark grayish brown, olive brown, and grayish brown, calcareous coarse sand and loamy coarse sand. In some areas the subsoil is brighter colored. In other areas the depth to sand and gravel is more than 3 feet.

Included with this soil in mapping are small areas of the poorly drained Mayer and Biscay soils on the lower parts of the landscape and the well drained Dickinson and Wadena soils on the higher parts. Mayer soils are calcareous throughout. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate or moderately rapid in the upper part of the Linder soil and very rapid in the lower part. The available water capacity is low. Organic matter content is moderate, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 2 to 4 feet. The surface layer is medium acid to mildly alkaline.

Most areas are used as cropland. This soil is well suited to most of the crops commonly grown in the county. If cultivated crops are grown, wetness is a limitation in the spring and droughtiness is a limitation in

the summer. Short-season row crops and small grain can mature before the hot, dry periods in the summer.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand both wet and dry conditions. Weed control increases the seedling survival rate.

The land capability classification is IIs.

255—Mayer loam. This nearly level, poorly drained soil is in low areas on outwash plains. Individual areas are irregular in shape and range from 10 to 60 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 13 inches thick. The subsoil is dark gray and olive gray, mottled sandy clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, mottled sand. The soil is calcareous throughout. In some areas the dark surface soil is more than 24 inches thick. In a few places the depth to carbonates is more than 20 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Linder soils on slight rises and the well drained Wadena soils on the higher parts of the landscape. The included soils are not calcareous throughout. They make up 2 to 10 percent of the map unit.

Permeability is moderate in the upper part of the Mayer soil and rapid in the lower part. The available water capacity is moderate. Organic matter content is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains lower the water table. A good fertility program is needed because the high content of lime restricts the uptake of plant nutrients. Fall tillage allows the soil to warm up and dry out sooner in the spring, but it increases the hazard of erosion. Ridge planting reduces this hazard.

If this soil is used for pasture or hay, the wetness is a problem. Grazing in wet areas can result in compaction and poor tilth. Restricted use during wet periods helps to keep the pasture in good condition.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites and that can tolerate the high content of lime. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIw.

269—Millington clay loam, occasionally flooded. This nearly level, poorly drained soil is on flood plains. It is occasionally flooded for brief periods in the spring. Individual areas are long and narrow and range from 10 to 75 acres in size.

Typically, the surface layer is black clay loam about 11 inches thick. The subsurface layer also is black clay loam. It is about 17 inches thick. The subsoil is very dark gray clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is very dark gray, mottled, stratified clay loam and loam. The soil is calcareous throughout. In some areas the underlying material has strata of gravel or sand. In a few places the surface soil and subsoil are not calcareous.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Spillville soils on slight rises and the poorly drained Coland soils in old drainageways or stream channels. The included soils are not calcareous. They make up 5 to 15 percent of the map unit.

Permeability is moderate in the Millington soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is slow. A seasonal high water table is within a depth of 2 feet. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If not flooded during the growing season and if drained, this soil is well suited to the crops commonly grown in the county. Channeling can straighten and deepen existing streams and thus can reduce the hazard of flooding. Tile can reduce the wetness in areas where a suitable drainage outlet is available. Fall tillage allows the soil to warm up and dry out earlier in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

If this soil is used for pasture or hay, the wetness is a problem. Grazing in wet areas can result in compaction and poor tilth. Restricted use during wet periods helps to keep the pasture in good condition.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand the wetness and the high content of lime. Weed control helps to establish seedlings.

The land capability classification is IIw.

275B—Ocheyedan loam, 1 to 5 percent slopes. This gently sloping, well drained soil is on summits and shoulder slopes in the uplands. Individual areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black, very dark gray, and brown loam about 12 inches thick. The subsoil is brown silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In some areas the soil is underlain by glacial till. In places the surface layer is silty.

Included with this soil in mapping are small areas of the somewhat poorly drained or moderately well drained Fostoria and Kingston soils in the lower landscape positions. Also included are small areas of the well drained Grogan soils. These soils are in landscape positions similar to those of the Ocheyedan soil. They contain more silt than the Ocheyedan soil. Included soils make up 2 to 10 percent of the map unit.

Permeability is moderate in the Ocheyedan soil, and the available water capacity is high. Organic matter content is moderate, and natural fertility is high. Surface runoff is slow or medium. The surface layer is medium acid to neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. It can be controlled by a system of conservation tillage that leaves crop residue on the surface.

This soil is well suited to field and farmstead windbreaks, which are effective in controlling soil blowing. The trees and shrubs selected for planting should be those that are suited to dry sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIe.

282—Hanska loam. This nearly level, poorly drained soil is on the lower foot slopes and in drainageways on outwash plains. Individual areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 11 inches thick. The subsoil is gray and olive gray sandy loam about 13 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled sand. In some places the dark surface soil is more than 24 inches thick. In other places the underlying material has bands of gravel or loamy material.

Included with this soil in mapping are small areas of the poorly drained Lemond soils on the rims of depressions and the moderately well drained or somewhat poorly drained Litchfield soils on the higher parts of the landscape. Lemond soils have carbonates throughout. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Hanska soil and rapid in the lower part. The available water capacity is moderate. Organic matter content is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is slightly acid to mildly alkaline.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains lower the water table.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIw.

313—Spillville loam, occasionally flooded. This nearly level, moderately well drained or somewhat poorly drained soil is in slightly convex and nearly plane areas on flood plains. It is occasionally flooded for brief periods in the spring. Individual areas are long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark grayish brown loam about 22 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown, mottled loam. In places the surface layer is sandy loam.

Included with this soil in mapping are small areas of the poorly drained Millington and somewhat poorly drained Linder soils. Millington soils are calcareous throughout. Linder soils contain more gravel than the Spillville soil. Both of the included soils are in landscape positions similar to those of the Spillville soil. They make up to 2 to 10 percent of the map unit.

Permeability is moderate in the Spillville soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow. The depth to a seasonal high water table is 3 to 5 feet. The surface layer is medium acid to neutral.

Most areas are used as cropland. Some are pastured. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation, and the flooding is a hazard. This hazard can be reduced by ditches or dikes. Tile drains can reduce the wetness if a suitable drainage outlet is available.

This soil is well suited to grasses and legumes for pasture and hay. Pasture rotation and restricted use during wet periods help to keep the pasture in good condition.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to moderately wet sites and that can withstand the brief periods of flooding.

The land capability classification is IIw.

336—Delft loam. This nearly level, poorly drained soil is on the lower foot slopes and in narrow drainageways on till plains. Individual areas are long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is black and very dark gray loam about 35 inches thick. The subsoil is dark grayish brown, mottled loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. Some areas

are ponded after heavy rains. In places the dark surface soil is less than 24 inches thick.

Included with this soil in mapping are small areas of the well drained Clarion and moderately well drained Terril soils. These soils are on slopes above the Delft soil. They make up 5 to 15 percent of the map unit.

Permeability is moderately slow in the Delft soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow, but the water can move onto this soil rapidly because of the steepness of the adjacent side slopes. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is medium acid to mildly alkaline.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains lower the water table, and grassed waterways help to remove excess surface water. Fall tillage allows the soil to warm up faster and dry out sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

If this soil is used for pasture or hay, the wetness is a problem. Grazing in wet areas can result in compaction and poor tilth. Restricted use during wet periods helps to keep the pasture in good condition.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Weed control increases the seedling survival rate.

The land capability classification is IIw.

350—Canisteo clay loam, depressional. This nearly level, very poorly drained soil is in depressions on till plains. It commonly is ponded for brief periods in the spring and after prolonged or heavy rainfall. Individual areas are circular and range from 5 to 60 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer also is black clay loam. It is about 18 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled loam. The soil is calcareous throughout. In places the surface layer is peat. In a few areas some parts of the profile are not calcareous.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Harps soils on the rims of the depressions and the very poorly drained Glencoe soils in the depressions. Glencoe soils are not calcareous. Included soils make up 10 to 15 percent of the map unit.

Permeability is moderate in the Canisteo soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is very slow or ponded. A seasonal high water table is 1 foot above to 1 foot below the surface. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. If drained, this soil is fairly well suited to the crops commonly grown in the county. The high water table is a limitation, and the ponding is a hazard. Tile drains lower the water table. Ditches may be needed to provide outlets for the drainage system. A good fertility program is needed because the high content of lime restricts the uptake of plant nutrients. Fall tillage allows the soil to warm up and dry out earlier in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

If this soil is used for pasture or hay, the wetness is a problem. The ponding can destroy new seedlings and can restrict grazing. Tile drains are needed. Grazing when the soil is wet results in compaction and poor tilth. Restricted use during wet periods helps to keep the pasture in good condition.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand the wetness and the high content of lime. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIIw.

392—Biscay sandy clay loam. This nearly level, poorly drained soil is in low areas on glacial outwash plains and on some stream terraces. Individual areas are irregular in shape and range from 10 to 60 acres in size.

Typically, the surface layer is black sandy clay loam about 10 inches thick. The subsurface layer also is black sandy clay loam. It is about 12 inches thick. The subsoil is dark grayish brown, mottled, calcareous sandy clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is grayish brown, stratified, calcareous loamy sand and sand. In some areas the soil is calcareous throughout. In a few places the surface layer is sandy.

Included with this soil in mapping are small areas of the poorly drained Lemond soils on toe slopes, the somewhat poorly drained Linder soils on slight rises, and the well drained Wadena soils on the higher parts of the landscape. Lemond soils are calcareous throughout. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the upper part of the Biscay soil and rapid in the lower part. The available water capacity is moderate. Organic matter content is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is slightly acid to mildly alkaline.

Most areas are used as cropland. If drained, this soil is well suited to the crops commonly grown in the county. Wetness is a limitation in the spring and after heavy or prolonged rainfall. Drainage tile lowers the water table. Fall tillage allows the soil to warm up faster and dry out sooner in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

If this soil is used for pasture or hay, the wetness is a problem. Grazing in wet areas can result in compaction and poor tilth. Restricted use during wet periods helps to keep the pasture in good condition.

This soil is fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate.

The land capability classification is IIw.

499—Hanska loam, depressional. This nearly level, very poorly drained soil is in depressions and drainageways on outwash plains. It is rarely or occasionally ponded for brief periods in the spring. Individual areas are circular or elongated and range from 5 to 25 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 14 inches thick. The subsoil is sandy loam about 13 inches thick. The upper part is dark grayish brown, and the lower part is grayish brown. The underlying material to a depth of about 60 inches is light olive brown and grayish brown loamy sand. In many areas the dark surface soil is more than 24 inches thick.

Included with this soil in mapping are small areas of the poorly drained Lemond soils on the rims of the depressions and the moderately well drained or somewhat poorly drained Litchfield soils on slight rises. Lemond soils are calcareous throughout. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Hanska soil and rapid in the lower part. The available water capacity is moderate. Organic matter content and natural fertility are high. Surface runoff is slow to ponded. A seasonal high water table is 1.0 foot above to 2.5 feet below the surface. The surface layer is slightly acid to mildly alkaline.

Most areas are used as cropland. If drained, this soil is fairly well suited to the crops commonly grown in the county. The wetness is a limitation. Tile drains lower the water table and help to remove ponded water.

If this soil is used for pasture or hay, the wetness is a limitation. Tile drains and restricted use during wet periods help to keep the pasture in good condition.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Weed control increases the seedling survival rate.

The land capability classification is IIIw.

539—Palms muck. This nearly level, very poorly drained soil is in depressions on glacial moraines and lake plains. It is commonly ponded for brief or long periods in the spring. Individual areas are circular or oblong and range from 5 to 40 acres in size.

Typically, the surface layer is black muck about 11 inches thick. The subsurface layer also is black muck. It is about 22 inches thick. The underlying material to a depth of about 60 inches is black silty clay loam and olive gray clay loam. In a few areas the organic material is more than 51 inches thick. In some areas the surface layer is calcareous. In places the underlying material is sandy, and in a few areas it is coprogenous earth.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Harps soils on the rims of the depressions and areas of the very poorly drained Glencoe and Okoboji soils in some of the depressions. The included soils are not mucky. They make up 5 to 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the Palms soil and moderate in the lower part. The available water capacity is high. Organic matter content is very high, and natural fertility is high. Surface runoff is very slow or ponded. A seasonal high water table is 1 foot above to 1 foot below the surface. The surface layer is medium acid to mildly alkaline.

Most areas are used as cropland or support native vegetation or grasses. This soil is well suited to wetland wildlife habitat. If drained, it is fairly well suited to corn, soybeans, and hay. Tile drains lower the water table. Ditches are needed in some areas to provide suitable outlets for drainage systems. The high organic matter content reduces the effectiveness of preemergence herbicides. Fall tillage allows the soil to warm up and dry out earlier in the spring, but it increases the erosion hazard. Mulch tillage reduces this hazard. Restricted use during wet periods helps to keep pasture or hayland in good condition.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites and that can tolerate the high content of lime. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIIw.

548—Palms muck, sandy substratum. This nearly level, very poorly drained soil is in depressions and on the outer edges of lakebeds and marshes. It is commonly ponded for brief or long periods in the spring. Individual areas are circular and range from 10 to 50 acres in size.

Typically, the surface layer is black muck about 10 inches thick. The subsurface layer also is black muck. It is about 11 inches thick. The upper 13 inches of the underlying material is black and dark grayish brown silty clay loam. The lower part to a depth of about 60 inches is grayish brown, light olive brown, dark brown, and dark grayish brown, stratified loamy sand and sand. In some areas the underlying material is loamy. In a few places the surface layer is calcareous.

Included with this soil in mapping are small areas of the poorly drained Lemond and somewhat poorly drained Linder soils on old beaches and the very poorly drained Blue Earth soils in the depressions. Blue Earth soils are calcareous throughout. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the upper part of Palms soil and moderately rapid in the lower part. The available water capacity is high. Organic matter content is very high, and natural fertility is high. Surface runoff is very slow or ponded. A seasonal high water table is 1 foot above to 1 foot below the surface. The surface layer is medium acid to mildly alkaline.

Most areas support native vegetation or grasses or are used as cropland. This soil is well suited to wetland wildlife habitat. If drained, it is fairly well suited to corn, soybeans, and hay. Tile drains lower the water table. Ditches are needed in some areas to provide suitable outlets for drainage systems. Fall tillage allows the soil to warm up and dry out earlier in the spring, but it increases the erosion hazard. Mulch tillage reduces this hazard. Restricted use during wet periods helps to keep pasture or hayland in good condition.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to wet sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIIw.

664—Zook silty clay loam, occasionally flooded. This nearly level, poorly drained soil is on flood plains along the major streams. It is occasionally flooded for brief or long periods in the spring and after heavy or prolonged rainfall. Individual areas are irregularly shaped and range from 10 to 90 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black silty clay about 14 inches thick. The subsoil is very dark gray and very dark grayish brown silty clay about 14 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown and dark grayish brown silty clay loam. In some areas the surface layer is calcareous.

Included with this soil in mapping are small areas of the poorly drained Millington and Coland soils. These soils are in slightly concave to slightly convex areas close to stream channels. They make up 2 to 10 percent of the map unit.

Permeability is slow in the Zook soil, and the available water capacity is moderate. Organic matter content and natural fertility are high. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is slightly acid or neutral.

Most areas are used as cropland. If drained, this soil is well suited to most of the crops commonly grown in the county. The wetness is a limitation, and the flooding is a hazard. This hazard can be reduced by straightening stream channels or by building dikes. Drainage tile can lower the water table if an outlet is available. Fall tillage allows the soil to warm up and dry out earlier in the spring, but it increases the erosion hazard. Ridge planting reduces this hazard.

If this soil is used for pasture or hay, the wetness is a limitation. Grazing when the soil is wet can result in compaction and poor tilth. Restricted use during wet periods helps to keep the pasture in good condition.

This soil is fairly well suited to field windbreaks. The trees and shrubs selected for planting should be those that can withstand the wetness and the periods of flooding. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIw.

818—Lemond-Linder complex. These nearly level soils are in slightly concave to slightly convex areas on old beaches in drained lakes and marshes. The poorly drained Lemond soil is on the lower toe slopes. It is subject to rare flooding in the spring. The somewhat poorly drained Linder soil is on summits. Individual areas are elongated and range from 5 to 30 acres in size. They are about 55 percent Lemond soil and 25 percent Linder soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Lemond soil has a surface layer of black loam about 8 inches thick. The subsurface layer is very dark gray sandy loam about 12 inches thick. The subsoil is dark gray sandy loam about 12 inches thick. The upper 24 inches of the underlying material is olive gray loamy sand. The lower part to a depth of more than 60 inches is olive brown, loamy glacial till. The soil is calcareous throughout. In places the loamy glacial till is closer to the surface.

Typically, the Linder soil has a surface layer of black sandy loam about 16 inches thick. The subsurface layer also is black sandy loam. It is about 6 inches thick. The subsoil is dark grayish brown sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, calcareous loamy coarse sand. In some areas it is loamy glacial till.

Included with these soils in mapping are small areas of the very poorly drained Blue Earth and Palms soils in lakebeds and the somewhat poorly drained Crippin soils on slight rises. Included soils make up about 20 percent of the map unit.

Permeability is moderately rapid in the upper part of the Lemond soil and rapid in the lower part. It is moderate or moderately rapid in the upper part of the Linder soil and very rapid in the lower part. The available water capacity is low in the Linder soil and moderate in the Lemond soil. Organic matter content is high in the Lemond soil and moderate in the Linder soil. Natural fertility is medium in both soils. The depth to a seasonal high water table is 1 to 3 feet in the Lemond soil and 2 to 4 feet in the Linder soil. The surface layer of the Linder soil is medium acid to mildly alkaline, and that of the Lemond soil is mildly alkaline or moderately alkaline.

Many areas are used as cropland. Some are pastured. A few are left idle. If drained, these soils are well suited

to the crops commonly grown in the county. They are better suited to small grain and early maturing row crops than to other crops. Wetness is a limitation in spring, and drought is a hazard in summer. In the areas used for grazing, pasture rotation is needed during both wet and dry periods.

These soils are poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand both wet and dry conditions and the high content of lime in the Lemond soil. Measures that control weeds are needed.

The land capability classification is IIw.

886—Nicollet-Crippin complex. These nearly level soils are in slightly concave to slightly convex areas on glacial till plains. The moderately well drained or somewhat poorly drained Nicollet soil is on the lower summits, and the somewhat poorly drained Crippin soil is on shoulder slopes surrounding the Nicollet soil. Individual areas are irregular in shape and range from 8 to 75 acres in size. They are about 50 percent Nicollet soil and 35 percent Crippin soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Nicollet soil has a surface layer of black clay loam about 8 inches thick. The subsurface layer also is black clay loam. It is about 9 inches thick. The subsoil is grayish brown, mottled clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous loam. In some areas the soil has silt lenses.

Typically, the Crippin soil has a surface layer of black loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is dark grayish brown clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is mottled grayish brown and light olive brown loam. The soil is calcareous throughout. In places the subsoil has duller colors.

Included with these soils in mapping are small areas of the well drained Clarion and Swanlake soils on the higher parts of the landscape and the poorly drained Webster soils in drainageways. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the Nicollet and Crippin soils, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow. The depth to a seasonal high water table is 2.5 to 5.0 feet in the Nicollet soil and 2.0 to 4.0 feet in the Crippin soil. The surface layer of the Nicollet soil is medium acid to neutral, and that of the Crippin soil is neutral to moderately alkaline.

Most areas are used as cropland. These soils are well suited to the crops commonly grown in the county. They can be cropped intensively. Tilling during wet periods can result in compaction and poor tilth. Restricting tillage during wet periods and returning crop residue to the soils help to prevent deterioration of tilth. Because the high content of lime restricts the uptake of iron and phosphorus, a good fertility program is needed in areas of the Crippin soil.

These soils are fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to moderately wet sites and that can tolerate the high content of lime in the Crippin soil. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is I.

887B—Clarion-Swanlake loams, 2 to 6 percent slopes. These undulating, well drained soils are on glacial uplands. The Swanlake soil is on shoulder slopes, and the Clarion soil is on summits and the higher back slopes. Individual areas are irregular in shape and range from 5 to 60 acres in size. They are about 60 percent Clarion soil and 25 percent Swanlake soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was impractical.

Typically, the Clarion soil has a surface layer of black loam about 10 inches thick. The subsurface layer also is black loam. It is about 5 inches thick. The subsoil is brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. It is mottled in the lower part. In some areas the surface soil or subsoil has sandy or silty sediments.

Typically, the Swanlake soil has a surface layer of black loam about 11 inches thick. The subsurface layer is very dark gray and dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown, mottled loam. The soil is calcareous throughout. In places the dark surface layer is less than 8 inches thick.

Included with these soils in mapping are small areas of the moderately well drained or somewhat poorly drained Nicollet and poorly drained Canisteo and Webster soils. These included soils are on the lower parts of the landscape. They make up about 15 percent of the map unit.

Permeability is moderate in the Clarion and Swanlake soils, and the available water capacity is high. Organic matter content is moderate. Natural fertility is high in the Clarion soil and medium in the Swanlake soil. Surface runoff is medium on both soils. The surface layer of the Clarion soil is medium acid to neutral, and that of the Swanlake soil is mildly alkaline.

Most areas are used as cropland. These soils are well suited to the crops commonly grown in the county. If cultivated crops are grown, the Swanlake soil is susceptible to soil blowing and the Clarion soil is susceptible to water erosion. Contour farming and a system of conservation tillage that leaves crop residue on the surface help to prevent excessive soil loss.

These soils are well suited to field and farmstead windbreaks, which are effective in controlling soil blowing. The trees and shrubs selected for planting should be those that are suited to dry sites. Controlling weeds by applications of herbicide or by cultivation increases the seedling survival rate.

The land capability classification is IIe.

909C—Truman-Bold silt loams, 6 to 12 percent slopes. These sloping, well drained soils are in convex areas on glacial lake plains. The Truman soil is on summits and the higher back slopes. The Bold soil is on shoulder slopes. Individual areas are elongated and range from 5 to 35 acres in size. They are about 45 percent Truman soil and 35 percent Bold soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Truman soil has a surface layer of very dark gray silt loam about 10 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil is brown silt loam about 16 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In some areas carbonates are within 18 inches of the surface. In a few areas the soil has a loamy mantle. In places the content of fine sand is higher.

Typically, the Bold soil has a surface layer of yellowish brown and very dark grayish brown silt loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown silt loam. It is mottled in the lower part. The soil is calcareous throughout. In places it has more clay or more pebbles.

Included with these soils in mapping are small areas of the moderately well drained or somewhat poorly drained Kingston, moderately well drained Terril, and poorly drained Madelia soils on the lower parts of the landscape. Included soils make up about 20 percent of the map unit.

Permeability is moderate in the Truman and Bold soils, and the available water capacity is high. Organic matter content is high and natural fertility medium in the Truman soil. Organic matter content and natural fertility are low in the Bold soil. Surface runoff is medium on both soils. The surface layer of the Truman soil is medium acid to neutral, and that of the Bold soil is mildly alkaline or moderately alkaline.

Most areas are used as cropland. These soils are poorly suited to most of the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. Planting cover crops (fig. 7), tilling on the contour, terracing, and leaving crop residue on the surface slow runoff, increase the moisture supply and the rate of water infiltration, and help to control erosion. Applications of fertilizer are needed on the Bold soil.

Field windbreaks and a cover of pasture plants or hay are effective in controlling erosion and conserving moisture. These soils are poorly suited to windbreaks. The trees and shrubs selected for planting should be those that can withstand the high content of lime in the Bold soil. Seedlings survive and grow well if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IVe.

909D2—Bold-Truman silt loams, 12 to 18 percent slopes, eroded. These moderately steep, well drained soils are in convex areas along drainageways on glacial lake plains. The Bold soil is on shoulder slopes, and the Truman soil is on the higher back slopes. Individual areas are long and narrow and range from 5 to 25 acres in size. They are about 45 percent Bold soil and 45 percent Truman soil. The two soils occur as areas so intricately mixed or so small that separating them in mapping was not practical.

Typically, the Bold soil has a surface layer of dark yellowish brown silt loam about 8 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown silt loam. It is mottled in the lower part. The soil is calcareous throughout. In some areas it contains clay and has a few pebbles.

Typically, the Truman soil has a surface layer of very dark gray silt loam about 10 inches thick. The subsoil is brown silt loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In some areas the soil contains more sand.

Included with these soils in mapping are small areas of the moderately well drained Terril and poorly drained Madelia soils. These included soils are on the lower parts of the landscape. They make up about 10 percent of the map unit.

Permeability is moderate in the Bold and Truman soils, and the available water capacity is high. Organic matter content is low in the Bold soil and high in the Truman soil. Natural fertility is low in the Bold soil and medium in the Truman soil. Surface runoff is medium or rapid on both soils. The surface layer of the Truman soil is slightly acid to moderately alkaline, and that of the Bold soil is moderately alkaline.

Most areas are used for pasture or hay. These soils are generally unsuitable as cropland because of the slope. A permanent cover of pasture plants is effective in controlling erosion. Restricted use during wet or very dry periods helps to keep the pasture in good condition.

Some areas support trees. These soils are poorly suited to windbreaks. The trees and shrubs selected for planting should be those that are suited to dry sites and that can tolerate the high content of lime in the Bold soil. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is VIe.

920B—Clarion-Estherville complex, 2 to 6 percent slopes. These undulating soils are on narrow ridges on

Figure 7.—A cover crop in an area of Truman-Bold silt loams, 6 to 12 percent slopes.

glacial moraines. The well drained Clarion soil is on summits and back slopes, and the well drained or somewhat excessively drained Estherville soil is on shoulder slopes and the upper back slopes. Individual areas are irregular in shape and range from 5 to 25 acres in size. They are about 50 percent Clarion soil and 25 percent Estherville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Clarion soil has a surface layer of black loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 20 inches thick. The upper part is brown loam, and the lower part is yellowish brown sandy loam. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some areas the soil is calcareous throughout.

Typically, the Estherville soil has a surface layer of very dark grayish brown sandy loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is brown sandy loam, and the lower part is yellowish brown, calcareous gravelly loamy sand. The underlying material to a depth of about 60 inches is yellowish brown, calcareous gravelly loamy sand. In some areas the gravelly material is at or near the surface. In other areas the soil has little or no gravel.

Included with these soils in mapping are small areas of the well drained Storden and Swanlake soils on shoulder slopes and the moderately well drained Terril and poorly drained Webster soils on the lower parts of the landscape. Storden and Swanlake soils are calcareous throughout. Included soils make up about 25 percent of the map unit.

Permeability is moderate in the Clarion soil. It is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. The available water capacity is high in the Clarion soil and low in the Estherville soil. Organic matter content is moderate in both soils, and

natural fertility is medium or high. Surface runoff is medium. The surface layer is medium acid to neutral.

Most areas are used as cropland. These soils are well suited to the crops commonly grown in the county. Erosion is a hazard. Also, drought is a hazard in areas of the Estherville soil. Contour farming and a system of conservation tillage that leaves crop residue on the surface help to control erosion and increase the rate of water infiltration and the moisture supply. Small grain or early maturing crops can withstand drought better than other crops.

These soils are fairly well suited to windbreaks. The trees and shrubs selected for planting should be those that can withstand the droughtiness of the Estherville soil. Periodic watering on the Estherville soil and weed control on both soils help to establish seedlings.

The land capability classification is IIe.

920C2—Clarion-Estherville-Storden complex, 6 to 12 percent slopes, eroded. These rolling soils are on narrow ridges on glacial moraines. The well drained Clarion soil is on summits, the well drained or somewhat excessively drained Estherville soil is on the upper back slopes, and the well drained Storden soil is on shoulder slopes. Individual areas are elongated and range from 5 to 25 acres in size. They are about 30 percent Clarion soil, 20 percent Estherville soil, and 20 percent Storden soil. The three soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Clarion soil has a surface layer of very dark gray loam about 10 inches thick. The subsoil is about 26 inches of brown loam and yellowish brown clay loam. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some areas the soil has sandy or silty sediments.

Typically, the Estherville soil has a surface layer of very dark grayish brown sandy loam about 10 inches thick. The subsoil is about 20 inches thick. The upper part is brown coarse sandy loam, and the lower part is dark yellowish brown, calcareous loamy coarse sand. The upper part of the underlying material is brown, calcareous coarse sand. The lower part to a depth of about 60 inches is light olive brown, calcareous loam glacial till. In some areas the soil is calcareous throughout. In places gravelly material is at or near the surface.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is mottled yellowish brown and light olive brown loam. The soil is calcareous throughout. In some areas the surface layer is darker.

Included with these soils in mapping are small areas of the moderately well drained Terril soils, the moderately well drained or somewhat poorly drained Nicollet soils, and the poorly drained Delft and Webster soils. The included soils are on the lower parts of the landscape. They make up about 30 percent of the map unit.

Permeability is moderate in the Clarion and Storden soils. It is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. The available water capacity is low in the Estherville soil and high in the Clarion and Storden soils. Organic matter content is low in the Storden soil and moderate in the Clarion and Estherville soils. Natural fertility is low in the Storden and Estherville soils and high in the Clarion soil. Surface runoff is medium or rapid on all three soils. The surface layer of the Clarion and Estherville soils is medium acid to neutral. The Storden soil is mildly alkaline or moderately alkaline throughout.

Many areas are used as cropland. Some are used as permanent pasture. These soils are fairly well suited to most of the crops commonly grown in the county. Erosion is a hazard. It has reduced the productivity of the soils. Unless it is controlled, it can further reduce productivity. Drought is a hazard in areas of the Estherville soil. Small grain, grasses, and legumes are grown in these areas. Measures that improve the fertility of the Storden and Estherville soils are needed. Farming on the contour, terracing, and leaving crop residue on the surface help to control erosion and increase the rate of water infiltration and the moisture supply. Crop residue management and additions of manure improve fertility and tilth.

Windbreaks and a cover of pasture plants or hay help to prevent excessive soil loss. The trees and shrubs selected for planting should be those that can withstand the droughtiness of the Estherville soil and the high content of lime in the Storden soil. Restricted use during dry periods helps to keep pastures in good condition.

The land capability classification is IIIe.

920D2—Clarion-Estherville-Storden complex, 12 to 18 percent slopes, eroded. These hilly soils are on narrow ridges on glacial moraines. The well drained Clarion soil is on summits, the well drained or somewhat excessively drained Estherville soil is on the upper back slopes, and the well drained Storden soil is on shoulder slopes. Individual areas are long and narrow and range from 5 to 20 acres in size. They are about 25 percent Clarion soil, 20 percent Estherville soil, and 20 percent Storden soil. The three soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 9 inches thick. The subsoil is dark yellowish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. In some areas the soil has sandy or silty sediments.

Typically, the Estherville soil has a surface layer of very dark grayish brown sandy loam about 9 inches thick. The subsoil is dark yellowish brown sandy loam

about 7 inches thick. The underlying material to a depth of about 60 inches is grayish brown, yellowish brown, and light yellowish brown gravelly coarse sand and sand. In some areas gravel is near the surface.

Typically, the Storden soil has a surface layer of grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. The soil is calcareous throughout. In some areas the surface layer is darker.

Included with these soils in mapping are small areas of the moderately well drained Terril and poorly drained Delft soils on the lower parts of the landscape. These included soils make up about 35 percent of the map unit.

Permeability is moderate in the Clarion and Storden soils. It is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. The available water capacity is low in the Estherville soil and high in the Clarion and Storden soils. Organic matter content is low in the Storden soil and moderate in the Clarion and Estherville soils. Natural fertility is low in the Storden and Estherville soils and medium in the Clarion soil. Surface runoff is medium or rapid on all three soils. The surface layer of the Clarion and Estherville soils is medium acid to neutral. The Storden soil is mildly alkaline or moderately alkaline throughout.

Most areas are used as permanent pasture. These soils are unsuitable as cropland because of the erosion hazard and the slope. A cover of pasture grasses is effective in controlling erosion. Restricted use during dry periods helps to keep the pasture in good condition.

Some areas support trees. These soils are poorly suited to field windbreaks. The trees and shrubs selected for planting should be those that can withstand the droughtiness of the Estherville soil and the high content of lime in the Storden soil. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is VIe.

921B—Clarion-Storden loams, 2 to 6 percent slopes. These undulating, well drained soils are in convex to slightly concave areas on till plains. The Clarion soil is on summits, and the Storden soil is on shoulder slopes. Individual areas are irregular in shape and range from 5 to 50 acres in size. They are about 45 percent Clarion soil and 35 percent Storden soil. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Clarion soil has a surface layer of very dark gray loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 6 inches thick. The subsoil is brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some areas the soil has sandy or silty sediments.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. The soil is calcareous throughout. In some areas the surface layer is darker.

Included with these soils in mapping are small areas of the moderately well drained or somewhat poorly drained Nicollet soils and the poorly drained Webster soils. The included soils are on the lower parts of the landscape. They make up about 20 percent of the map unit.

Permeability is moderate in the Clarion and Storden soils, and the available water capacity is high. Organic matter content is moderate in the Clarion soil and low in the Storden soil. Natural fertility is high in the Clarion soil and low in the Storden soil. Surface runoff is medium or rapid on both soils. The surface layer of the Clarion soil is medium acid to neutral. The Storden soil is mildly alkaline or moderately alkaline throughout.

Most areas are used as cropland. These soils are well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. It has reduced the productivity of the soils. Unless it is controlled, it can further reduce productivity. Measures that improve the fertility of the Storden soil are needed. Contour farming and a system of conservation tillage that leaves crop residue on the surface help to control erosion. Terraces are effective in controlling runoff and erosion. A combination of these measures is needed.

These soils are fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to dry sites and that can tolerate the high content of lime in the Storden soil. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIe.

921C2—Clarion-Storden loams, 6 to 12 percent slopes, eroded. These rolling, well drained soils are in convex areas on glacial moraines. The Clarion soil is on summits, and the Storden soil is on shoulder slopes. Individual areas are irregular in shape and range from 5 to 50 acres in size. They are about 35 percent Clarion soil and 30 percent Storden soil. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 10 inches thick. The subsoil is brown loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some areas the soil has sandy or silty sediments.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled loam. The soil is calcareous throughout. In some areas the surface layer is darker.

Included with these soils in mapping are small areas of the moderately well drained Terril soils, the moderately well drained or somewhat poorly drained Nicollet soils,

and the poorly drained Delft and Webster soils. The included soils are on the lower parts of the landscape. They make up about 35 percent of the map unit.

Permeability is moderate in the Clarion and Storden soils, and the available water capacity is high. Organic matter content is low in the Storden soil and moderate in the Clarion soil. Natural fertility is low in the Storden soil and high in the Clarion soil. Surface runoff is medium or rapid on both soils. The surface layer of the Clarion soil is medium acid to neutral. The Storden soil is mildly alkaline or moderately alkaline throughout.

Most areas are used as cropland. These soils are fairly well suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a hazard. It has reduced the productivity of the soils. Unless it is controlled, it can further reduce productivity. Measures that improve the fertility of the Storden soil are needed. Contour farming, a system of conservation tillage that leaves crop residue on the surface, and terraces slow runoff, increase the rate of water infiltration and the moisture supply, and help to control erosion. Returning crop residue to the soil and adding manure improve fertility.

These soils are well suited to pasture. A cover of pasture plants or hay is effective in controlling erosion. Restricted use during dry periods helps to keep the pasture in good condition.

These soils are fairly well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to dry sites and that can tolerate the high content of lime in the Storden soil. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIIe.

956—Canisteo-Glencoe clay loams. These nearly level soils are on slightly convex to concave lowlands on till plains and glacial moraines. The very poorly drained Glencoe soil is in depressions. It is frequently ponded for brief or long periods in spring and after heavy or prolonged rainfall. The poorly drained Canisteo soil is in the convex and nearly plane areas surrounding the depressions. Individual areas are irregular in shape and range from 20 to several hundred acres in size. They are about 60 percent Canisteo soil and 30 percent Glencoe soil. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Canisteo soil has a surface layer of black clay loam about 11 inches thick. The subsurface layer is very dark gray and dark grayish brown clay loam about 11 inches thick. The subsoil is olive gray, mottled clay loam about 6 inches thick. The underlying material to a depth of about 60 inches is mottled light olive gray and light gray loam. The soil is calcareous throughout. In some areas it has sandy or silty sediments. In a few places gypsum crystals are at or near the surface.

Typically, the Glencoe soil has a surface layer of black clay loam about 10 inches thick. The subsurface layer is black and very dark gray, mottled clay loam about 16 inches thick. The subsoil is dark gray and grayish brown, mottled clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled, calcareous loam. In some areas the surface soil and subsoil have more clay and less sand. In other areas sandy sediments are in the underlying material.

Included with these soils in mapping are small areas of the poorly drained Webster soils and the moderately well drained or somewhat poorly drained Nicollet and Crippin soils. The included soils are on slight rises or in drainageways. They make up about 10 percent of the map unit.

Permeability is moderate in the Canisteo soil and moderate or moderately slow in the Glencoe soil. The available water capacity is high in both soils. Natural fertility is medium in the Canisteo soil and high in the Glencoe soil. Organic matter content is high in both soils. Surface runoff is slow to ponded. A seasonal high water table is 1 to 3 feet below the surface of the Canisteo soil and 1 foot above to 3 feet below the surface of the Glencoe soil. The surface layer of the Glencoe soil is slightly acid to mildly alkaline. The Canisteo soil is mildly alkaline or moderately alkaline throughout.

Most areas are used as cropland. If drained, these soils are fairly well suited to the crops commonly grown in the county. Tile drains lower the water table in both soils and remove surface water from the Glencoe soil. Soybeans often exhibit iron chlorosis, or "yellowing," on the rims of the depressions. A good fertility program is needed because the high content of lime in the Canisteo soil restricts the uptake of phosphorus and iron. If it is worked when dry, this soil becomes powdery and thus more susceptible to soil blowing. Tilling during wet periods results in compaction and poor tilth. A system of conservation tillage that leaves crop residue on the surface reduces the hazard of soil blowing and helps to prevent compaction and deterioration of tilth.

These soils are well suited to pasture. A cover of pasture plants or hay is effective in controlling soil blowing. Restricted use during wet periods helps to keep the pasture in good condition.

These soils are fairly well suited to field and farmstead windbreaks, which help to control soil blowing. The trees and shrubs selected for planting should be those that can withstand the wetness of both soils and the high content of lime in the Canisteo soil. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIIw.

960D2—Storden-Clarion loams, 12 to 18 percent slopes, eroded. These hilly, well drained soils are in convex areas on glacial moraines and till plains. The

Storden soil is on shoulder slopes, and the Clarion soil is on back slopes and summits. Individual areas are long and narrow and range from 5 to 25 acres in size. They are about 40 percent Storden soil and 30 percent Clarion soil. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Storden soil has a surface layer of dark brown and dark grayish brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, mottled loam. The soil is calcareous throughout. In some areas the surface layer is darker.

Typically, the Clarion soil has a surface layer of very dark gray loam about 8 inches thick. The subsoil is yellowish brown loam about 14 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loam. In some areas the soil has sandy or silty sediments.

Included with these soils in mapping are small areas of the moderately well drained Terril and poorly drained Delft soils on the lower parts of the landscape. These included soils make up about 30 percent of the map unit.

Permeability is moderate in the Storden and Clarion soils, and the available water capacity is high. Organic matter content and natural fertility are low. Surface runoff is rapid or medium. The surface layer of the Clarion soil is slightly acid or neutral. The Storden soil is mildly alkaline or moderately alkaline throughout.

Some areas are cropped along with the less sloping adjacent areas. These soils are poorly suited to the crops commonly grown in the county. If cultivated crops are grown, erosion is a severe hazard. It has reduced the productivity of the soils. Unless it is controlled, it can further reduce productivity. Measures that improve fertility are needed. Farming on the contour, terracing, and incorporating crop residue into the soil help to control erosion.

Many areas are used as pasture or hayland. A permanent cover of pasture plants or hay is effective in controlling erosion (fig. 8). Gullies can form during periods of heavy or prolonged rainfall. Restricted use during very wet and very dry periods helps to keep the pasture in good condition.

Some areas support trees. These soils are fairly well suited to windbreaks. The trees and shrubs selected for planting should be those that are suited to dry sites and that can tolerate the high content of lime in the Storden soil. In the steeper areas, seedlings are planted by hand. They survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IVe.

960E—Storden-Clarion loams, 18 to 25 percent slopes. These steep, well drained soils are in convex areas on glacial moraines and till plains. The Storden soil is on shoulder slopes, and the Clarion soil is on summits and back slopes. Individual areas are long and narrow and range from 5 to 25 acres in size. They are about 45 percent Storden soil and 35 percent Clarion soil. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled loam. The soil is calcareous throughout. In some areas the surface layer is darker.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 9 inches thick. The subsurface layer also is very dark grayish brown loam. It is about 6 inches thick. The subsoil is brown loam about 15 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In places the soil has sandy or silty sediments.

Included with these soils in mapping are small areas of the moderately well drained Terril and poorly drained Delft soils on the lower parts of the landscape. These included soils make up about 20 percent of the map unit.

Permeability is moderate in the Storden and Clarion soils, and the available water capacity is high. Organic matter content is low in the Storden soil and moderate in the Clarion soil. Natural fertility is low in the Storden soil and moderate in the Clarion soil. Surface runoff is rapid or medium on both soils. The surface layer of the Clarion soil is slightly acid or neutral. The Storden soil is mildly alkaline or moderately alkaline throughout.

Most areas support native vegetation. Some support grasses, and others support trees. These soils are generally unsuitable as cropland because of the slope. They are poorly suited to windbreaks. They are fairly well suited to openland wildlife habitat and well suited to woodland wildlife habitat. The trees or shrubs planted for wildlife cover should be those that can withstand a high content of lime. Leaving a few rows of corn or other grain close to these steep areas increases the food supply during the winter.

The land capability classification is VIe.

1029—Pits, gravel. This nearly level to very steep map unit consists of open excavations from which gravel or sand has been or is being removed. Some areas are ponded for long periods. Individual areas generally are rectangular and range from 5 to 75 acres in size.

Included with the gravel pits in mapping are small areas of Biscay, Mayer, Estherville, Linder, and Wadena soils. These soils are along the edges of the pits. They make up 1 to 5 percent of the map unit.

Permeability is rapid or very rapid in the gravel pits. Surface runoff is very rapid to ponded. A seasonal high water table is several feet above to 6 feet below the surface.

These pits are used as a source of roadfill or gravel. They also are used as landfill areas. They are unsuitable as cropland unless extensive reclamation measures are applied.

Figure 8.—A protective cover of grasses in an area of Storden-Clarion loams, 12 to 18 percent slopes, eroded.

Abandoned gravel pits are well suited to wildlife habitat. A pit that contains water and that has trees and shrubs around the outer edges is well suited to both wetland and openland wildlife habitat. Leaving a few rows of corn or other grain in nearby areas increases the food supply during the winter.

The land capability classification is VIIs.

1052—Palms and Okoboji soils, ponded. These nearly level, very poorly drained soils are in undrained depressions. They are ponded during much of the year. Individual areas are circular and range from 5 to more than 100 acres in size. They consist of Palms soil, Okoboji soil, or both soils. The two soils were mapped together because they have no major differences that affect use and management.

Typically, the upper 26 inches of the Palms soil is black muck. The underlying material to a depth of about 60 inches is black silty clay loam and dark gray clay loam. In some areas the organic material is more than 51 inches thick. In a few areas the underlying material is coprogenous earth.

Typically, the Okoboji soil has a surface layer of black silty clay loam about 35 inches thick. The subsoil is dark gray silty clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is olive gray clay loam. In some areas the soil has less clay and more sand. In a few areas the surface layer is calcareous.

Included with these soils in mapping are small areas of the somewhat poorly drained Linder soils and the poorly drained Canisteo, Harps, and Lemond soils. The included soils are on the rims of the depressions. They make up 2 to 10 percent of the map unit.

Permeability is moderately rapid in the organic part of the Palms soil and moderate in the underlying material. It is moderately slow in the Okoboji soil. The available water capacity is high in both soils. Organic matter content is high or very high, and natural fertility is high.

Surface runoff is ponded. A seasonal high water table is 1 foot above to 1 foot below the surface. The surface layer of the Okoboji soil is neutral or mildly alkaline, and that of the Palms soil is strongly acid to mildly alkaline.

Most areas are used as wildlife habitat. Cattails, reeds, sedges, and other water-tolerant plants grow around the edges of the depressions and in other scattered areas. These soils are well suited to wetland wildlife habitat. They are unsuitable as cropland because of the ponding.

The land capability classification is VIIIw.

1090—Blue Earth silt loam. This nearly level, poorly drained soil is on manmade lake plains. It formed in material dredged from lake bottoms in Fairmont (fig. 9). Individual areas are rectangular and range from 20 to 100 acres in size.

Typically, the surface layer is black silt loam about 9 inches thick. The underlying material to a depth of about 60 inches is black silt loam and silty clay loam. The soil is calcareous throughout. In places the surface layer is sandy loam.

Permeability is moderately slow. The available water capacity is high. Organic matter content also is high. Natural fertility is medium or low. Surface runoff is very slow or ponded. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is mildly alkaline or moderately alkaline.

Much of the acreage is idle land or is used as cropland. Some areas are used for gardens. This soil is fairly well suited to the crops commonly grown in the county. The wetness is a limitation, and soil blowing is a hazard. A drainage system is needed. A good fertility program is needed because of the low or medium fertility and the alkalinity. The high content of organic matter reduces the effectiveness of preemergence herbicides. As a result, controlling weeds is difficult.

The land capability classification is IIw.

1833—Coland loam, occasionally flooded. This nearly level, poorly drained soil is in slightly concave to slightly convex areas on flood plains along rivers and streams. It is occasionally flooded for brief periods in the

Figure 9.—An area of Blue Earth silt loam, which formed in material dredged out of lakes.

spring and after heavy or prolonged rainfall. Individual areas are elongated and range from 10 to more than 100 acres in size.

Typically the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark gray, mottled clay loam about 36 inches thick. The underlying material to a depth of about 60 inches is dark gray, mottled loam. In some areas the soil is calcareous. In a few places the subsoil has brighter colors. In places the sand grains in the soil are mainly very fine. In some channels the underlying material contains more sand and gravel.

Included with this soil in mapping are small areas of Millington, Linder, and Zook soils. The poorly drained Millington soils are in landscape positions similar to those of the Coland soil. They are calcareous throughout. The somewhat poorly drained Linder soils are in the higher positions. The poorly drained Zook soils are in low areas along the Des Moines River. They contain more clay than the Coland soil. Included soils make up 5 to 10 percent of the map unit.

Permeability is moderate in the Coland soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is medium. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is slightly acid or neutral.

Most areas are used as cropland or pasture. If drained, this soil is well suited to the crops commonly grown in the county. The wetness is a limitation, and the flooding is a hazard. This hazard can be reduced by straightening stream channels. Tile drains can lower the water table if a suitable drainage outlet is available. Soil blowing is a hazard on large flood plains. A system of conservation tillage that leaves crop residue on the surface helps to prevent excessive soil loss and allows the soil to warm up and dry out sooner in the spring.

A cover of pasture plants or hay is effective in controlling soil blowing. Rotation grazing and restricted use during wet periods help to keep the pasture in good condition.

This soil is fairly well suited to field and farmstead windbreaks, which are effective in controlling soil blowing. The trees and shrubs selected for planting should be those that can withstand the wetness and the brief periods of flooding. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is IIw.

1834—Coland loam, frequently flooded. This nearly level, poorly drained soil is in slightly convex to slightly concave areas on flood plains adjacent to rivers and streams. It is frequently flooded for brief periods in the spring and after prolonged or heavy rainfall (fig. 10). Individual areas are elongated and range from 25 to more than 100 acres in size.

Typically, the surface layer is black loam about 16 inches thick. The subsurface layer is about 28 inches of very dark gray clay loam and silty clay loam. The underlying material to a depth of about 60 inches is very dark gray, mottled clay loam. In some areas the surface layer is calcareous. In other areas pebbles are at or near the surface.

Included with this soil in mapping are small areas of the poorly drained Millington and Zook and somewhat poorly drained Linder soils on slight rises. Millington soils are calcareous throughout. Zook soils have more clay than the Coland soil. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Coland soil, and the available water capacity is high. Organic matter content also is high, and natural fertility is medium. Surface runoff is slow. The depth to a seasonal high water table is 1 to 3 feet. The surface layer is slightly acid or neutral.

Most areas are pastured or are left idle. Because of the flooding, this soil is unsuitable as cropland. Restricted use during wet periods helps to keep pastures in good condition.

This soil is poorly suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that can withstand the wetness and the flooding.

This soil is well suited to wetland and openland wildlife habitat. The habitat can be enhanced by planting trees and shrubs and by leaving some food, such as a few rows of corn, in nearby areas throughout the winter.

The land capability classification is Vw.

1852F—Terril-Swanlake loams, 18 to 40 percent slopes. These very steep soils are in upland areas along lakes, streams, and the major drainageways. The moderately well drained Terril soil is on foot slopes and the lower back slopes. The well drained Swanlake soil is on the upper back slopes and on shoulder slopes. Individual areas are long and narrow and range from 5 to 25 acres in size. They are about 45 percent Terril soil and 25 percent Swanlake soil. The two soils occur as areas so intricately mixed or so small that mapping them separately was not practical.

Typically, the Terril soil has a surface layer of black loam about 15 inches thick. The subsurface layer is black and brown loam about 25 inches thick. The subsoil to a depth of more than 60 inches is brown loam. In some areas the dark surface soil is less than 24 inches thick.

Typically, the Swanlake soil has a surface layer of very dark grayish brown loam about 10 inches thick. The subsurface layer is dark grayish brown loam about 4 inches thick. The subsoil is yellowish brown loam about 16 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, mottled loam. The soil is calcareous throughout. In some areas the depth to carbonates is more than 10 inches.

Figure 10.—An area of Coland loam, frequently flooded.

Included with this soil in mapping are small areas of the well drained Clarion and poorly drained Delft soils. Clarion soils are higher on the landscape than the Swanlake soil. They are not calcareous throughout. Delft soils are lower on the landscape than the Terril soil. They make up about 30 percent of the map unit.

Permeability is moderate in the Terril and Swanlake soils, and the available water capacity is high. Organic matter content is high in the Terril soil and moderate in the Swanlake soil. Natural fertility is high in the Terril soil and medium in the Swanlake soil. Surface runoff is rapid or very rapid on both soils. The surface layer of the Terril soil is slightly acid or neutral, and that of the Swanlake soil is mildly alkaline.

Most areas support native grasses or trees. These soils are unsuitable as cropland because of the slope and the hazard of erosion. A permanent cover of pasture plants or trees is effective in controlling erosion. Restricted use during very wet or very dry periods helps to keep pastures in good condition.

These soils are poorly suited to windbreaks. The trees selected for planting on the Swanlake soil should be those that are suited to dry sites. The trees selected for planting on the Terril soil should be those that are suited to moderately wet sites. Weed control increases the seedling survival rate. Hand planting is necessary because of the slope.

The land capability classification is VIe.

1877—Fostoria clay loam. This nearly level, somewhat poorly drained soil is in slightly convex to slightly concave areas on glacial till plains. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is black and very dark grayish brown clay loam about 9 inches thick. The

subsoil is about 13 inches thick. The upper part is dark grayish brown clay loam, and the lower part is grayish brown, mottled, calcareous silt loam. The underlying material to a depth of about 60 inches is light olive brown, mottled, calcareous silt loam that has strata of loam in the upper part. In some areas the soil is calcareous throughout. In other areas it has more clay or more silt.

Included with this soil in mapping are small areas of Ocheyedan, Kingston, Webster, and Waldorf soils. The well drained Ocheyedan soils are in the higher areas. The moderately well drained or somewhat poorly drained Kingston soils are in the landscape positions similar to those of the Fostoria soil. They have less sand and more silt than the Fostoria soil. The poorly drained Webster and Waldorf soils are in the lower areas and in drainageways. Included soils make up 5 to 20 percent of the map unit.

Permeability is moderate in the Fostoria soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is slow. The depth to a seasonal high water table is 2 to 4 feet. The surface layer is slightly acid or neutral.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. It can be cropped intensively. Returning crop residue to the soil and restricting fieldwork during wet periods help to prevent compaction and deterioration of tilth.

This soil is well suited to field and farmstead windbreaks. The trees and shrubs selected for planting should be those that are suited to moderately wet sites. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is I.

1907—Lakefield silt loam. This nearly level, moderately well drained or somewhat poorly drained soil is in slightly convex and nearly plane areas on lake plains. Individual areas are irregularly shaped or elongated and range from 5 to 20 acres in size.

Typically, the soil is calcareous silt loam throughout. The surface layer is black. It is about 10 inches thick. The subsurface layer is very dark gray and dark brown. It is about 10 inches thick. The subsoil is dark grayish brown and light olive brown and is mottled. It is about 16 inches thick. The underlying material to a depth of about 60 inches is light olive brown and light brownish gray and is mottled. In a few areas the soil is not calcareous.

Included with this soil in mapping are small areas of Truman and Madelia soils, which have carbonates at a depth of more than 18 inches. The well drained Truman soils are in the higher areas. The poorly drained Madelia soils are in the lower areas or in drainageways. Included soils make up 5 to 15 percent of the map unit.

Permeability is moderate in the Lakefield soil, and the available water capacity is high. Organic matter content and natural fertility also are high. Surface runoff is medium. The depth to a seasonal high water table is 2.5 to 5.0 feet. The surface layer is mildly alkaline or moderately alkaline.

Most areas are used as cropland. This soil is well suited to the crops commonly grown in the county. The high content of lime restricts the uptake of some plant nutrients. As as result, a good fertility program is needed. If cultivated crops are grown, soil blowing is a hazard. A system of conservation tillage that leaves crop residue on the surface reduces this hazard.

This soil is well suited to field and farmstead windbreaks, which are effective in controlling soil blowing. The trees and shrubs selected for planting should be those that are suited to moderately wet sites and that can tolerate the high content of lime. Seedlings survive and grow best if weeds are controlled by applications of herbicide or by cultivation.

The land capability classification is I.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 400,000 acres in the survey area, or 89 percent of the total acreage, meets the soil requirements for prime farmland. Areas of this land are throughout the

county. Most of the prime farmland is used for crops, mainly corn and soybeans.

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 generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. 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 at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

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 woodland; 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 (*8*).

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

Michael D. Appel, district conservationalist, Soil Conservation Service, prepared this section.

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.

In 1980, approximately 425,000 acres in Martin County was cropland or pasture. Of this total, about 396,700 acres was used for row crops, mainly soybeans and corn; 12,300 acres was used for hay, mainly alfalfa; 10,000 acres was pasture or idle land; and 6,000 acres was used for sweet corn or canning peas (*6*). The acreage used for row crops has increased significantly over the past 10 years. As a result of this increase, the acreage of hayland and pasture has decreased significantly.

Crops

The main concerns in managing the soils in Martin County for optimum crop production are water erosion, soil blowing, and poor internal drainage. About 10 percent of the cropland consists of moderately well drained or somewhat poorly drained, nearly level soils, such as Nicollet and Kingston soils. Few or no limitations affect the management of these soils.

About 30 percent of the cropland consists of well drained, gently sloping soils that are subject to moderate runoff and erosion. Examples are the gently sloping Clarion and Truman soils. No-till planting or another system of conservation tillage that leaves part or all of the crop residue on the surface can greatly reduce the hazard of erosion.

About 9 percent of the cropland consists of soils that are highly susceptible to erosion if conventional tillage methods are used. Swanlake, Bold, and Storden soils are examples. Crop rotations that include grasses and legumes, contour farming, terraces, and conservation tillage are needed to protect these soils.

About 6 percent of the cropland consists of droughty soils that are subject to water erosion and soil blowing. Estherville, Litchfield, and Sparta soils are examples. Conservation tillage, field windbreaks, and crop rotations that include grasses and legumes help to protect these soils.

About 45 percent of the cropland consists of poorly drained or very poorly drained soils, such as Canisteo and Webster soils. A subsurface drainage system generally is needed to increase the depth to which roots can penetrate. Additional tile and graded grassed waterways are needed to divert runoff from drainageways in the sloping adjacent areas. The drainage system in areas of poorly drained soils is not so extensive as that in areas of very poorly drained soils, where both surface and subsurface drains are needed. A scarcity of adequate drainage outlets, insufficient laterals and intakes, and old or undersized tile systems reduce crop production on the very poorly drained soils. Seasonal flooding is a hazard on the poorly drained Coland, Zook, and Millington soils. Excess surface water and inadequate drainage outlets are problems in managing these soils.

About 55 percent of the poorly drained and very poorly drained soils in the county are highly calcareous. Canisteo, Harps, Lemond, and Spicer soils are examples. Proper crop and variety selection, a drainage system, and applications of fertilizer are needed on these soils.

Soil fertility is naturally medium or high in most of the soils in the county. On most of the soils, crops respond well to applications of fertilizer. The soils are somewhat low in content of phosphorus but have adequate supplies of potassium and lime. The need for fertilizer depends on the kind of soil, past and present management, the crop to be grown, and the expected level of yields. The proper kinds and amounts of fertilizer should be determined by the results of soil tests.

Pasture

About 2 percent of the county is used for grazing. The acreage of grazing land has decreased by about 50 percent during the past 15 years. Many pastures have been converted to cropland in areas where cattle are no longer raised. The remaining pastures commonly are on wooded slopes and along meandering streams and rivers or are in areas that are too hilly for farming. Swanlake, Terril, Storden, Coland, and Millington are examples of soils that are used for pasture.

Deep, well drained to somewhat poorly drained soils, such as Clarion, Crippin, Nicollet, Lester, Truman, and Storden soils, are suited to the widest range of pasture species. These species include alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, timothy, orchardgrass, Kentucky bluegrass, and reed canarygrass. Warm-season grasses, including big bluestem, indiangrass, and switchgrass, grow well during July and August on these soils. All of these cool-season and warm-season species also grow well on the poorly drained Biscay, Canisteo, Delft, Harps, and Webster soils.

The very poorly drained Blue Earth, Okoboji, and Glencoe soils are suited only to the species adapted to wet conditions. These species include reed canarygrass, Garrison creeping foxtail, redtop, birdsfoot trefoil, alsike clover, and ladino clover. If drained, these soils also are suitable for timothy, smooth bromgrass, Kentucky bluegrass, and red clover.

Moderately well drained to excessively drained soils, including Dickinson, Estherville, Sparta, and Litchfield soils, usually provide forage in spring and early summer and again in fall, when precipitation is adequate. During the summer, however, droughty conditions limit forage production. Alfalfa, red clover, birdsfoot trefoil, smooth bromgrass, orchardgrass, timothy, Kentucky bluegrass, and intermediate wheatgrass grow well on these soils when adequate moisture supplies are available. Warm-season grasses, including big bluestem, little bluestem, indiangrass, switchgrass, and sideoats grama, also grow well on these soils. If good management is applied, these species provide good forage during the summer. Along with the cool-season species, they help to provide forage during the entire grazing season.

Overgrazing can be a problem in all pastured areas. It results in a poor stand of grasses and a greater susceptibility to erosion. Timely deferment of grazing, proper stocking rates, and rotation grazing help to keep the pasture in good condition.

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 6. 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 land capability classification of each map unit also is shown in the table.

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 ensures 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 6 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 for those crops.

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 criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include 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 engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*10*). Only class and subclass are used in this survey.

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 few limitations that restrict their use.

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

Class III soils have severe limitations that reduce the choice of plants 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.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Windbreaks and Environmental Plantings

Since the days of the early settlers, windbreaks have been planted to protect farmsteads and livestock. In the 1930's, they were planted to control soil blowing. In recent years field windbreaks have been planted to trap snow and thus increase the moisture supply. Maximum growth and survival rates can be obtained by controlling weeds around newly planted seedlings.

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, help to keep 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 ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 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 commercial nursery.

Recreation

The major recreational area in the county is the chain of five lakes near Fairmont. Parks and golf courses are available in this area. The county park system provides camping facilities along many other lakes. Private campgrounds also are available. The county has more

than 40 lakes, which provide many opportunities for recreation (fig. 11). Ice fishing, snowmobiling, and hunting are popular winter sports. The Minnesota Department of Natural Resources manages 14 wildlife areas. The shorelines of some lakes have good potential for further recreational development.

The soils of the survey area are rated in table 8 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 8, 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 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads

Figure 11.—A campground along one of the many lakes in Martin County.

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 and horseback riding 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 in Martin County can provide excellent habitat for many species of wildlife. Changes in land use have affected the population of many wildlife species. The county once had a high population of pheasants, but a change from diversified farming, which included the production of alfalfa, small grain, and row crops, to continuous row cropping has eliminated much of the cover once available to pheasants. The removal of fence lines and cultivation of areas close to roads and streams and of marginal land also have reduced the extent of the habitat available to pheasants.

Ducks are concentrated near marshes, many of which are in 14 wildlife areas managed by the Minnesota Department of Natural Resources (fig. 12). These areas and the wooded areas along lakes and streams have a moderate population of whitetail deer and also are inhabited by racoons, squirrels, and rabbits. Shallow lakes are inhabited by ducks, geese, and muskrat and by a few mink and beaver.

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 9, 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, wheat, oats, and soybeans.

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 bromegrass, clover, timothy, orchardgrass, birdsfoot trefoil, 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

Figure 12.—Waterfowl on Lake Okamanpeedan, which is in the southern part of Martin County.

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, switchgrass, goldenrod, beggarweed, indiangrass, wheatgrass, and quackgrass.

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, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, hackberry, apple, hawthorn, dogwood, and hickory. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, crabapple, chokecherry, and wild plum.

Coniferous plants furnish browse and seeds. 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, and cedar.

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, cattail, reed canarygrass, 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, field sparrow, cottontail, 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 woodcock, thrushes, woodpeckers, squirrels, 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, 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 10 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, slope, 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 11 shows the degree and 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 11 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 filter the effluent effectively. 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 11 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 11 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 12 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 12, 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 13 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 soil blowing 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 soil blowing, 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.

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.

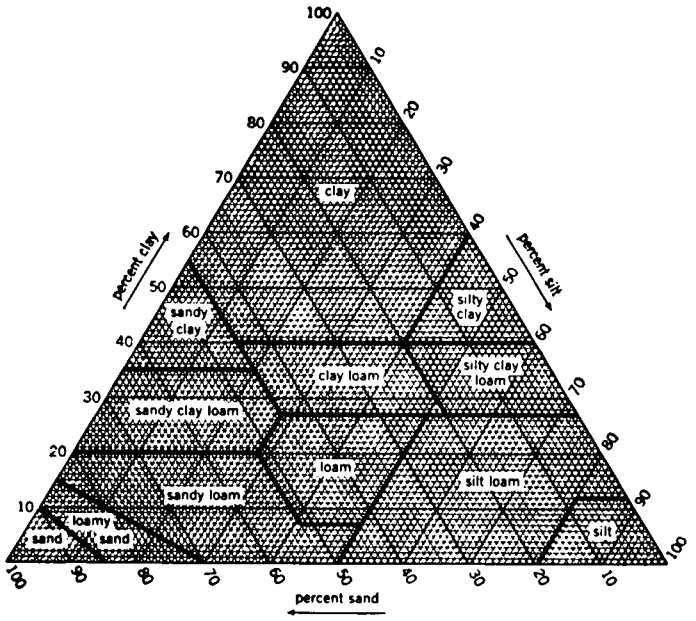


Figure 13.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 14 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 (fig. 13). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, 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, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance (*3*). 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.

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 generally 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 15 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 earthmoving 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 soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. 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 soil blowing 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 soil blowing 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 soil blowing 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 soil blowing are used.
5. Loamy soils that are less than 20 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 soil blowing are used.
6. Loamy soils that are 20 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 soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter 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 16 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.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

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 is not considered flooding, nor is water in swamps and marshes.

Table 16 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, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, 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 are 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 16 are the depth to the seasonal high water table, the kind of water table, 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 16. 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.

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.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 16 shows the total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

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 the 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.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*11*). 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. Table 17 shows the classification of the soils in the survey area. 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 Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that has 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 Haplaquolls.

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 (calcareous), 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 underlying material 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. 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* (*9*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*11*). 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."

Biscay Series

The Biscay series consists of deep, poorly drained soils on outwash plains, valley trains, and stream terraces. These soils formed in a loamy mantle 20 to 40 inches deep over sandy or sandy-skeletal sediments. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Biscay sandy clay loam, 1,950 feet west and 600 feet south of the northeast corner of sec. 15, T. 104 N., R. 31 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy clay 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.

A—10 to 22 inches; black (10YR 2/1) sandy clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; few fine dark grayish brown (2.5Y 4/2) worm casts; neutral; clear smooth boundary.

Bg—22 to 32 inches; dark grayish brown (2.5Y 4/2) sandy clay loam; common fine distinct light olive brown (2.5Y 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear smooth boundary.

2Cg1—32 to 40 inches; grayish brown (2.5Y 5/2) loamy sand; many medium distinct light olive brown (2.5Y 5/6) mottles; single grain; loose; common fine strong brown (7.5YR 5/6) iron oxide stains; about 8 percent coarse fragments; neutral; clear smooth boundary.

2Cg2—40 to 48 inches; grayish brown (2.5Y 5/2) stratified sand and loamy sand; common medium faint light brownish gray (2.5Y 6/2) and common fine distinct light olive brown (2.5Y 5/6) mottles; single grain; loose; few soft masses of calcium carbonate; about 14 percent coarse fragments; slight to strong effervescence; mildly alkaline; clear smooth boundary.

2Cg3—48 to 60 inches; grayish brown (2.5Y 5/2) stratified loamy sand and sand; common medium distinct light olive brown (2.5Y 5/6) mottles; single grain; loose; about 8 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to calcareous sand and gravel range from 20 to 40 inches. The mollic epipedon ranges from 16 to 24 inches in thickness. Typically, the content of gravel is 5 to 10 percent in the solum. The content of coarse fragments ranges from 5 to 50 percent in the 2C horizon. The coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is typically sandy clay loam, but the range includes loam, clay loam, and silty clay loam. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 to 3 and has few or common mottles. It is dominantly loam, sandy clay loam, or clay loam, but in some pedons the lower part is gravelly loam or gravelly sand loam. Free carbonates are in the lower part in some pedons. The 2C horizon has hue of 2.5Y or 5Y, value or 4 or 5, and chroma of 1 or 2. It is loamy coarse sand, loamy sand, coarse sand, or sand.

Blue Earth Series

The Blue Earth series consists of deep, very poorly drained, moderately permeable soils in depressions in glacial lake basins. These soils formed dominantly in silty, calcareous coprogenous earth. Slopes are 0 to 1 percent.

Typical pedon of Blue Earth mucky silty clay loam, 1,550 feet east and 100 feet south of the northwest corner of sec. 28, T. 101 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) mucky silty clay loam (coprogenous earth), dark gray (5Y 4/1) dry; weak fine granular structure; very friable; few snail shells and fragments of snail shells; slight effervescence; mildly alkaline; abrupt smooth boundary.

C—10 to 60 inches; stratified very dark gray (10YR 3/1 and 5Y 3/1) and dark olive gray (5Y 3/2) mucky silty clay loam and clay loam (coprogenous earth); few fine distinct dark brown (7.5YR 3/2) and dark reddish brown (5YR 3/2) mottles; weak thin and very thin platy structure; very friable; few to many scattered snail shells; strong effervescence; mildly alkaline.

The thickness of the coprogenous earth and the depth to loamy glacial till or lacustrine sediments range from 30 to more than 80 inches. Free carbonates are throughout the profile, and shell fragments make up 0 to 25 percent of the profile. Sapric material as much as 8 inches thick is on the surface of some pedons. Organic matter content ranges from 10 to 25 percent in the upper part of the profile.

The coprogenous earth has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4, and chroma of 1 or 2. It has few to many mottles in most or all parts. It is silt loam, silty clay loam, clay loam, loam, mucky silt loam, mucky silty clay loam, mucky clay loam, or mucky loam. Some pedons have a 2C horizon.

Bold Series

The Bold series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous, silty loess. Slopes range from 6 to 18 percent.

Typical pedon of Bold silt loam, in an area of Truman-Bold silt loams, 6 to 12 percent slopes; 250 feet west and 50 feet south of the northeast corner of sec. 1, T. 103 N., R. 29 W.

Ap—0 to 10 inches; mixed yellowish brown (10YR 5/4) and very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) and pale brown (10YR 6/3) dry, dark grayish brown (10YR 4/2) crushed; weak fine granular structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—10 to 18 inches; yellowish brown (10YR 5/4) silt loam; weak fine and very fine subangular blocky

structure; friable; violent effervescence; moderately alkaline; gradual wavy boundary.
C2—18 to 30 inches; yellowish brown (10YR 5/4) and light brownish gray (10YR 6/2) silt loam; few fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; violent effervescence; moderately alkaline; gradual wavy boundary.
C3—30 to 60 inches; light yellowish brown (10YR 6/4) silt loam; many medium distinct strong brown (7.5YR 5/8) mottles; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 4 to 12 inches. The A horizon has value of 3 to 6 and chroma of 2 to 6. The C horizon has value of 5 to 7 and chroma of 2 to 8 and is commonly mottled in the lower part.

Brownton Series

The Brownton series consists of deep, poorly drained, slowly permeable soils on glacial lake plains. These soils formed in clayey and silty lacustrine sediments. Slopes are 0 to 1 percent.

Typical pedon of Brownton silty clay, 800 feet east and 50 feet south of the northwest corner of sec. 17, T. 104 N., R. 29 W.

Ap—0 to 10 inches; black (N 2/0) silty clay, dark gray (N 4/0) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; abrupt smooth boundary.
A—10 to 20 inches; black (N 2/0) silty clay, dark gray (5Y 4/1) dry; moderate fine and medium subangular blocky structure; friable; strong effervescence; mildly alkaline; clear smooth boundary.
Bg1—20 to 32 inches; dark gray (5Y 4/1) clay; common fine distinct olive (5Y 5/3) and few fine distinct light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; very sticky; strong effervescence; mildly alkaline; clear smooth boundary.
Bg2—32 to 40 inches; olive gray (5Y 5/2) clay; dark gray (5Y 4/1) coatings in root channels; common medium faint gray (5Y 5/1) and few fine distinct light olive brown (2.5Y 5/6) mottles; moderate fine and medium subangular blocky structure; very sticky; strong effervescence; mildly alkaline; clear smooth boundary.
Cg—40 to 60 inches; olive gray (5Y 5/2) silty clay; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; sticky; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 24 to 44 inches. The depth to loamy glacial till ranges from 30 to more than 60 inches. The mollic epipedon is 12 to 24 inches thick.

The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is silty clay loam, silty clay, or clay. The B horizon has hue of 2.5Y or 5Y. It is silty clay or clay. The C horizon has hue of 2.5Y or 5Y and value of 5 or 6. It is dominantly silty clay, clay, or silty clay loam, but the range includes silt loam. Some pedons have a 2C horizon.

Canisteo Series

The Canisteo series consists of deep, poorly drained, moderately permeable soils on glacial till plains (fig. 14). These soils formed in calcareous, loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Canisteo clay loam, 200 feet east and 2,275 feet south of the northwest corner of sec. 15, T. 102 N., R. 29 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.
A—9 to 23 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.
Bg—23 to 36 inches; dark grayish brown (2.5Y 4/2) clay loam; common fine distinct olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; friable; common fine faint very dark gray (10YR 3/1) coatings on peds; about 4 percent coarse fragments; few fine threads of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.
Cg—36 to 60 inches; grayish brown (2.5Y 5/2) loam; common fine distinct light olive gray (5Y 6/2) and common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; few fine distinct yellowish brown (10YR 5/8) iron oxide stains; few fine prominent black (10YR 2/1) accumulations of manganese oxide; about 4 percent coarse fragments; few fine threads of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. Some pedons are leached to a depth of as much as 10 inches. The content of coarse fragments ranges from 2 to 8 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly clay loam, but the range includes loam, silty

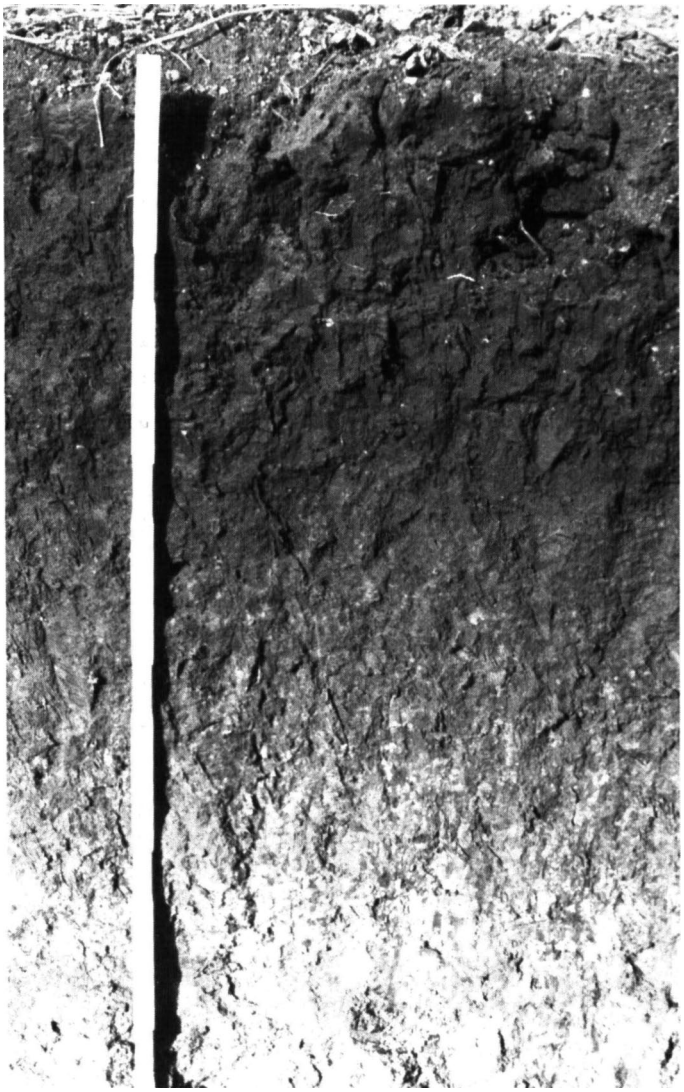


Figure 14.—Profile of Canisteo clay loam. Canisteo soils are dark to a depth of 14 to 24 inches. Depth is marked in inches.

clay loam, and silt loam. The B and C horizons are clay loam, sandy loam, or loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 or hue of 10YR, value of 4 or 5, and chroma of 1. Few to many mottles are in part or all of this horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4 and has few to many mottles.

Canisteo clay loam, depressional, has a mollic epipedon that is thicker than is defined as the range for the series. This difference, however, does not alter the usefulness or behavior of the soil.

Clarion Series

The Clarion series consists of deep, well drained, moderately permeable soils on glacial till plains (fig. 15). These soils formed in loamy glacial till. Slopes range from 1 to 25 percent.

Typical pedon of Clarion loam, 1 to 6 percent slopes, 660 feet east and 100 feet south of the northwest corner of sec. 12, T. 103 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine subangular blocky structure; friable; about 5 percent coarse fragments; neutral; abrupt smooth boundary.

A—10 to 14 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; few very dark grayish brown (10YR 3/2) worm casts; neutral; clear wavy boundary.

Bw1—14 to 18 inches; dark brown (10YR 4/3) loam, dark brown (10YR 3/3) crushed; moderate fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; many very dark grayish brown (10YR 3/2) worm casts; neutral; gradual irregular boundary.

Bw2—18 to 33 inches; dark yellowish brown (10YR 4/4) loam; moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

C1—33 to 40 inches; yellowish brown (10YR 5/4) loam; massive; friable; about 5 percent coarse fragments; few fine distinct soft masses of calcium carbonate; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—40 to 60 inches; yellowish brown (10YR 5/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; friable; common fine distinct yellowish brown (10YR 5/8) iron oxide stains; about 8 percent coarse fragments; few fine distinct soft masses of calcium carbonate; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates are commonly 20 to 35 inches but range from 18 to 50 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loam, but the range includes clay loam, sandy loam, and silt loam high in content of sand. The B horizon has value of 4 or 5. It is dominantly loam or clay loam, but some pedons have subhorizons of sandy loam. The C horizon has no mottles or has few or common mottles. It is loam or sandy loam.

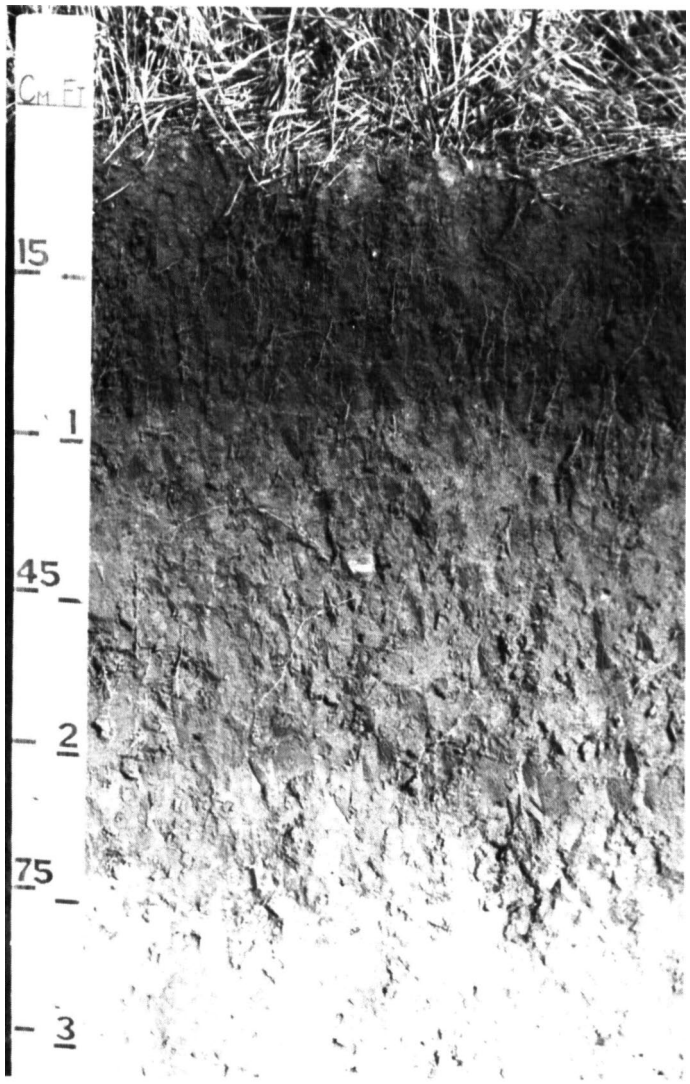


Figure 15.—Profile of Clarion loam. Clarion soils are dark to a depth of 10 to 20 inches.

Coland Series

The Coland series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in loamy alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Coland loam, occasionally flooded, 160 feet west and 2,520 feet north of the southeast corner of sec. 10, T. 101 N., R. 32 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A1—8 to 27 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; few fine distinct very dark grayish brown (10YR 3/2) mottles; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—27 to 36 inches; very dark gray (N 3/0) clay loam, dark gray (N 4/0) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

AC—36 to 44 inches; very dark gray (N 3/0) clay loam, dark gray (10YR 4/1) dry; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.

Cg—44 to 60 inches; dark gray (5Y 4/1) loam; common medium faint dark grayish brown (2.5Y 4/2) mottles; weak fine and medium subangular blocky structure; friable; very dark gray (N 3/0) coatings on lateral faces of peds; neutral.

The thickness of solum and of the mollic epipedon ranges from 36 to 48 inches. The depth to free carbonates ranges from 36 to more than 60 inches.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3. It is clay loam, silty clay loam, or loam. The AC horizon has hue of 5Y or is neutral in hue. It has value of 2 to 4. The C horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 2 to 5. It is dominantly clay loam or loam, but strata of sandy or gravelly material are in the lower part of some pedons.

Collinwood Series

The Collinwood series consists of deep, moderately well drained or somewhat poorly drained, moderately slowly permeable or slowly permeable soils on glacial lake plains. These soils formed in clayey and silty lacustrine sediments. Slopes range from 0 to 3 percent.

Typical pedon of Collinwood silty clay, 150 feet east and 2,100 feet north of the southwest corner of sec. 12, T. 104 N., R. 29 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.

AB—9 to 15 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; weak fine and medium angular blocky structure; friable; very dark gray (10YR 3/1) coatings on faces of peds; slightly acid; gradual wavy boundary.

Bw—15 to 29 inches; dark grayish brown (2.5Y 4/2) clay; moderate medium subangular blocky structure parting to moderate fine angular blocky; firm; dark brown (10YR 4/3) coatings on lateral faces of peds; medium acid; gradual smooth boundary.

BC—29 to 35 inches; grayish brown (2.5Y 5/2) silty clay; common fine faint light olive brown (2.5Y 5/4 and

5/6) mottles; weak medium subangular blocky structure; firm; neutral; clear smooth boundary.
C—35 to 60 inches; light olive brown (2.5Y 5/4) silty clay loam; moderate medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; few fine distinct black (10YR 2/1) accumulations of manganese oxide; few coarse soft masses of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of solum and the depth to free carbonates range from 24 to 54 inches. The mollic epipedon ranges from 14 to 24 inches in thickness.

The A horizon has value of 2 or 3. It is silty clay or silty clay loam. The B and C horizons are silty clay, clay, or silty clay loam. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4.

Crippin Series

The Crippin series consists of deep, somewhat poorly drained, moderately permeable soils on ground moraines. These soils formed in loamy, calcareous glacial till. Slopes range from 0 to 3 percent.

Typical pedon of Crippin loam, 2,090 feet south and 775 feet west of the northeast corner of sec. 16, T. 102 N., R. 29 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and very fine subangular blocky structure; friable; about 4 percent coarse fragments; few very dark grayish brown (10YR 3/2) worm casts; slight effervescence; mildly alkaline; abrupt smooth boundary.
AB—9 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark gray (10YR 4/1) dry; very dark gray (10YR 3/1) coatings on faces of peds; dark grayish brown (2.5Y 4/2) worm casts; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.
Bw—15 to 27 inches; dark grayish brown (2.5Y 4/2) loam; common fine faint olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.
C1—27 to 45 inches; olive brown (2.5Y 4/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; very weak medium subangular blocky structure; friable; few fine distinct yellowish brown (10YR 5/8) iron oxide stains; few fine prominent black (10YR 2/1) accumulations of manganese oxide; about 7 percent coarse fragments; common medium distinct soft masses of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.
C2—45 to 60 inches; olive brown (2.5Y 4/4) loam; common coarse distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; common fine distinct yellowish brown (10YR 5/8) iron oxide stains; common fine prominent black (10YR 2/1) concretions of manganese oxide; about 6 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches. Free carbonates are commonly at the surface but in some pedons are leached to a depth of as much as 10 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The Ap horizon has value of 2 or 3. The A horizon is dominantly loam, but the range includes clay loam. The AB horizon has value of 2 or 3 and chroma of 1 or 2. The B and C horizons are loam or clay loam. The B horizon has hue of 10YR or 2.5Y, value of 2 to 5, and chroma of 1 to 4. Few or common mottles are in most or all of this horizon. The C horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 2 to 4 and has few or common mottles.

Delft Series

The Delft series consists of deep, poorly drained, moderately slowly permeable soils on glacial till plains. These soils formed in loamy alluvial sediments and in the underlying loamy glacial till. Slopes range from 1 to 3 percent.

Typical pedon of Delft loam, 1,050 feet south and 1,870 feet west of the northeast corner of sec. 5, T. 102 N., R. 30 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.
A—9 to 36 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; gradual smooth boundary.
AB—36 to 44 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; neutral; gradual wavy boundary.
Bg—44 to 54 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; common very dark gray (5Y 3/1) worm casts; neutral; gradual wavy boundary.
Cg—54 to 60 inches; grayish brown (2.5Y 5/2) loam; many medium distinct light olive brown (2.5Y 5/6)

mottles; massive; friable; few fine faint threads of calcium carbonate; common fine distinct strong brown (7.5YR 5/6) iron oxide stains; few fine prominent black (10YR 2/1) accumulations of manganese oxide; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon and the depth to free carbonates range from 24 to 60 inches. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has hue of 10YR to 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly loam, but the range includes clay loam and silty clay loam. The B horizon is loam or clay loam. It has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. Mottles are in part or all of this horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 and has common or many mottles. It is dominantly loam, but the range includes silt loam and sandy loam.

Dickinson Series

The Dickinson series consists of deep, well drained or somewhat excessively drained soils on outwash plains, stream terraces, and glacial uplands. These soils formed in loamy and sandy glacial outwash or in alluvial sediments reworked by the wind. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 1 to 6 percent.

Typical pedon of Dickinson fine sandy loam, 1 to 6 percent slopes, 1,030 feet east and 490 feet south of the northwest corner of sec. 15, T. 102 N., R. 29 W.

A—0 to 14 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

AB—14 to 19 inches; black (10YR 2/1) and very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) and brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

Bw—19 to 34 inches; brown (10YR 4/3) sandy loam; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

C—34 to 60 inches; dark yellowish brown (10YR 4/4) fine sand; single grain; loose; slightly acid.

The thickness of the solum ranges from 24 to 50 inches. The depth to loamy sand or coarser textured material ranges from 20 to 42 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam, sandy loam, or loam. The B horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 6. It is sandy loam, fine sandy loam, loamy fine sand, loamy sand, fine sand, or sand. The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It is loamy fine sand, loamy sand, fine sand, or sand.

Estherville Series

The Estherville series consists of deep, well drained or somewhat excessively drained soils on outwash plains, valley trains, and glacial moraines. These soils formed in sandy glacial outwash mantled with loamy material. Permeability is moderately rapid in the loamy mantle and rapid in the underlying sandy sediments. Slopes range from 1 to 18 percent.

Typical pedon of Estherville sandy loam, 1 to 6 percent slopes, 2,540 feet north and 500 feet west of the southeast corner of sec. 1, T. 103 N., R. 31 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; slightly acid; abrupt smooth boundary.

A—9 to 13 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; clear smooth boundary.

Bw—13 to 18 inches; brown (7.5YR 4/4 and 10YR 4/3) sandy loam; weak fine and very fine subangular blocky structure; friable; about 4 percent coarse fragments; slightly acid; clear smooth boundary.

2BC—18 to 22 inches; dark yellowish brown (10YR 4/4) loamy sand; single grain; loose; about 10 percent coarse fragments; neutral; clear smooth boundary.

2C—22 to 60 inches; yellowish brown (10YR 5/4 and 5/6) gravelly coarse sand; single grain; loose; about 20 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 15 to 30 inches. The loamy mantle is 10 to 20 inches thick. The mollic epipedon is 7 to 20 inches thick. The content of coarse fragments is 0 to 15 percent in the loamy mantle and 10 to 35 percent in the underlying sediments. Typically, the coarse fragments are 0.1 inch to 1.2 inches in size.

The A horizon has value of 2 or 3. It is sandy loam or loam. The Bw horizon has value of 3 or 4. It is sandy loam, coarse sandy loam, or loam. The 2BC horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 to 4. It is loamy coarse sand or loamy sand. The 2C horizon has value of 4 to 7 and chroma of 2 to 6. It is dominantly coarse sand or sand but has thin strata of fine sand, shaly sand, or gravel in some pedons.

Farrar Series

The Farrar series consists of deep, well drained soils on glacial uplands. These soils formed in about 2 feet of loamy eolian sediments and in the underlying loamy glacial till. Permeability is moderately rapid in the upper part of the profile and moderate in the lower part. Slopes range from 1 to 6 percent.

Typical pedon of Farrar fine sandy loam, 1 to 6 percent slopes, 400 feet east and 1,500 feet north of the southwest corner of sec. 28, T. 103 N., R. 29 W.

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

A—10 to 14 inches; black (10YR 2/1) and very dark brown (10YR 2/2) fine sandy loam, very dark grayish brown (10YR 3/2) dry; weak and moderate very fine and fine subangular blocky structure; friable; slightly acid; gradual wavy boundary.

BA—14 to 20 inches; very dark grayish brown (10YR 3/2) and brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) crushed; moderate very fine and fine subangular blocky structure; friable; slightly acid; gradual wavy boundary.

2Bw—20 to 30 inches; dark yellowish brown (10YR 4/4) loam; moderate fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; brown (10YR 4/3) coatings on lateral faces of peds; neutral; gradual wavy boundary.

2C1—30 to 34 inches; light olive brown (2.5Y 5/4) loam; few fine distinct grayish brown (10YR 5/2) and common medium distinct strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

2C2—34 to 60 inches; yellowish brown (10YR 5/4) loam; common fine distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) mottles; friable; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 40 inches. The depth to glacial till ranges from 18 to 36 inches. The content of coarse fragments is as much as 10 percent in the underlying till. Typically, the coarse fragments are 0.1 inch to 1.2 inches in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is fine sandy loam or loamy fine sand. The 2B horizon has value and chroma of 4 or 5. The 2C horizon has value of 4 to 6 and has few to many mottles.

Fostoria Series

The Fostoria series consists of deep, somewhat poorly drained, moderately permeable soils on glacial till plains. These soils formed in loamy and silty sediments. Slopes range from 0 to 2 percent.

Typical pedon of Fostoria clay loam, 2,630 feet south and 100 feet east of the northwest corner of sec. 22, T. 104 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—10 to 15 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.

AB—15 to 19 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; very dark gray (10YR 3/1) coatings on faces of peds; moderate medium subangular blocky structure; friable; neutral; gradual irregular boundary.

Bw—19 to 25 inches; dark grayish brown (10YR 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; very dark gray (10YR 3/1) coatings on faces of peds; neutral; gradual smooth boundary.

2BC—25 to 32 inches; grayish brown (10YR 5/2) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; slight effervescence in spots; neutral; gradual smooth boundary.

2C1—32 to 40 inches; light olive brown (2.5Y 5/6) stratified silt loam and loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

2C2—40 to 60 inches; light olive brown (2.5Y 5/6) silt loam; common medium distinct grayish brown (10YR 5/2) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches. The depth to free carbonates ranges from 24 to 48 inches. The mollic epipedon ranges from 12 to 23 inches in thickness.

The A and B horizons are loam, clay loam, or silt loam. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4 and has few or common mottles. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. It is stratified silt loam, loam, or sandy loam.

Glencoe Series

The Glencoe series consists of deep, very poorly drained, moderately permeable or moderately slowly permeable soils in depressions on glacial moraines. These soils formed in loamy and silty alluvium and in glacial till. Slopes are 0 to 1 percent.

Typical pedon of Glencoe clay loam, 1,150 feet north and 450 feet west of the southeast corner of sec. 1, T. 102 N., R. 31 W.

A1—0 to 15 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; clear smooth boundary.

A2—15 to 29 inches; black (5Y 2/1) clay loam, very dark gray (5Y 3/1) dry; common fine distinct olive (5Y 4/3) mottles; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

ABg—29 to 41 inches; very dark gray (5Y 3/1) clay loam, dark gray (10YR 4/1) dry; common fine distinct dark grayish brown (2.5Y 4/2) and few fine distinct olive (5Y 5/3) mottles; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bg1—41 to 53 inches; gray (5Y 5/1) silty clay loam; common fine faint olive (5Y 5/3) and few fine faint greenish gray (5BG 5/1) mottles; moderate fine and medium angular blocky structure; sticky; common fine distinct yellowish brown (10YR 5/8) iron oxide stains; about 1 percent coarse fragments; common very dark gray (5Y 3/1) coatings on lateral faces of peds; mildly alkaline; gradual smooth boundary.

Bg2—53 to 60 inches; olive gray (5Y 4/2) silty clay loam; common fine prominent yellowish brown (10YR 5/8) and few fine distinct olive (5Y 5/4) mottles; weak fine and medium subangular blocky structure; sticky; about 2 percent coarse fragments; few fine distinct soft masses of calcium carbonate; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to more than 60 inches. The thickness of the mollic epipedon ranges from 30 to 46 inches. The content of coarse fragments is 0 to 5 percent in the solum and 2 to 8 percent in the C horizon. Typically, the coarse fragments are 0.1 to 0.8 inch in size. Some pedons have as much as 6 inches of organic material on the surface.

The A and B horizons are silty clay loam, clay loam, or loam. The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It has no mottles or few or common mottles. The B horizon has hue of 5Y or 2.5Y and has few to many mottles. Few or common dark tongues of the A horizon extend into the B horizon. Some pedons have a C horizon.

Grogan Series

The Grogan series consists of deep, well drained, moderately rapidly permeable soils on glacial lake plains. These soils formed in silty lacustrine sediments. Slopes range from 1 to 6 percent.

Typical pedon of Grogan silt loam, 1 to 6 percent slopes, 2,600 feet north and 80 feet west of the southeast corner of sec. 34, T. 104 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

AB—10 to 18 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak fine granular; friable; neutral; gradual wavy boundary.

Bw—18 to 38 inches; brown (10YR 4/3) silt loam; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

C—38 to 60 inches; yellowish brown (10YR 5/4) stratified very fine sandy loam and silt loam; common medium faint yellowish brown (10YR 5/6) and common medium distinct light brownish gray (10YR 6/2) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches. Glacial till is at a depth of 50 inches or more in some pedons.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is silt loam or loam. The B horizon has value of 4 or 5 and chroma of 3 to 5. It is loam, silt loam, very fine sandy loam, or loamy very fine sand. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 to 6. It has no mottles or has few to many mottles. It is very fine sandy loam, loamy very fine sand, or silt loam.

Hanska Series

The Hanska series consists of deep, poorly drained or very poorly drained soils on outwash plains. These soils formed in glacial outwash sediments. They are loamy in the upper part and sandy in the lower part. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Hanska loam, 1,280 feet east and 80 feet south of the northwest corner of sec. 4, T. 103 N., R. 30 W.

Ap—0 to 10 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak fine and medium subangular blocky structure; friable; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

A—10 to 14 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak fine and medium subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear smooth boundary.

AB—14 to 21 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual smooth boundary.

Bg1—21 to 29 inches; gray (5Y 5/1) sandy loam; few fine distinct light olive brown (2.5Y 5/4) mottles; single grain; loose; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bg2—29 to 34 inches; olive gray (5Y 5/2) sandy loam; few fine distinct light olive brown (2.5Y 5/4) mottles; single grain; loose; about 1 percent coarse fragments; neutral; clear smooth boundary.

2C—34 to 60 inches; grayish brown (2.5Y 5/2) sand; common fine distinct light yellowish brown (2.5Y 6/4) mottles; single grain; loose; about 4 percent coarse fragments; slight effervescence in spots; neutral.

The thickness of the solum ranges from 24 to 46 inches. The depth to free carbonates generally ranges from 30 to 55 inches, but a few pedons have carbonates in the upper 10 inches. The mollic epipedon is 12 to 24 inches thick. The coarse-loamy mantle is 20 to 40 inches thick. The content of coarse fragments is 0 to 5 percent in the solum and is as much as 10 percent in the underlying material. Typically, the coarse fragments are 0.1 to 0.4 inch in size.

The A horizon has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is sandy loam, fine sandy loam, or loam. The B horizon has hue of 2.5Y or 5Y and value of 4 or 5 and has few or common mottles. It is sandy loam, coarse sandy loam, or loam. Some pedons have a 2BC horizon. The 2C horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 2 to 4. It has no mottles or has few to many mottles. It is dominantly sand or coarse sand but is stratified with loam or silt loam in a few pedons.

Hanska loam, depressional, is a taxadjunct to the series because its mollic epipedon is 24 to 35 inches thick. The difference, however, does not alter the usefulness or behavior of the soil.

Harps Series

The Harps series consists of deep, poorly drained, moderately permeable soils on till plains. These soils formed in loamy, calcareous glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Harps clay loam, 940 feet east and 100 feet south of the center of sec. 32, T. 101 N., R. 29 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; violent effervescence; moderately alkaline; abrupt smooth boundary.

ABk—9 to 14 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; few fine prominent light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; few fine soft masses of calcium carbonate; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg—14 to 25 inches; olive gray (5Y 5/2) clay loam; few fine distinct pale olive (5Y 6/3) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; fine medium soft masses of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

BCg—25 to 33 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) loam; few fine distinct olive (5Y 5/6) mottles; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; few fine soft masses of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg1—33 to 45 inches; light olive gray (5Y 6/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; sticky; few yellowish brown (10YR 5/8) iron oxide stains; about 1 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—45 to 60 inches; light gray (5Y 6/1) loam; many coarse distinct light yellowish brown (2.5Y 6/4) mottles; massive; friable; common yellowish brown (10YR 5/8) iron oxide stains; common fine black (10YR 2/1) accumulations of manganese oxide; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 45 inches. The thickness of the mollic epipedon ranges from 10 to 21 inches. The content of coarse fragments is 1 to 5 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The Ap horizon has hue of 10YR and value of 2 or 3 or is neutral in hue and has value of 3. It is loam or clay loam. The B horizon is loam, clay loam, or sandy clay loam. It has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. Mottles with high chroma increase in size and number with increasing depth. The C horizon has hue of 2.5Y or 5Y and value of 5 or 6.

Kingston Series

The Kingston series consists of deep, moderately well drained or somewhat poorly drained, moderately

permeable soils on glacial lake plains. These soils formed in silty, calcareous lacustrine sediments. Slopes range from 0 to 3 percent.

Typical pedon of Kingston silt loam, 125 feet south and 6 feet east of the northwest corner of sec. 31, T. 104 N., R. 29 W.

Ap—0 to 11 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—11 to 18 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

BA—18 to 22 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 4/3) silty clay loam, dark grayish brown (10YR 4/2) crushed; weak medium subangular blocky structure; friable; very dark gray (10YR 3/1) coatings on faces of peds; neutral; gradual wavy boundary.

Bw—22 to 29 inches; yellowish brown (10YR 5/4) silty clay loam; common fine distinct dark grayish brown (2.5Y 4/2) and few fine faint pale brown (10YR 6/3) mottles; weak medium subangular blocky structure; friable; few very dark grayish brown (10YR 3/2) worm casts; neutral; clear smooth boundary.

BC—29 to 38 inches; light olive brown (2.5Y 5/4) silt loam; few fine distinct light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; friable; few fine strong brown (7.5YR 5/6) iron oxide stains; strong effervescence; mildly alkaline; gradual smooth boundary.

C—38 to 60 inches; light olive brown (2.5Y 5/4) silt loam; common fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; common medium distinct yellowish brown (10YR 5/6) iron oxide stains; common fine distinct black (10YR 2/1) concretions of manganese oxide; few medium light gray (10YR 7/2) soft accumulations of calcium carbonate; dominantly strong effervescence but violent effervescence in spots; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The mollic epipedon ranges from 12 to 24 inches in thickness.

The A horizon has value of 2 or 3. It is silty clay loam, silt loam, or loam. The B and C horizons are silt loam or silty clay loam. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. Faint or distinct mottles are in part or all of this horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 and 6, and chroma of 2 to 4. Mottles are in part or all of this horizon.

Lakefield Series

The Lakefield series consists of deep, moderately well drained or somewhat poorly drained, moderately permeable soils on glacial lake plains. These soils formed in silty, calcareous lacustrine sediments. Slopes range from 0 to 3 percent.

Typical pedon of Lakefield silt loam, 450 feet south and 525 feet west of the northeast corner of sec. 34, T. 104 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; mildly alkaline; abrupt smooth boundary.

AB—10 to 20 inches; very dark gray (10YR 3/1) and dark brown (10YR 3/3) silt loam; weak fine and medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw1—20 to 28 inches; dark grayish brown (2.5Y 4/2) silt loam; common fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

Bw2—28 to 36 inches; light olive brown (2.5Y 5/4) silt loam; common medium faint dark grayish brown (2.5Y 4/2) and few fine distinct pale brown (10YR 6/3) mottles; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

C1—36 to 40 inches; light olive brown (2.5Y 5/4) silt loam; common medium distinct pale brown (10YR 6/3) mottles; massive; friable; strong effervescence; moderately alkaline; clear smooth boundary.

C2—40 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; common fine yellowish brown (10YR 5/6) iron oxide stains; few large concretions of calcium carbonate; strong and violent effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. Free carbonates are commonly at the surface but in some pedons are leached to a depth of as much as 10 inches. The mollic epipedon ranges from 12 to 24 inches in thickness.

The A horizon has value of 2 or 3. It is silt loam, silty clay loam, or loam. The B and C horizons are silt loam or silty clay loam. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. Faint or distinct mottles are in part or all of this horizon. The C horizon has hue of 2.5Y or 5Y. Mottles are in part or all of this horizon.

Lemond Series

The Lemond series consists of deep, poorly drained soils on outwash plains. These soils formed in loamy material over sandy glacial outwash. Permeability is

moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Lemond sandy loam, 1,360 feet north and 250 feet east of the southwest corner of sec. 16, T. 102 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak very fine granular; very friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 15 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak very fine granular; very friable; strong effervescence; mildly alkaline; clear smooth boundary.

A2—15 to 20 inches; black (10YR 2/1) and very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; very friable; strong effervescence; mildly alkaline; clear smooth boundary.

Bg—20 to 30 inches; dark gray (5Y 4/1) sandy loam; few fine distinct brown (10YR 5/3) mottles; weak fine subangular blocky structure; very friable; very dark gray (10YR 3/1) coatings on lateral faces of peds; strong effervescence; mildly alkaline; clear smooth boundary.

2Cg—30 to 43 inches; olive gray (5Y 5/2) sand; common fine faint light brownish gray (2.5Y 6/2) mottles; single grain; loose; slight effervescence; mildly alkaline; clear smooth boundary.

2C—43 to 60 inches; grayish brown (2.5Y 5/2) sand; many coarse distinct yellowish brown (10YR 5/6) and common medium distinct dark brown (7.5YR 3/2) mottles; single grain; loose; common medium prominent black (10YR 2/1) accumulations of manganese oxide; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 40 inches. The mollic epipedon ranges from 14 to 24 inches in thickness. The content of coarse fragments is 0 to 5 percent in the solum and is as much as 10 percent in the underlying material. The coarse fragments are 0.1 to 0.4 inch in size.

The A horizon has hue of 2.5Y or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is loam, sandy loam, or coarse sandy loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 and has few to many mottles. It is loam, sandy loam, coarse sandy loam, loamy sand, or loamy coarse sand. The 2C horizon has hue of 2.5Y or 5Y. It is typically sand, but the range includes loamy sand, loamy coarse sand, and coarse sand.

Lester Series

The Lester series consists of deep, well drained, moderately permeable soils on glacial till plains. These soils formed in loamy glacial till. Slopes range from 2 to 12 percent.

These soils are taxadjuncts to the Lester series because they do not have an E horizon and have a mollic epipedon. These differences, however, do not alter the usefulness or behavior of the soils.

Typical pedon of Lester loam, 2 to 6 percent slopes, 1,700 feet south and 1,215 feet east of the northwest corner of sec. 32, T. 101 N., R. 30 W.

A1—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

A2—9 to 19 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; firm; about 4 percent coarse fragments; medium acid; gradual smooth boundary.

Bt1—19 to 25 inches; dark yellowish brown (10YR 4/4) clay loam, dark grayish brown (10YR 4/2) crushed; weak fine and medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous very dark grayish brown (10YR 3/2) clay coatings on faces of peds; about 4 percent coarse fragments; strongly acid; gradual wavy boundary.

Bt2—25 to 41 inches; yellowish brown (10YR 5/4) clay loam; strong medium prismatic structure; very firm; few fine yellowish brown (10YR 5/8) iron oxide stains; moderately thick continuous very dark grayish brown (10YR 3/2) clay and silt coatings on faces of peds; about 5 percent coarse fragments; medium acid; gradual irregular boundary.

C1—41 to 48 inches; light olive brown (2.5Y 5/4) clay loam; weak fine subangular blocky structure; firm; few fine distinct yellowish brown (10YR 5/8) iron oxide stains; about 6 percent coarse fragments; few threads and common masses of calcium carbonate; slight effervescence; mildly alkaline; gradual irregular boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; common fine distinct yellowish brown (10YR 5/6) iron oxide stains; few fine distinct black (10YR 2/1) manganese oxide concretions; about 8 percent coarse fragments; few threads and common concretions of calcium carbonate; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 54 inches. The thickness of

the mollic epipedon ranges from 10 to 20 inches. The content of coarse fragments is 2 to 8 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It typically is loam or clay loam, but the range includes silt loam and sandy loam. The Bt horizon has hue of 10YR or 2.5Y and chroma of 3 or 4. It is clay loam or loam. It has clay coatings that are thin or thick and are continuous or discontinuous. The C horizon has value of 4 to 6 and chroma of 3 to 6. It has few or common masses of carbonate, iron stains, and mottles.

Linder Series

The Linder series consists of deep, somewhat poorly drained soils on outwash plains and stream terraces. These soils formed in loamy sediments 22 to 36 inches deep over calcareous, sandy and sandy-skeletal sediments. Permeability is moderate or moderately rapid in the upper part of the profile and very rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Linder loam, 2,800 feet west and 1,100 feet north of the southeast corner of sec. 31, T. 104 N., R. 30 W.

Ap—0 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

AB—11 to 15 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bw—15 to 22 inches; dark grayish brown (2.5Y 4/2) sandy loam; common fine faint light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear wavy boundary.

BC—22 to 29 inches; grayish brown (2.5Y 5/2) sandy loam; common fine faint olive brown (2.5Y 4/4) mottles; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; neutral; gradual smooth boundary.

2C1—29 to 35 inches; dark grayish brown (2.5Y 4/2) loamy coarse sand; single grain; loose; common medium distinct very dark brown (10YR 2/2) manganese oxide stains; few fine distinct yellowish brown (10YR 5/6) iron oxide stains; about 6 percent coarse fragments; mildly alkaline; clear wavy boundary.

2C2—35 to 45 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) coarse sand; single grain; loose; about 12 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

2C3—45 to 60 inches; grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4) gravelly coarse sand; single grain; loose; about 18 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 42 inches. The mollic epipedon is 10 to 20 inches thick. The content of coarse fragments ranges from 2 to 20 percent in the loamy mantle and from 5 to 50 percent in the 2C horizon. Typically, the coarse fragments range from 0.1 inch to 1.2 inches in size.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 to 2. It is loam or sandy loam. The B horizon has hue of 10YR or 2.5Y and value of dominantly 4 or 5. In some pedons where this horizon has hue of 2.5Y, it has chroma of 3. It has few to many mottles. The BC horizon is dominantly sandy loam but grades to loamy sand or sand. The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It is loamy coarse sand, coarse sand, or gravelly coarse sand.

Litchfield Series

The Litchfield series consists of deep, moderately well drained or somewhat poorly drained, moderately rapidly permeable soils on outwash plains and stream terraces. These soils formed in sandy and loamy glacial outwash. Slopes range from 0 to 3 percent.

These soils do not have distinct geological strata, which are definitive for the Litchfield series. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Litchfield sandy loam, 810 feet north and 200 feet west of the southeast corner of sec. 17, T. 102 N., R. 29 W.

Ap—0 to 12 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak very fine granular; very friable; slightly acid; abrupt smooth boundary.

AB—12 to 16 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak very fine granular; very friable; slightly acid; clear smooth boundary.

Bw1—16 to 24 inches; stratified dark grayish brown (10YR 4/2) and brown (10YR 4/3) loamy sand and fine sandy loam; weak fine and medium subangular blocky structure; very friable; very dark grayish brown (10YR 3/2) coatings on lateral faces of peds; slightly acid; clear smooth boundary.

Bw2—24 to 31 inches; dark grayish brown (10YR 4/2) loamy sand; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium

subangular blocky structure; very friable; slightly acid; clear smooth boundary.

BC—31 to 37 inches; yellowish brown (10YR 5/4) loamy sand; common medium fine grayish brown (10YR 5/2) mottles; single grain; loose; common medium distinct yellowish brown (10YR 5/6) iron oxide stains; few fine prominent black (10YR 2/1) manganese oxide stains; slightly acid; clear smooth boundary.

C1—37 to 50 inches; grayish brown (2.5Y 5/2) sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; neutral; clear smooth boundary.

C2—50 to 60 inches; grayish brown (2.5Y 5/2) sand; few medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 30 to 65 inches. The mollic epipedon is 12 to 20 inches thick. Free carbonates are at a depth of more than 50 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy fine sand, loamy sand, or sandy loam. The B horizon has hue of 10YR or 2.5Y and value of 4 or 5. It has chroma of 2 or 3 in the upper part and chroma of 2 to 4 in the lower part. This horizon has few or common mottles. It is dominantly fine sand, loamy fine sand, loamy sand, or sand, but some pedons have strata of loam or sandy loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 3 and commonly has faint to prominent mottles. It is sand, fine sand, loamy sand, or loamy fine sand.

Madelia Series

The Madelia series consists of deep, poorly drained, moderately permeable soils on glacial lake plains. These soils formed in silty lacustrine sediments. Slopes range from 0 to 2 percent.

Typical pedon of Madelia silty clay loam, 340 feet north and 80 feet west of the southeast corner of sec. 35, T. 104 N., R. 29 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—9 to 22 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg—22 to 32 inches; olive gray (5Y 4/2) silty clay loam; common fine faint olive (5Y 5/3) mottles; weak fine and very fine subangular blocky structure; friable; few fine distinct yellowish brown (10YR 5/6) iron oxide stains; very dark gray (10YR 3/1) coatings on faces of peds; neutral; clear smooth boundary.

BCg—32 to 37 inches; olive gray (5Y 5/2) silty clay loam; common fine faint olive (5Y 5/4) mottles; weak fine and very fine subangular blocky structure; friable; common fine distinct yellowish brown (10YR 5/8) iron oxide stains; slight effervescence; mildly alkaline; clear smooth boundary.

Cg1—37 to 43 inches; olive (5Y 5/3) silt loam; common fine faint light olive gray (5Y 6/2) mottles; weak very fine and fine subangular blocky structure; friable; common fine distinct yellowish brown (10YR 5/8) iron oxide stains; strong effervescence; moderately alkaline; clear smooth boundary.

Cg2—43 to 60 inches; light olive gray (5Y 6/2) silt loam; common medium distinct light yellowish brown (2.5Y 6/4) mottles; massive; friable; many fine distinct yellowish brown (10YR 5/8) iron oxide stains; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The mollic epipedon ranges from 14 to 24 inches in thickness.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is silty clay loam or silt loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 3. It has no mottles or has few to many mottles. The C horizon has hue of 2.5Y or 5Y and chroma of 1 to 4. It commonly is mottled. It is silt loam, silty clay loam, or loam. Some pedons have a 2C horizon below a depth of 40 inches.

Mayer Series

The Mayer series consists of deep, poorly drained soils on outwash plains. These soils formed in calcareous, loamy material over sandy glacial outwash sediments. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Mayer loam, 1,250 feet west and 700 feet south of the northeast corner of sec. 2, T. 102 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (N 3/) dry; weak fine granular structure; friable; about 4 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 16 inches; black (10YR 2/1) and very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

ABg—16 to 23 inches; very dark gray (10YR 3/1) loam, gray (5Y 5/1) dry; few fine distinct very dark grayish brown (2.5Y 3/2) mottles; weak medium subangular blocky structure; friable; about 4 percent coarse

fragments; strong effervescence; moderately alkaline; gradual wavy boundary.
Bg—23 to 30 inches; dark gray (5Y 4/1) and olive gray (5Y 4/2) sandy clay loam; common medium distinct olive brown (2.5Y 4/4) and common fine distinct pale olive (5Y 6/3) mottles; weak medium subangular blocky structure; friable; about 8 percent coarse fragments; very dark gray (5Y 3/1) coatings on faces of peds; strong effervescence; moderately alkaline; clear wavy boundary.
2Cg—30 to 60 inches; dark grayish brown (2.5Y 4/2) sand; common fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 11 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and of the fine-loamy mantle ranges from 20 to 40 inches. The mollic epipedon is 14 to 24 inches thick. The content of coarse fragments ranges from 0 to 10 percent in the loamy mantle and from 10 to 50 percent in the underlying sediments. Typically, the coarse fragments are 0.1 inch to 1.2 inches in size.

The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. The B horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 4 or 5 and chroma of 0 to 2. It is loam or sandy clay loam. Some pedons have a 2BC horizon. The 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 to 3. It is sand, gravelly sand, or very gravelly sand.

Millington Series

The Millington series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in loamy, calcareous alluvium. Slopes range from 0 to 2 percent.

Typical pedon of Millington clay loam, occasionally flooded, 950 feet north and 2,100 feet west of the southeast corner of sec. 25, T. 104 N., R. 33 W.

Ap—0 to 11 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; strong effervescence; mildly alkaline; abrupt smooth boundary.
A—11 to 28 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.
Bg—28 to 39 inches; very dark gray (10YR 3/1) clay loam; moderate medium subangular blocky structure; firm; few snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.
Cg—39 to 60 inches; very dark gray (5Y 3/1) stratified loam and clay loam; common fine distinct olive (5Y 4/3) mottles; weak medium subangular blocky structure; slightly sticky; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 40 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is clay loam, loam, silt loam, or silty clay loam. The B horizon generally has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. In some pedons, however, the lower part is neutral in hue, has value of 4 or 5 and chroma of 0, and has mottles with high chroma. The Cg horizon has hue of 10YR, 2.5Y, or 5Y, value of 3 to 5, and chroma of 1 to 6. It is stratified loam, clay loam, silty clay loam, or sandy loam.

Nicollet Series

The Nicollet series consists of deep, moderately well drained or somewhat poorly drained, moderately permeable soils on till plains. These soils formed in loamy glacial till. Slopes range from 1 to 3 percent.

Typical pedon of Nicollet clay loam, 400 feet south and 100 feet east of the northwest corner of sec. 5, T. 102 N., R. 32 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.
A—10 to 17 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; about 5 percent coarse fragments; common black (10YR 2/1) worm casts; slightly acid; gradual irregular boundary.
BA—17 to 21 inches; dark grayish brown (10YR 4/2) clay loam; moderate fine subangular blocky structure; friable; about 5 percent coarse fragments; common very dark gray (10YR 3/1) worm casts; medium acid; clear smooth boundary.
Bw1—21 to 29 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint olive brown (2.5Y 4/4) mottles; moderate fine prismatic structure parting to moderate fine subangular blocky; friable; about 5 percent coarse fragments; few very dark gray (10YR 3/1) worm casts; medium acid; abrupt wavy boundary.
Bw2—29 to 33 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint grayish brown (2.5Y 5/2) and few fine distinct and prominent light olive brown (2.5Y 5/4) and brown (7.5YR 5/4) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; about 5 percent coarse fragments; few very dark gray (10YR 3/1) worm casts; slightly acid; abrupt wavy boundary.
BC—33 to 36 inches; grayish brown (2.5Y 5/2) clay loam; many fine faint light olive brown (2.5Y 5/4)

mottles; weak fine and medium subangular blocky structure; friable; about 6 percent coarse fragments; few very dark gray (10YR 3/1) worm casts; slight effervescence in spots; mildly alkaline; abrupt wavy boundary.

C—36 to 60 inches; grayish brown (2.5Y 5/2) loam; many fine faint light olive brown (2.5Y 5/4) and few fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 7 percent coarse fragments; common fine distinct soft masses of calcium carbonate; few fine prominent black (10YR 2/1) accumulations of manganese oxide; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 48 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches. The content of coarse fragments is 1 to 8 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has chroma of 1 or 2. The A and B horizons are loam or clay loam. The upper part of the B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. The lower part has value of 4 or 5 and chroma of 2 to 4. Mottles are in part or all of the B horizon. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, chroma of 2 to 4 and has faint to prominent mottles. It has few or common masses of calcium carbonate in the upper part.

Ocheyedan Series

The Ocheyedan series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loamy glacial sediments and in the underlying silty and loamy sediments. Slopes range from 1 to 5 percent.

Typical pedon of Ocheyedan loam, 1 to 5 percent slopes, 2,080 feet south and 100 feet west of the northeast corner of sec. 4, T. 104 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—10 to 15 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine angular blocky structure parting to weak fine subangular blocky; friable; neutral; gradual wavy boundary.

AB—15 to 22 inches; very dark gray (10YR 3/1) and brown (10YR 4/3) loam, grayish brown (10YR 5/2) and brown (10YR 5/3) dry; moderate fine angular blocky structure; friable; neutral; gradual wavy boundary.

2Bw—22 to 30 inches; brown (10YR 4/3) silt loam; weak medium subangular blocky structure; friable; very dark grayish brown (10YR 3/2) worm casts; neutral; gradual smooth boundary.

2C—30 to 60 inches; yellowish brown (10YR 5/4) silt loam; common fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; common fine distinct strong brown (7.5YR 5/8) iron oxide stains; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches. The depth to free carbonates ranges from 20 to 40 inches. The mollic epipedon is 10 to 16 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has chroma of 3 or 4. It is loam, sandy clay loam, or fine sandy loam. The 2B horizon is silt loam, sandy loam, or sandy clay loam. The 2C horizon has value of 4 to 6 and chroma of 1 to 6. It is dominantly silt loam, loam, sandy loam, or sandy clay loam but in some pedons has strata of loamy sand less than 6 inches thick.

Okoboji Series

The Okoboji series consists of deep, very poorly drained, moderately slowly permeable soils on glacial till plains. These soils formed in silty and loamy alluvium. Slopes are 0 to 1 percent.

Typical pedon of Okoboji silty clay loam, 600 feet north and 120 feet east of the southwest corner of sec. 5, T. 104 N., R. 29 W.

Ap—0 to 12 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—12 to 22 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

ABg—22 to 28 inches; black (10YR 2/1) silty clay loam, dark gray (5Y 4/1) dry; common medium distinct olive gray (5Y 5/2) mottles; moderate fine and medium subangular blocky structure; friable; neutral; gradual irregular boundary.

Bg1—28 to 35 inches; olive gray (5Y 5/2) silty clay loam; common fine faint olive (5Y 5/3) mottles; moderate fine and medium subangular blocky structure; slightly sticky; common medium distinct very dark gray (10YR 3/1) root channels; neutral; clear smooth boundary.

Bg2—35 to 42 inches; olive gray (5Y 5/2) silty clay loam; common fine faint olive (5Y 5/3) and few fine faint light olive gray (5Y 6/2) mottles; moderate fine subangular blocky structure; slightly sticky; few fine distinct very dark gray (10YR 3/1) root channels; neutral; clear smooth boundary.

2Cg1—42 to 55 inches; olive gray (5Y 5/2) clay loam; common fine faint olive (5Y 5/4) and few fine distinct light olive brown (2.5Y 5/6) mottles; massive; sticky; about 4 percent coarse fragments;

slight effervescence; mildly alkaline; clear smooth boundary.
2Cg2—55 to 60 inches; olive gray (5Y 5/2) silt loam; common medium faint pale olive (5Y 6/3) mottles; massive; slightly sticky; common fine prominent yellowish brown (10YR 5/8) iron oxide stains; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches. The depth to free carbonates ranges from 20 to 50 inches. The mollic epipedon is 24 to 40 inches thick. The solum has coarse fragments only in areas where the C horizon formed in glacial till. The content of coarse fragments in the till is 2 to 10 percent. Typically, these fragments are 0.1 to 0.8 inch in size.

The A horizon is neutral in hue or has hue of 10YR. It has chroma of 0 or 1. It is silty clay loam, silt loam, or mucky silt loam. The B horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 to 5 and chroma of 0 to 2. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam, silt loam, or clay loam.

Palms Series

The Palms series consists of deep, very poorly drained soils on glacial moraines and lake plains. These soils formed in organic material over silty and loamy sediments or lacustrine deposits. Permeability is moderately rapid in the upper part of the profile and moderate in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Palms muck, 800 feet east and 720 feet north of the southwest corner of sec. 13, T. 103 N., R. 31 W.

Op—0 to 11 inches; sapric material, black (10YR 2/1) broken face and rubbed, dark gray (10YR 4/1) dry; weak very fine and fine granular structure; friable; slightly acid; abrupt smooth boundary.
Oa—11 to 33 inches; sapric material, black (10YR 2/1) broken face and rubbed, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; slightly sticky; slightly acid; clear smooth boundary.
2C—33 to 47 inches; black (10YR 2/1) silty clay loam; weak medium subangular blocky structure; sticky; neutral; gradual smooth boundary.
2Cg—47 to 60 inches; olive gray (5Y 4/2) clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; massive; sticky; neutral.

The organic material ranges from 16 to 50 inches in thickness. It has hue of 10YR or 7.5YR or is neutral in hue. It has chroma of 0 to 2. It is primarily sapric material, but some pedons have as much as 10 inches of hemic material. The upper part of the 2C horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or 2. It is silty clay loam, clay loam, or silt loam. The lower part has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, silt loam, or sandy loam.

Sparta Series

The Sparta series consists of deep, excessively drained, rapidly permeable soils on outwash plains and stream terraces. These soils formed in sandy deposits that have been reworked by the wind in many places. Slopes range from 1 to 6 percent.

Typical pedon of Sparta loamy fine sand, 1 to 6 percent slopes, 2,260 feet north and 1,200 feet west of the southeast corner of sec. 4, T. 102 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy fine sand, dark grayish brown (10YR 4/2) dry; single grain; loose; medium acid; abrupt smooth boundary.
AB—10 to 14 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; single grain; loose; medium acid; gradual smooth boundary.
Bw—14 to 30 inches; dark brown (10YR 4/3) and dark yellowish brown (10YR 4/4) loamy fine sand; single grain; loose; medium acid; gradual smooth boundary.
C—30 to 60 inches; dark brown (10YR 4/3 and 7.5YR 4/4) fine sand; single grain; loose; medium acid.

The thickness of the solum ranges from 24 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. The Ap horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. It is loamy sand, loamy fine sand, or sand. Some pedons do not have an AB horizon. The B horizon has hue of 10YR or 7.5YR and value and chroma of 4 to 6. It is sand, fine sand, loamy sand, or loamy fine sand. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is fine sand or sand.

Spicer Series

The Spicer series consists of deep, poorly drained, moderately permeable soils on glacial lake plains. These soils formed in silty, calcareous lacustrine sediments. Slopes range from 0 to 2 percent.

Typical pedon of Spicer silty clay loam, 1,550 feet south, and 100 feet west of the northeast corner of sec. 1, T. 102 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.
A—10 to 20 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine

subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

AB—20 to 24 inches; very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) silty clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Bg—24 to 34 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; weak fine and medium subangular blocky structure; friable; very dark gray (5Y 3/1) coatings on vertical faces of peds; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg1—34 to 48 inches; light brownish gray (2.5Y 6/2) silty clay loam; common fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; common fine distinct strong brown (7.5YR 5/8) iron oxide stains; few black (10YR 2/1) accumulations of manganese oxide; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg2—48 to 60 inches; olive gray (5Y 5/2) silty clay loam; common medium prominent light olive brown (2.5Y 5/6) mottles; massive; friable; few medium distinct strong brown (7.5YR 5/8) iron oxide stains; few black (10YR 2/1) concretions of manganese oxide; strong 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. Typically, free carbonates are throughout the profile. Some pedons have a calcic horizon below a depth of 16 inches.

The A and B horizons are silty clay loam or silt loam. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is mottled in some pedons. 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 chroma of 1 or 2. It has few to many mottles and has dark manganese concretions or iron stains. It is dominantly silt loam or silty clay loam, but some pedons have thin strata of coarser textured material.

Spillville Series

The Spillville series consists of deep, moderately well drained or somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in loamy alluvial sediments. Slopes range from 0 to 3 percent.

Typical pedon of Spillville loam, occasionally flooded, 615 feet south and 2,600 feet east of the northwest corner of sec. 34, T. 102 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—10 to 27 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

AC—27 to 32 inches; black (10YR 2/1) and very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.

C—32 to 60 inches; very dark grayish brown (2.5Y 3/2) loam; common fine prominent yellowish brown (10YR 5/6) and few fine distinct olive (5Y 5/3) mottles; massive; friable; neutral.

The thickness of the solum and of the mollic epipedon ranges from 30 to 56 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. The C horizon has hue of 10YR or 2.5Y and chroma of 1 or 2 and is mottled. In some pedons it is stratified with sandy clay loam or sandy loam.

Storden Series

The Storden series consists of deep, well drained, moderately permeable soils on glacial moraines. These soils formed in loamy, calcareous glacial till. Slopes range from 2 to 25 percent.

Typical pedon of Storden loam, in an area of Storden-Clarion loams, 12 to 18 percent slopes, eroded; 1,320 feet west and 80 feet north of the southeast corner of sec. 35, T. 104 N., R. 33 W.

Ap—0 to 8 inches; mixed dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—8 to 21 inches; yellowish brown (10YR 5/4) loam; few fine distinct grayish brown (10YR 5/2) mottles; massive; friable; few fine distinct yellowish brown (10YR 5/8) iron oxide stains; about 6 percent coarse fragments; common fine distinct threads of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—21 to 60 inches; light yellowish brown (2.5Y 6/4) loam; few fine distinct grayish brown (10YR 5/2) mottles; massive; friable; common fine distinct yellowish brown (10YR 5/8) iron oxide stains; few fine prominent black (10YR 2/1) concretions of manganese oxide; about 7 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 7 to 10 inches thick. The content of coarse fragments ranges from 2 to 10 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has value of 4 or 5. The C horizon has hue of 10YR or 2.5Y and chroma of 2 to 6. It has no mottles or has few to many relict mottles.

Swanlake Series

The Swanlake series consists of deep, well drained, moderately permeable soils on glacial moraines and till plains. These soils formed in loamy, calcareous glacial till (fig. 16). Slopes range from 2 to 40 percent.

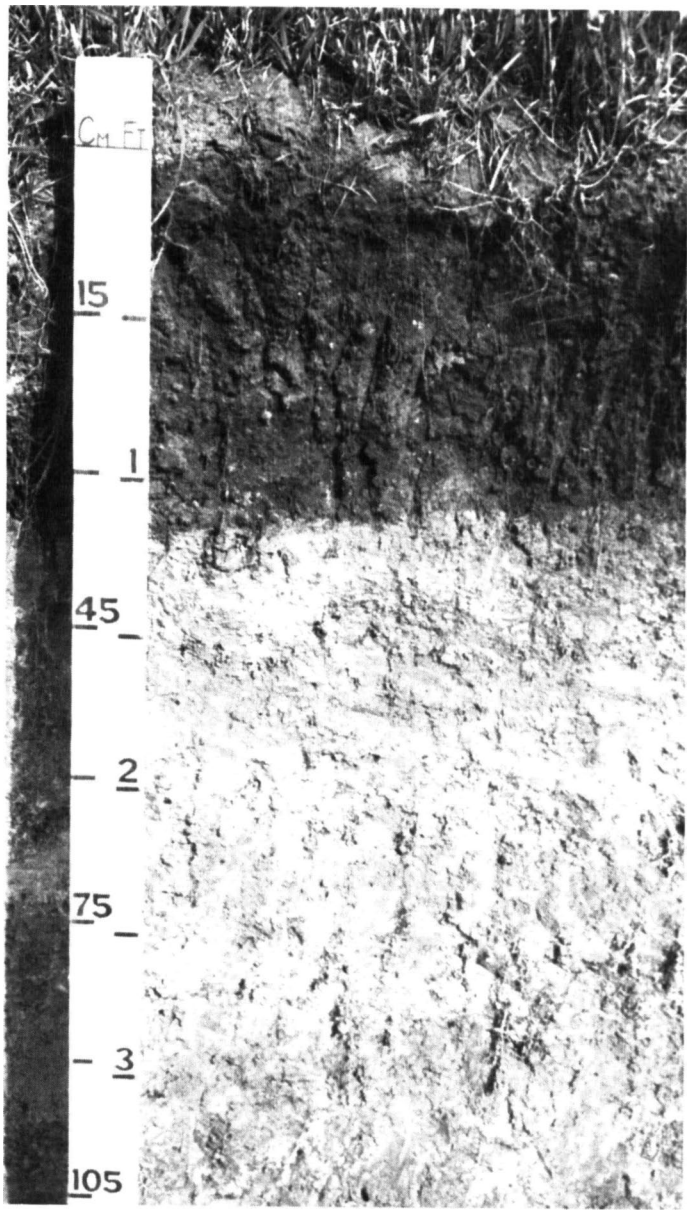


Figure 16.—Profile of Swanlake loam. The white spots near the bottom of the picture are accumulations of lime.

Typical pedon of Swanlake loam, in an area of Clarion-Swanlake loams, 2 to 6 percent slopes; 2,500 feet west and 420 feet south of the northeast corner of sec. 16, T. 104 N., R. 31 W.

Ap—0 to 11 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

AC—11 to 20 inches; very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—20 to 28 inches; light olive brown (2.5Y 5/4) loam; common fine distinct grayish brown (10YR 5/2) mottles; massive; friable; few fine prominent strong brown (7.5YR 5/8) iron oxide stains; about 6 percent coarse fragments; common fine distinct masses of calcium carbonate; strong effervescence; moderately alkaline; clear smooth boundary.

C2—28 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct gray (10YR 5/1) mottles; friable; few fine faint strong brown (7.5YR 5/8) iron oxide stains; few fine prominent concretions of manganese oxide; about 8 percent coarse fragments; common medium distinct threads of calcium carbonate; strong effervescence; moderately alkaline.

The solum and the mollic epipedon are 7 to 14 inches thick. The depth to free carbonates is 0 to 10 inches. The content of coarse fragments ranges from 1 to 10 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The AC and C horizons have few to many relict mottles. The AC horizon has hue of 10YR or 2.5Y and value and chroma of 3 to 5. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 to 6.

Terril Series

The Terril series consists of deep, moderately well drained, moderately permeable soils on foot slopes and alluvial fans. These soils formed in loamy alluvium derived from the adjacent uplands. Slopes range from 2 to 40 percent.

Typical pedon of Terril loam, 2 to 6 percent slopes, 3,750 feet east and 20 feet south of the northwest corner of sec. 30, T. 102 N., R. 30 W.

A1—0 to 15 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium

subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
A2—15 to 36 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; weak medium prismatic structure parting to weak fine and medium subangular blocky; friable; slightly acid; gradual smooth boundary.
BA—36 to 44 inches; very dark grayish brown (10YR 3/2) and brown (10YR 4/3) loam, dark brown (10YR 3/3) crushed; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.
Bw1—44 to 51 inches; dark brown (10YR 3/3) and dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; firm; neutral; gradual smooth boundary.
Bw2—51 to 60 inches; dark yellowish brown (10YR 4/4) loam; common fine distinct grayish brown (10YR 5/2) and common fine faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; neutral.

The solum ranges from 35 to more than 60 inches in thickness. It is loam or clay loam. The depth to calcareous, loamy till ranges from 40 to more than 60 inches.

The A horizon has value of 2 or 3. The B horizon has chroma of 2 to 4. It has few or common mottles in the lower part. Some pedons have a C horizon.

Truman Series

The Truman series consists of deep, well drained, moderately permeable soils on glacial moraines and lake plains. These soils formed in silty lacustrine sediments. Slopes range from 1 to 18 percent.

Typical pedon of Truman silt loam, 1 to 6 percent slopes, 330 feet south and 50 feet east of the northwest corner of sec. 12, T. 103 N., R. 29 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
A—9 to 13 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine subangular blocky structure; friable; neutral; clear smooth boundary.
AB—13 to 17 inches; dark brown (10YR 3/3 and 4/3) silt loam; weak to moderate fine and very fine subangular blocky structure; friable; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) coatings on faces of peds; neutral; clear smooth boundary.
Bw—17 to 27 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) silt loam; weak to moderate fine and medium subangular blocky structure; friable; mildly alkaline; clear smooth boundary.
BC—27 to 33 inches; yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) silt loam; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.
C—33 to 60 inches; brownish yellow (10YR 6/6) silt loam; common fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 56 inches. The mollic epipedon ranges from 10 to 18 inches in thickness. The soils have no coarse fragments to a depth of more than 4 feet.

The A horizon has value of 2 or 3 and chroma of 1 to 3. The B horizon has value of 3 to 5 and chroma of 3 to 6. In some pedons it has mottles in the lower part. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 to 6. In some pedons mottles are in part or all of this horizon.

Wadena Series

The Wadena series consists of deep, well drained soils on outwash plains and valley trains. These soils formed in loamy material over sandy and sandy-skeletal sediments. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slopes range from 1 to 6 percent.

Typical pedon of Wadena loam, 1 to 6 percent slopes, 1,500 feet west and 100 feet south of the northeast corner of sec. 1, T. 103 N., R. 32 W.

A1—0 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.
A2—13 to 20 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; neutral; gradual wavy boundary.
Bw—20 to 34 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; dark brown (10YR 3/3) coatings on lateral faces of peds; about 3 percent coarse fragments; neutral; gradual smooth boundary.
BC—34 to 38 inches; dark yellowish brown (10YR 4/4) sandy loam; single grain; loose; about 7 percent coarse fragments; neutral; gradual smooth boundary.
2C—38 to 60 inches; mixed dark yellowish brown (10YR 4/4), grayish brown (10YR 5/2), and yellowish brown (10YR 5/4) sand; single grain; loose; about 12 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to loamy sand or coarser textured material range from 24 to 40 inches. The mollic epipedon is 12 to 20 inches thick. The depth to free carbonates ranges from 30 to 50 inches. The content of coarse fragments ranges from 0 to 15 percent in the loamy mantle and from 5 to 50 percent in the 2C horizon. Typically, the coarse fragments are 0.1 inch to 1.2 inches in size.

The A horizon has value of 2 or 3. It is loam or clay loam. The B horizon has hue of 10YR in the upper part and hue of 10YR or 7.5YR in the lower part. It has value of 3 to 5 and chroma of 3 or 4. It is loam or clay loam in the upper part and coarse sandy loam, sandy loam, sandy clay loam, or loam in the lower part. The 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 4. It is coarse sand, sand, or gravelly coarse sand.

Waldorf Series

The Waldorf series consists of deep, poorly drained, moderately slowly permeable soils on glacial lake plains. These soils formed in silty and clayey lacustrine sediments. Slopes are 0 to 1 percent.

Typical pedon of Waldorf silty clay loam, 2,490 feet north and 120 feet east of the southwest corner of sec. 3, T. 104 N., R. 29 W.

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

A—10 to 20 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; firm; neutral; gradual smooth boundary.

ABg—20 to 24 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (5Y 4/1) dry; common fine distinct dark gray (5Y 4/1) mottles; moderate medium subangular blocky structure; firm; neutral; gradual smooth boundary.

Bg—24 to 36 inches; dark gray (5Y 4/1) silty clay, dark grayish brown (2.5Y 4/2) crushed; few fine faint olive (5Y 5/3) mottles; moderate fine subangular blocky structure; firm; very dark gray (10YR 3/1) coatings on lateral faces of peds; neutral; gradual smooth boundary.

Cg—36 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; firm; common fine distinct yellowish brown (10YR 5/6) iron oxide stains; few black (10YR 2/1) accumulations of manganese oxide; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 26 to 48 inches. The depth to free carbonates ranges from 26 to 55 inches. The mollic epipedon is 16 to 24 inches thick.

The A horizon has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. 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 is silty clay, silty clay loam, or clay. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2 and is commonly mottled. It is dominantly silty clay loam, silty clay, or clay, but the range includes silt loam.

Webster Series

The Webster series consists of deep, poorly drained, moderately permeable soils on till plains. These soils formed in loamy glacial till. Slopes range from 0 to 2 percent.

Typical pedon of Webster clay loam, 700 feet south and 150 feet west of the northeast corner of sec. 7, T. 104 N., R. 32 W.

Ap—0 to 11 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

AB—11 to 19 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; common fine distinct dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; friable; few fine prominent strong brown (7.5YR 5/6) iron oxide stains; about 3 percent coarse fragments; neutral; gradual smooth boundary.

Bg1—19 to 26 inches; dark grayish brown (2.5Y 4/2) clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; moderate fine and medium subangular blocky structure; friable; common fine distinct strong brown (7.5YR 5/6) iron oxide stains; about 4 percent coarse fragments; neutral; clear smooth boundary.

Bg2—26 to 34 inches; dark grayish brown (2.5Y 4/2) clay loam; common medium faint grayish brown (2.5Y 5/2) and few fine faint light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; friable; common fine distinct strong brown (7.5YR 5/6) iron oxide stains; about 4 percent coarse fragments; neutral; clear smooth boundary.

C—34 to 60 inches; olive gray (5Y 5/2) loam; many medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; common fine distinct yellowish brown (10YR 5/8) iron oxide stains; common fine prominent black (10YR 2/1) accumulations of manganese oxide; about 4 percent coarse fragments; common soft masses of calcium carbonate; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates are commonly 24 to 36 inches but range to 50 inches. The thickness of the mollic epipedon ranges

from 15 to 24 inches. The content of coarse fragments is 2 to 8 percent throughout the profile. Typically, the coarse fragments are 0.1 to 0.8 inch in size.

The A horizon has hue of 10YR or is neutral in hue. It has chroma of 0 or 1. It is dominantly silty clay loam or clay loam, but the range includes loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 and has few or common mottles. It is clay loam, loam, or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 3 and has few or common mottles. It is dominantly loam, clay loam, or sandy loam. In some pedons, however, the lower part of this horizon has thin strata of silty or sandy material.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on flood plains. These soils formed in alluvial sediments. Slopes are from 0 to 1 percent.

Typical pedon of Zook silty clay loam, occasionally flooded, 800 feet west and 100 feet south of the northeast corner of sec. 17, T. 101 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, very dark gray (N 3/) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—10 to 24 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; sticky; neutral; gradual wavy boundary.

Bg—24 to 38 inches; very dark gray (10YR 3/1) and very dark grayish brown (2.5Y 3/2) silty clay; common fine distinct dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; sticky; neutral; gradual smooth boundary.

Cg—38 to 60 inches; very dark grayish brown (2.5Y 3/2) and dark grayish brown (2.5Y 4/2) silty clay loam; few fine faint dark gray (5Y 4/1) mottles; massive; slightly sticky; mildly alkaline.

The thickness of the solum ranges from 36 to 60 inches. The mollic epipedon is 36 or more inches thick. The depth to free carbonates is more than 50 inches. The soils are silty clay or silty clay loam throughout.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. The Bg and Cg horizons have hue of 10YR, 2.5Y, or 5Y, value of 2 to 5, and chroma of 1 or 2.

Formation of the Soils

Soil forms through physical and chemical processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material (*4*). The factors of soil formation are so closely interrelated that the effects of any one factor cannot be easily determined without consideration of the other factors.

Parent Material

The soils in Martin County formed mainly in glacial till, lacustrine sediments, alluvium, and sandy or gravelly outwash. The New Ulm phase of the Des Moines Lobe of the Wisconsin Glaciation was the last glacier to cover the county (*7, 13, 14*). This glacier retreated from the county about 12,000 years ago. The glacial till covering most of the county is calcareous loam or clay loam. Canisteo, Glencoe, Webster, Clarion, Nicollet, and Swanlake are the major soils that formed in the till. Sandy and gravelly soils are in a few areas. Some drained depressions are filled with thick deposits of organic material.

The northeast corner of the county has lacustrine deposits of Glacial Lake Minnesota (*5*). This body of water resulted from the melting glacier and included parts of Blue Earth, Watonwan, Martin, Faribault, and Waseca Counties. The lake plain is gently sloping and consists mainly of silty clays and silty clay loams. Some scattered areas of glacial till are throughout the old glacial lakebed. Waldorf, Collinwood, Okoboji, and Brownton are the major soils that formed on the lake plain.

On the edges of the lake plain are areas of silty soils thought to be of deltaic origin. Kingston, Truman, and Madelia are the major soils in these areas.

Alluvial material is on the bottom land along rivers and creeks. This material is dark loam, clay loam, or silty clay loam and is several feet thick. Sandy and gravelly material on terraces is intermingled with the alluvium in many areas of the bottom land. Coland and Millington are the major soils that formed in alluvium.

Scattered meltwater channels and outwash plains are throughout the county. Channels between existing streams have discontinuous terraces of sand or gravel. Deposits of outwash sand and gravel are in several areas in the eastern part of the county and on high terraces along streams. Lemond, Hanska, Dickinson, and Sparta soils formed in the sandy areas, and Estherville, Linder, Biscay, and Mayer soils formed in the gravelly areas.

Climate

Martin County has a subhumid, midcontinental climate characterized by cold winters and hot summers. Alternate periods of freezing and thawing play a significant role in the development of soil structure and tilth. They also break up rocks and further the weathering process. Rainfall plays a major role in the leaching of lime. Climate also affected the native vegetation.

Plant and Animal Life

The native vegetation in Martin County was mainly tall and mid prairie grasses. Because of this vegetation, most of the soils have a dark surface layer. Before the soils were plowed, the native vegetation was very important to the other living organisms that affect soil formation. Earthworms, ants, and other burrowing animals help to transform and translocate organic material and mix the upper few feet of the soil.

Forested areas are along the chains of lakes, mostly on the east sides of the lakes. The soils in these areas are more acid than the other soils in the county and contain more clay in the lower part of the subsoil. They generally are transitional between prairie soils and forest soils.

Human activities affect soil formation. In Martin County farming has changed the rate of some soil-forming processes. It has slowed or stopped the accumulation of organic matter in many soils and has accelerated erosion in many of the sloping areas. The rich surface soil is removed from hillsides and deposited in the lower areas. Plowing has weakened or destroyed soil structure in many soils. Human activities can further affect the processes of soil formation either positively or negatively.

Relief

In Martin County relief ranges from nearly level to very steep. Relief plays a major role in the formation of different soils in an area of uniform parent material. Soil drainage is directly related to relief. A typical drainage sequence is represented by the Clarion, Nicollet, Webster, and Glencoe soils. Each of these soils is on a distinctive part of the landscape. The well drained Clarion soils are on convex hilltops, concave side slopes, and nearly level rises. The well drained or somewhat poorly drained Nicollet soils are on concave side slopes and nearly level rises. The poorly drained Webster soils are in drainageways and nearly level areas. The very poorly drained Glencoe soils are in depressions.

Slope affects water erosion. As slope increases, the hazards of runoff and erosion increase and the degree of soil profile development decreases. The increased runoff rate reduces the amount of moisture available to plants. The resulting decrease in plant growth reduces the amount of organic matter that accumulates in the soil. Runoff also reduces the extent to which carbonates are leached from the soil and the rate of soil profile development.

Time

In a geological sense, all of the soils in Martin County are very young. They are all about the same age, approximately 12,000 years old. In most areas of the county, the time required for soil formation depends to a large extent on the other soil-forming factors. In areas where relief and drainage are favorable, enough time has elapsed to allow for the formation of mature soils, such as Clarion soils. In areas of recently deposited alluvium on flood plains, little if any soil formation has occurred. Soils in steep areas also show little evidence of profile development because erosion removes a significant amount of soil material.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

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.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

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 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

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.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

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.

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.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

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.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

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.

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 is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

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.

Fine textured soil. Sandy clay, silty clay, and clay.

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.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

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 meltwater.

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 meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

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 uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

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, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon 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) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

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 overlying 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, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

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.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

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.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

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).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

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.

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.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

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.

Percolation. The downward movement of water through 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 0.2 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

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, 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.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

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.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

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.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

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.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of 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 millimeters 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, E, 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.

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 soil blowing 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.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

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.

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.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

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.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-80 at Fairmont, Minnesota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	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*	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-----	21.2	2.8	12.0	45	-25	0	0.72	0.24	1.11	3	7.8
February----	27.8	9.0	18.4	51	-20	0	.93	.31	1.43	3	9.0
March-------	38.1	20.4	29.3	71	-10	18	1.75	.87	2.50	5	11.3
April-------	56.1	36.0	46.1	86	17	67	2.71	1.44	3.82	6	1.9
May---------	70.3	48.1	59.2	91	29	303	3.71	1.90	5.28	8	.0
June--------	79.9	58.0	69.0	97	44	570	4.27	2.52	5.81	7	.0
July--------	83.6	62.0	72.8	97	49	707	3.88	1.95	5.54	7	.0
August------	81.4	59.7	70.6	96	47	639	4.20	1.93	6.14	7	.0
September---	72.3	50.3	61.3	92	33	342	2.98	1.20	4.47	6	.0
October-----	60.9	39.7	50.3	86	21	138	1.91	.54	3.01	4	.4
November----	42.2	25.0	33.6	68	-2	0	1.24	.28	1.99	3	3.3
December----	27.8	11.3	19.6	54	-18	0	.89	.42	1.29	3	8.0
Yearly:											
Average---	55.1	35.2	45.2	---	---	---	---	---	---	---	---
Extreme---	---	---	---	99	-26	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,784	29.19	24.45	33.68	62	41.7

* 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 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-80 at Fairmont, Minnesota)

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--	Apr. 21	May 1	May 13
2 years in 10 later than--	Apr. 17	Apr. 26	May 9
5 years in 10 later than--	Apr. 8	Apr. 17	May 2
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 15	Oct. 7	Sept. 26
2 years in 10 earlier than--	Oct. 20	Oct. 12	Oct. 1
5 years in 10 earlier than--	Oct. 31	Oct. 22	Oct. 11

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-80 at Fairmont, Minnesota)

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	183	170	145
8 years in 10	191	176	151
5 years in 10	205	187	161
2 years in 10	220	198	172
1 year in 10	227	204	178

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
8B	Sparta loamy fine sand, 1 to 6 percent slopes	885	0.2
27B	Dickinson fine sandy loam, 1 to 6 percent slopes	1,215	0.3
35	Blue Earth mucky silty clay loam	5,725	1.3
37B	Farrar fine sandy loam, 1 to 6 percent slopes	715	0.2
39B	Wadena loam, 1 to 6 percent slopes	255	0.1
41B	Estherville sandy loam, 1 to 6 percent slopes	1,955	0.4
41C	Estherville sandy loam, 6 to 12 percent slopes	225	0.1
84	Brownton silty clay	915	0.2
86	Canisteo clay loam	11,925	2.7
94B	Terril loam, 2 to 6 percent slopes	1,475	0.3
96	Collinwood silty clay	575	0.1
101B	Truman silt loam, 1 to 6 percent slopes	2,125	0.5
102B	Clarion loam, 1 to 6 percent slopes	31,650	7.0
106B	Lester loam, 2 to 6 percent slopes	2,125	0.5
106C	Lester loam, 6 to 12 percent slopes	455	0.1
112	Harps clay loam	1,030	0.2
113	Webster clay loam	31,295	7.0
114	Glencoe clay loam	13,650	3.0
118	Crippin loam	10,150	2.3
128B	Grogan silt loam, 1 to 6 percent slopes	760	0.2
130	Nicollet clay loam	25,700	5.7
134	Okoboji silty clay loam	3,075	0.7
136	Madelia silty clay loam	1,765	0.4
140	Spicer silty clay loam	3,075	0.7
181	Litchfield sandy loam	3,225	0.7
197	Kingston silt loam	1,280	0.3
227	Lemond sandy loam	5,000	1.1
229	Waldorf silty clay loam	3,690	0.8
247	Linder loam	1,500	0.3
255	Mayer loam	1,675	0.4
269	Millington clay loam, occasionally flooded	485	0.1
275B	Ocheyedan loam, 1 to 5 percent slopes	1,750	0.4
282	Hanska loam	1,170	0.3
313	Spillville loam, occasionally flooded	255	0.1
336	Delft loam	19,690	4.4
350	Canisteo clay loam, depressional	730	0.2
392	Biscay sandy clay loam	1,550	0.3
499	Hanska loam, depressional	850	0.2
539	Palms muck	4,185	0.9
548	Palms muck, sandy substratum	330	0.1
664	Zook silty clay loam, occasionally flooded	250	0.1
818	Lemond-Linder complex	1,180	0.3
886	Nicollet-Crippin complex	28,000	6.2
887B	Clarion-Swanlake loams, 2 to 6 percent slopes	44,950	9.9
909C	Truman-Bold silt loams, 6 to 12 percent slopes	540	0.1
909D2	Bold-Truman silt loams, 12 to 18 percent slopes, eroded	150	*
920B	Clarion-Estherville complex, 2 to 6 percent slopes	3,150	0.7
920C2	Clarion-Estherville-Storden complex, 6 to 12 percent slopes, eroded	1,350	0.3
920D2	Clarion-Estherville-Storden complex, 12 to 18 percent slopes, eroded	280	0.1
921B	Clarion-Storden loams, 2 to 6 percent slopes	6,350	1.4
921C2	Clarion-Storden loams, 6 to 12 percent slopes, eroded	24,785	5.5
956	Canisteo-Glencoe clay loams	118,220	26.0
960D2	Storden-Clarion loams, 12 to 18 percent slopes, eroded	4,950	1.1
960E	Storden-Clarion loams, 18 to 25 percent slopes	395	0.1
1029	Pits, gravel	755	0.2
1052	Palms and Okoboji soils, ponded	2,025	0.5
1090	Blue Earth silt loam	270	0.1
1833	Coland loam, occasionally flooded	4,250	0.9
1834	Coland loam, frequently flooded	4,005	0.8
1852F	Terril-Swanlake loams, 18 to 40 percent slopes	220	0.1
1877	Fostoria clay loam	2,825	0.6
1907	Lakefield silt loam	935	0.2
	Total	449,920	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
27B	Dickinson fine sandy loam, 1 to 6 percent slopes
37B	Farrar fine sandy loam, 1 to 6 percent slopes
39B	Wadena loam, 1 to 6 percent slopes
84	Brownton silty clay (where drained)
86	Canisteo clay loam (where drained)
94B	Terril loam, 2 to 6 percent slopes
96	Collinwood silty clay
101B	Truman silt loam, 1 to 6 percent slopes
102B	Clarion loam, 1 to 6 percent slopes
106B	Lester loam, 2 to 6 percent slopes
112	Harps clay loam (where drained)
113	Webster clay loam (where drained)
114	Glencoe clay loam (where drained)
118	Crippin loam
128B	Grogan silt loam, 1 to 6 percent slopes
130	Nicollet clay loam
134	Okoboji silty clay loam (where drained)
136	Madelia silty clay loam (where drained)
140	Spicer silty clay loam (where drained)
181	Litchfield sandy loam
197	Kingston silt loam
227	Lemond sandy loam (where drained)
229	Waldorf silty clay loam (where drained)
247	Linder loam
255	Mayer loam (where drained)
269	Millington clay loam, occasionally flooded (where drained)
275B	Ocheyedan loam, 1 to 5 percent slopes
282	Hanska loam (where drained)
313	Spillville loam, occasionally flooded
336	Delft loam (where drained)
350	Canisteo clay loam, depressional (where drained)
392	Biscay sandy clay loam (where drained)
499	Hanska loam, depressional (where drained)
664	Zook silty clay loam, occasionally flooded (where drained)
818	Lemond-Linder complex (where drained)
886	Nicollet-Crippin complex
887B	Clarion-Swanlake loams, 2 to 6 percent slopes
920B	Clarion-Estherville complex, 2 to 6 percent slopes
921B	Clarion-Storden loams, 2 to 6 percent slopes
956	Canisteo-Glencoe clay loams (where drained)
1833	Coland loam, occasionally flooded (where drained)
1877	Fostoria clay loam
1907	Lakefield silt loam

TABLE 6.--LAND CAPABILITY AND 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	Land capability	Corn	Soybeans	Oats	Alfalfa-bromegrass hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
8B---------- Sparta	IVs	65	23	40	2.5	---
27B---------- Dickinson	IIe	85	31	60	3.0	5.0
35---------- Blue Earth	IIIw	105	35	---	3.0	4.5
37B---------- Farrar	IIe	100	33	69	3.6	6.0
39B---------- Wadena	IIe	95	34	72	3.6	6.0
41B---------- Estherville	IIIs	60	22	40	2.0	2.5
41C---------- Estherville	IVs	50	20	35	1.5	2.5
84---------- Brownton	IIw	120	36	75	4.0	5.8
86---------- Canisteo	IIw	145	42	85	4.5	6.2
94B---------- Terril	IIe	150	45	94	5.0	8.3
96---------- Collinwood	IIw	140	43	85	4.5	6.0
101B---------- Truman	IIe	150	45	80	4.5	7.0
102B---------- Clarion	IIe	150	44	88	4.6	7.6
106B---------- Lester	IIe	145	43	85	4.5	6.5
106C---------- Lester	IIIe	105	33	75	4.0	6.0
112---------- Harps	IIw	130	33	76	4.0	6.0
113---------- Webster	IIw	155	48	88	4.8	7.3
114---------- Glencoe	IIIw	125	36	75	3.5	5.2
118---------- Crippin	I	140	41	84	4.3	7.1
128B---------- Grogan	IIe	115	35	80	4.0	6.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa-bromegrass hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
130--- Nicollet	I	155	49	90	5.2	7.6
134--- Okoboji	IIIw	125	35	70	3.4	6.3
136--- Madelia	IIw	145	46	90	4.5	6.5
140--- Spicer	IIw	135	39	85	4.0	6.0
181--- Litchfield	IIs	95	29	55	3.0	4.5
197--- Kingston	I	155	50	95	5.2	7.2
227--- Lemond	IIw	110	31	60	3.5	5.0
229--- Waldorf	IIw	135	40	85	4.0	6.0
247--- Linder	IIs	95	30	50	3.0	4.1
255--- Mayer	IIw	115	30	60	3.0	5.0
269--- Millington	IIw	120	37	75	4.0	5.5
275B--- Ocheyedan	IIe	150	45	85	4.0	6.2
282--- Hanska	IIw	115	34	65	3.5	5.2
313--- Spillville	IIw	135	43	85	4.8	6.6
336--- Delft	IIw	150	46	90	4.5	6.5
350--- Canisteo	IIIw	120	34	70	3.0	4.5
392--- Biscay	IIw	120	35	65	3.5	5.2
499--- Hanska	IIIw	100	32	60	3.0	5.0
539--- Palms	IIIw	115	38	65	---	---
548--- Palms	IIIw	100	35	60	---	---
664--- Zook	IIw	110	36	72	3.5	5.0

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa-bromegrass hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
818---------- Lemond-Linder	IIw	95	28	53	3.1	4.6
886---------- Nicollet-Crippin	I	150	45	90	4.8	7.3
887B---------- Clarion-Swanlake	IIe	135	38	81	4.3	6.9
909C---------- Truman-Bold	IVe	85	30	73	3.5	5.8
909D2---------- Bold-Truman	VIe	---	---	---	3.2	4.8
920B---------- Clarion-Estherville	IIe	110	33	71	3.8	5.9
920C2---------- Clarion-Estherville-Storden	IIIe	80	26	65	3.2	5.2
920D2---------- Clarion-Estherville-Storden	VIe	---	---	---	2.6	4.0
921B---------- Clarion-Storden	IIe	125	34	76	4.0	6.4
921C2---------- Clarion-Storden	IIIe	90	31	67	3.9	6.1
956---------- Canisteo-Glencoe	IIIw	135	39	80	4.0	5.6
960D2---------- Storden-Clarion	IVe	70	22	55	3.0	4.8
960E---------- Storden-Clarion	VIe	---	---	---	---	3.6
1029**. Pits						
1052---------- Palms and Okoboji	VIIIw	---	---	---	---	---
1090---------- Blue Earth	IIw	75	20	---	2.5	---
1833---------- Coland	IIw	120	38	80	4.0	5.6
1834---------- Coland	Vw	---	---	---	---	---
1852F---------- Terril-Swanlake	VIe	---	---	---	---	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa-bromegrass hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
1877---------- Fostoria	I	155	47	85	4.5	6.6
1907---------- Lakefield	I	145	44	90	4.5	6.7

* 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 7.--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
8B---------- Sparta	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Austrian pine, jack pine, red pine, honeylocust, green ash, Russian-olive, Siberian elm.	Eastern white pine	---
27B---------- Dickinson	Lilac, Siberian peashrub.	Eastern redcedar, Manchurian crabapple, hackberry, Tatarian honeysuckle.	Eastern white pine, green ash, jack pine, bur oak, Russian-olive.	---	---
35---------- Blue Earth	---	Northern white-cedar, lilac, Tatarian honeysuckle, Siberian peashrub.	Hackberry, bur oak, white spruce, eastern redcedar.	Green ash, golden willow.	Eastern cottonwood.
37B---------- Farrar	Lilac----------	Siberian peashrub, eastern redcedar, Tatarian honeysuckle, Russian-olive.	Green ash, red pine, honeylocust, Norway spruce, eastern white pine, Amur maple, hackberry.	---	---
39B---------- Wadena	Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, hackberry, Manchurian crabapple.	Jack pine, bur oak, green ash, eastern white pine.	---	---
41B, 41C---------- Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
84---------- Brownton	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	White spruce, hackberry, bur oak, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
86---------- Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
94B---------- Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---

TABLE 7.--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
96---------- Collinwood	Lilac, Siberian peashrub, Tatarian honeysuckle.	Manchurian crabapple, eastern redcedar.	Hackberry, green ash, Russian-olive, Austrian pine, honeylocust.	Siberian elm------	---
101B---------- Truman	---	Gray dogwood, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, hackberry, Russian-olive, eastern redcedar, Amur maple.	Eastern white pine, green ash.	---
102B---------- Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
106B, 106C-------- Lester	---	Redosier dogwood, Siberian peashrub, lilac, gray dogwood.	Hackberry, eastern redcedar, northern white-cedar, Amur maple, Russian-olive, blue spruce.	Eastern white pine, green ash.	---
112---------- Harps	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
113---------- Webster	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
114---------- Glencoe	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
118---------- Crippin	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
128B---------- Grogan	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, Russian-olive, hackberry, Amur maple, eastern redcedar.	Eastern white pine, green ash.	---
130---------- Nicollet	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.

TABLE 7.--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
134---------- Okoboji	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
136---------- Madelia	---	American plum, Tatarian honeysuckle, redosier dogwood.	Northern white-cedar, white spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.
140---------- Spicer	---	Tatarian honeysuckle, lilac, Siberian peashrub, northern white-cedar.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
181---------- Litchfield	---	Redosier dogwood, lilac, Tatarian honeysuckle.	White spruce, blue spruce, Amur maple, northern white-cedar.	Austrian pine, hackberry, green ash, eastern white pine.	Silver maple.
197---------- Kingston	---	Lilac, Tatarian honeysuckle, redosier dogwood.	Northern white-cedar, white spruce, Amur maple, blue spruce.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
227---------- Lemond	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
229---------- Waldorf	---	Redosier dogwood, Tatarian honeysuckle, American plum.	Northern white-cedar, white spruce, Amur maple, tall purple willow, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
247---------- Linder	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, Amur maple, white spruce, northern white-cedar.	Eastern white pine, Austrian pine, green ash, hackberry.	Silver maple.
255---------- Mayer	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
269---------- Millington	---	Northern white-cedar, Tatarian honeysuckle, lilac, Siberian peashrub.	Hackberry, white spruce, bur oak, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
275B---------- Ocheyedan	---	Redosier dogwood, Siberian peashrub, gray dogwood, lilac.	Northern white-cedar, hackberry, Russian-olive, Amur maple, blue spruce.	Eastern white pine, ponderosa pine, green ash.	---

TABLE 7.--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
282---------- Hanska	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
313---------- Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
336---------- Delft	---	Tatarian honeysuckle, redosier dogwood, American plum.	Hackberry, Amur maple, white spruce, northern white-cedar, tall purple willow.	Green ash, golden willow.	Silver maple, eastern cottonwood.
350---------- Canisteo	---	Tatarian honeysuckle, lilac, Siberian peashrub, northern white-cedar.	White spruce, hackberry, bur oak, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
392---------- Biscay	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
499---------- Hanska	---	American plum, Tatarian honeysuckle, redosier dogwood.	Northern white-cedar, white spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.
539, 548---------- Palms	Whitebelle honeysuckle, common ninebark.	Silky dogwood, Tatarian honeysuckle, Amur privet.	Tall purple willow	Black willow, white willow, golden willow.	Carolina poplar.
664---------- Zook	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
818*:					
Lemond----------	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Linder----------	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, Amur maple, white spruce, northern white-cedar.	Eastern white pine, Austrian pine, green ash, hackberry.	Silver maple.

See footnote at end of table.

TABLE 7.--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
886*:					
Nicollet	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
Crippin	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, white spruce, eastern redcedar, bur oak.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
887B*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Swanlake	American plum	Eastern redcedar, Tatarian honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
909C*:					
Truman	---	Gray dogwood, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, hackberry, Russian-olive, eastern redcedar, Amur maple.	Eastern white pine, green ash.	---
Bold	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
909D2*:					
Bold	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Truman	---	Gray dogwood, redosier dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, hackberry, Russian-olive, eastern redcedar, Amur maple.	Eastern white pine, green ash.	---

See footnote at end of table.

TABLE 7.--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
920B*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
920C2*, 920D2*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
921B*, 921C2*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
956*:					
Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--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
956*: Glencoe	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
960D2*: Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
960E*: Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
1029*. Pits					
1052*: Palms.					
Okoboji.					
1090 Blue Earth	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
1833, 1834 Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--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	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---
Swanlake	American plum	Eastern redcedar, Tatarian honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
1877 Fostoria	---	Redosier dogwood, lilac, Tatarian honeysuckle.	White spruce, blue spruce, northern white-cedar, Amur maple.	Austrian pine, green ash, eastern white pine, hackberry.	Silver maple.
1907 Lakefield	---	Siberian peashrub, lilac, northern white-cedar, Tatarian honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry.	Green ash, honeylocust, golden willow.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--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
8B Sparta	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
27B Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
35 Blue Earth	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
37B Farrar	Slight	Slight	Moderate: slope.	Slight	Slight.
39B Wadena	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
41B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
41C Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
84 Brownton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
86 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
94B Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
96 Collinwood	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
101B Truman	Slight	Slight	Moderate: slope.	Slight	Slight.
102B Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
106B Lester	Slight	Slight	Moderate: slope.	Slight	Slight.
106C Lester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
112 Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
113 Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114 Glencoe	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
118--Crippin	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
128B--Grogan	Slight	Slight	Moderate: slope.	Slight	Slight.
130--Nicollet	Slight	Slight	Slight	Slight	Slight.
134--Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
136--Madelia	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
140--Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
181--Litchfield	Slight	Slight	Slight	Slight	Moderate: droughty.
197--Kingston	Slight	Slight	Slight	Slight	Slight.
227--Lemond	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
229--Waldorf	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
247--Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
255--Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
269--Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
275B--Ocheyedan	Slight	Slight	Moderate: slope.	Slight	Slight.
282--Hanska	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
313--Spillville	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
336--Delft	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
350--Canisteo	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
392--Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
499--Hanska	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
539--- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
548--- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
664--- Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
818*:					
Lemond---	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Linder---	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight---	Slight.
886*:					
Nicollet---	Slight---	Slight---	Slight---	Slight---	Slight.
Crippin---	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight---	Slight.
887B*:					
Clarion---	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
Swanlake---	Slight---	Slight---	Moderate: slope, small stones.	Slight---	Slight.
909C*:					
Truman---	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight---	Moderate: slope.
Bold---	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
909D2*:					
Bold---	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
Truman---	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight---	Moderate: slope.
920B*:					
Clarion---	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
Estherville---	Slight---	Slight---	Moderate: slope, small stones.	Slight---	Moderate: droughty.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
920C2*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
920D2*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Estherville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
921B*:					
Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
921C2*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
956*:					
Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Glencoe	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
960D2*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
960E*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1029*. Pits					

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1052*:					
Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1090 Blue Earth	Severe: wetness, excess humus.	Severe: excess humus.	Severe: excess humus, wetness.	Severe: excess humus.	Moderate: wetness.
1833 Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
1834 Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
1852F*:					
Terril	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1877 Fostoria	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
1907 Lakefield	Slight	Slight	Slight	Slight	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--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
8B---------- Sparta	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
27B---------- Dickinson	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.
37B---------- Farrar	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
39B---------- Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
41B, 41C---------- Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
84---------- Brownton	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
86---------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
94B---------- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
96---------- Collinwood	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Good	Poor.
101B---------- Truman	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
102B---------- Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
106B---------- Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
106C---------- Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
112---------- Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
113---------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
114---------- Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
118---------- Crippin	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Poor.
128B---------- Grogan	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
130---------- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

TABLE 9.--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
134--- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
136--- Madelia	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
140--- Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
181--- Litchfield	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
197--- Kingston	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
227--- Lemond	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
229--- Waldorf	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
247--- Linder	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
255--- Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
269--- Millington	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Poor.
275B--- Ocheyedan	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
282--- Hanska	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
313--- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
336--- Delft	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
350--- Canisteo	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
392--- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
499--- Hanska	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
539--- Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
548--- Palms	Fair	Fair	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
664--- Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.

See footnote at end of table.

TABLE 9.--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
818*:										
Lemond	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Linder	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
886*:										
Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Crippin	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Poor.
887B*:										
Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Swanlake	Good	Good	Good	Fair	Fair	Poor	Very poor.	Good	Fair	Very poor.
909C*:										
Truman	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
Bold	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
909D2*:										
Bold	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Truman	Fair	Good	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
920B*:										
Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
920C2*:										
Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Estherville	Fair	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.
920D2*:										
Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Estherville	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 9.--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
921B*:										
Clarion	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.
921C2*:										
Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
956*:										
Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
960D2*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
960E*:										
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Clarion	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
1029*. Pits										
1052*:										
Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
Okoboji	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
1090 Blue Earth	Good	Good	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
1833 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
1834 Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1852F*:										
Terril	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Swanlake	Poor	Poor	Good	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
1877 Fostoria	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
1907 Lakefield	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--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
8B---- Sparta	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Moderate: droughty.
27B---- Dickinson	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Moderate: frost action.	Slight.
35---- Blue Earth	Severe: excess humus, ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding.	Severe: flooding, ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
37B---- Farrar	Slight---	Slight---	Slight---	Slight---	Moderate: low strength, frost action.	Slight.
39B---- Wadena	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Slight---	Slight.
41B---- Estherville	Severe: cutbanks cave.	Slight---	Slight---	Moderate: slope.	Slight---	Moderate: droughty.
41C---- Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
84---- Brownton	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: 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.
96---- Collinwood	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action.	Severe: too clayey.
101B---- Truman	Slight---	Slight---	Slight---	Slight---	Severe: low strength, frost action.	Slight.
102B---- Clarion	Slight---	Slight---	Slight---	Slight---	Moderate: frost action.	Slight.
106B---- Lester	Slight---	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
106C---- Lester	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
112---- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
113---- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

TABLE 10.--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
114--- Glencoe	Severe: ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding.	Severe: flooding, ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
118--- Crippin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
128B--- Grogan	Severe: cutbanks cave.	Slight---	Slight---	Slight---	Severe: frost action.	Slight.
130--- Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
134--- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
136--- Madelia	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
140--- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
181--- Litchfield	Severe: cutbanks cave.	Slight---	Moderate: wetness.	Slight---	Moderate: frost action.	Moderate: droughty.
197--- Kingston	Moderate: wetness.	Slight---	Moderate: wetness.	Slight---	Severe: frost action.	Slight.
227--- Lemond	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
229--- Waldorf	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: wetness.
247--- Linder	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
255--- Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
269--- Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
275B--- Ocheyedan	Slight---	Slight---	Slight---	Slight---	Moderate: frost action.	Slight.
282--- Hanska	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.

TABLE 10.--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
313---------- Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
336---------- Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
350---------- Canisteo	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding, flooding.	Severe: ponding, flooding.	Severe: low strength, ponding, frost action.	Severe: ponding.
392---------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
499---------- Hanska	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
539---------- Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
548---------- Palms	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
664---------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
818*:						
Lemond----------	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: frost action.	Moderate: wetness.
Linder----------	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
886*:						
Nicollet---------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
Crippin----------	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.
887B*:						
Clarion----------	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
Swanlake---------	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
909C*:						
Truman----------	Moderate: slope.	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: low strength, frost action.	Moderate: slope.

See footnote at end of table.

TABLE 10.--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
909C*:						
Bold	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
909D2*:						
Bold	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
Truman	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
920B*:						
Clarion	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
920C2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Moderate: slope.	Moderate: slope, frost action.	Moderate: slope.
Estherville	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.
920D2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Estherville	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
921B*:						
Clarion	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
921C2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Moderate: slope.	Moderate: slope, frost action.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.

See footnote at end of table.

TABLE 10.--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
956*:						
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Glencoe	Severe: ponding.	Severe: flooding, ponding, low strength.	Severe: flooding, ponding.	Severe: flooding, ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
960D2*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
960E*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1029*. Pits						
1052*:						
Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
1090 Blue Earth	Severe: excess humus, wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: low strength, frost action.	Moderate: wetness.
1833 Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
1834 Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: flooding.
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.
1877 Fostoria	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action, low strength.	Slight.

See footnote at end of table.

TABLE 10.--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
1907---------- Lakefield	Moderate: tness.	Slight---------	Moderate: wetness.	Slight---------	Severe: low strength, frost action.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--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
8B Sparta	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
27B Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
35 Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
37B Farrar	Slight	Moderate: slope, seepage.	Slight	Severe: seepage.	Good.
39B Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
41B Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
41C Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
84 Brownton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
86 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
94B Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
96 Collinwood	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
101B Truman	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
102B Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
106B Lester	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.

TABLE 11.--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
106C---------- Lester	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
112---------- Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, 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.
118---------- Crippin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
128B---------- Grogan	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
130---------- Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
134---------- Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
136---------- Madelia	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
140---------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
181---------- Litchfield	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
197---------- Kingston	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness, too clayey.
227---------- Lemond	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
229---------- Waldorf	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
247---------- Linder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
255---------- Mayer	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
269---------- Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.

TABLE 11.--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
275B---------- Ocheyedan	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
282---------- Hanska	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
313---------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
336---------- Delft	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
350---------- Canisteo	Severe: ponding.	Severe: seepage, ponding.	Severe: ponding.	Severe: seepage, ponding.	Poor: ponding.
392---------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
499---------- Hanska	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
539---------- Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
548---------- Palms	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
664---------- Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
818*:					
Lemond----------	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Linder----------	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
886*:					
Nicollet----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Crippin----------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.

See footnote at end of table.

TABLE 11.--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
887B*:					
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Swanlake	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
909C*:					
Truman	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Bold	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
909D2*:					
Bold	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Truman	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
920B*:					
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
920C2*:					
Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Estherville	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.
920D2*:					
Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Estherville	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
921B*:					
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.

See footnote at end of table.

TABLE 11.--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
921B*: Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
921C2*: Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
956*: Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
960D2*: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
960E*: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1029*. Pits					
1052*: Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
1090 Blue Earth	Severe: wetness.	Severe: wetness.	Severe: wetness, excess humus.	Severe: wetness.	Poor: hard to pack, wetness.
1833, 1834 Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
1852F*: Terril	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 11.--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
1877---------- Fostoria	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
1907---------- Lakefield	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--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
8B--- Sparta	Good	Probable	Improbable: too sandy.	Poor: thin layer.
27B--- Dickinson	Good	Probable	Improbable: too sandy.	Good.
35--- Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
37B--- Farrar	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
39B--- Wadena	Good	Probable	Probable	Poor: small stones, area reclaim.
41B, 41C--- Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
84--- Brownton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
86--- Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
94B--- Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
96--- Collinwood	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
101B--- Truman	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
102B--- Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
106B--- Lester	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
106C--- Lester	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
112--- Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: large stones.
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.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
118--Crippin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
128B--Grogan	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
130--Nicollet	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
134--Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
136--Madelia	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
140--Spicer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
181--Litchfield	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
197--Kingston	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
227--Lemond	Fair: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
229--Waldorf	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
247--Linder	Fair: wetness.	Probable	Improbable: too sandy.	Poor: small stones, area reclaim.
255--Mayer	Fair: wetness.	Probable	Probable	Fair: area reclaim, thin layer.
269--Millington	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
275B--Ocheyedan	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
282--Hanska	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
313--Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
336--Delft	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
350--Canisteo	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
392--Biscay	Fair: wetness.	Probable	Probable	Fair: area reclaim, thin layer.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
499---------- Hanska	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: wetness.
539---------- Palms	Poor: wetness.	Improbable: excess humus, excess fines.	Improbable: excess humus, excess fines.	Poor: wetness, excess humus.
548---------- Palms	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: excess humus, wetness.
664---------- Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
818*:				
Lemond----------	Fair: wetness.	Probable----------	Improbable: too sandy.	Poor: wetness.
Linder----------	Fair: wetness.	Probable----------	Improbable: too sandy.	Poor: small stones, area reclaim.
886*:				
Nicollet----------	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Crippin----------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
887B*:				
Clarion----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
Swanlake----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
909C*:				
Truman----------	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Bold----------	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
909D2*:				
Bold----------	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Truman----------	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
920B*:				
Clarion----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
Estherville----------	Good----------	Probable----------	Probable----------	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
920C2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
920D2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Estherville	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
921B*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
921C2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
956*:				
Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
960D2*:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
960E*:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Clarion	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1029*. Pits				

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1052*:				
Palms	Poor: wetness.	Improbable: excess humus, excess fines.	Improbable: excess humus, excess fines.	Poor: wetness, excess humus.
Okoboji	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
1090 Blue Earth	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
1833, 1834 Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1852F*:				
Terril	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Swanlake	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1877 Fostoria	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1907 Lakefield	Poor: 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 13.--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--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
8B---------- Sparta	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
27B---------- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy.	Favorable.
35---------- Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
37B---------- Farrar	Severe: seepage.	Moderate: piping.	Deep to water	Slope, soil blowing.	Soil blowing---	Erodes easily.
39B---------- Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope----------	Too sandy------	Favorable.
41B---------- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
41C---------- Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
84---------- Brownton	Moderate: seepage.	Severe: wetness.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness--------	Wetness, percs slowly.
86---------- Canisteo	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
94B---------- Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Favorable------	Favorable.
96---------- Collinwood	Slight---------	Severe: hard to pack.	Percs slowly, frost action.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Percs slowly.
101B---------- Truman	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
102B---------- Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
106B---------- Lester	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope----------	Erodes easily	Erodes easily.
106C---------- Lester	Severe: slope.	Severe: thin layer.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
112---------- Harps	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
113---------- Webster	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
114---------- Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding--------	Ponding--------	Wetness.
118---------- Crippin	Moderate: seepage.	Moderate: wetness, piping.	Frost action---	Wetness--------	Wetness, erodes easily.	Erodes easily.
128B---------- Grogan	Severe: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
130---------- Nicollet	Moderate: seepage.	Moderate: piping.	Frost action---	Wetness--------	Wetness--------	Favorable.
134---------- Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding--------	Not needed-----	Not needed.
136---------- Madelia	Moderate: seepage.	Severe: wetness, piping.	Frost action---	Wetness--------	Erodes easily, wetness.	Wetness, erodes easily.
140---------- Spicer	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness, erodes easily.	Wetness, erodes easily.
181---------- Litchfield	Severe: seepage.	Severe: piping.	Cutbanks cave	Wetness, droughty.	Wetness, too sandy, soil blowing.	Droughty.
197---------- Kingston	Moderate: seepage.	Severe: piping.	Frost action---	Wetness--------	Erodes easily, wetness.	Erodes easily.
227---------- Lemond	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
229---------- Waldorf	Moderate: seepage.	Severe: hard to pack, wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
247---------- Linder	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Droughty.
255---------- Mayer	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
269---------- Millington	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness--------	Wetness.
275B---------- Ocheyedan	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Favorable------	Favorable.
282---------- Hanska	Severe: seepage.	Severe: seepage, wetness, piping.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
313---------- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding-------	Favorable------	Favorable.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
336---------- Delft	Slight---------	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
350---------- Canisteo	Severe: seepage.	Severe: ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
392---------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
499---------- Hanska	Severe: seepage.	Severe: seepage, ponding.	Ponding, frost action, cutbanks cave.	Ponding--------	Ponding, too sandy.	Wetness.
539---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
548---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
664---------- Zook	Slight---------	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed-----	Not needed.
818*:						
Lemond----------	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
Linder----------	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Droughty.
886*:						
Nicollet---------	Moderate: seepage.	Moderate: piping.	Frost action---	Wetness--------	Wetness--------	Favorable.
Crippin----------	Moderate: seepage.	Moderate: wetness, piping.	Frost action---	Wetness--------	Wetness, erodes easily.	Erodes easily.
887B*:						
Clarion----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Swanlake---------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
909C*:						
Truman----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Bold----------	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
909D2*:						
Bold	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Truman	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
920B*:						
Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
920C2*, 920D2*:						
Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Estherville	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.
921B*:						
Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
921C2*:						
Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
956*:						
Canisteo	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding	Ponding	Wetness.
960D2*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
960E*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
1029*. Pits						
1052*:						
Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
Okoboji	Slight	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness, erodes easily.
1090 Blue Earth	Moderate: seepage.	Severe: excess humus, wetness.	Frost action	Wetness	Wetness	Wetness.
1833, 1834 Coland	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
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.
1877 Fostoria	Moderate: seepage.	Moderate: wetness, piping.	Frost action	Wetness	Wetness, erodes easily.	Erodes easily.
1907 Lakefield	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--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	
8B---------- Sparta	0-14	Loamy fine sand	SM	A-2, A-4	0	85-100	85-100	50-95	15-50	---	NP
	14-30	Loamy fine sand, fine sand, sand.	SP-SM, SM	A-2, A-3, A-4	0	85-100	85-100	50-95	5-50	---	NP
	30-60	Sand, fine sand	SP-SM, SM, SP	A-2, A-3	0	85-100	85-100	50-95	2-30	---	NP
27B---------- Dickinson	0-19	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	19-34	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	34-60	Loamy sand, sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
35---------- Blue Earth	0-10	Mucky silty clay loam.	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	10-60	Mucky silty clay loam, clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
37B---------- Farrar	0-20	Fine sandy loam	SC, SM-SC	A-2, A-4	0	100	100	85-95	25-45	<30	5-10
	20-60	Loam----------	CL	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	8-20
39B---------- Wadena	0-20	Loam----------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
	20-38	Loam, sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	38-60	Stratified gravelly coarse sand to sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
41B, 41C---------- Estherville	0-13	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	13-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly coarse sand, loamy sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
84---------- Brownton	0-20	Silty clay-------	MH, CH	A-7	0	100	98-100	90-98	85-95	50-65	20-35
	20-60	Silty clay, clay, silty clay loam.	MH, CH	A-7	0	100	98-100	90-98	85-95	50-80	25-40
86---------- Canisteo	0-9	Clay loam--------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	9-23	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	23-36	Clay loam, loam, sandy loam.	CL, ML, SM, SC	A-6, A-4	0-5	90-100	80-95	60-90	40-80	30-40	5-15
	36-60	Clay loam, loam, fine sandy loam.	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
94B---------- Terril	0-15	Loam----------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	15-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
96---------- Collinwood	0-15	Silty clay-------	CL, CH, ML, MH	A-7	0	100	100	95-100	90-95	40-55	15-25
	15-35	Silty clay, clay, silty clay loam.	MH, CH	A-7	0	100	100	95-100	90-95	50-65	20-35
	35-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-95	40-60	15-30

TABLE 14.--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	
101B---------- Truman	0-13	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	25-40	5-15
	13-33	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-100	25-45	5-20
	33-60	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	75-95	25-40	5-15
102B---------- Clarion	0-14	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	14-33	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	33-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
106B, 106C------- Lester	0-9	Loam----------	ML, CL	A-6, A-4	0	95-100	90-100	80-95	50-70	30-40	5-15
	9-41	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-50	15-25
	41-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
112---------- Harps	0-14	Clay loam--------	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
	14-33	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	33-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
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
	19-34	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
	34-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
114---------- Glencoe	0-41	Clay loam--------	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	41-60	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
118---------- Crippin	0-15	Loam----------	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
	15-27	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-90	60-80	30-40	10-20
	27-60	Loam, clay loam	CL	A-6	2-5	90-100	85-100	75-90	55-80	30-40	10-20
128B---------- Grogan	0-18	Silt loam--------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	18-38	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	38-60	Stratified loamy very fine sand to silt loam.	ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
130---------- Nicollet	0-17	Clay loam--------	ML, CL	A-6, A-7	0	95-100	90-100	85-98	55-85	35-50	10-25
	17-36	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	36-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
134---------- Okoboji	0-28	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	28-42	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	42-60	Stratified loam to silty clay loam.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
136---------- Madelia	0-22	Silty clay loam	ML	A-7	0	100	100	100	90-100	40-50	10-20
	22-37	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	90-100	30-50	10-25
	37-60	Silt loam, silty clay loam.	ML, CL	A-6, A-4, A-7	0	100	100	100	90-100	30-50	5-25
140---------- Spicer	0-24	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	24-34	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	34-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12

TABLE 14.--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	
181---------- Litchfield	0-16	Sandy loam-------	SM, SM-SC, SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	16-37	Stratified fine sand to very fine sandy loam.	SM	A-2	0	100	100	80-95	20-35	<20	NP-4
	37-60	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	70-95	5-30	<20	NP-4
197---------- Kingston	0-11	Silt loam--------	ML, OL, CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	6-20
	11-29	Silty clay loam, silt loam.	CL, ML, CL-ML	A-6, A-7, A-4	0	100	100	95-100	85-100	35-50	6-20
	29-60	Silt loam, silty clay loam.	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	85-100	25-50	5-15
227---------- Lemond	0-20	Sandy loam-------	SM, SM-SC	A-4	0	95-100	95-100	80-95	35-50	<25	NP-5
	20-30	Sandy loam, loamy sand, loam.	SM, SM-SC	A-2, A-4	0	95-100	95-100	65-80	25-50	<25	NP-7
	30-60	Sand, coarse sand, loamy sand.	SP-SM, SP	A-3, A-1, A-2	0	90-100	85-100	35-85	2-10	---	NP
229---------- Waldorf	0-24	Silty clay loam	ML, MH	A-7	0	100	100	95-100	90-100	45-65	14-30
	24-36	Silty clay, silty clay loam.	MH	A-7	0	100	100	95-100	95-100	50-70	20-35
	36-60	Silty clay loam, silty clay, silt loam.	MH, CL, ML, CH	A-7, A-6	0	100	100	95-100	90-100	35-65	11-30
247---------- Linder	0-15	Loam----------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-15
	15-29	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	29-60	Gravelly coarse sand, coarse sand, loamy coarse sand.	SP, SP-SM	A-1	0-5	75-95	30-95	25-50	2-12	---	NP
255---------- Mayer	0-16	Loam----------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	16-30	Loam, sandy clay loam, silt loam.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-85	30-40	5-15
	30-60	Gravelly coarse sand, sand, coarse sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
269---------- Millington	0-28	Clay loam--------	CL, ML, OL	A-7, A-6	0	100	90-100	90-100	90-100	35-50	11-20
	28-39	Loam, silty clay loam, clay loam.	CL	A-7, A-6	0	95-100	90-100	80-100	70-95	28-50	10-22
	39-60	Stratified sandy loam to silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	80-100	80-100	80-100	60-95	20-45	5-20
275B---------- Ocheyedan	0-15	Loam----------	CL	A-6	0	100	100	75-90	65-80	30-40	10-15
	15-22	Sandy clay loam, fine sandy loam, loam.	SC, CL, SM-SC, CL-ML	A-4, A-6	0	100	100	60-80	35-55	25-40	5-15
	22-60	Sandy loam, sandy clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	100	100	85-95	50-90	25-40	5-15

TABLE 14.--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	
282---------- Hanska	0-21	Loam----------	ML, CL, CL-ML	A-4	0	95-100	95-100	80-95	50-65	<25	2-10
	21-34	Sandy loam, coarse sandy loam, loam.	SM, SM-SC, SC	A-4	0	95-100	95-100	65-80	35-50	<20	2-8
	34-60	Sand, coarse sand	SP-SM	A-3, A-1, A-2	0	95-100	85-100	45-70	5-10	<20	NP
313---------- Spillville	0-32	Loam----------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	32-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
336---------- Delft	0-36	Loam----------	CL	A-6, A-7	0	95-100	90-98	75-90	60-80	30-45	10-20
	36-54	Loam, clay loam, silt loam.	CL	A-6, A-4	0	95-100	90-98	70-90	50-75	25-40	7-15
	54-60	Loam, clay loam, sandy loam.	CL, ML, CL-ML	A-6, A-4	0-5	90-100	85-100	55-90	50-85	20-40	3-15
350---------- Canisteo	0-9	Clay loam--------	ML, CL	A-7	0	95-100	95-100	85-100	60-90	40-50	15-20
	9-27	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	85-95	65-85	35-50	15-25
	27-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	80-95	60-75	30-40	12-20
392---------- Biscay	0-22	Sandy clay loam	CL, ML	A-6, A-7	0	95-100	95-100	70-90	50-70	35-50	10-25
	22-32	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	32-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
499---------- Hanska	0-24	Loam----------	ML, CL, CL-ML	A-4	0	95-100	95-100	80-95	50-65	<25	2-10
	24-60	Sandy loam, loamy sand.	SM, SC, SM-SC	A-4	0	95-100	95-100	65-80	36-50	<25	NP-8
539---------- Palms	0-33	Sapric material	PT	---	---	---	---	---	---	---	---
	33-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
548---------- Palms	0-21	Sapric material	PT	A-8	0	---	---	---	---	---	---
	21-34	Clay loam, silt loam, silty clay loam.	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-80	20-35	5-15
	34-60	Fine sand, stratified loamy sand to sand.	SM, SP-SM	A-2, A-4, A-3	0	90-100	75-100	50-100	5-40	---	NP
664---------- Zook	0-10	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	10-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
818*: Lemond----------	0-8	Sandy loam-------	SM, ML, CL, SC	A-4	0	95-100	95-100	80-95	40-65	<25	2-10
	8-32	Sandy loam, loamy sand, loam.	SM, SM-SC	A-2, A-4	0	95-100	95-100	65-80	25-50	<25	NP-7
	32-60	Sand, coarse sand, loamy sand.	SP-SM, SP	A-3, A-1, A-2	0	90-100	85-100	35-85	2-10	---	NP

See footnote at end of table.

TABLE 14.--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	
818*:											
Linder----------	0-22	Sandy loam-------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-15
	22-30	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	30-60	Gravelly sand, gravelly loamy sand, loamy coarse sand.	SP, SP-SM	A-1	0-5	75-95	30-95	25-50	2-12	---	NP
886*:											
Nicollet--------	0-17	Clay loam--------	ML, CL	A-6, A-7	0	95-100	90-100	85-98	55-85	35-50	10-25
	17-29	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	29-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
Crippin---------	0-10	Loam-------------	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
	10-24	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-90	60-80	30-40	10-20
	24-60	Loam, clay loam	CL	A-6	2-5	90-100	85-100	75-90	55-80	30-40	10-20
887B*:											
Clarion---------	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	10-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	18-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Swanlake--------	0-20	Loam-------------	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	20-28	Loam, clay loam	CL-ML, CL	A-4, A-6	0	90-100	85-98	70-90	50-70	20-35	5-15
	28-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	75-90	50-75	20-35	3-15
909C*:											
Truman----------	0-14	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	25-40	5-15
	14-30	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-100	25-45	5-20
	30-60	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	75-95	25-40	5-15
Bold------------	0-10	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15
	10-60	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15
909D2*:											
Bold------------	0-8	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15
	8-60	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15
Truman----------	0-9	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	25-40	5-15
	19-19	Silt loam, silty clay loam.	ML, CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	80-100	25-45	5-20
	19-60	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	75-95	25-40	5-15
920B*:											
Clarion---------	0-14	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	14-34	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	34-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15

See footnote at end of table.

TABLE 14.--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	
920B*:											
Estherville-----	0-10	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	10-18	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	18-60	Coarse sand, gravelly loamy sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
920C2*, 920D2*:											
Clarion---------	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	10-36	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	36-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Estherville-----	0-10	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	10-20	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	20-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
Storden---------	0-9	Loam-------------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
921B*, 921C2*:											
Clarion---------	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	9-25	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	25-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Storden---------	0-9	Loam-------------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
956*:											
Canisteo--------	0-11	Clay loam--------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	11-22	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	22-28	Clay loam, loam, sandy loam.	CL, ML, SM, SC	A-6, A-4	0-5	90-100	80-95	60-90	40-80	30-40	5-15
	28-60	Clay loam, loam, fine sandy loam.	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
Glencoe---------	0-38	Clay loam--------	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	38-60	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
960D2*:											
Storden---------	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15

See footnote at end of table.

TABLE 14.--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	
960D2*:											
Clarion---------	0-8	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	8-22	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	22-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
960E*:											
Storden---------	0-9	Loam----------	ML, CL, CL-ML	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Clarion---------	0-9	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	9-30	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	30-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
1029*. Pits											
1052*:											
Palms-----------	0-26	Sapric material	PT	---	---	---	---	---	---	---	---
	26-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
Okoboji---------	0-35	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	35-46	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	46-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
1090---------- Blue Earth	0-9	Silt loam--------	OL	A-4, A-5, A-7	0	100	95-100	85-100	85-95	35-50	5-15
	9-60	Silt loam, silty clay loam.	OL	A-4, A-6, A-7	0	100	90-100	80-100	75-95	35-50	8-20
1833---------- Coland	0-8	Loam----------	CL	A-6	0	100	95-100	85-95	60-75	30-40	10-20
	8-60	Clay loam, silty clay loam, loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
1834---------- Coland	0-16	Loam----------	CL	A-6	0	100	95-100	85-95	60-75	30-40	10-20
	16-44	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	44-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
1852F*:											
Terril----------	0-40	Loam----------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	40-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
Swanlake---------	0-14	Loam----------	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	14-30	Loam, clay loam	CL-ML, CL	A-4, A-6	0	90-100	85-98	70-90	50-70	20-35	5-15
	30-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	75-90	50-75	20-35	3-15
1877---------- Fostoria	0-25	Clay loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	80-95	25-40	5-15
	25-60	Silt loam, loam, sandy loam.	CL	A-6	0-5	100	100	75-100	55-95	30-40	10-20
1907---------- Lakefield	0-20	Silt loam--------	CL-ML, CL	A-4, A-6, A-7	0	100	100	90-100	70-95	25-45	6-20
	20-60	Silty clay loam, silt loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	90-100	70-95	25-45	6-20

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF 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		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
8B----------	0-14	3-10	1.20-1.40	2.0-6.0	0.09-0.12	5.1-7.3	<2	Low-------	0.17	5	2	1-2
Sparta	14-30	1-8	1.40-1.60	6.0-20	0.05-0.11	5.1-6.5	<2	Low-------	0.17			
	30-60	0-5	1.50-1.70	6.0-20	0.04-0.07	5.1-6.0	<2	Low-------	0.17			
27B----------	0-19	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	<2	Low-------	0.20	4	3	1-2
Dickinson	19-34	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	<2	Low-------	0.20			
	34-60	4-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	<2	Low-------	0.20			
35----------	0-10	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	<2	Moderate	0.28	5	4L	10-25
Blue Earth	10-60	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	<2	Low-------	0.28			
37B----------	0-20	10-14	1.45-1.50	2.0-6.0	0.16-0.18	5.6-7.3	<2	Low-------	0.20	5	3	1-2
Farrar	20-60	18-24	1.60-1.80	0.6-2.0	0.17-0.19	6.1-8.4	<2	Low-------	0.37			
39B----------	0-20	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low-------	0.24	4	5	3-6
Wadena	20-38	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	<2	Low-------	0.32			
	38-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	<2	Low-------	0.10			
41B, 41C-----	0-13	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low-------	0.20	3	3	2-4
Estherville	13-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low-------	0.20			
	18-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	<2	Low-------	0.10			
84----------	0-20	35-55	1.20-1.30	0.06-0.2	0.18-0.22	7.4-8.4	<2	High------	0.28	5	4	4-8
Brownton	20-60	35-55	1.20-1.30	0.06-0.2	0.13-0.16	7.4-8.4	<2	High------	0.28			
86----------	0-9	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
Canisteo	9-23	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.32			
	23-36	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	<2	Low-------	0.32			
	36-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low-------	0.32			
94B----------	0-15	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
Terril	15-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low-------	0.32			
96----------	0-15	35-45	1.20-1.30	0.2-0.6	0.14-0.17	5.6-7.3	<2	Moderate	0.32	5	4	5-7
Collinwood	15-35	35-60	1.25-1.35	0.06-0.6	0.13-0.16	5.6-7.3	<2	High------	0.32			
	35-60	30-45	1.25-1.40	0.06-0.6	0.11-0.15	7.4-8.4	<2	High------	0.32			
101B----------	0-13	18-32	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	<2	Low-------	0.32	5	6	4-8
Truman	13-33	18-32	1.30-1.45	0.6-2.0	0.18-0.21	5.6-7.8	<2	Low-------	0.43			
	33-60	18-32	1.35-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Low-------	0.43			
102B----------	0-14	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low-------	0.28	5	6	3-4
Clarion	14-33	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	<2	Low-------	0.37			
	33-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low-------	0.37			
106B, 106C----	0-9	15-27	1.30-1.40	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low-------	0.28	5	6	2-4
Lester	9-41	24-35	1.45-1.55	0.6-2.0	0.15-0.19	5.1-6.5	<2	Moderate	0.28			
	41-60	20-30	1.55-1.75	0.6-2.0	0.14-0.19	6.6-7.8	<2	Low-------	0.37			
112----------	0-14	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate	0.24	5	4L	4-5
Harps	14-33	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	<2	Moderate	0.32			
	33-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Moderate	0.32			
113----------	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
Webster	19-34	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32			
	34-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Moderate	0.32			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
114----------	0-41	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
Glencoe	41-60	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.28			
118----------	0-15	22-28	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low--------	0.28	5	6	5-6
Crippin	15-27	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
	27-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	<2	Low--------	0.37			
128B---------	0-18	8-18	1.25-1.40	2.0-6.0	0.22-0.24	5.6-7.3	<2	Low--------	0.32	5	5	2-4
Grogan	18-38	8-18	1.40-1.50	2.0-6.0	0.17-0.19	6.1-7.8	<2	Low--------	0.43			
	38-60	5-15	1.50-1.60	2.0-6.0	0.17-0.19	7.4-8.4	<2	Low--------	0.43			
130----------	0-17	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.24	5	6	4-8
Nicollet	17-36	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	<2	Moderate	0.32			
	36-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low--------	0.32			
134----------	0-28	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	<2	High------	0.37	5	4	9-18
Okoboji	28-42	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	<2	High------	0.37			
	42-60	25-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	<2	High------	0.37			
136----------	0-22	18-35	1.20-1.30	0.6-2.0	0.18-0.24	6.1-7.3	<2	Moderate	0.28	5	6	4-8
Madelia	22-37	18-35	1.25-1.35	0.6-2.0	0.16-0.22	6.6-7.8	<2	Moderate	0.28			
	37-60	18-35	1.30-1.40	0.6-2.0	0.16-0.22	7.4-8.4	<2	Low--------	0.37			
140----------	0-24	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
Spicer	24-34	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	<2	Moderate	0.37			
	34-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	<2	Low--------	0.37			
181----------	0-16	10-22	1.45-1.55	2.0-6.0	0.12-0.15	6.1-7.3	<2	Low--------	0.20	5	3	2-4
Litchfield	16-37	5-10	1.40-1.65	2.0-6.0	0.07-0.16	5.1-6.5	<2	Low--------	0.17			
	37-60	1-8	1.45-1.65	2.0-6.0	0.08-0.10	6.1-7.8	<2	Low--------	0.17			
197----------	0-11	18-32	1.20-1.30	0.6-2.0	0.18-0.24	5.6-7.3	<2	Low--------	0.28	5	7	4-8
Kingston	11-29	18-32	1.25-1.35	0.6-2.0	0.16-0.20	5.6-7.8	<2	Low--------	0.37			
	29-60	18-32	1.25-1.35	0.6-2.0	0.16-0.20	7.4-8.4	<2	Low--------	0.37			
227----------	0-20	6-18	1.30-1.40	2.0-6.0	0.15-0.18	7.4-8.4	<2	Low--------	0.28	5	3	4-8
Lemond	20-30	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-8.4	<2	Low--------	0.28			
	30-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	<2	Low--------	0.15			
229----------	0-24	35-45	1.20-1.30	0.2-0.6	0.18-0.25	6.1-7.3	<2	Moderate	0.28	5	4	6-8
Waldorf	24-36	40-55	1.25-1.35	0.2-0.6	0.13-0.16	6.6-7.8	<2	High------	0.28			
	36-60	24-45	1.25-1.35	0.2-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.28			
247----------	0-15	14-18	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.8	<2	Low--------	0.24	4	5	3-4
Linder	15-29	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	<2	Low--------	0.24			
	29-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	<2	Low--------	0.10			
255----------	0-16	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	4	4L	4-8
Mayer	16-30	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low--------	0.28			
	30-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	<2	Low--------	0.15			
269----------	0-28	27-35	1.40-1.60	0.6-2.0	0.17-0.23	7.4-8.4	<2	Moderate	0.28	5	6	4-6
Millington	28-39	18-35	1.40-1.60	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.28			
	39-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	<2	Moderate	0.28			
275B---------	0-15	24-27	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low--------	0.24	5	6	3-4
Ocheyedan	15-22	14-24	1.45-1.60	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low--------	0.32			
	22-60	12-24	1.45-1.70	0.6-2.0	0.19-0.21	6.6-8.4	<2	Low--------	0.32			
282----------	0-21	6-18	1.30-1.40	2.0-6.0	0.20-0.22	6.1-7.8	<2	Low--------	0.28	4	5	4-8
Hanska	21-34	6-18	1.35-1.50	2.0-6.0	0.10-0.13	6.1-7.3	<2	Low--------	0.28			
	34-60	1-10	1.50-1.60	6.0-20	0.03-0.05	6.6-7.8	<2	Low--------	0.17			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
313----------	0-32	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	<2	Moderate	0.28	5	6	4-6
Spillville	32-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	<2	Low-------	0.28			
336----------	0-36	24-35	1.40-1.65	0.2-2.0	0.18-0.20	5.6-7.8	<2	Moderate	0.24	5	6	4-8
Delft	36-54	18-32	1.30-1.40	0.2-0.6	0.19-0.22	6.6-7.8	<2	Low-------	0.32			
	54-60	15-32	1.40-1.55	0.2-2.0	0.15-0.19	7.4-8.4	<2	Low-------	0.32			
350----------	0-9	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
Canisteo	9-27	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.32			
	27-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low-------	0.32			
392----------	0-22	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.1-7.8	<2	Moderate	0.28	4	5	4-6
Biscay	22-32	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.28			
	32-60	1-6	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low-------	0.10			
499----------	0-24	6-18	1.30-1.50	2.0-6.0	0.20-0.22	6.1-7.3	<2	Low-------	0.28	5	5	4-8
Hanska	24-60	6-18	1.40-1.60	2.0-20	0.10-0.13	6.1-7.3	<2	Low-------	0.28			
539----------	0-33	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	<2	----------	----	2	2	>30
Palms	33-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	<2	Low-------	----			
548----------	0-21	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-6.5	<2	----------	----	2	2	>30
Palms	21-34	7-35	1.45-1.70	0.6-2.0	0.16-0.20	6.1-7.8	<2	Moderate	----			
	34-60	0-10	1.50-1.65	2.0-20	0.04-0.10	7.4-7.8	<2	Low-------	----			
664----------	0-10	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	<2	High------	0.28	5	7	5-7
Zook	10-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High------	0.28			
818*:												
Lemond----------	0-8	6-18	1.30-1.40	2.0-6.0	0.15-0.18	7.4-8.4	<2	Low-------	0.28	5	3	4-8
	8-32	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-8.4	<2	Low-------	0.28			
	32-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	<2	Low-------	0.15			
Linder----------	0-22	14-18	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.8	<2	Low-------	0.24	4	5	3-4
	22-30	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	<2	Low-------	0.24			
	30-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	<2	Low-------	0.10			
886*:												
Nicollet--------	0-17	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.24	5	6	4-8
	17-29	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	<2	Moderate	0.32			
	29-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	<2	Low-------	0.32			
Crippin---------	0-10	22-28	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low-------	0.28	5	6	5-6
	10-24	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low-------	0.28			
	24-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	<2	Low-------	0.37			
887B*:												
Clarion---------	0-10	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low-------	0.28	5	6	2-4
	10-18	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	<2	Low-------	0.37			
	18-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low-------	0.37			
Swanlake--------	0-20	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	<2	Low-------	0.28	5	4L	2-4
	20-28	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low-------	0.37			
	28-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low-------	0.37			
909C*:												
Truman----------	0-14	18-32	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	<2	Low-------	0.32	5	6	4-8
	14-30	18-32	1.30-1.45	0.6-2.0	0.18-0.21	5.6-7.8	<2	Low-------	0.43			
	30-60	18-32	1.35-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Low-------	0.43			
Bold----------	0-10	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low-------	0.43	5	4L	.5-2
	10-60	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low-------	0.43			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
909D2*:												
Bold----------	0-8	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.43	5	4L	.5-2
	8-60	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.43			
Truman----------	0-9	18-32	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	<2	Low--------	0.32	5	6	2-4
	9-19	18-32	1.30-1.45	0.6-2.0	0.18-0.21	5.6-7.8	<2	Low--------	0.43			
	19-60	18-32	1.35-1.45	0.6-2.0	0.18-0.20	7.4-8.4	<2	Low--------	0.43			
920B*:												
Clarion---------	0-14	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low--------	0.28	5	6	2-4
	14-34	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	<2	Low--------	0.37			
	34-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Estherville-----	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low--------	0.20	3	3	2-4
	10-18	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low--------	0.20			
	18-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	<2	Low--------	0.10			
920C2*, 920D2*:												
Clarion---------	0-10	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low--------	0.28	5	6	2-4
	10-36	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	<2	Low--------	0.37			
	36-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Estherville-----	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low--------	0.20	3	3	1-3
	10-20	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low--------	0.20			
	20-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	<2	Low--------	0.10			
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	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
921B*, 921C2*:												
Clarion---------	0-9	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low--------	0.28	5	6	2-4
	9-25	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	<2	Low--------	0.37			
	25-60	12-22	1.50-1.70	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	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
956*:												
Canisteo--------	0-11	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
	11-22	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.32			
	22-28	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	<2	Low--------	0.32			
	28-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low--------	0.32			
Glencoe---------	0-38	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
	38-60	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.28			
960D2*:												
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	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Clarion---------	0-8	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low--------	0.28	5	6	2-4
	8-22	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	<2	Low--------	0.37			
	22-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
960E*:												
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	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Clarion---------	0-9	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	<2	Low--------	0.28	5	6	2-4
	9-30	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	<2	Low--------	0.37			
	30-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Frosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
1029*. Pits												
1052*:												
Palms	0-26	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	<2		----	2	2	>30
	26-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	<2	Low	----			
Okoboji	0-35	35-45	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	<2	High	0.37	5	8	5-10
	35-46	35-45	1.35-1.40	0.2-0.6	0.18-0.20	6.6-7.8	<2	High	0.37			
	46-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	6.6-7.8	<2	High	0.37			
1090 Blue Earth	0-9	15-30	0.90-1.30	0.6-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.28	5	5	5-15
	9-60	18-32	1.10-1.50	0.6-2.0	0.14-0.20	7.4-8.4	<2	Moderate	0.28			
1833 Coland	0-8	22-26	1.40-1.45	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.28	5	6	5-7
	8-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	<2	High	0.28			
1834 Coland	0-16	22-26	1.40-1.45	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.28	5	6	5-7
	16-44	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	<2	High	0.28			
	44-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	<2	Low	0.28			
1852F*:												
Terril	0-40	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
	40-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low	0.32			
Swanlake	0-14	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	<2	Low	0.28	5	4L	2-4
	14-30	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
	30-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
1877 Fostoria	0-25	25-30	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	0.24	5	6	5-6
	25-60	16-26	1.40-1.75	0.6-2.0	0.20-0.22	6.6-8.4	<2	Low	0.43			
1907 Lakefield	0-20	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	<2	Low	0.32	5	7	4-8
	20-60	18-35	1.25-1.35	0.6-2.0	0.16-0.20	7.4-8.4	<2	Low	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," and "apparent" are explained in the text. The symbol < means less than; > 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			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
8B---------- Sparta	A	None--------	---	---	>6.0	---	---	---	Low------	Low------	Moderate.
27B---------- Dickinson	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
35---------- Blue Earth	B/D	Rare--------	---	---	+2-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.
37B---------- Farrar	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
39B---------- Wadena	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
41B, 41C---------- Estherville	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
84---------- Brownton	C/D	None--------	---	---	1.0-2.5	Apparent	Nov-Jun	---	High-----	High-----	Low.
86---------- Canisteo	B/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jul	---	High-----	High-----	Low.
94B---------- Terril	B	None--------	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
96---------- Collinwood	C	None--------	---	---	2.0-5.0	Apparent	Nov-May	---	High-----	High-----	Low.
101B---------- Truman	B	None--------	---	---	>6.0	---	---	---	High-----	Low------	Low.
102B---------- Clarion	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Low.
106B, 106C-------- Lester	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Moderate.
112---------- Harps	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
113---------- Webster	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	---	High-----	High-----	Low.
114---------- Glencoe	B/D	Rare--------	---	---	+1-1.0	Apparent	Oct-Jun	---	High-----	High-----	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
118--Crippin	B	None	---	---	2.0-4.0	Apparent	Nov-Jun	---	High	High	Low.
128B--Grogan	B	None	---	---	>6.0	---	---	---	High	Low	Low.
130--Nicollet	B	None	---	---	2.5-5.0	Apparent	Apr-May	---	High	High	Low.
134--Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	---	High	High	Low.
136--Madelia	B/D	None	---	---	1.0-2.5	Apparent	Nov-May	---	High	High	Low.
140--Spicer	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
181--Litchfield	A	None	---	---	2.5-5.0	Apparent	Apr-May	---	Moderate	Low	Low.
197--Kingston	B	None	---	---	2.5-5.0	Apparent	Apr-May	---	High	High	Low.
227--Lemond	B/D	None	---	---	1.0-3.0	Apparent	Nov-May	---	High	High	Low.
229--Waldorf	C/D	None	---	---	0-3.0	Apparent	Nov-Jun	---	High	High	Low.
247--Linder	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	---	High	Moderate	Low.
255--Mayer	B/D	None	---	---	1.0-3.0	Apparent	Oct-Jun	---	High	High	Low.
269--Millington	B/D	Occasional	Brief	Apr-Jun	0-2.0	Apparent	Mar-Jul	---	High	High	Low.
275B--Ocheyedan	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
282--Hanska	C	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.
313--Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	---	Moderate	High	Moderate.
336--Delft	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	---	High	High	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
350---------- Canisteo	B/D	Rare--------	---	---	+1-1.0	Apparent	Jan-Dec	---	High-----	High-----	Low.
392---------- Biscay	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	---	High-----	Moderate	Low.
499---------- Hanska	B/D	None--------	---	---	+1-2.5	Apparent	Nov-Jun	---	High-----	High-----	Low.
539---------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-May	25-32	High-----	High-----	Moderate.
548---------- Palms	A/D	Frequent----	---	---	+1-1.0	Apparent	Nov-May	25-30	High-----	High-----	High.
664---------- Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-May	---	High-----	High-----	Moderate.
818*:											
Lemond----------	B/D	Rare--------	---	---	1.0-3.0	Apparent	Nov-May	---	High-----	High-----	Low.
Linder----------	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	---	High-----	Moderate	Low.
886*:											
Nicollet---------	B	None--------	---	---	2.5-5.0	Apparent	Apr-May	---	High-----	High-----	Low.
Crippin----------	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jun	---	High-----	High-----	Low.
887B*:											
Clarion----------	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Low.
Swanlake---------	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Low.
909C*:											
Truman----------	B	None--------	---	---	>6.0	---	---	---	High-----	Low------	Low.
Bold----------	B	None--------	---	---	>6.0	---	---	---	High-----	Low------	Low.
909D2*:											
Bold----------	B	None--------	---	---	>6.0	---	---	---	High-----	Low------	Low.
Truman----------	B	None--------	---	---	>6.0	---	---	---	High-----	Low------	Low.
920B*:											
Clarion----------	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Low.
Estherville------	B	None--------	---	---	>6.0	---	---	---	Low------	Low------	Low.
920C2*, 920D2*:											
Clarion----------	B	None--------	---	---	>6.0	---	---	---	Moderate	Low------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
920C2*, 920D2*:											
Estherville	B	None	---	---	>6.0	---	---	---	Low	Low	Low.
Storden	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
921B*, 921C2*:											
Clarion	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Storden	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
956*:											
Canisteo	B/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	---	High	High	Low.
Glencoe	B/D	Rare	---	---	+1-1.0	Apparent	Oct-Jun	---	High	High	Low.
960D2*:											
Storden	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Clarion	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
960E*:											
Storden	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
Clarion	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
1029*. Pits											
1052*:											
Palms	A/D	None	---	---	+1-1.0	Apparent	Nov-May	25-32	High	High	Moderate.
Okoboji	D	None	---	---	+1-1.0	Apparent	Jan-Dec	---	High	High	Low.
1090 Blue Earth	B/D	None	---	---	1.0-3.0	Apparent	Jan-Jun	---	High	High	Low.
1833 Coland	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	---	High	High	Low.
1834 Coland	B/D	Frequent	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	---	High	High	Low.
1852F*:											
Terril	B	None	---	---	>6.0	---	---	---	Moderate	Moderate	Low.
Swanlake	B	None	---	---	>6.0	---	---	---	Moderate	Low	Low.
1877 Fostoria	B	None	---	---	2.0-4.0	Apparent	Nov-Jul	---	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months			Uncoated steel	Concrete
					Ft			In			
1907---------- Lakefield	B	None--------	---	---	2.5-5.0	Apparent	Apr-May	---	High-----	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

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
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Bold	Coarse-silty, mixed (calcareous), mesic Typic Udorthents
Brownton	Fine, montmorillonitic (calcareous), mesic Typic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Collinwood	Fine, montmorillonitic, mesic Aquic Hapludolls
Crippin	Fine-loamy, mixed, mesic Aquic Hapludolls
Delft	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Farrar	Fine-loamy, mixed, mesic Typic Hapludolls
Fostoria	Fine-loamy, mixed, mesic Aquic Hapludolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Grogan	Coarse-silty, mixed, mesic Typic Hapludolls
Hanska	Coarse-loamy, mixed, mesic Typic Haplaquolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Kingston	Fine-silty, mixed, mesic Aquic Hapludolls
Lakefield	Fine-silty, mixed, mesic Aquic Hapludolls
Lemond	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
*Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Linder	Coarse-loamy, mixed, mesic Aquic Hapludolls
*Litchfield	Sandy, mixed, mesic Aquic Hapludolls
Madelia	Fine-silty, mixed, mesic Typic Haplaquolls
Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Millington	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Ocheyedan	Fine-loamy, mixed, mesic Typic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Sparta	Sandy, mixed, mesic Entic Hapludolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Swanlake	Fine-loamy, mixed, mesic Entic Hapludolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Truman	Fine-silty, mixed, mesic Typic Hapludolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Waldorf	Fine, montmorillonitic, mesic Typic Haplaquolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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