United States Department of Agriculture

Soil Conservation Service

In cooperation with Minnesota Agricultural Experiment Station

Soil Survey of Watonwan County, Minnesota

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How To Use This Soil Survey

General Soil Map

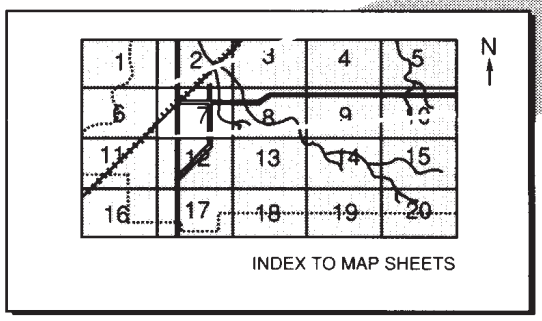
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

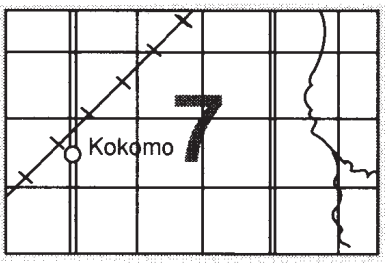
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



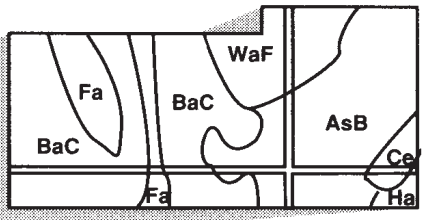
INDEX TO MAP SHEETS



MAP SHEET

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.

MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1986. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. Assistance was provided by the Minnesota Extension Service and the Soil and Water Conservation Board. The survey was partially funded by the Legislative Commission for Minnesota Resources and Watonwan County. It is part of the technical assistance furnished to the Watonwan 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.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Terraces in an area of Fedji loamy fine sand, 1 to 6 percent slopes, help to control water erosion.

Contents

Issued May 1992

Index to Map Units

Summary of Tables

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Foreword

This soil survey contains information that can be used in land-planning programs in Watonwan 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

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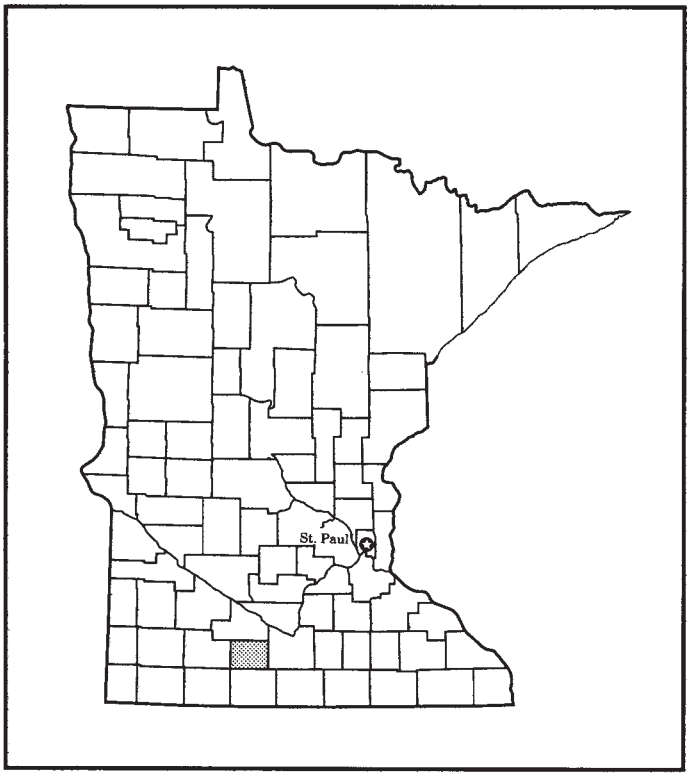
State Conservationist
Soil Conservation Service



Location of Watonwan County in Minnesota.

Soil Survey of Watonwan County, Minnesota

By James J. Murray, Soil Conservation Service

Fieldwork by James J. Murray and Michael J. Domeier, Soil Conservation Service, and Gary S. Elsner, Minnesota Agricultural Experiment Station

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

WATONWAN COUNTY is in the south-central part of Minnesota. St. James is the county seat. The county has a total land area of 277,120 acres, or 433 square miles, and total water areas of about 2,560 acres.

The soils in Watonwan County are dark and nearly level to steep. They formed in glacial till or water-sorted till material. Their original vegetation was tall and mid prairie grasses.

General Nature of the County

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

History

Watonwan County was established on February 25, 1860, when Gov. Alexander Ramsey signed the implementing legislation. Originally part of Blue Earth County, Watonwan County was organized in April 1861, with Madelia as the county seat. In 1978, the county seat was moved to St. James after a countywide referendum.

In 1857 and 1858, the first settlers of the area now called Watonwan County arrived in and around Madelia, and a few families settled near Long Lake. Before the arrival of the settlers, the area was home to the Sioux and the Dakotas. Germans, Norwegians, and Swedes settled the northern part of the county. The Irish and pioneers from Indiana and Wisconsin settled the central part. As soon as the new settlers arrived, each group established their own schools and churches.

In 1870, a railroad was constructed from Lake Crystal to St. James, which is between Minneapolis and Sioux City, Iowa.

The population in 1910 was 11,382. The people were mainly of German, Swedish, Norwegian, English, Irish, Danish, Austrian, and Russian descent *(5)*. In 1940, the population was 13,920; in 1980, it was 12,362 *(6)*. The incorporated cities in the county are Butterfield, Darfur, LaSalle, Lewisville, Madelia, Odin, Ormsby, and St. James.

Climate

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at St. James in the period 1948 to 1989. 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 7 degrees. The lowest temperature on record, which occurred at St. James on January 21, 1970, is -30 degrees. In summer, the average temperature is 71 degrees and the average daily maximum temperature is 83 degrees. The highest recorded temperature, which occurred at St. James on July 10, 1976, 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 26.9 inches. Of this, nearly 21 inches, or about 80 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 17 inches. The heaviest 1-day rainfall during the period of record was 6.1 inches at St. James on June 8, 1953. Thunderstorms occur on about 42 days each year.

The average seasonal snowfall is about 38 inches. The greatest snow depth at any one time during the period of record was 44 inches. On the average, 90 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 65 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 50 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 14 miles per hour, in spring.

Farming

In 1982, the 885 farms in the county had a total land area of 260,395 acres *(12)*. Since then, the farms have been decreasing in number but increasing in average size. Farming is the most important enterprise in the county. The main crops are corn, soybeans, small grain, hay, peas, and sweet corn. The main kinds of livestock are beef and dairy cattle, poultry, and hogs.

Transportation Facilities and Markets

A railroad connecting the northeastern and southwestern parts of the county serves Madelia, Grogan, St. James, and Butterfield. At Butterfield it branches north and south to serve Darfur and Odin.

The major highways in the county are paved or blacktop roads. Minnesota State Highway 60 crosses the county from northeast to southwest. Minnesota State Highways 15 and 4 cross the county from north to south. Of the 352 miles of county and township roads that serve every farmstead, about 182 miles have been paved, and more are being paved each year. The rest are gravel roads.

Grain elevators are located in all the cities. Livestock usually are trucked to South St. Paul, Estherville, Austin, or Worthington. Most milk is marketed as whole milk and is picked up daily by truck. Grain is shipped by truck or rail.

Water Supply

Much of Watonwan County is flat and poorly drained, and many shallow wells have practically inexhaustible supplies of water *(7)*. Some shallow gravel pits hold water even during the driest seasons. In areas where glacial drift is clayey and impervious, shallow wells produce inadequate yields. In these areas deeper wells drilled into the sand and gravel beds near the base of drift produce more abundantly and regularly than the shallow wells.

Except for areas where bedrock of Sioux Quartzite crops out, the entire county has a mantle of glacial drift. In some areas in the western part of the county, the drift is less than 20 feet thick. In the eastern part of the county, it ranges in thickness from 150 to 300 feet. The supply of water from the glacial drift is primarily from the sand and gravel layers in the deeper blue clay material or from permeable layers at the base of the drift. During wet years, the gravelly zones in the upper yellow clay material near the surface provide satisfactory yields, but during prolonged dry periods the water level may drop significantly.

In the western part of the county, most farm wells are drilled into the upper part of the quartzite. Where the quartzite is porous and decomposed, water can be drawn from the contact between drift and the firm, impervious quartzite. In the southeastern part of the county, most farm wells are 150 to 225 feet deep.

Irrigation

In 1985, about 1,500 acres of irrigated cropland in Watonwan County was planted to corn and soybeans. The potential for irrigation is good on about 22,000 acres.

Irrigation is common on the sandy Dickman, Estherville, Lasa, and Sparta soils, which have a low available water capacity. These soils are droughty in July and August.

The economic feasibility of irrigation depends on crop prices, the availability of financing, and water sources. In Watonwan County, irrigation water mainly comes from wells rather than from areas of surface water. Wells draw water from the surficial outwash if the outwash is thick enough. In some areas the water is drawn from a gravel or sand aquifer within the underlying till.

Physiography, Relief, and Drainage

The surface of Watonwan County consists mostly of a nearly level to rolling glacial till plain, a nearly level to gently sloping outwash plain, and a lake plain. The county is about 1,300 feet above sea level in the southwestern corner and slopes gradually to about 1,000 feet above sea level in the northeastern part. A quartzite bedrock ridge crosses the northwestern part of the county, and small areas of bedrock exposures are near Darfur.

Shallow stream valleys break the surface of the county. The streams include the North Fork of the Watonwan River, which flows through the northern part of the county, and the South Fork, which drains the southern and eastern parts. These two forks unite west of Madelia to form the Watonwan River, which flows east into Blue Earth County.

The last ice sheet that covered the county was the New Ulm phase of the Des Moines lobe. The landscape of Watonwan County formed from glacial till and outwash material and from lake sediments of the great ice sheet.

The glacial till plain is in the western and south-central parts of the county. The topography of this area consists of small hills interspersed with lowlands and depressions. This area is nearly level near Odin and Ormsby, nearly level to gently undulating near St. James, and gently undulating to rolling near Butterfield and Darfur.

During the warm periods that occurred while the ice sheets covered the county, meltwater formed the proglacial Lake Minnesota basin, which covered part of Watonwan County and the adjacent Brown, Blue Earth, and Martin Counties. This glacial meltwater deposited sandy and gravelly outwash over the silty and loamy sediments of this lake basin near LaSalle and Grogan. It eventually cut the stream channels of the present North and South Forks of the Watonwan River. It also deposited fine-silty and clayey sediments to form the lake plain between Madelia and Truman.

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 biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and 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 a considerable degree of 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, reaction, 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 *(10)*. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils

in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are 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 are 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 predict with a fairly high degree of accuracy 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 similar inclusions. They are described but are not identified by name 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 identified by name 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. Some soil boundaries and soil names may not fully match those of adjoining areas that were published at an earlier date. This is a result of changes and refinements in series concepts, different slope groupings, and application of the latest soil classification system.

In some areas along the borders of the county, the general soil map names do not correspond exactly to those in adjacent soil survey areas. The soils, however, are very similar in use and management. The differences in map unit names do not affect the usefulness of the general soil map for its intended purposes.

1. Webster-Nicollet-Canisteo Association

Nearly level and gently sloping, poorly drained and moderately well drained soils formed in glacial till; on uplands

Setting

Landform and position on the landform: Low rises, flats, slightly convex areas, and rims of depressions on till plains

Slope range: 0 to 3 percent

Composition

Percent of survey area: 13

Extent of components in the association:
Webster and similar soils—30 percent
Nicollet and similar soils—25 percent
Canisteo and similar soils—15 percent
Minor soils—30 percent

Soil Properties and Qualities

Webster

Drainage class: Poorly drained
Parent material: Glacial till
Surface texture: Clay loam

Nicollet

Drainage class: Moderately well drained
Parent material: Glacial till
Surface texture: Loam

Canisteo

Drainage class: Poorly drained
Parent material: Calcareous glacial till
Surface texture: Clay loam

Minor Soils

- Well drained Clarion soils in the higher landscape positions
- Very poorly drained Glencoe and Okoboji soils in depressions

Use and Management

Major uses: Cropland

Major management factors: Webster—the seasonal high water table, tilth; Nicollet—tilth; Canisteo—the seasonal high water table, pH, tilth

2. Canisteo-Ves Association

Nearly level to moderately steep, poorly drained and well drained soils formed in glacial till; on uplands

Setting

Landform and position on the landform: Slightly convex areas, rims of depressions, and hills on till plains (fig. 1)

Slope range: 0 to 15 percent

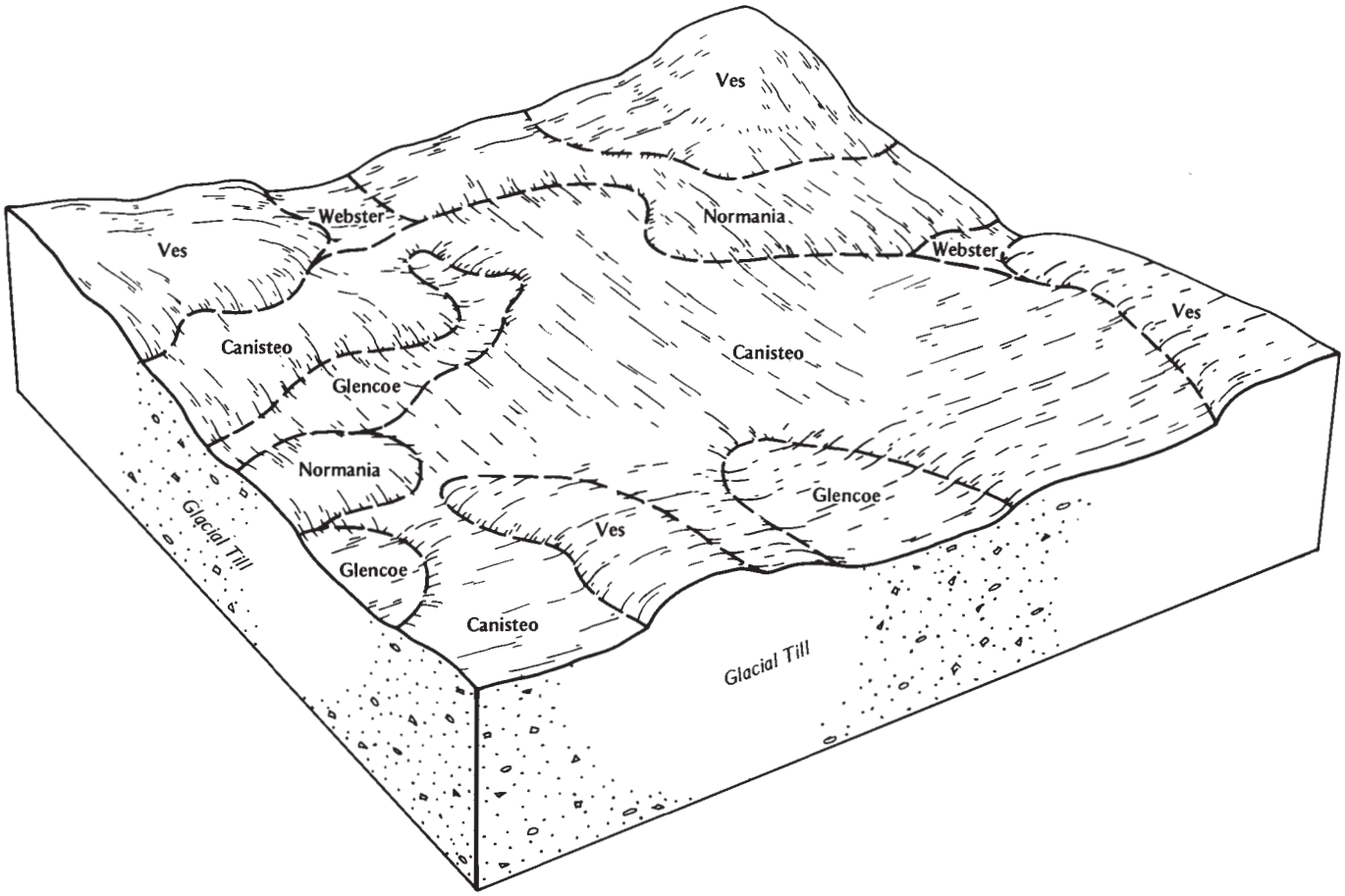


Figure 1.—Typical pattern of soils, landscape, and underlying material in the Canisteo-Ves association.

Composition

Percent of survey area: 7
Extent of components in the association:
Canisteo and similar soils—35 percent
Ves and similar soils—30 percent
Minor soils—35 percent

Soil Properties and Qualities

Canisteo

Drainage class: Poorly drained
Parent material: Calcareous glacial till
Surface texture: Clay loam

Ves

Drainage class: Well drained
Parent material: Glacial till
Surface texture: Loam

Minor Soils

- Very poorly drained Glencoe and Okoboji soils in depressions
- Moderately well drained Normania soils on side slopes
- Moderately well drained Seaforth soils on knobs and low ridges
- Poorly drained Webster soils on low flats

Use and Management

Major uses: Cropland
Major management factors: Canisteo—the seasonal high water table, pH, tilth; Ves—slope, tilth, eroded surface

3. Canisteo-Clarion-Webster Association

Nearly level to moderately steep, poorly drained and well drained soils formed in glacial till; on uplands

Setting

Landform and position on the landform: Slightly convex areas, rims of depressions, knolls, side slopes, and low flats on till plains (fig. 2)

Slope range: 0 to 18 percent

Composition

Percent of survey area: 28
Extent of components in the association:
Canisteo and similar soils—30 percent
Clarion and similar soils—25 percent
Webster and similar soils—15 percent
Minor soils—30 percent

Soil Properties and Qualities

Canisteo

Drainage class: Poorly drained
Parent material: Calcareous glacial till
Surface texture: Clay loam

Clarion

Drainage class: Well drained
Parent material: Glacial till
Surface texture: Loam

Webster

Drainage class: Poorly drained
Parent material: Glacial till
Surface texture: Clay loam

Minor Soils

• Very poorly drained Okoboji and Glencoe soils in depressions

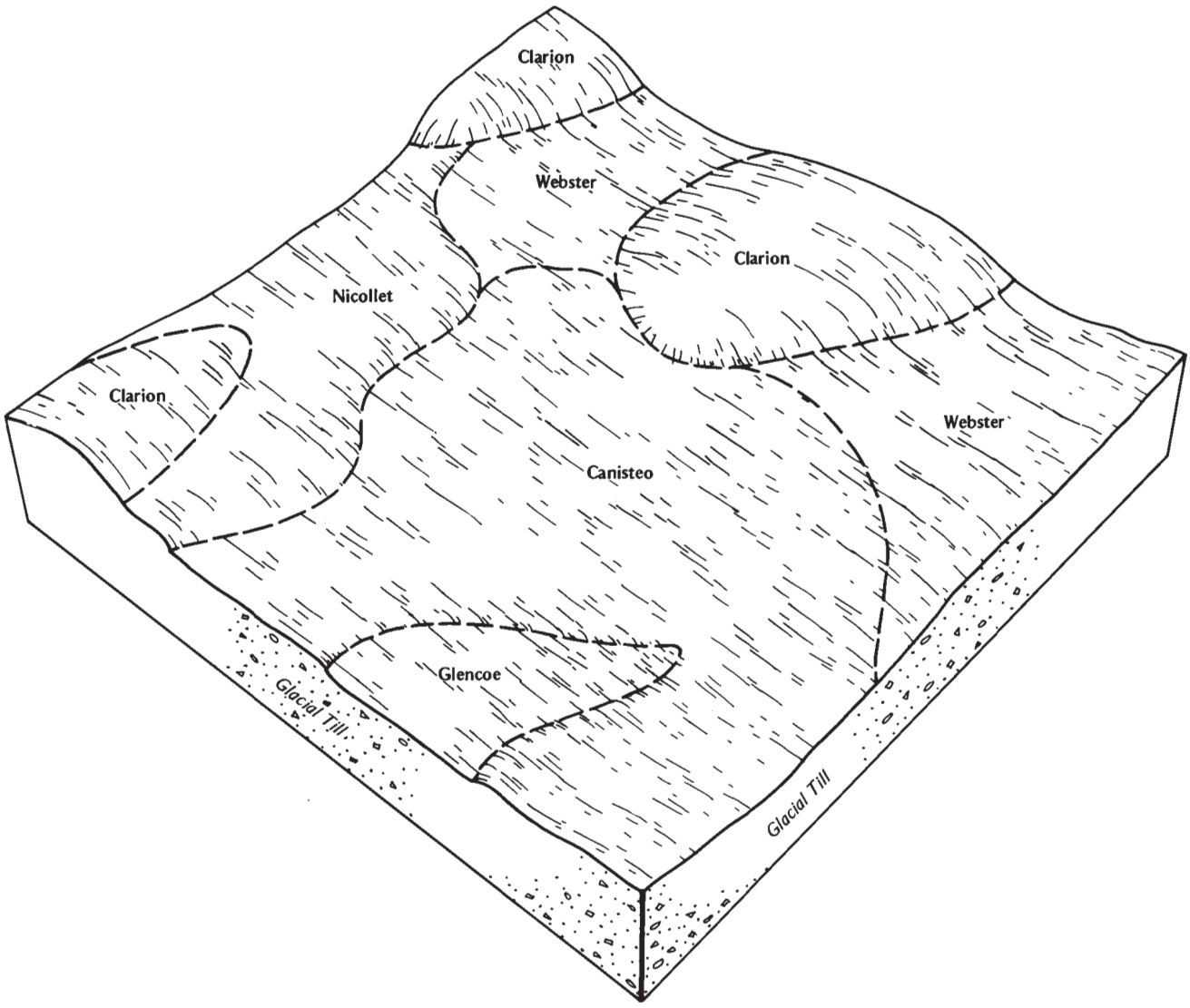


Figure 2.—Typical pattern of soils, landscape, and underlying material in the Canisteo-Clarion-Webster association.

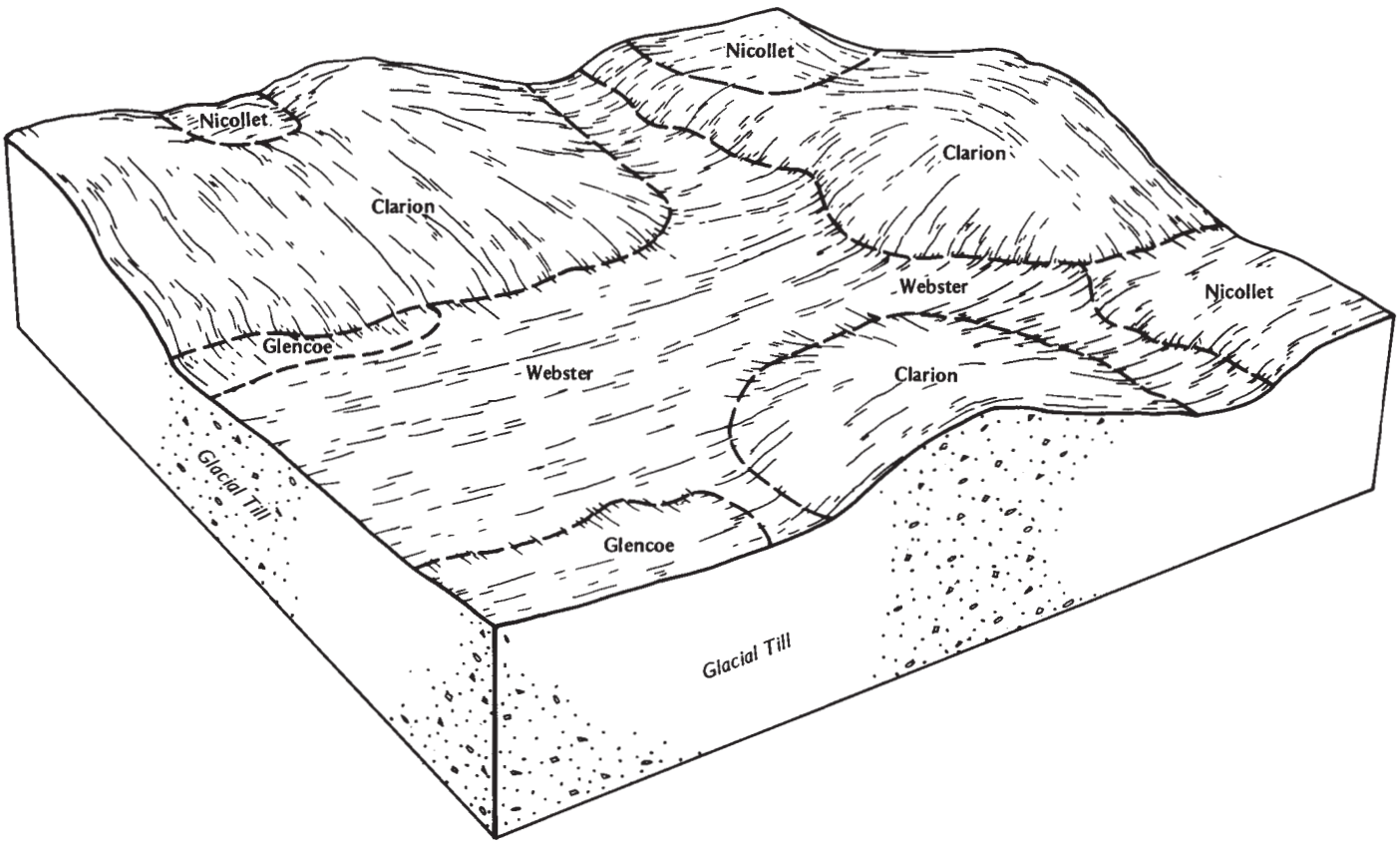


Figure 3.—Typical pattern of soils, landscape, and underlying material in the Clarion-Webster-Nicollet association.

- Moderately well drained Nicollet soils on low rises
- Well drained Storden soils on hills and knolls

Use and Management

Major uses: Cropland

Major management factors: Canisteo—the seasonal high water table, pH, tilth; Clarion—slope, tilth; Webster—the seasonal high water table, tilth

4. Clarion-Webster-Nicollet Association

Nearly level to moderately steep, well drained, poorly drained, and moderately well drained soils formed in glacial till; on uplands

Setting

Landform and position on the landform: Low rises, low flats, hills, knolls, and side slopes on till plains (fig. 3)

Slope range: 0 to 18 percent

Composition

Percent of survey area: 9

Extent of components in the association:
Clarion and similar soils—30 percent
Webster and similar soils—20 percent
Nicollet and similar soils—15 percent
Minor soils—35 percent

Soil Properties and Qualities

Clarion

Drainage class: Well drained
Parent material: Glacial till
Surface texture: Loam

Webster

Drainage class: Poorly drained
Parent material: Glacial till
Surface texture: Clay loam

Nicollet

Drainage class: Moderately well drained
Parent material: Glacial till
Surface texture: Loam

Minor Soils

- Very poorly drained Glencoe soils in depressions
- Poorly drained Delft soils in drainageways or swales
- Poorly drained Canisteo soils on the rims of depressions
- Well drained Storden soils on side slopes

Use and Management

Major uses: Cropland
Major management factors: Clarion—slope, tilth; Webster—the seasonal high water table, tilth; Nicollet—tilth

5. Clarion-Fieldon-Litchfield Association

Nearly level to moderately steep, well drained, poorly drained, and moderately well drained soils formed in glacial till, glacial outwash sediments, and glacial outwash; on uplands

Setting

Landform and position on the landform: Knolls, side slopes, low flats, and low rises on till plains, lake plains, and outwash plains
Slope range: 0 to 18 percent

Composition

Percent of survey area: 9
Extent of components in the association:
Clarion and similar soils—30 percent
Fieldon and similar soils—20 percent
Litchfield and similar soils—15 percent
Minor soils—35 percent

Soil Properties and Qualities

Clarion

Drainage class: Well drained
Parent material: Glacial till
Surface texture: Loam

Fieldon

Drainage class: Poorly drained
Parent material: Calcareous glacial outwash sediments
Surface texture: Loam

Litchfield

Drainage class: Moderately well drained
Parent material: Glacial outwash
Surface texture: Loamy fine sand

Minor Soils

- Excessively drained Sparta soils in the higher landscape positions
- Well drained Lasa and Dickman soils on flats and convex slopes

Use and Management

Major uses: Cropland
Major management factors: Clarion—slope, tilth; Fieldon—the seasonal high water table, pH, available water capacity, ground water; Litchfield—available water capacity, ground water, droughtiness, soil blowing, organic matter content

6. Okoboji-Waldorf Association

Nearly level, very poorly drained and poorly drained soils formed in glacial sediments; on uplands

Setting

Landform and position on the landform: Closed depressions and low flats on till plains and lake plains
Slope range: 0 to 1 percent

Composition

Percent of survey area: 5
Extent of components in the association:
Okoboji and similar soils—40 percent
Waldorf and similar soils—25 percent
Minor soils—35 percent

Soil Properties and Qualities

Okoboji

Drainage class: Very poorly drained
Parent material: Glacial sediments
Surface texture: Silty clay loam

Waldorf

Drainage class: Poorly drained
Parent material: Glaciolacustrine sediments
Surface texture: Silty clay loam

Minor Soils

- Well drained Bold soils on shoulders and summits
- Poorly drained Brownton soils in slightly convex or nearly plane areas
- Poorly drained Spicer soils in low-lying areas
- Well drained Truman soils on convex slopes
- Moderately well drained Kingston soils on slight rises

Use and Management

Major uses: Cropland
Major management factors: Okoboji—the seasonal high water table, ponding, tilth, permeability; Waldorf—the seasonal high water table, tilth, permeability

7. Madelia-Kingston-Spicer Association

Nearly level and gently sloping, poorly drained and moderately well drained soils formed in lacustrine sediments; on uplands

Setting

Landform and position on the landform: Low-lying flats and low rises on lake plains
Slope range: 0 to 3 percent

Composition

Percent of survey area: 10
Extent of components in the association:
Madelia and similar soils—25 percent
Kingston and similar soils—20 percent
Spicer and similar soils—20 percent
Minor soils—35 percent

Soil Properties and Qualities

Madelia

Drainage class: Poorly drained
Parent material: Silty lacustrine sediments
Surface texture: Silty clay loam

Kingston

Drainage class: Moderately well drained
Parent material: Silty lacustrine sediments
Surface texture: Silty clay loam

Spicer

Drainage class: Poorly drained
Parent material: Calcareous glaciolacustrine sediments
Surface texture: Silty clay loam

Minor Soils

- Very poorly drained Okoboji soils in depressions
- Well drained Bold soils on shoulders and summits
- Poorly drained Brownton soils in slightly convex or nearly plane areas
- Poorly drained Waldorf soils in slightly concave or nearly plane areas
- Well drained Truman soils on convex slopes

Use and Management

Major uses: Cropland
Major management factors: Madelia—the seasonal high water table, tilth; Kingston—tilth; Spicer—the seasonal high water table, pH, tilth

8. Dickman-Fieldon-Sparta Association

Nearly level and gently sloping, well drained, poorly drained, and excessively drained soils formed in glacial outwash sediments; on uplands

Setting

Landform and position on the landform: Low-lying flats, plane areas, and slightly convex rises and slopes on outwash plains and glacial lake plains
Slope range: 0 to 6 percent

Composition

Percent of survey area: 4
Extent of components in the association:
Dickman and similar soils—30 percent
Fieldon and similar soils—20 percent
Sparta and similar soils—15 percent
Minor soils—35 percent

Soil Properties and Qualities

Dickman

Drainage class: Well drained
Parent material: Glacial outwash sediments
Surface texture: Sandy loam

Fieldon

Drainage class: Poorly drained
Parent material: Calcareous glacial outwash sediments
Surface texture: Loam

Sparta

Drainage class: Excessively drained
Parent material: Glacial outwash sediments
Surface texture: Loamy sand

Minor Soils

- Well drained Lasa soils in plane areas and on convex slopes
- Well drained Estherville soils on convex slopes

Use and Management

Major uses: Cropland
Major management factors: Sparta and Dickman—available water capacity, soil blowing, ground water, organic matter content; Fieldon—the seasonal high water table, pH, available water capacity, ground water

9. Lasa-Fieldon-Litchfield Association

Nearly level and gently sloping, well drained, poorly drained, and moderately well drained soils formed in glacial outwash and glacial outwash sediments; on uplands

Setting

Landform and position on the landform: Low-lying flats and low rises on outwash plains and lake plains (fig. 4)

Figure 4.—An area of the Lasa-Fieldon-Litchfield association, which is used mainly for crops.

Slope range: 0 to 6 percent

Composition

Percent of survey area: 9
Extent of components in the association:
Lasa and similar soils—25 percent
Fieldon and similar soils—25 percent
Litchfield and similar soils—15 percent
Minor soils—35 percent

Soil Properties and Qualities

Lasa

Drainage class: Well drained
Parent material: Glacial outwash
Surface texture: Loamy fine sand

Fieldon

Drainage class: Poorly drained
Parent material: Calcareous glacial outwash sediments
Surface texture: Loam

Litchfield

Drainage class: Moderately well drained
Parent material: Glacial outwash
Surface texture: Loamy fine sand

Minor Soils

- Poorly drained Darfur soils in the lower landscape positions
- Very poorly drained Dassel soils in depressions
- Excessively drained Sparta soils in the higher landscape positions
- Well drained Grogan soils on convex slopes

Use and Management

Major uses: Cropland

Major management factors: Fieldon—the seasonal high water table, pH, available water capacity, ground water; Litchfield and Lasa—available water capacity, ground water, soil blowing, organic matter content

10. Coland-Storden-Millington Association

Nearly level to very steep, poorly drained and well drained soils; formed in alluvium on flood plains and in glacial till on uplands

Setting

Landform and position on the landform: Low-lying flat areas and convex hills and side slopes on flood plains and till plains
Slope range: 0 to 35 percent

Composition

Percent of survey area: 6
Extent of components in the association:
Coland and similar soils—30 percent
Storden and similar soils—20 percent
Millington and similar soils—15 percent
Minor soils—35 percent

Soil Properties and Qualities

Coland

Drainage class: Poorly drained
Parent material: Loamy alluvium
Surface texture: Clay loam

Storden

Drainage class: Well drained
Parent material: Calcareous glacial till
Surface texture: Loam

Millington

Drainage class: Poorly drained
Parent material: Calcareous alluvium
Surface texture: Clay loam

Minor Soils

- Moderately well drained Hanlon soils on flood plains
- Very poorly drained Kalmarville soils on flood plains
- Well drained Clarion soils on side slopes

Use and Management

Major uses: Pasture, wildlife habitat
Secondary use: Cropland
Major management factors: Coland and Millington—the seasonal high water table, flooding, tilth; Storden—slope, eroded surface, organic matter content, pH

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, Grogan silt loam, 0 to 2 percent slopes, is a phase of the Grogan series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, 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. Fieldon-Canisteo complex is an example.

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

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits 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.

As a result of changes in soil series concepts, different soil patterns, and map unit design, some soil boundaries and names in this county do not match those in adjacent counties.

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.

Note to user.—This technical publication includes suggested management practices that are intended to increase crop production, to control soil blowing and water erosion, and to reduce wetness. Over a period of time, some or all of these conservation practices may or may not be in accordance with federal, state, and local laws and agency rules and guidelines.

8B—Sparta loamy sand, 1 to 6 percent slopes

Composition

Sparta soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Flat areas and slightly convex slopes on outwash plains
Shape of areas: Circular or oblong

Size of areas: 3 to 90 acres

Typical Profile

0 to 10 inches—black loamy sand
10 to 23 inches—very dark brown loamy sand
23 to 38 inches—brown loamy sand
38 to 60 inches—brown sand

Soil Properties and Qualities

Drainage class: Excessively drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Low
Organic matter content: Moderately low
Surface runoff: Slow
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur soils on the lower parts of the landscape
• Moderately well drained Litchfield soils on the lower parts of the landscape

Similar soils:
• Soils that have a surface layer of loamy coarse sand, sand, or coarse sandy loam
• Soils that have a thinner surface layer

Use and Management

Cropland:
• Major management factors: Available water capacity, soil blowing, ground water, organic matter content
• Select drought-tolerant plants, or install an irrigation system for crops.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IVs

27A—Dickinson fine sandy loam, 0 to 2 percent slopes

Composition

Dickinson soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Plane or slightly convex areas on uplands and stream terraces
Shape of areas: Circular or oblong
Size of areas: 3 to 60 acres

Typical Profile

0 to 7 inches—black fine sandy loam
7 to 17 inches—very dark gray fine sandy loam
17 to 40 inches—yellowish brown fine sandy loam
40 to 60 inches—brown and dark yellowish brown fine sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Moderate
Organic matter content: Moderately low
Surface runoff: Slow
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur soils on the lower parts of the landscape
• Somewhat poorly drained Linder soils on the lower parts of the landscape

Similar soils:
• Soils that have underlying material of stratified, loamy sediments
• Soils that have a loamy mantle less than 20 inches thick
• Soils that have carbonates in the underlying material

Use and Management

Cropland:
• Major management factors: Available water capacity, ground water, soil blowing, organic matter content
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.
• Return crop residue to the soil and use minimum tillage to conserve moisture.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIs

27B—Dickinson fine sandy loam, 2 to 6 percent slopes

Composition

Dickinson soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on uplands and stream terraces
Shape of areas: Circular or oblong
Size of areas: 3 to 80 acres

Typical Profile

0 to 9 inches—black fine sandy loam
9 to 14 inches—very dark gray fine sandy loam
14 to 19 inches—dark grayish brown fine sandy loam
19 to 40 inches—dark yellowish brown fine sandy loam
40 to 60 inches—dark yellowish brown fine sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Moderate
Organic matter content: Moderately low
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur soils on the lower parts of the landscape
• Somewhat poorly drained Linder soils on the lower parts of the landscape

Similar soils:
• Soils that have stratified, loamy sediments within 60 inches of the surface
• Soils that have carbonates in the underlying material

Use and Management

Cropland:
• Major management factors: Available water capacity, slope, ground water, organic matter content
• Available water capacity is moderate, and in some years crops may not have sufficient moisture.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to control erosion.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIe

31F—Storden loam, 20 to 35 percent slopes

Composition

Storden soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Steep side slopes along stream valleys and ravines on till plains
Shape of areas: Long and narrow
Size of areas: 4 to 40 acres

Typical Profile

0 to 10 inches—dark grayish brown, calcareous loam
10 to 60 inches—brown and yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderately low
Surface runoff: Very rapid
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Well drained Clarion soils, which are in landscape positions similar to those of the Storden soil and have a thicker, darker surface layer
• Poorly drained Delft soils in low areas

Similar soils:
• Soils that have a surface layer of sandy loam
• Soils that have small pockets of sand and gravel

Use and Management

Cropland:
• This soil is generally unsuited to cropland because of steep and very steep slopes.

Wildlife habitat:
• Major management factors: Slope, pH
• Planting shrubs and trees can improve habitat for wildlife.
• Maintaining a permanent plant cover helps to control erosion.
• Plants sensitive to high pH should not be planted.

Interpretive Groups

Land capability classification: VIIe

35—Blue Earth mucky silt loam

Composition

Blue Earth soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Drained lakes on till plains
Slope range: 0 to 1 percent
Shape of areas: Irregular or circular
Size of areas: 5 to 220 acres

Typical Profile

0 to 10 inches—black, calcareous mucky silt loam
10 to 60 inches—very dark gray, mottled, calcareous mucky silt loam (coprogenous earth)

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderate
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to water table: 2 feet above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo soils, which formed in glacial till in the higher landscape positions

Similar soils:
• Soils that have a surface layer of peat more than 8 inches thick

Use and Management

Cropland:
• Major management factors: Ponding, the seasonal high water table, organic matter content, pH
• Suitable crops can be grown if drainage is adequate.
• Install surface inlets to reduce the hazard of ponding.
• High organic matter content may reduce effectiveness of herbicides.
• High lime content in the soil causes chlorosis in some plants. Select lime-tolerant crop varieties.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.

Interpretive Groups

Land capability classification: IIIw

41B—Estherville sandy loam, 1 to 6 percent slopes

Composition

Estherville soil and similar soils: 85 to 95 percent
Contrasting inclusions: 10 to 15 percent

Setting

Landform and position on the landform: Convex slopes on outwash plains
Shape of areas: Oblong or circular
Size of areas: 3 to 30 acres

Typical Profile

0 to 9 inches—black sandy loam
9 to 13 inches—very dark grayish brown sandy loam
13 to 18 inches—dark yellowish brown sandy loam
18 to 60 inches—variegated yellowish brown and brown, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Biscay soils in the lower landscape positions
• Somewhat poorly drained Linder soils in the lower landscape positions

Similar soils:
• Soils that have glacial till within 60 inches of the surface
• Soils that have a loamy mantle less than 10 inches thick or more than 20 inches thick

Use and Management

Cropland:
• Major management factors: Available water capacity, soil blowing, ground water
• Select drought-tolerant plants, or install an irrigation system for crops.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soi blowing.
• Carefully control the use and application of agricultura chemicals to prevent ground water contamination.

Interpretive Groups

Land capability classification: IIIs

69B—Fedji loamy fine sand, 1 to 6 percent slopes

Composition

Fedji soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Convex slopes on outwash plains and deltas
Shape of areas: Circular or oblong
Size of areas: 3 to 20 acres

Typical Profile

0 to 8 inches—very dark grayish brown loamy fine sand
8 to 12 inches—dark brown fine sand
12 to 35 inches—dark yellowish brown loamy fine sand and loose fine sand
35 to 42 inches—yellowish brown clay loam
42 to 60 inches—light olive brown, mottled, calcareous clay loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Upper part—rapid; lower part—moderate
Available water capacity: Moderate
Organic matter content: Moderately low or moderate
Surface runoff: Slow
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained soils in low areas
• Well drained Clarion soils on knolls

Similar soils:
• Soils in which the surface layer or the lower part of the subsoil is fine sandy loam or sandy loam
• Soils that have underlying material of loamy fine sand, fine sand, or sand

Use and Management

Cropland:
• Major management factors: Available water capacity, soil blowing, organic matter content
• During years of low rainfall, the drought hazard can limit crop yields. Early maturing crops that avoid the late season drought are best suited.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIs

84—Brownton silty clay loam

Composition

Brownton soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Slightly convex or nearly plane areas on glacial lake plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 10 to 100 acres

Typical Profile

0 to 22 inches—black, calcareous silty clay loam
22 to 38 inches—dark grayish brown, mottled, calcareous silty clay
38 to 60 inches—grayish brown and light brownish gray, mottled, calcareous silty clay loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—slow; lower part—moderately slow or moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1.0 to 2.5 feet

Inclusions

Contrasting inclusions:
• Very poorly drained Okoboji soils in depressions

Similar soils:
• Soils that have a surface layer more than 24 inches thick
• Soils that have a subsoil that has less clay
• Soils where gypsum powder or crystals are at or near the surface
• Soils that are leached to a depth of 20 inches or more

Use and Management

Cropland:
• Major management factors: The seasonal high water table, pH, tilth, permeability
• Crops suited to this soil can be grown if adequate drainage is provided.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• If worked when wet, this soil will compact and form clods.
• High clay content limits water movement within the soil; consequently, tile needs closer spacing.

Interpretive Groups

Land capability classification: IIw

86—Canisteo clay loam

Composition

Canisteo soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Slightly convex areas and rims of depressions on till plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 4 to 600 acres

Typical Profile

0 to 14 inches—black, calcareous clay loam
14 to 22 inches—very dark gray, calcareous clay loam
22 to 36 inches—dark grayish brown, mottled, calcareous clay loam
36 to 60 inches—light brownish gray, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Somewhat poorly drained Crippin soils in the higher landscape positions
• Very poorly drained soils in depressions

Similar soils:
• Soils that have a dark surface layer more than 24 inches thick
• Soils that contain gypsum crystals or are very high in carbonates
• Soils that have underlying material of silt loam or very fine sandy loam

Use and Management

Cropland:
• Major management factors: The seasonal high water table, pH, tilth
• Crops suited to this soil can be grown if adequate drainage is provided.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• If worked when wet, this soil will compact and form clods.

Interpretive Groups

Land capability classification: IIw

101B—Truman silt loam, 1 to 4 percent slopes

Composition

Truman soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Rises on lake plains
Shape of areas: Oblong or irregular
Size of areas: 5 to 40 acres

Typical Profile

0 to 9 inches—black silt loam
9 to 14 inches—very dark gray silt loam
14 to 34 inches—brown silt loam
34 to 40 inches—yellowish brown, calcareous silt loam
40 to 60 inches—yellowish brown, mottled, calcareous silt loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Madelia and Spicer soils in the lower landscape positions
• Well drained Bold soils, which are in landscape positions similar to those of the Truman soil and have carbonates at or near the surface

Similar soils:
• Soils that have a mantle of loam
• Soils that have less clay in the surface layer and subsoil

Use and Management

Cropland:
• Major management factors: Slope, tilth
• Conservation tillage practices that leave crop residue on the surface help to control runoff and erosion.
• Waterways that are shaped, seeded, and maintained in grasses help to control gully erosion.
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: IIe

102B—Clarion loam, 1 to 4 percent slopes

Composition

Clarion soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls and side slopes on till plains
Shape of areas: Irregular
Size of areas: 3 to 60 acres

Typical Profile

0 to 10 inches—black loam
10 to 16 inches—very dark gray loam
16 to 32 inches—brown and dark yellowish brown loam
32 to 60 inches—brown and light olive brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderate or high
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Webster soils in the lower landscape positions
• Storden soils, which are in landscape positions similar to those of the Clarion soil and have carbonates at or near the surface

Similar soils:
• Soils that have underlying material of silt loam or very fine sandy loam
• Soils that are mottled in the subsoil

Use and Management

Cropland:
• Major management factors: Slope, tilth
• Conservation tillage practices that leave plant residue on the surface help to control runoff and erosion.
• Grassed waterways help to control gully erosion.
• Return crop residue to the soil, rotate crops, and use minimum tillage to help maintain tilth and fertility.

Interpretive Groups

Land capability classification: IIe

112—Harps clay loam

Composition

Harps soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Convex rims around depressions on till plains
Slope range: 0 to 2 percent
Shape of areas: Elongated or irregular
Size of areas: 3 to 25 acres

Typical Profile

0 to 9 inches—black, calcareous clay loam
9 to 18 inches—very dark gray, calcareous clay loam
18 to 36 inches—grayish brown, mottled, calcareous clay loam
36 to 60 inches—grayish brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Somewhat poorly drained Crippin soils in the higher landscape positions
• Very poorly drained soils in depressions

Similar soils:
• Soils that have gypsum crystals or powder in the surface layer and subsoil

Use and Management

Cropland:
• Major management factors: pH, the seasonal high water table, tilth
• Crops suited to this soil can be grown if adequate drainage is provided.
• If worked when wet, this soil will compact and form clods.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.

Interpretive Groups

Land capability classification: IIw

113—Webster clay loam

Composition

Webster soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on till plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 500 acres

Typical Profile

0 to 16 inches—black clay loam
16 to 23 inches—black and very dark grayish brown clay loam
23 to 33 inches—dark grayish brown, mottled clay loam
33 to 60 inches—grayish brown, mottled, calcareous clay loam and loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 2 feet

Inclusions

Contrasting inclusions:
• Moderately well drained Nicollet and Normania soils in the higher landscape positions
• Soils that have bedrock at a depth of 3 to 5 feet

Similar soils:
• Soils that have carbonates at or near the surface
• Soils that have a dark surface layer more than 24 inches thick

Use and Management

Cropland:
• Major management factors: The seasonal high water table, tilth
• Crops suited to this soil can be grown if adequate drainage is provided.
• If worked when wet, this soil will compact and form clods.

Interpretive Groups

Land capability classification: IIw

114—Glencoe clay loam

Composition

Glencoe soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Closed depressions on till plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 40 acres

Typical Profile

0 to 20 inches—black clay loam
20 to 28 inches—very dark gray clay loam
28 to 46 inches—olive gray, mottled, firm clay loam
46 to 60 inches—grayish brown, mottled clay loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Upper part—moderate or moderately slow; lower part—moderate
Available water capacity: High
Organic matter content: High or very high
Surface runoff: Very slow or ponded
Depth to water table: 1 foot above to 1 foot below the surface
Special characteristics: Water ponds in spring or after intensive or prolonged rainfall.

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo, Revere, and Harps soils on the rims of depressions or on slight rises

Similar soils:
• Soils that have a dark surface layer less than 24 inches thick or more than 46 inches thick
• Soils that have underlying material of silt loam or very fine sandy loam

Use and Management

Cropland:
• Major management factors: The seasonal high water table, tilth, ponding
• Crops suited to this soil can be grown if adequate drainage is provided.
• If worked when wet, this soil will compact and form clods.
• Surface inlets shorten the periods of ponding.

Interpretive Groups

Land capability classification: IIIw

118—Crippin loam

Composition

Crippin soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on till plains
Slope range: 1 to 3 percent
Shape of areas: Narrow and elongated

Size of areas: 5 to 25 acres

Typical Profile

0 to 10 inches—black, calcareous loam
10 to 17 inches—very dark gray, calcareous loam
17 to 26 inches—grayish brown, calcareous loam
26 to 60 inches—light olive brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 2 to 4 feet

Inclusions

Contrasting inclusions:
• Well drained Clarion and Swanlake soils in the higher landscape positions
• Poorly drained Canisteo soils in the lower landscape positions

Similar soils:
• Soils in which the surface layer is leached of carbonates

Use and Management

Cropland:
• Major management factors: Tilth
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.
• Consider soil pH when selecting agricultural chemicals and crop varieties.

Interpretive Groups

Land capability classification: I

128A—Grogan silt loam, 0 to 2 percent slopes

Composition

Grogan soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on till plains
Shape of areas: Irregular
Size of areas: 3 to 15 acres

Typical Profile

0 to 10 inches—black silt loam
10 to 21 inches—very dark brown and dark brown silt loam
21 to 38 inches—brown and yellowish brown, mottled, calcareous silt loam
38 to 41 inches—light olive brown, mottled, calcareous silt loam
41 to 60 inches—light olive brown, mottled, calcareous very fine sandy loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderately rapid
Available water capacity: High
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: 3 to 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained soils in the lower landscape positions

Similar soils:
• Soils that have more sand throughout
• Soils that are calcareous at or near the surface

Use and Management

Cropland:
• Major management factors: Tilth
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: I

128B—Grogan silt loam, 2 to 6 percent slopes

Composition

Grogan soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Rises and convex slopes on lake plains
Slope range: 2 to 6 percent
Shape of areas: Irregular
Size of areas: 3 to 35 acres

Typical Profile

0 to 9 inches—black silt loam
9 to 15 inches—dark brown silt loam
15 to 30 inches—dark yellowish brown silt loam
30 to 36 inches—yellowish brown, calcareous silt loam
36 to 41 inches—light olive brown, mottled, calcareous silt loam
41 to 60 inches—light olive brown, mottled, calcareous very fine sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: High
Organic matter content: Moderate
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained soils in the lower landscape positions

Similar soils:
• Soils that have more sand throughout
• Soils that are calcareous at or near the surface

Use and Management

Cropland:
• Major management factors: Slope, tilth
• Conservation tillage practices that leave residue on the surface help to control runoff and erosion.
• Grassed waterways help to control gully erosion.
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: IIe

130—Nicollet loam

Composition

Nicollet soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on till plains
Slope range: 1 to 3 percent
Shape of areas: Irregular
Size of areas: 3 to 200 acres

Typical Profile

0 to 12 inches—black loam
12 to 19 inches—very dark gray loam
19 to 28 inches—dark grayish brown clay loam
28 to 34 inches—olive brown, mottled clay loam
34 to 60 inches—light olive brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 2.5 to 5.0 feet

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo and Webster soils in the lower landscape positions
• Well drained Clarion soils in the higher landscape positions

Similar soils:
• Soils that are calcareous at or near the surface

Use and Management

Cropland:
• Major management factors: Tilth
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: I

134—Okoboji silty clay loam

Composition

Okoboji soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Closed depressions on till plains
Slope range: 0 to 1 percent
Shape of areas: Circular or oblong
Size of areas: 3 to 60 acres

Typical Profile

0 to 34 inches—black silty clay loam
34 to 48 inches—very dark gray silty clay loam
48 to 60 inches—grayish brown, mottled, calcareous, silty clay loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Upper part—moderately slow; lower part—moderate
Available water capacity: High
Organic matter content: High or very high
Surface runoff: Very slow or ponded
Depth to water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo and Spicer soils on the rims of depressions and on slight rises
• Poorly drained Waldorf soils in the higher landscape positions

Similar soils:
• Soils in which the dark surface layer is less than 24 inches thick
• Soils that have a thin layer of peat on the surface
• Soils that have more clay

Use and Management

Cropland:
• Major management factors: The seasonal high water table, ponding, tilth, permeability
• Crops suited to this soil can be grown if adequate drainage is provided.
• If worked when wet, this soil will compact and form clods.
• Surface inlets shorten the periods of ponding.
• High clay content limits water movement within the soil; consequently, tile needs closer spacing.

Interpretive Groups

Land capability classification: IIIw

136—Madelia silty clay loam

Composition

Madelia soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on lake plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 20 acres

Typical Profile

0 to 18 inches—black silty clay loam
18 to 25 inches—dark grayish brown, mottled silty clay loam
25 to 60 inches—grayish brown and light brownish gray, mottled, calcareous silt loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1.0 to 2.5 feet

Inclusions

Contrasting inclusions:
• Moderately well drained Kingston soils in the higher landscape positions
• Very poorly drained Okoboji soils in depressions

Similar soils:
• Soils that have carbonates at or near the surface
• Soils that have more clay

Use and Management

Cropland:
• Major management factors: The seasonal high water table, tilth
• Crops suited to this soil can be grown if adequate drainage is provided.
• If worked when wet, this soil will compact and form clods.

Interpretive Groups

Land capability classification: IIw

140—Spicer silty clay loam

Composition

Spicer soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying areas on lake plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 120 acres

Typical Profile

0 to 18 inches—black calcareous silty clay loam
18 to 30 inches—dark grayish brown, mottled, calcareous silty clay loam
30 to 44 inches—grayish brown, mottled, calcareous silty clay loam
44 to 60 inches—light brownish gray, mottled calcareous silt loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Moderately well drained Kingston soils in the higher landscape positions
• Very poorly drained Okoboji soils in depressions

Similar soils:
• Soils that have a dark surface layer more than 24 inches thick

• Soils in which the surface layer is leached of carbonates

Use and Management

Cropland:
• Major management factors: The seasonal high water table, pH, tilth
• Crops suited to this soil can be grown if adequate drainage is provided.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• If worked when wet, this soil will compact and form clods.

Interpretive Groups

Land capability classification: IIw

160—Fieldon loam

Composition

Fieldon soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on lake plains and outwash plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 400 acres

Typical Profile

0 to 16 inches—black, calcareous loam
16 to 20 inches—dark gray, calcareous fine sandy loam
20 to 32 inches—olive gray, mottled, calcareous fine sandy loam
32 to 60 inches—pale olive and light olive gray, mottled, calcareous loamy fine sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo and Webster soils, which are in landscape positions similar to those of the Fieldon soil and have more clay and less sand
• Very poorly drained Dassel soils in depressions

Similar soils:
• Soils in which the surface layer is leached of carbonates
• Soils that have a surface layer more than 24 inches thick
• Soils that have loamy material within a depth of 40 inches
• Soils that have more sand and coarse sand

Use and Management

Cropland:
• Major management factors: The seasonal high water table, pH, available water capacity, ground water
• Crops suited to this soil can be grown if adequate drainage is provided.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.

Interpretive Groups

Land capability classification: IIw

178—Granby loamy sand

Composition

Granby soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats and closed depressions on outwash plains
Slope range: 0 to 2 percent
Shape of areas: Oblong or irregular
Size of areas: 3 to 20 acres

Typical Profile

0 to 10 inches—black loamy sand
10 to 21 inches—black, mottled loamy sand
21 to 26 inches—very dark grayish brown, mottled loamy sand
26 to 32 inches—dark grayish brown, mottled loamy sand
32 to 60 inches—grayish brown, mottled loamy sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Rapid
Available water capacity: Low
Organic matter content: High or very high
Surface runoff: Slow to ponded
Depth to water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• Moderately well drained Litchfield soils in the higher landscape positions
• Very poorly drained Dassel soils, which are in landscape positions similar to those of the Granby soil and have more clay

Similar soils:
• Soils that have a surface layer of sand

Use and Management

Cropland:
• Major management factors: The seasonal high water table, ponding, soil blowing, available water capacity, ground water
• Crops suited to this soil can be grown if adequate drainage is provided.
• Install surface inlets to reduce the hazard of ponding.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.

Interpretive Groups

Land capability classification: IVw

181—Litchfield loamy fine sand

Composition

Litchfield soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on outwash plains
Slope range: 0 to 3 percent
Shape of areas: Irregular
Size of areas: 3 to 100 acres

Typical Profile

0 to 9 inches—black loamy fine sand
9 to 15 inches—very dark gray loamy fine sand
15 to 21 inches—very dark grayish brown loamy fine sand
21 to 30 inches—brown, mottled loamy fine sand
30 to 40 inches—grayish brown, mottled fine sand
40 to 60 inches—light brownish gray, mottled fine sand

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderately rapid
Available water capacity: Moderate
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: 2.5 to 5.0 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur soils in the lower landscape positions
• Very poorly drained Dassel soils in depressions
• Excessively drained Sparta soils in the higher landscape positions

Similar soils:
• Soils that have a subsoil of fine sandy loam

Use and Management

Cropland:
• Major management factors: Available water capacity, ground water, soil blowing, organic matter content
• Select drought-tolerant plants, or install an irrigation system for crops.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIs

183—Dassel fine sandy loam

Composition

Dassel soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Closed depressions on outwash plains
Slope range: 0 to 1 percent
Shape of areas: Oblong
Size of areas: 3 to 30 acres

Typical Profile

0 to 19 inches—black fine sandy loam
19 to 27 inches—very dark gray, mottled sandy loam
27 to 37 inches—dark gray, mottled sandy loam
37 to 60 inches—olive gray, mottled loamy sand

Soil Properties and Qualities

Drainage class: Very poorly drained

Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Slow to ponded
Depth to water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• Poorly drained Darfur soils in the higher landscape positions
• Poorly drained Fieldon soils on the rims of depressions and on slight rises

Similar soils:
• Soils that have a surface layer and subsoil of clay loam
• Soils that have more sand in the surface layer and subsoil

Use and Management

Cropland:
• Major management factors: The seasonal high water table, ponding, ground water, available water capacity, soil blowing
• Crops suited to this soil can be grown if adequate drainage is provided.
• Install surface inlets to reduce the hazard of ponding.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.

Interpretive Groups

Land capability classification: IIIw

197—Kingston silty clay loam

Composition

Kingston soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on lake plains
Slope range: 1 to 3 percent
Shape of areas: Irregular
Size of areas: 10 to 160 acres

Typical Profile

0 to 16 inches—black silty clay loam
16 to 22 inches—dark grayish brown silty clay loam
22 to 28 inches—light olive brown, calcareous silty clay loam
28 to 60 inches—light olive brown, mottled, calcareous silt loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Medium or slow
Depth to water table: 2.5 to 5.0 feet

Inclusions

Contrasting inclusions:
• Well drained Bold and Truman soils in the higher landscape positions
• Poorly drained Spicer and Madelia soils in the lower landscape positions

Similar soils:
• Soils that have underlying material of clay loam or loam
• Soils that have carbonates at or near the surface

Use and Management

Cropland:
• Major management factors: Tilth
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: I

222B—Lasa loamy fine sand, 1 to 6 percent slopes

Composition

Lasa soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Slight rises and flat areas on outwash plains and lake plains
Shape of areas: Circular or oblong
Size of areas: 3 to 20 acres

Typical Profile

0 to 10 inches—black loamy fine sand
10 to 18 inches—very dark grayish brown loamy fine sand
18 to 46 inches—dark yellowish brown and brown fine sand
46 to 60 inches—yellowish brown loamy fine sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur soils in the lower landscape positions

Similar soils:
• Soils that have loamy strata within 40 inches of the surface
• Soils that have a dark surface layer more than 24 inches thick
• Soils that are mottled in the subsoil

Use and Management

Cropland:
• Major management factors: Available water capacity, ground water, soil blowing, organic matter content
• Select drought-tolerant plants, or install an irrigation system for crops.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIs

227—Lemond loam

Composition

Lemond soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on outwash plains
Slope range: 0 to 2 percent
Shape of areas: Elongated or irregular
Size of areas: 5 to 100 acres

Typical Profile

0 to 18 inches—black, calcareous loam
18 to 23 inches—very dark gray, calcareous sandy loam
23 to 28 inches—grayish brown, mottled, calcareous sandy loam
28 to 60 inches—light brownish gray, mottled, calcareous sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Very poorly drained Dassel soils in depressions

Similar soils:
• Soils that have a higher content of fine sand
• Soils that have a surface layer that is leached of carbonates

Use and Management

Cropland:
• Major management factors: The seasonal high water table, pH, ground water, available water capacity
• Crops suited to this soil can be grown if adequate drainage is provided.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.

Interpretive Groups

Land capability classification: IIw

229—Waldorf silty clay loam

Composition

Waldorf soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on lake plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 10 to 300 acres

Typical Profile

0 to 19 inches—black silty clay loam
19 to 23 inches—black, mottled silty clay loam

23 to 38 inches—olive gray, mottled silty clay
38 to 60 inches—light olive gray, mottled, calcareous silty clay loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—moderately slow or moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Very slow
Depth to water table: 0 to 3 feet

Inclusions

Contrasting inclusions:
• Poorly drained Brownton soils on the rims of depressions
• Moderately well drained Kingston soils in the higher landscape positions
• Very poorly drained Okoboji soils in depressions

Similar soils:
• Soils in which glacial till is within 38 inches of the surface

Use and Management

Cropland:
• Major management factors: The seasonal high water table, tilth, permeability
• Crops suited to this soil can be grown if adequate drainage is provided.
• If worked when wet, this soil will compact and form clods.
• High clay content limits water movement within the soil; consequently, tile needs closer spacing.

Interpretive Groups

Land capability classification: IIw

247—Linder sandy loam

Composition

Linder soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Plane areas or low rises on outwash plains and stream terraces
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 75 acres

Typical Profile

0 to 10 inches—black sandy loam
10 to 18 inches—very dark grayish brown sandy loam
18 to 33 inches—grayish brown sandy loam
33 to 60 inches—olive brown, light olive brown, and yellowish brown, calcareous coarse sand

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Upper part—moderate or moderately rapid; lower part—very rapid
Available water capacity: Moderate
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: 2 to 4 feet

Inclusions

Contrasting inclusions:
• Poorly drained Biscay soils in the lower landscape positions
• Well drained Dickinson and Estherville soils in the higher landscape positions

Similar soils:
• Soils in which glacial till is within 60 inches of the surface

Use and Management

Cropland:
• Major management factors: Available water capacity, ground water, soil blowing
• Select drought-tolerant plants, or install an irrigation system for crops.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.

Interpretive Groups

Land capability classification: IIs

255—Mayer loam

Composition

Mayer soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on outwash plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 100 acres

Typical Profile

0 to 12 inches—black, calcareous loam
12 to 19 inches—very dark gray, calcareous loam

19 to 33 inches—grayish brown, mottled, calcareous loam
33 to 38 inches—grayish brown, mottled, calcareous sandy loam
38 to 60 inches—grayish brown, mottled gravelly coarse sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Very poorly drained Dassel soils in depressions
• Moderately well drained Linder soils in the higher landscape positions

Similar soils:
• Soils that have underlying material of fine sand
• Soils that have a surface layer that is leached of carbonates

Use and Management

Cropland:
• Major management factors: The seasonal high water table, pH, ground water, available water capacity
• Crops suited to this soil can be grown if adequate drainage is provided.
• Choose plants will tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.

Interpretive Groups

Land capability classification: IIw

269—Millington clay loam, occasionally flooded

Composition

Millington soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on flood plains
Slope range: 0 to 2 percent
Shape of areas: Elongated
Size of areas: 10 to 600 acres

Typical Profile

0 to 38 inches—black, calcareous clay loam
38 to 60 inches—dark grayish brown, mottled, calcareous, stratified clay loam and loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet
Frequency of flooding: Occasional

Inclusions

Contrasting inclusions:
• Poorly drained Fieldon soils in the higher landscape positions above flood levels

Similar soils:
• Soils that have a surface layer that is leached of carbonates
• Soils that have a surface layer more than 40 inches deep
• Soils that have underlying material that has brighter colors than those of the Millington soil

Use and Management

Cropland:
• Major management factors: Flooding, the seasonal high water table, pH, tilth
• Crops suited to this soil can be grown if adequate drainage and protection from flooding are provided.
• Seasonal flooding limits the production and harvesting of crops.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• If worked when wet, this soil will compact and form clods.

Pasture:
• Rotation grazing, mowing and clipping, and installing a drainage system will maintain the quality and quantity of pasture plants.

Interpretive Groups

Land capability classification: IIw

281—Darfur fine sandy loam

Composition

Darfur soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on outwash plains and lake plains
Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

0 to 18 inches—black fine sandy loam
18 to 23 inches—very dark gray fine sandy loam
23 to 36 inches—dark grayish brown, mottled fine sandy loam
36 to 60 inches—olive gray, mottled loamy fine sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—moderate or moderately rapid; lower part—moderately rapid
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Very slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Very poorly drained Dassel soils in depressions
• Moderately well drained Litchfield soils in the higher landscape positions
• Poorly drained Webster soils, which are in landscape positions similar to those of the Darfur soil and contain more clay

Similar soils:
• Soils that have carbonates at or near the surface
• Soils that have glacial till within 40 inches of the surface

Use and Management

Cropland:
• Major management factors: The seasonal high water table, available water capacity, ground water, soil blowing
• Crops suited to this soil can be grown if adequate drainage is provided.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.

Interpretive Groups

Land capability classification: IIw

282—Hanska loam

Composition

Hanska soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low lying flats on outwash plains
Slope range: 0 to 1 percent
Shape of areas: Elongated
Size of areas: 3 to 100 acres

Typical Profile

0 to 18 inches—black loam
18 to 23 inches—very dark gray sandy loam
23 to 30 inches—dark grayish brown, mottled sandy loam
30 to 60 inches—grayish brown, mottled sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Very slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Well drained Dickman soils in the higher landscape positions

Similar soils:
• Soils that have a higher content of fine sand throughout
• Soils that have carbonates at or near the surface

Use and Management

Cropland:
• Major management factors: The seasonal high water table, ground water, available water capacity
• Crops suited to this soil can be grown if adequate drainage is provided.
• Carefully control the use and application of agricultura chemicals to prevent ground water contamination.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.

Interpretive Groups

Land capability classification: IIw

327A—Dickman sandy loam, 0 to 2 percent slopes

Composition

Dickman soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Plane areas and slight rises on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 250 acres

Typical Profile

0 to 9 inches—black sandy loam
9 to 15 inches—very dark gray sandy loam
15 to 38 inches—brown loamy sand
38 to 60 inches—dark yellowish brown sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur, Fieldon, and Hanska soils in the lower landscape positions

Similar soils:
• Soils that have a loamy mantle that is less than 12 inches or more than 20 inches thick
• Soils that are mottled in the subsoil

Use and Management

Cropland:
• Major management factors: Available water capacity, soil blowing, ground water, organic matter content (figs. 5 and 6)
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIs

327B—Dickman sandy loam, 2 to 6 percent slopes

Composition

Dickman soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Rises on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 40 acres

Typical Profile

0 to 10 inches—black sandy loam
10 to 15 inches—very dark grayish brown sandy loam
15 to 20 inches—brown loamy sand
20 to 36 inches—dark yellowish brown sand
36 to 60 inches—brown sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Low
Organic matter content: Moderate
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur, Fieldon, and Hanska soils in the lower landscape positions

Similar soils:
• Soils that have a loamy mantle that is less than 12 inches or more than 20 inches thick
• Soils that are mottled in the subsoil

Use and Management

Cropland:
• Major management factors: Available water capacity, slope, ground water, soil blowing, organic matter content
• Select drought-tolerant plants, or install an irrigation system for crops.
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.

Figure 5.—Irrigated corn in an area of Dickman sandy loam, 0 to 2 percent slopes.

• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIe

336—Delft loam

Composition

Delft soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Drainageways or swales on till plains
Slope range: 1 to 3 percent
Shape of areas: Elongated
Size of areas: 3 to 55 acres

Typical Profile

0 to 30 inches—black loam
30 to 37 inches—black clay loam
37 to 43 inches—very dark grayish brown clay loam
43 to 60 inches—grayish brown, mottled clay loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderately slow or moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Moderately well drained Nicollet soils and well drained Clarion soils in the higher landscape positions

Similar soils:
• Soils that have a dark surface layer less than 24 inches thick

Use and Management

Cropland:
- Major management factors: The seasonal high water table, tilth
- Crops suited to this soil can be grown if adequate drainage is provided.
- If worked when wet, this soil will compact and form clods.

Interpretive Groups

Land capability classification: IIw

362—Millington clay loam, frequently flooded

Composition

Millington soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on flood plains
Slope range: 0 to 2 percent

Figure 6.—Corn showing moisture stress in an unirrigated area of Dickman sandy loam, 0 to 2 percent slopes.

Shape of areas: Elongated
Size of areas: 10 to 150 acres

Typical Profile

0 to 10 inches—black, calcareous clay loam
10 to 36 inches—black and very dark gray, calcareous clay loam
36 to 60 inches—stratified, calcareous loam and sandy loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet
Frequency of flooding: Frequent

Inclusions

Contrasting inclusions:
• Poorly drained Fieldon soils in the higher landscape positions above flood plains

Similar soils:
• Soils that have a surface soil more than 40 inches thick

Use and Management

Cropland:
• This soil is generally unsuited to cropland because of frequent flooding.

Habitat for wetland wildlife:
• Major management factors: The seasonal high water table, flooding, pH
• Plant adapted species, such as Japanese millet and reed canarygrass, that provide food and cover for wildlife.
• Choose plants that tolerate a high pH (high calcium carbonate content).

Pasture:
• Major management factors: Flooding
• Seasonal flooding limits the suitability for pasture.

Interpretive Groups

Land capability classification: Vw

392—Biscay loam

Composition

Biscay soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on outwash plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

0 to 15 inches—black loam
15 to 22 inches—very dark gray loam
22 to 32 inches—grayish brown, mottled loam
32 to 36 inches—grayish brown, mottled sandy loam
36 to 40 inches—grayish brown, mottled, calcareous gravelly loamy sand
40 to 60 inches—grayish brown, mottled, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Very poorly drained Dassel soils in depressions
• Somewhat poorly drained Linder soils in the higher landscape positions

Similar soils:
• Soils that have a surface layer of silt loam

Use and Management

Cropland:
• Major management factors: The seasonal high water table, available water capacity, ground water
• Crops suited to this soil can be grown if adequate drainage is provided.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.

Interpretive Groups

Land capability classification: IIw

421B—Ves loam, 1 to 4 percent slopes

Composition

Ves soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls and side slopes on till plains
Shape of areas: Irregular
Size of areas: 3 to 80 acres

Typical Profile

0 to 10 inches—black loam
10 to 14 inches—very dark gray loam
14 to 18 inches—brown loam
18 to 25 inches—dark yellowish brown loam
25 to 36 inches—yellowish brown, calcareous loam
36 to 60 inches—brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderate or high
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Storden soils, which are in landscape positions similar to those of the Ves soil and have carbonates at or near the surface
• Poorly drained Webster soils in the lower landscape positions
• Soils that have bedrock within 60 inches of the surface

Similar soils:
• Soils that have a subsoil and underlying material of sandy loam
• Soils that are mottled in the subsoil

Use and Management

Cropland:
• Major management factors: Slope, tilth
• Use minimum tillage, farm on the contour, use grassed waterways, and rotate high-residue crops to help control erosion.
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: IIe

423—Seaforth loam

Composition

Seaforth soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on till plains
Slope range: 1 to 3 percent
Shape of areas: Oblong
Size of areas: 3 to 30 acres

Typical Profile

0 to 9 inches—black, calcareous loam
9 to 12 inches—very dark gray, calcareous loam
12 to 16 inches—dark grayish brown, mottled, calcareous clay loam
16 to 24 inches—grayish brown, mottled, calcareous clay loam
24 to 60 inches—grayish brown and light olive brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Moderate or high
Surface runoff: Medium or slow
Depth to water table: 3 to 6 feet

Inclusions

Contrasting inclusions:
• Well drained Storden and Ves soils in the higher landscape positions
• Poorly drained Webster soils in the lower landscape positions

Similar soils:
• Soils that have a surface layer that is leached of carbonates

Use and Management

Cropland:
• Major management factors: pH, tilth
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: IIs

446—Normania loam

Composition

Normania soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on till plains

Slope range: 1 to 3 percent
Shape of areas: Irregular
Size of areas: 3 to 100 acres

Typical Profile

0 to 10 inches—black loam
10 to 16 inches—very dark gray clay loam
16 to 24 inches—dark grayish brown clay loam
24 to 32 inches—grayish brown, mottled, calcareous clay loam
32 to 60 inches—light olive brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Medium or slow
Depth to water table: 2.5 to 6.0 feet

Inclusions

Contrasting inclusions:
• Well drained Ves soils in the higher landscape positions
• Poorly drained Webster soils in the lower landscape positions
• Soils that have bedrock within 60 inches of the surface

Similar soils:
• Soils that have underlying material of sandy loam

Use and Management

Cropland:
• Major management factors: Tilth
• Return crop residue to the soil, rotate crops, and use minimum tillage to maintain tilth and fertility.

Interpretive Groups

Land capability classification: I

487—Hoopeston fine sandy loam

Composition

Hoopeston soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on outwash plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 4 to 50 acres

Typical Profile

0 to 12 inches—black fine sandy loam
12 to 18 inches—very dark gray sandy loam
18 to 26 inches—dark grayish brown, mottled fine sandy loam
26 to 32 inches—olive brown, mottled sandy loam
32 to 40 inches—light olive brown, mottled loamy fine sand
40 to 60 inches—dark yellowish brown, mottled fine sand

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Available water capacity: Moderate
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur soils in the lower landscape positions
• Well drained Dickinson soils in the higher landscape positions

Similar soils:
• Soils that have a surface layer of very fine sandy loam

Use and Management

Cropland:
• Major management factors: Available water capacity, ground water, soil blowing
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.

Interpretive Groups

Land capability classification: IIs

517—Shandep clay loam

Composition

Shandep soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Closed depressions on outwash plains

Slope range: 0 to 1 percent
Shape of areas: Irregular
Size of areas: 3 to 40 acres

Typical Profile

0 to 10 inches—black clay loam
10 to 22 inches—black clay loam
22 to 32 inches—very dark gray clay loam
32 to 40 inches—dark gray, mottled clay loam
40 to 60 inches—gray, mottled loamy sand

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Upper part—moderate; lower part—rapid
Available water capacity: Moderate
Organic matter content: High or very high
Surface runoff: Very slow or ponded
Depth to water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• Poorly drained Darfur and Fieldon soils in the slightly higher landscape positions

Similar soils:
• Soils that have a surface layer of loam

Use and Management

Cropland:
• Major management factors: The seasonal high water table, ponding, tilth
• Suitable crops can be grown if drainage is adequate.
• Install surface inlets to shorten the periods of ponding.
• If worked when wet, this soil will compact and form clods.

Interpretive Groups

Land capability classification: IIIw

539—Palms muck

Composition

Palms soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Closed depressions on till plains, lake plains, and outwash plains
Slope range: 0 to 1 percent
Shape of areas: Irregular or circular
Size of areas: 5 to 320 acres

Typical Profile

0 to 31 inches—black muck
31 to 49 inches—black, mottled silty clay loam
49 to 60 inches—very dark gray, mottled, calcareous silty clay loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Upper part—moderate; lower part—moderately slow
Available water capacity: Very high
Organic matter content: Very high
Surface runoff: Very slow or ponded
Depth to water table: 1 foot above to 1 foot below the surface
Special characteristics: Water ponds on the surface in spring or after intensive or prolonged rainfall.

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo and Harps soils on the rims of depressions

Similar soils:
• Soils that have an organic layer less than 16 inches thick
• Soils that have a surface layer of mucky silty clay loam
• Soils that are calcareous throughout

Use and Management

Cropland:
• Major management factors: Wetness, ponding, organic matter content, soil blowing
• Crops suited to the soil can be grown if adequate drainage is provided.
• Install surface inlets to reduce the hazard of ponding.
• High organic matter content may reduce effectiveness of herbicides.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.

Interpretive Groups

Land capability classification: IIIw

562—Knoke silty clay loam

Composition

Knoke soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Closed depressions on lake plains
Slope range: 0 to 1 percent
Shape of areas: Circular or oblong
Size of areas: 5 to 25 acres

Typical Profile

0 to 50 inches—black, calcareous silty clay loam
50 to 60 inches—black, mottled, calcareous silty clay loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Moderately slow
Available water capacity: Very high
Organic matter content: High or very high
Surface runoff: Very slow or ponded
Depth to water table: 1 foot above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo and Harps soils on the rims of depressions

Similar soils:
• Soils that have a surface layer of silt loam

Use and Management

Cropland:
• Major management factors: The seasonal high water table, ponding, permeability, tilth, pH
• Crops suited to the soil can be grown if adequate drainage is provided.
• Install surface inlets to reduce the hazard of ponding.
• High clay content limits water movement within the soil; consequently, tile needs closer spacing.
• If worked when wet, this soil will compact and form clods.
• Consider soil pH when selecting agricultural chemicals and crop varieties.

Interpretive Groups

Land capability classification: IIIw

575—Nishna silty clay loam

Composition

Nishna soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on flood plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 10 to 340 acres

Typical Profile

0 to 10 inches—black, calcareous silty clay loam
10 to 25 inches—black, calcareous silty clay
25 to 37 inches—black, calcareous silty clay loam
37 to 60 inches—very dark gray, mottled, calcareous silty clay loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Slow
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet
Frequency of flooding: Occasional

Inclusions

Contrasting inclusions:
• Poorly drained Coland and Millington soils, which are in landscape positions similar to those of the Nishna soil and are sandier and less clayey

Similar soils:
• Soils in which the surface layer is leached of carbonates

Use and Management

Cropland:
• Major management factors: Flooding, the seasonal high water table, permeability, tilth, pH
• Seasonal flooding limits the production and harvesting of crops.
• Crops suited to the soil can be grown if adequate drainage is provided.
• High clay content limits water movement within the soil; consequently, tile needs closer spacing.
• If worked when wet, this soil will compact and form clods.
• Consider soil pH when selecting agricultural chemicals and crop varieties.

Interpretive Groups

Land capability classification: IIIw

639B—Ridgeport sandy loam, 1 to 6 percent slopes

Composition

Ridgeport soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Rises on outwash plains
Shape of areas: Irregular
Size of areas: 3 to 40 acres

Typical Profile

0 to 10 inches—black sandy loam
10 to 16 inches—very dark brown sandy loam
16 to 28 inches—dark yellowish brown sandy loam
28 to 33 inches—brown sandy loam
33 to 60 inches—yellowish brown, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Somewhat excessively drained
Permeability: Upper part—moderately rapid; lower part—very rapid
Available water capacity: Low
Organic matter content: Moderately low
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Biscay and Mayer soils in the lower landscape positions
• Somewhat poorly drained Linder soils in swales

Similar soils:
• Soils that have a loamy mantle that is sandier and less clayey

Use and Management

Cropland:
• Major management factors: Available water capacity, soil blowing, slope, ground water, organic matter content
• Select drought-tolerant plants, or install an irrigation system for crops.
• Carefully control the use and application of agricultural chemicals to prevent ground water contamination.
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIe

654—Revere clay loam

Composition

Revere soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Rims of depressions on till plains
Slope range: 0 to 2 percent
Shape of areas: Irregular
Size of areas: 3 to 80 acres

Typical Profile

0 to 18 inches—black, calcareous clay loam
18 to 22 inches—very dark gray, calcareous clay loam
22 to 36 inches—dark grayish brown, mottled, calcareous clay loam
36 to 60 inches—olive gray, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Very poorly drained Glencoe and Okoboji soils in depressions

Similar soils:
• Soils that have a surface layer that is leached of carbonates
• Soils that do not contain gypsum

Use and Management

Cropland:
• Major management factors: The seasonal high water table, tilth, pH, gypsum
• Crops suited to the soil can be grown if drainage is adequate.
• If worked when wet, this soil will compact and form clods.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• Choose plants that tolerate a high gypsum content.

Interpretive Groups

Land capability classification: IIw

668—Corwith silt loam

Composition

Corwith soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on lake plains
Slope range: 1 to 3 percent
Shape of areas: Irregular or oblong
Size of areas: 5 to 40 acres

Typical Profile

0 to 14 inches—black, calcareous silt loam
14 to 17 inches—very dark gray, calcareous silt loam
17 to 27 inches—dark grayish brown, calcareous silt loam
27 to 55 inches—light olive brown, mottled, calcareous loamy very fine sand
55 to 60 inches—light brownish gray, mottled, calcareous very fine sandy loam

Soil Properties and Qualities

Drainage class: Somewhat poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 2 to 4 feet

Inclusions

Contrasting inclusions:
• Poorly drained Madelia and Spicer soils in the lower landscape positions

Similar soils:
• Soils in which the surface soil is not calcareous

Use and Management

Cropland:
• Major management factors: pH, tilth
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a conservation tillage system, plant cover crops, and return crop residue to the surface to maintain the organic matter content and tilth.

Interpretive Groups

Land capability classification: I

789B2—Grogan-Lasa Variant complex, 2 to 6 percent slopes, eroded

Composition

Grogan soil and similar soils: 40 to 60 percent
Lasa Variant soil and similar soils: 30 to 50 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls and side slopes on lake plains and outwash plains
Shape of areas: Elongated
Size of areas: 5 to 20 acres

Typical Profile

Brogan:
0 to 10 inches—very dark grayish brown loam
10 to 36 inches—dark yellowish brown and yellowish brown silt loam
36 to 60 inches—yellowish brown, mottled, calcareous very fine sandy loam

Lasa Variant:
0 to 10 inches—very dark grayish brown, calcareous loamy fine sand
10 to 36 inches—yellowish brown, calcareous loamy fine sand
36 to 60 inches—yellowish brown, calcareous, stratified loamy fine sand and fine sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: Grogan—high; Lasa Variant—low
Organic matter content: Moderately low
Surface runoff: Medium
Depth to water table: More than 6 feet
Special characteristics: In places erosion has exposed the subsoil. On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Clarion soils in landscape positions similar to those of the Grogan and Lasa Variant soils

Similar soils:
• Soils that have a surface layer of fine sand

Use and Management

Cropland:
• Major management factors: Slope, eroded surface layer—both Grogan and Lasa Variant; available water capacity, soil blowing, pH, organic matter content—Lasa Variant
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• Erosion will continue to reduce productivity unless these soils are protected.
• Available water capacity is low in the Lasa Variant, and in some years crops may not have sufficient moisture.
• Maintain crop residue on the surface, plant field

windbreaks, and use minimum tillage to help control soil blowing.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to maintain the organic matter content.

Interpretive Groups

Land capability classification: Grogan—IIe; Lasa Variant—IIIs

789C2—Lasa Variant-Grogan complex, 6 to 12 percent slopes, eroded

Composition

Lasa Variant soil and similar soils: 45 to 60 percent
Grogan soil and similar soils: 30 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Sloping hills on lake plains and outwash plains
Shape of areas: Elongated
Size of areas: 5 to 20 acres

Typical Profile

Lasa Variant:
0 to 10 inches—very dark grayish brown, calcareous loamy fine sand
10 to 34 inches—yellowish brown, calcareous loamy fine sand
34 to 60 inches—yellowish brown, calcareous, stratified loamy fine sand and fine sand

Grogan:
0 to 10 inches—very dark grayish brown loam
10 to 32 inches—dark yellowish brown very fine sandy loam
32 to 60 inches—yellowish brown, mottled, calcareous very fine sandy loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderately rapid
Available water capacity: Lasa Variant—low; Grogan—high
Organic matter content: Moderately low
Surface runoff: Rapid
Depth to water table: More than 6 feet
Special characteristics: In places erosion has exposed the subsoil. On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Clarion soils in landscape positions similar to those of the Lasa Variant and Grogan soils

Similar soils:
• Soils that have a surface layer of fine sand

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Lasa Variant and Grogan; available water capacity, soil blowing, pH, organic matter content—Lasa Variant
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• In many areas of irregular and complex slopes, terracing and contouring are difficult. Where possible, use terraces and diversions to help control erosion.
• Erosion will continue to reduce productivity if these soils are unprotected.
• Available water capacity is low in the Lasa Variant, and in some years crops may not have sufficient moisture.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: Lasa Variant—IVs; Grogan—IIIe

790B—Grogan-Dickinson complex, 1 to 4 percent slopes

Composition

Grogan soil and similar soils: 40 to 60 percent
Dickinson soil and similar soils: 35 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls and side slopes on lake plains and outwash plains
Shape of areas: Elongated
Size of areas: 5 to 25 acres

Typical Profile

Grogan:
0 to 10 inches—black loam

10 to 18 inches—very dark gray loam
18 to 35 inches—brown and dark yellowish brown silt loam
35 to 60 inches—yellowish brown, mottled, calcareous very fine sandy loam

Dickinson:
0 to 10 inches—black fine sandy loam
10 to 14 inches—very dark gray fine sandy loam
14 to 36 inches—brown and dark yellowish brown fine sandy loam
36 to 60 inches—dark yellowish brown fine sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Grogan—moderately rapid; Dickinson—moderately rapid in the upper part and rapid in the lower part
Available water capacity: Grogan—high; Dickinson—moderate
Organic matter content: Grogan—moderate; Dickinson—moderately low
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Darfur and Fieldon soils in the lower landscape positions
• Well drained Truman soils, which are in landscape positions similar to those of the Grogan and Dickinson soils and have more clay

Similar soils:
• Soils that have a surface layer of very fine sandy loam

Use and Management

Cropland:
• Major management factors: Slope—both Grogan and Dickinson; available water capacity, soil blowing, organic matter content—Dickinson
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• Available water capacity is moderate in the Dickinson soil, and in some years some crops may not have sufficient moisture.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content

Interpretive Groups

Land capability classification: Grogan—IIe; Dickinson—IIIe

887B—Clarion-Swanlake loams, 1 to 4 percent slopes

Composition

Clarion soil and similar soils: 40 to 55 percent
Swanlake soil and similar soils: 30 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Clarion—gently sloping hills on till plains; Swanlake—gently sloping hills and knolls on till plains
Slope range: Clarion—1 to 4 percent; Swanlake—2 to 4 percent
Shape of areas: Irregular
Size of areas: 5 to 60 acres

Typical Profile

Clarion:
0 to 10 inches—black loam
10 to 15 inches—very dark gray loam
15 to 30 inches—brown and dark yellowish brown loam
30 to 60 inches—brown, calcareous loam

Swanlake:
0 to 9 inches—black, calcareous loam
9 to 30 inches—pale brown, calcareous loam
30 to 40 inches—light yellowish brown, calcareous loam
40 to 60 inches—light yellowish brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Clarion—moderate or high; Swanlake—moderate
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo and Webster soils in the lower landscape positions

Similar soils:
• Soils that are mottled in the subsoil
• Soils that have sandy or silty sediments in the underlying material

Use and Management

Cropland:
• Major management factors: Slope—both Clarion and Swanlake; pH—Swanlake
• Use minimum tillage, farm on the contour, install

grassed waterways, and rotate high-residue crops to help control erosion.
• Consider soil pH when selecting agricultural chemicals and crop varieties.

Interpretive Groups

Land capability classification: IIe

909C2—Bold-Truman silt loams, 5 to 12 percent slopes, eroded

Composition

Bold soil and similar soils: 40 to 55 percent
Truman soil and similar soils: 25 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Bold—sloping hills and knolls on lake plains; Truman—sloping hills on lake plains
Shape of areas: Irregular
Size of areas: 3 to 40 acres

Typical Profile

Bold:
0 to 6 inches—dark grayish brown, calcareous silt loam
6 to 38 inches—yellowish brown, calcareous silt loam
38 to 60 inches—light yellowish brown, mottled, calcareous silt loam

Truman:
0 to 9 inches—very dark grayish brown silt loam
9 to 20 inches—brown and dark yellowish brown silt loam
20 to 60 inches—yellowish brown and light yellowish brown, calcareous silt loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: Bold—very high; Truman—high
Organic matter content: Bold—low; Truman—moderate
Surface runoff: Medium
Depth to water table: More than 6 feet
Special characteristics: In places erosion has exposed the subsoil. On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Moderately well drained Kingston soils in the lower landscape positions
• Poorly drained Madelia soils in the lower landscape positions
Similar soils:
• Soils that have a higher content of fine sand throughout

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Bold and Truman; pH, organic matter content—Bold
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• In many areas where slopes are irregular and complex, terracing and contouring are difficult. Where possible, install terraces and diversions to help control erosion.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIe

920B2—Clarion-Estherville complex, 2 to 6 percent slopes, eroded

Composition

Clarion soil and similar soils: 35 to 55 percent
Estherville soil and similar soils: 30 to 50 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Knolls and side slopes on till plains
Shape of areas: Irregular
Size of areas: 3 to 50 acres

Typical Profile

Clarion:
0 to 9 inches—very dark grayish brown loam
9 to 28 inches—brown and dark yellowish brown loam
28 to 60 inches—brown and light olive brown, mottled, calcareous loam

Estherville:
0 to 9 inches—very dark grayish brown sandy loam
9 to 16 inches—brown sandy loam
16 to 20 inches—brown coarse sandy loam
20 to 60 inches—variegated brown and yellowish brown, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Clarion—moderate; Estherville—

moderately rapid in the upper part and rapid in the lower part
Available water capacity: Clarion—high; Estherville—low
Organic matter content: Clarion—moderate; Estherville—moderately low
Surface runoff: Medium
Depth to water table: More than 6 feet
Special characteristics: In places erosion has exposed the subsoil. On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Poorly drained Delft and Webster soils in the lower landscape positions

Similar soils:
• Soils that have carbonates within 18 inches of the surface

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Clarion and Estherville; available water capacity, soil blowing, organic matter content—Estherville
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• Erosion will continue to reduce productivity unless the soils are protected.
• Available water capacity is low in the Esterville soil, and in some years crops may not have sufficient moisture.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: Clarion—IIe; Estherville—IIIs

920C2—Clarion-Estherville complex, 6 to 12 percent slopes, eroded

Composition

Clarion soil and similar soils: 40 to 60 percent
Estherville soil and similar soils: 30 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Sloping hills on till plains
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

Clarion:
0 to 8 inches—very dark grayish brown loam
8 to 26 inches—brown loam
26 to 60 inches—dark yellowish brown and yellowish brown, mottled, calcareous loam

Estherville:
0 to 8 inches—very dark grayish brown sandy loam
8 to 21 inches—brown sandy loam
21 to 60 inches—variegated brown and yellowish brown, calcareous coarse sand

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Clarion—moderate; Estherville—moderately rapid in the upper part and rapid in the lower part
Available water capacity: Clarion—high; Estherville—low
Organic matter content: Clarion—moderate; Estherville—moderately low
Surface runoff: Rapid
Depth to water table: More than 6 feet
Special characteristics: In places erosion has exposed the subsoil. On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Poorly drained Delft and Webster soils in the lower landscape positions
• Moderately well drained Nicollet soils in the lower landscape positions

Similar soils:
• Soils that have carbonates within 18 inches of the surface

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Clarion and Estherville; available water capacity, soil blowing, organic matter content—Estherville
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• In many areas where slopes are irregular and complex, terracing and contouring are difficult. Where possible, install terraces and diversions to help control erosion.
• Erosion will continue to reduce productivity unless the soils are protected.

• Available water capacity is low in the Estherville soil, and in some years crops may not have sufficient moisture.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: Clarion—IIIe; Estherville—IVs

921B2—Clarion-Storden loams, 3 to 6 percent slopes, eroded

Composition

Clarion soil and similar soils: 60 to 75 percent
Storden soil and similar soils: 15 to 35 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Clarion—gently sloping hills on till plains; Storden—gently sloping hills and knolls on till plains
Shape of areas: Irregular
Size of areas: 4 to 30 acres

Typical Profile

Clarion:
0 to 10 inches—very dark brown loam
10 to 21 inches—brown loam
21 to 60 inches—olive brown, mottled, calcareous loam

Storden:
0 to 8 inches—dark grayish brown, calcareous loam
8 to 37 inches—brown, calcareous loam
37 to 60 inches—yellowish brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Clarion—moderate; Storden—low
Surface runoff: Medium
Depth to water table: More than 6 feet
Special characteristics: On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Poorly drained Delft and Webster soils in the lower landscape positions

Similar soils:
• Soils that have more silt throughout
• Soils that are mottled in the subsoil

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Clarion and Storden; pH, organic matter content—Storden
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• Erosion will continue to reduce productivity unless the soils are protected.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to help maintain organic matter content.

Interpretive Groups

Land capability classification: IIe

921C2—Clarion-Storden loams, 6 to 12 percent slopes, eroded

Composition

Clarion soil and similar soils: 55 to 75 percent
Storden soil and similar soils: 25 to 35 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Clarion—sloping hills on till plains; Storden—sloping hills and knolls on till plains
Shape of areas: Irregular
Size of areas: 4 to 30 acres

Typical Profile

Clarion:
0 to 7 inches—very dark grayish brown loam
7 to 23 inches—dark yellowish brown loam
23 to 60 inches—brown, calcareous, mottled loam

Storden:
0 to 8 inches—dark grayish brown, calcareous loam
8 to 37 inches—brown, calcareous loam
37 to 60 inches—yellowish brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Clarion—moderate; Storden—low
Surface runoff: Medium or rapid
Depth to water table: More than 6 feet
Special characteristics: On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Poorly drained Delft soils in the lower landscape positions
• Moderately well drained Nicollet soils in the lower landscape positions

Similar soils:
• Soils that are siltier throughout the profile

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Clarion and Storden; pH, organic matter content—Storden
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• In many areas where slopes are irregular and complex, terracing and contouring are difficult. Where possible, install terraces and diversions to help control erosion.
• Unless the soils are protected, erosion will continue to reduce productivity.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIIe

929—Fieldon-Canisteo complex

Composition

Fieldon soil and similar soils: 40 to 55 percent
Canisteo soil and similar soils: 30 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Rims of depressions and low flats on till plains and outwash plains
Shape of areas: Irregular
Size of areas: 3 to 300 acres

Typical Profile

Fieldon:
0 to 12 inches—black, calcareous loam
12 to 22 inches—dark gray, calcareous fine sandy loam
22 to 38 inches—grayish brown, calcareous fine sandy loam
38 to 60 inches—light olive brown, mottled, calcareous, loamy fine sand

Canisteo:
0 to 10 inches—black, calcareous clay loam
10 to 20 inches—very dark gray, calcareous loam
20 to 32 inches—grayish brown, mottled, calcareous loam
32 to 60 inches—light brownish gray, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Fieldon—moderate in the upper part and rapid in the lower part; Canisteo—moderate
Available water capacity: Fieldon—moderate; Canisteo—high
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: 1 to 3 feet

Inclusions

Contrasting inclusions:
• Very poorly drained Dassel and Shandep soils in depressions
• Moderately well drained Crippin soils in the higher landscape positions

Similar soils:
• Soils in which the surface layer is leached of carbonates

Use and Management

Cropland:
• Major management factors: The seasonal high water table, pH, tilth—both Fieldon and Canisteo; available water capacity—Fieldon
• Crops suited to the soils can be grown if adequate drainage is provided.
• Choose plants that tolerate a high pH (high calcium

carbonate content) to avoid chlorosis.
• If worked when wet, these soils will compact and form clods.
• Because of a moderate available water capacity in the Fieldon soil, some crops may not have sufficient moisture in some years.

Interpretive Groups

Land capability classification: IIw

954B2—Ves-Storden loams, 3 to 6 percent slopes, eroded

Composition

Ves soil and similar soils: 40 to 60 percent
Storden soil and similar soils: 25 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Ves—gently sloping hills on till plains; Storden—gently sloping hills and knolls on till plains
Shape of areas: Irregular
Size of areas: 3 to 40 acres

Typical Profile

Ves:
0 to 9 inches—very dark grayish brown loam
9 to 32 inches—brown and yellowish brown loam
32 to 60 inches—brown, calcareous loam

Storden:
0 to 7 inches—dark grayish brown, calcareous loam
7 to 60 inches—yellowish brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Ves—moderate; Storden—low
Surface runoff: Medium
Depth to water table: More than 6 feet
Special characteristics: On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Poorly drained Delft and Webster soils in the lower landscape positions

Similar soils:
• Soils that have pockets of sand and gravel in the subsoil and underlying material
• Soils that are mottled in the subsoil

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Ves and Storden; pH, organic matter content—Storden
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• Unless the soils are protected, erosion will continue to reduce productivity.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IIe

954C2—Storden-Ves loams, 6 to 15 percent slopes, eroded

Composition

Storden soil and similar soils: 35 to 55 percent
Ves soil and similar soils: 30 to 60 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Storden—sloping hills and knolls on till plains; Ves—sloping hills on till plains
Shape of areas: Oblong
Size of areas: 3 to 40 acres

Typical Profile

Storden:
0 to 7 inches—dark grayish brown, calcareous loam
7 to 60 inches—brown and pale brown, calcareous loam

Ves:
0 to 8 inches—very dark grayish brown loam
8 to 30 inches—brown loam
30 to 60 inches—brown, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Storden—low; Ves—moderate
Surface runoff: Medium
Depth to water table: More than 6 feet

Inclusions

Contrasting inclusions:
• Poorly drained Delft and Webster soils in the lower landscape positions
• Moderately well drained Normania and Seaforth soils in the lower landscape positions

Similar soils:
• Soils that have pockets of sand and gravel in the subsoil and underlying material

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Storden and Ves; pH, organic matter content—Storden
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• In many areas where slopes are irregular and complex, terracing and contouring are difficult. Where possible, install terraces and diversions to help control erosion.
• Unless the soils are protected, erosion will continue to reduce productivity.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to help maintain organic matter content.

Interpretive Groups

Land capability classification: IIIe

956—Canisteo-Glencoe clay loams

Composition

Canisteo soil and similar soils: 50 to 70 percent
Glencoe soil and similar soils: 15 to 35 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Canisteo—flat areas and rims of depression on till plains; Glencoe—closed depressions on till plains
Slope range: Canisteo—0 to 2 percent; Glencoe—0 to 1 percent
Shape of areas: Irregular
Size of areas: 5 to 500 acres

Typical Profile

Canisteo:
0 to 11 inches—black, calcareous clay loam
11 to 22 inches—very dark gray, calcareous clay loam
22 to 28 inches—olive gray, mottled, calcareous clay loam
28 to 60 inches—light olive gray, mottled, calcareous loam

Glencoe:
0 to 10 inches—black clay loam
10 to 26 inches—black clay loam
26 to 38 inches—olive gray, mottled clay loam
38 to 60 inches—grayish brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Canisteo—poorly drained; Glencoe—very poorly drained
Permeability: Canisteo—moderate; Glencoe—moderate or moderately slow in the upper part and moderate in the lower part
Available water capacity: High
Organic matter content: Canisteo—high; Glencoe—high or very high
Surface runoff: Very slow or ponded
Depth to water table: Canisteo—1 to 3 feet; Glencoe—1 foot above to 1 foot below the surface
Special characteristics: Canisteo—a high soil pH causes a fertility imbalance, which results in iron chlorosis in soybeans; Glencoe—ponding in spring or after intensive or prolonged rainfall

Inclusions

Contrasting inclusions:
• Somewhat poorly drained Crippin soils in the higher landscape positions
• Moderately well drained Nicollet soils in the higher landscape positions

Similar soils:
• Soils that have bands of sandy and silty sediments in the underlying material
• Soils that have a few gypsum crystals on or near the surface

Use and Management

Cropland:
• Major management factors: The seasonal high water table, tilth—both Canisteo and Glencoe; pH—Canisteo; ponding—Glencoe
• Crops suited to the soils can be grown if adequate drainage is provided (fig. 7).
• If worked when wet, these soils will compact and form clods.
• Choose plants that tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• Install surface inlets to reduce the hazard of ponding.

Figure 7.—Suitable crops can be grown on Canisteo-Glencoe clay loams if a drainage system is installed.

Interpretive Groups

Land capability classification: Canisteo—IIw; Glencoe—IIIw

960D2—Storden-Clarion loams, 12 to 18 percent slopes, eroded

Composition

Storden soil and similar soils: 40 to 60 percent
Clarion soil and similar soils: 25 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Storden—moderately steep hills and knolls on till plains; Clarion—moderately steep hills on till plains
Shape of areas: Irregular
Size of areas: 5 to 30 acres

Typical Profile

Storden:
0 to 9 inches—dark grayish brown, calcareous loam
9 to 24 inches—yellowish brown, calcareous loam
24 to 60 inches—yellowish brown, mottled, calcareous loam

Clarion:
0 to 8 inches—very dark grayish brown loam
8 to 17 inches—dark yellowish brown loam
17 to 25 inches—yellowish brown loam
25 to 35 inches—yellowish brown, calcareous loam
35 to 60 inches—yellowish brown, mottled, calcareous loam

Soil Properties and Qualities

Drainage class: Well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: Clarion—moderate; Storden—low

Surface runoff: Rapid
Depth to water table: More than 6 feet
Special characteristics: On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Poorly drained Delft soils in the lower landscape positions
• Moderately well drained Nicollet soils in the lower landscape positions

Similar soils:
• Soils that have a surface layer of silt loam

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Storden and Clarion; pH, organic matter content—Storden
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion.
• In many areas where slopes are irregular and complex, terracing and contouring are difficult. Where possible, install terraces and diversions to help control erosion.
• Seeding these soils to native plants, pasture, or trees is effective in controlling erosion.
• Unless the soils are protected, erosion will continue to reduce productivity.
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Use a suitable crop rotation and return crop residue to the soil to maintain organic matter content.

Interpretive Groups

Land capability classification: IVe

999B2—Ves-Estherville complex, 2 to 8 percent slopes, eroded

Composition

Ves soil and similar soils: 40 to 70 percent
Estherville soil and similar soils: 15 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Ves—gently sloping hills on till plains; Estherville—gently sloping hills and knolls on till plains
Shape of areas: Irregular
Size of areas: 3 to 30 acres

Typical Profile

Ves:
0 to 9 inches—very dark grayish brown loam
9 to 32 inches—dark yellowish brown and yellowish brown loam
32 to 60 inches—dark yellowish brown, calcareous loam

Estherville:
0 to 9 inches—very dark grayish brown sandy loam
9 to 20 inches—dark yellowish brown coarse sandy loam
20 to 60 inches—grayish brown, brown, dark yellowish brown, and yellowish brown, calcareous gravelly coarse sand

Soil Properties and Qualities

Drainage class: Ves—well drained; Estherville—somewhat exessively drained
Permeability: Ves—moderate; Estherville—moderately rapid in the upper part and rapid in the lower part
Available water capacity: Ves—high; Estherville—low
Organic matter content: Ves—moderate; Estherville—moderately low
Surface runoff: Medium
Depth to water table: More than 6 feet
Special characteristics: On these eroded soils, more fertilizer is needed, productivity is lower, and crop yields will continue to decrease unless erosion is controlled.

Inclusions

Contrasting inclusions:
• Poorly drained Delft soils in the lower landscape positions
• Somewhat poorly drained Linder soils in the lower landscape positions
• Moderately well drained Normania soils in the lower landscape positions
• Well drained Storden soils on knolls

Similar soils:
• Soils that have more fine sand than the Ves and Estherville soils

Use and Management

Cropland:
• Major management factors: Slope, eroded surface—both Ves and Estherville; available water capacity, soil blowing, organic matter content—Estherville
• Use minimum tillage, farm on the contour, install grassed waterways, and rotate high-residue crops to help control erosion. In many areas where slopes are irregular and complex, terracing and contouring are difficult.

• Unless the soils are protected, erosion will continue to reduce productivity.
• Available water capacity is low in the Estherville soil, and in some years crops may not have sufficient moisture.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Use a suitable crop rotation and return crop residue to the soil to help maintain organic matter content.

Interpretive Groups

Land capability classification: Ves—IIe; Estherville—IIIs

1016—Udorthents, loamy

These soils are nearly level to sloping. Either excavation or cutting and filling with loamy material have altered them. In most areas, cutting and filling have been used for site improvement. Individual areas of these soils are irregular in shape and range from 4 to 40 acres in size.

These soils are in cut and fill areas along highways, filled-in dumps or landfills, leveled gravel pits, and filled-in sites of poorly drained or very poorly drained soils. Most of the filled-in material is loamy.

This unit is not assigned a capability subclass.

1030—Udorthents-Pits, complex

This unit consists of areas that were used or are used in mining sand or gravel. It includes excavations, stockpiles of sand and gravel, areas filled with waste soil material, some areas of grass or trees, and water in some pits. Individual areas range from 3 to 500 acres and are irregular in shape.

After reclamation, these areas are suitable for many uses. Reclamation generally includes extensive filling and grading. Some areas can be reclaimed for agricultural use if the topsoil is carefully stockpiled and is loamy. Some areas can be used for commercial, industrial, or residential development. After revegetation, other areas, some of which have ponds, can be used as habitat for wildlife or as recreation areas. Onsite investigation is needed to determine the potentials and limitations of these areas for any proposed use.

This unit is not assigned to a capability subclass.

1055—Palms-Glencoe complex, ponded

Composition

Palms soil: 40 to 65 percent
Glencoe soil: 25 to 45 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Closed depressions on till plains, lake plains, and outwash plains
Slope range: 0 to 1 percent
Shape of areas: Irregular or circular
Size of areas: 5 to 500 acres

Typical Profile

Palms:
0 to 30 inches—black muck
30 to 60 inches—black, mottled, calcareous clay loam
Glencoe:
0 to 30 inches—black clay loam
30 to 60 inches—black, mottled, calcareous clay loam

Soil Properties and Qualities

Drainage class: Very poorly drained
Permeability: Palms—moderate in the upper part and moderately slow in the lower part; Glencoe—moderately slow or moderate in the upper part and moderate in the lower part
Available water capacity: Palms—very high; Glencoe—high
Organic matter content: Palms—very high; Glencoe—high or very high
Surface runoff: Ponded
Depth to water table: 3 feet above to 1 foot below the surface

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo soils on the rims of depressions
• Poorly drained Essexville soils on the borders of depressions or in sandbars that extend into the depressions
• Areas of open water

Use and Management

Habitat for wetland wildlife:
• Major management factors: Ponding, the seasonal high water table
• The open water areas and marsh vegetation in this unit are well suited to use as habitat for wetland wildlife (fig. 8).
• Plant suitable species, such as burreed, bulrush, and arrowhead, that provide food and cover for wildlife.

Interpretive Groups

Land capability classification: VIIIw

Figure 8.—Palms-Glencoe complex, ponded, provides habitat for wetland wildlife. Planting burreed, bulrush, and arrowhead provides food and cover for wildlife.

1833—Coland clay loam, occasionally flooded

Composition

Coland soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on flood plains
Slope range: 0 to 2 percent
Shape of areas: Elongated
Size of areas: 3 to 600 acres

Typical Profile

0 to 60 inches—black clay loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet
Frequency of flooding: Occasional

Inclusions

Contrasting inclusions:
• Poorly drained Fieldon soils in the higher landscape positions above flood levels
Similar soils:
• Soils that have sandy underlying material
• Soils that have carbonates at or near the surface

Use and Management

Cropland:
• Major management factors: The seasonal high water table, tilth, flooding
• This soil is low on the landscape. In most areas, suitable outlets are not available and draining the soil is difficult.
• If worked when wet, this soil will compact and form clods.

Interpretive Groups

Land capability classification: IIw

1834—Coland clay loam, frequently flooded

Composition

Coland soil and similar soils: 85 to 95 percent

Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on flood plains
Slope range: 0 to 2 percent
Shape of areas: Elongated
Size of areas: 4 to 250 acres

Typical Profile

0 to 36 inches—black clay loam
36 to 60 inches—very dark gray clay loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 1 to 3 feet
Frequency of flooding: Frequent

Inclusions

Contrasting inclusions:
• Poorly drained Fieldon soils in the higher landscape positions above flood levels

Similar soils:
• Soils that have sandy underlying material

Use and Management

Pasture:
• Major management factors: Flooding, the seasonal high water table
• Seasonal flooding limits forage production and the suitability for pasture.

Habitat for wetland wildlife:
• Plant suitable species, such as Japanese millet, reed canarygrass, and elderberry, that provide food and cover for wildlife.

Interpretive Groups

Land capability classification: Vw

1907—Lakefield silty clay loam

Composition

Lakefield soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low rises on lake plains
Slope range: 1 to 3 percent
Shape of areas: Irregular
Size of areas: 4 to 30 acres

Typical Profile

0 to 10 inches—black, calcareous, silty clay loam
10 to 18 inches—very dark gray, calcareous silty clay loam
18 to 28 inches—olive brown, mottled, calcareous silt loam
28 to 60 inches—light olive brown, mottled, calcareous silt loam

Soil Properties and Qualities

Drainage class: Moderately well drained
Permeability: Moderate
Available water capacity: High
Organic matter content: High
Surface runoff: Slow
Depth to water table: 2.5 to 5.0 feet

Inclusions

Contrasting inclusions:
• Poorly drained Spicer soils in the lower landscape positions

Similar soils:
• Soils that have a surface layer that is leached of carbonates

Use and Management

Cropland:
• Major management factors: pH, tilth,
• Consider soil pH when selecting agricultural chemicals and crop varieties.
• Return crop residue to the soil, rotate crops, and use minimum tillage to help maintain tilth and fertility.

Interpretive Groups

Land capability classification: I

1931—Essexville sandy loam

Composition

Essexville soil and similar soils: 85 to 95 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Beach ridges on till plains and lake plains
Slope range: 0 to 2 percent
Shape of areas: Elongated
Size of areas: 3 to 50 acres

Typical Profile

0 to 8 inches—black sandy loam

8 to 13 inches—very dark grayish brown, calcareous loamy sand
13 to 22 inches—dark grayish brown, mottled, calcareous sand
22 to 60 inches—grayish brown, mottled, calcareous clay loam

Soil Properties and Qualities

Drainage class: Poorly drained
Permeability: Upper part—rapid; lower part—moderately slow
Available water capacity: Moderate
Organic matter content: High
Surface runoff: Very slow
Depth to water table: 0 to 1 foot

Inclusions

Contrasting inclusions:
• Poorly drained Canisteo and Lemond soils, which are in landscape positions similar to those of the Essexville soil and have more clay in the surface layer
• Very poorly drained soils in depressions

Similar soils:
• Soils that have more sand and gravel in the underlying material

Use and Management

Cropland:
• Crops suited to this soil can be grown if adequate drainage is provided.
• Choose plants that will tolerate a high pH (high calcium carbonate content) to avoid chlorosis.
• Maintain crop residue on the surface, plant field windbreaks, and use minimum tillage to help control soil blowing.
• Available water capacity is moderate, and in some years some crops may not have sufficient moisture.

Interpretive Groups

Land capability classification: IIIw

1981—Hanlon-Kalmarville complex, 0 to 4 percent slopes

Composition

Hanlon soil and similar soils: 45 to 60 percent
Kalmarville soil and similar soils: 25 to 40 percent
Contrasting inclusions: 5 to 15 percent

Setting

Landform and position on the landform: Low-lying flats on flood plains
Shape of areas: Irregular
Size of areas: 10 to 200 acres

Typical Profile

Hanlon:
0 to 15 inches—black fine sandy loam
15 to 35 inches—very dark gray fine sandy loam
35 to 40 inches—very dark grayish brown sandy loam
40 to 50 inches—very dark grayish brown loamy sand
50 to 60 inches—dark grayish brown loamy sand

Kalmarville:
0 to 12 inches—very dark gray loam
12 to 20 inches—dark gray fine sandy loam
20 to 30 inches— very dark gray, calcareous loam
30 to 55 inches—dark gray, calcareous fine sandy loam
55 to 60 inches—very dark grayish brown, calcareous loamy sand

Soil Properties and Qualities

Drainage class: Hanlon—moderately well drained; Kalmarville—very poorly drained
Permeability: Hanlon—moderately rapid; Kalmarville—moderately rapid in the upper part and rapid in the lower part
Available water capacity: Hanlon—high; Kalmarville—moderate
Organic matter content: Moderate
Surface runoff: Slow
Depth to water table: Hanlon—3 to 5 feet; Kalmarville—0 to 1 foot
Frequency of flooding: Frequent

Inclusions

Contrasting inclusions:
• Poorly drained Coland and Millington soils in the lower landscape positions

Similar soils:
• Soils that have sandy underlying material
• Soils that are very poorly drained and occasionally flooded

Use and Management

Pasture:
• Major management factors: Flooding, the seasonal high water table
• Seasonal flooding limits forage production and the suitability for pasture.

Habitat for wetland wildlife:
• Plant suitable species, such as Japanese millet, reed canarygrass, and elderberry, that provide food and cover for wildlife.

Interpretive Groups

Land capability classification: Vw

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 or 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 expenditure 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 236,578 acres in the survey area, or more than 85 percent of the total acreage, meets the soil requirements for prime farmland. The main crops grown on this land are corn, soybeans, and oats.

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 and all soils that are frequently flooded during the growing season qualify for prime farmland only in areas where these limitations have been overcome by drainage measures or flood control. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures.

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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 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 behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops 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 1985, nearly 242,000 acres in the survey area was used as cropland. About 229,000 acres was used for row crops, mainly corn and soybeans; 9,100 acres for close-growing crops, mainly wheat and oats; and 3,700 acres for hay, mainly alfalfa. About 7,100 acres was used as pasture, both permanent pasture and wooded pasture.

The field crops suited to the soils and climate include some that are not commonly grown, such as grain sorghum, sunflowers, and edible beans. When economic conditions are favorable, these crops are grown on small acreages. Barley and rye also are grown on small acreages. Forage crops, including alfalfa, sweet clover, red clover, and native grasses, can be grown for seed. The specialty crops commercially grown in the survey area include vegetables, mainly sweet corn and green peas, as well as nursery plants. Cucumbers used in the production of pickles are grown in small patches.

The main management needs on the cropland and pasture in the survey area are measures that help to control erosion and soil blowing, improve drainage, and improve or maintain fertility and tilth.

Water erosion is a management concern on about a third of the cropland in Watonwan County. Clarion, Storden, and Ves soils, for example, have lost one-third to two-thirds of the original topsoil.

Water erosion damages the surface layer of the soil. Productivity is reduced as the surface layer is lost and as part of the subsoil is incorporated into the plow layer. On soils that have a subsoil with a low available water capacity, such as Dickman, Estherville, and Lasa soils, loss of the surface layer is especially damaging. Water erosion generally results in the sedimentation of

lowlands and surface water. The eroded sediments contain a high concentration of nutrients, organic matter, and pesticides. Controlling water erosion minimizes this pollution, improves water quality, and reduces ditch and channel maintenance costs.

Erosion-control practices provide a protective cover, help to control runoff, and increase the rate of water infiltration.

A conservation tillage system keeps a vegetative cover on the soil for extended periods. It can hold soil losses to amounts that do not reduce the productive capacity of the soils. The tolerable soil loss, or "T" value of a soil, is the amount of soil loss, in tons per acre per year, that a soil can lose and still maintain its productivity. A "T" value has been given to each soil type. A system of conservation tillage that leaves crop residue on the surface can increase the rate of water infiltration and helps to control runoff and erosion. This practice works well in the undulating and flatter areas of the county, for example, on Clarion, Storden, Truman, and Ves soils.

Terraces, water- and sediment-control basins, diversions, and other conservation practices that reduce the length of slopes help to control runoff and erosion. These practices are effective on well drained soils that have long slopes. Clarion, Truman, and Ves soils, for example, are suitable for terraces. The most commonly installed erosion-control measures in the survey area are terraces and water- and sediment-control basins.

Soil blowing is a problem on Fedji, Lasa, Litchfield, Sparta, Blue Earth, Granby, and Palms soils. Soil blowing on knolls is another problem on slopes of more than 3 percent and less than 500 feet in length. It can damage the soils in a few hours if winds are strong and the soils are dry and have no protective cover. Field windbreaks and conservation tillage help to control soil blowing (fig. 9).

Information about the design of erosion-control measures for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil drainage is the major management concern on about a third of the acreage used for crops in the county. On naturally wet soils, crop production is possible only if a drainage system is installed. Examples of poorly drained or very poorly drained soils are Blue Earth and Palms soils, which are organic, and Canisteo, Darfur, Dassel, Glencoe, Madelia, and Webster soils.

Small areas of wetter soils along drainageways and in swales are commonly included with the well drained Normania, Seaforth, and Ves soils in mapping. A drainage system may be needed in these areas.

The design of both surface and subsurface drainage systems varies with the kind of soil. Most areas of the poorly drained and very poorly drained soils used for row crops are suitable for a combination of surface and subsurface drains. Drainage tiles should be more closely spaced in moderately slowly permeable or slowly permeable soils than in more permeable soils. Knoke, Nishna, Okoboji, and Waldorf soils, for example, are moderately slowly permeable or slowly permeable.

Information about the design of drainage systems for each kind of soil is contained in the Minnesota Drainage Guide, available in local offices of the Soil Conservation Service.

Soil fertility is naturally high in most of the soils in the county, but it may be low or medium in soils that formed in sandy outwash. Applications of fertilizer are beneficial on most of the soils in the county. Routine soil tests should be used to manage soil fertility efficiently.

Excess carbonates cause a fertility imbalance in Canisteo, Crippin, Fieldon, Harps, Revere, Seaforth, Storden, and other soils.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil.

A seasonal high water table is a problem on many soils in the county. Tilling when these soils are wet can adversely affect tilth.

Soils that are tilled in the fall are exposed to freezing and thawing cycles, which maintain or improve tilth. These soils are subject to soil blowing unless they are protected by crop residue.

Conservation tillage methods, such as chisel plowing, ridge tillage, and no-till, can maintain or improve soil tilth. Further, they leave crop residue on the surface and thus help to control soil blowing.

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

Figure 9.—Field windbreaks help to control soil blowing on Litchfield loamy fine sand and Sparta loamy sand, 1 to 6 percent slopes.

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 *(9)*. 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 woodland and for engineering purposes.

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

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 or hazards that restrict their use.

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

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

Class IV soils have very severe limitations or hazards 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 or hazards, impractical to remove, that limit their use.

Class VI soils have severe limitations or hazards that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations or hazards that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations or hazards 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 hazard is the 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 only in 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

Windbreaks have been planted since the days of the early settlers to protect both farmsteads and livestock. They have been planted to control soil blowing since the 1930's, and in recent years they have been planted to trap snow and thus increase the moisture supply. Controlling weeds around new windbreaks helps to achieve maximum growth and survival rates.

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

In Watonwan County, which is mainly agricultural, the potential for outdoor recreation is fair. Boating, camping, cross-country skiing, waterskiing, mushroom hunting, snowmobiling, swimming, trapping, watching wildlife, and visiting historic sites are some of the recreational activities.

The best potential recreation areas are along the lakes, creeks, and rivers in the county. In many places the Watonwan River, the main scenic area in the county, is lined with hardwoods. Anglers take northern pike, walleye, catfish, sunfish, crappie, and other species in the lakes, rivers, and creeks. Water sports can be pursued on the larger lakes. The city and county parks have picnic areas. Many areas of state-owned land are open to the public for hunting and other recreational activities. Historical sites are in scattered areas throughout the county.

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 sewer lines. 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 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 are gently sloping 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.

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

Douglas Wells, area wildlife manager, and Dr. Alfred Berner, Division of Fish and Wildlife, Farmland Wildlife Populations and Research, Minnesota Department of Natural Resources, helped prepare this section.

On the soils of Watonwan County, the potential is good for habitat for a large population of wildlife. Cottontail, Hungarian partridge, squirrels, waterfowl, white-tailed deer, and some other species are commonly hunted. Beaver, fox, mink, muskrat, skunk, weasel, and other furbearers are commonly trapped.

A large pheasant and waterfowl population once inhabited the county. Over the last two decades, it has declined, as agricultural practices have changed to more intensive cultivation. Pothole sloughs, which once were abundant, have been drained and tilled. These very poorly drained soils, which formerly were marginal for farming, now produce good yields of corn and soybeans. The trend in land use has reduced the extent of nesting areas and winter cover and, consequently, the pheasant and waterfowl population.

Watonwan County lies at the edge of a large area of small, closed depressions known as the prairie pothole area. This is an important production area for waterfowl and other wetland wildlife.

The best potential wildlife habitat adjoins the more than 2,500 acres of water in Watonwan County. In the areas near lakes, streams, and the Watonwan River and in other areas of habitat for wetland wildlife, the limitations that affect farming are frequent flooding, the seasonal high water table, ponding, or the slope. These limitations, however, are beneficial for wildlife. The Department of Natural Resources owns 10 wildlife management areas in the county. These areas range from 10 to 602 acres in size and total 942 acres.

Of the 942 acres of state-owned wildlife management areas in the county, 416 acres is wetland. These areas are diverse, ranging from temporary wetlands where reed canarygrass, sedges, and bluejoint reedgrass are dominant to permanent lakes, such as Lake Wilson, where the only vegetation is that along the fringe of the lake. Wetlands where cattails or bulrushes are dominant support the most species. These marshes provide nesting cover and brood habitat for various wetland birds and support muskrat, mink, and many other mammals.

The remaining 526 acres of the wildlife management areas is managed as cropland or grassland. The cropland provides standing corn for pheasants, deer, raccoons, rabbits, and many nongame species in the winter. The grassland provides nesting cover for both upland and wetland wildlife. Many waterfowl prefer to nest in upland fields and, after hatching, move their

young to a suitable marsh. Upland species, such as pheasants, Hungarian partridge, and songbirds, use the grassland during the entire year or during the nesting period.

White-tailed deer is the only big game animal in Watonwan County. Each year hunters harvest 300 to 400 deer in the county. The habitat for deer is good or excellent on about 2,700 acres of woodland in the county. In summer the deer disperse into areas of farmland. They are in excellent health because of the abundant, high-quality food that they can obtain, in part, on the farmland in the county.

Field windbreaks and shelterbelts help to control soil blowing and trap snow. Also, winter losses of wildlife are less severe in established field windbreaks and shelterbelts than in unprotected open areas.

In Watonwan County, the potential is good for the development of ponds, wetlands, and other habitat for wildlife. Landowners and operators interested in developing wildlife habitat can contact a local representative of the Soil Conservation Service or the Watonwan Soil and Water Conservation District for assistance in planning wildlife areas.

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 and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, and wheatgrass.

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 and poplar. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, and crabapple.

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 fir.

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, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, 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.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas.

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 should 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 or 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 kinds 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 evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and 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 or 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, 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 resulting from rapid permeability in 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 groundwater 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.

After soil material has been removed, the soil material in the borrow area must be thick enough over 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 to 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, a 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 a 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 depth to the water table is less than 1 foot. These soils 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 or of organic matter. 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, 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 large stones, slope, and the hazard of cutbanks caving. 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 control 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, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

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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 classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

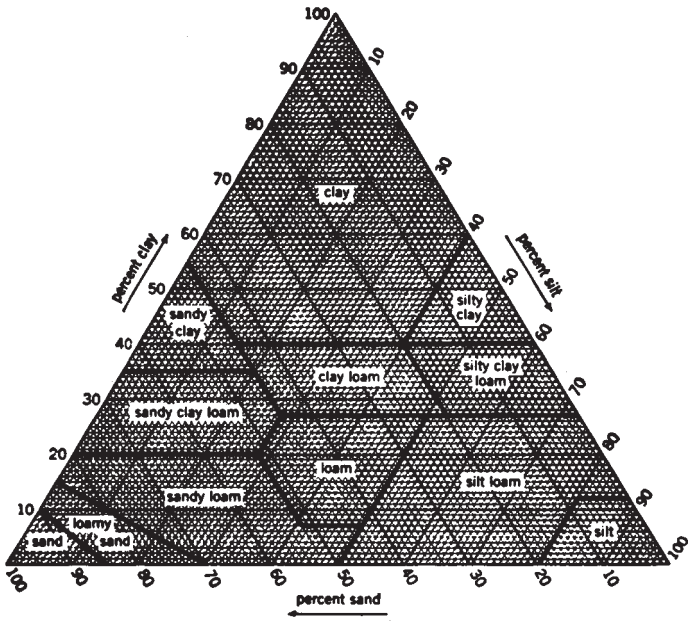

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

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. 10). "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. 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 ⅓ 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.

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. Coarse sands, 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 coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, 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 loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous 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. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

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 in 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 infiltration 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 or by runoff from adjacent slopes. 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—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 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. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

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.

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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. Eleven 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. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series. The Webster series is an example of a fine-loamy, mixed, mesic Typic Haplaquoll.

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" *(8)*. 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

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Landform: Outwash plains

Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls

Typical Pedon

Biscay loam, 2,000 feet south and 2,000 feet east of the northwest corner of sec. 9, T. 107 N., R. 31 W.

Ap—0 to 6 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A1—6 to 15 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; common roots; about 2 percent coarse fragments; neutral; gradual smooth boundary.

A2—15 to 22 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; few roots; about 3 percent coarse fragments; neutral; gradual smooth boundary.

Bg—22 to 32 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few roots; about 2 percent coarse fragments; neutral; gradual smooth boundary.

BCg—32 to 36 inches; grayish brown (2.5Y 5/2) sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; neutral; gradual smooth boundary.

2Cg1—36 to 40 inches; grayish brown (2.5Y 5/2) gravelly loamy sand; many medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 16 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

2Cg2—40 to 60 inches; grayish brown (2.5Y 5/2) gravelly coarse sand; many medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 18 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches
Mollic epipedon thickness: 16 to 24 inches
Depth to sandy sediments: 20 to 40 inches

Ap or A horizon:
Hue—10YR, 2.5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam
Rock fragment content—0 to 15 percent

Bg horizon:
Hue—5Y or 2.5Y
Value—4 or 5
Chroma—1 to 3
Texture—Loam, sandy clay loam, clay loam, or their gravelly analogs
Rock fragment content—0 to 35 percent

BCg horizon:
Colors and textures similar to those of the B and C horizons

2Cg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Loamy sand, loamy coarse sand, coarse sand, sand, or their gravelly or very gravelly analogs
Rock fragment content—0 to 50 percent

Blue Earth Series

Drainage class: Very poorly drained
Permeability: Moderate
Landform: Till plains
Parent material: Coprogenous earth
Slope range: 0 to 1 percent
Taxonomic class: Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents

Typical Pedon

Blue Earth mucky silt loam, 700 feet south and 1,400 feet west of the northeast corner of sec. 24, T. 107 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) mucky silt loam (coprogenous earth), gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; few snail shell fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

C—10 to 60 inches; very dark gray (5Y 3/1) mucky silt loam (coprogenous earth), gray (5Y 5/1) dry; common fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; few snail shell fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Rock fragment content: 0 to 15 percent
Thickness of coprogenous earth: 30 to more than 80 inches

Ap horizon:
Hue—10YR, 2.5Y, or 5Y
Value—2 or 3
Chroma—1 or 2
Texture—Mucky silt loam

C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—2 to 4
Chroma—1 or 2
Texture—Silt loam, silty clay loam, mucky silt loam, or mucky silty clay loam

2C horizon (not in all pedons)*:*
Hue—2.5Y or 5Y
Value—3 to 5
Chroma—1 or 2
Texture—Loam, silt loam, clay loam, or silty clay loam

Bold Series

Drainage class: Well drained
Permeability: Moderate
Landform: Lake plains
Parent material: Glaciolacustrine sediments
Slope range: 5 to 12 percent
Taxonomic class: Coarse-silty, mixed (calcareous), mesic Typic Udorthents

Typical Pedon

Bold silt loam, in an area of Bold-Truman silt loams, 5 to 12 percent slopes, eroded, 1,700 feet east and 350 feet north of the southwest corner of sec. 23, T. 106 N., R. 30 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, light gray (10YR 6/1) dry; weak fine subangular blocky structure; friable; common roots; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—6 to 23 inches; yellowish brown (10YR 5/4) silt loam; massive; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—23 to 38 inches; yellowish brown (10YR 5/6) silt loam; massive; friable; strong effervescence; mildly alkaline; clear smooth boundary.

C3—38 to 60 inches; light yellowish brown (10YR 6/4) silt loam that has lenses of very fine sandy loam; common medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile

Ap horizon:
Hue—10YR
Value—4 to 6
Chroma—2 to 4
Texture—Silt loam

C horizon:
Hue—10YR
Value—4 to 6
Chroma—2 to 8
Texture—Silt loam

Brownton Series

Drainage class: Poorly drained
Permeability: Upper part—slow; lower part—moderately slow or moderate
Landform: Glacial lake plains
Parent material: Lacustrine sediments
Slope range: 0 to 1 percent
Taxonomic class: Fine, montmorillonitic (calcareous), mesic Typic Haplaquolls

Typical Pedon

Brownton silty clay loam, 100 feet north and 1,200 feet east of the southwest corner of sec. 36, T. 105 N., R. 30 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 22 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate medium subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; gradual wavy boundary.

Bg—22 to 38 inches; dark grayish brown (2.5Y 4/2) silty clay; common medium distinct olive yellow (2.5Y 6/6) mottles; moderate medium subangular blocky structure; firm; common black (10YR 2/1) organic matter coatings in channels; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg1—38 to 52 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct olive yellow (2.5Y 6/6) mottles; weak medium subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg2—52 to 60 inches; light brownish gray (2.5Y 6/2) silty clay loam; many medium distinct olive yellow (2.5Y 6/8) mottles; massive; friable; few white (2.5Y 8/2) carbonate coatings in channels; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 12 to 24 inches

A horizon:
Hue—10YR, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Silty clay or silty clay loam

Cg horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—2
Texture—Silty clay loam or silt loam

Canisteo Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Till plains
Parent material: Glacial till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Canisteo clay loam, 800 feet south and 2,500 feet east of the northwest corner of sec. 32, T. 106 N., R. 31 W.

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

A—10 to 14 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common roots; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

AB—14 to 22 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; friable; few roots; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Bg—22 to 36 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg—36 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium prominent yellowish brown (10YR 5/6) mottles; massive; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 14 to 24 inches
Rock fragment content: 2 to 8 percent

A horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Clay loam

AB horizon:
Colors and textures of the A and B horizons

Bg horizon:
Hue—2.5Y, 5Y, or 10YR
Value—4 or 5
Chroma—1 or 2
Texture—Clay loam, loam, silty clay loam, silt loam, or sandy loam

Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2 to 4
Texture—Loam, clay loam, or fine sandy loam

Clarion Series

Drainage class: Well drained
Permeability: Moderate
Landform: Till plains
Parent material: Glacial till
Slope range: 1 to 18 percent
Taxonomic class: Fine-loamy, mixed, mesic Typic Hapludolls

Typical Pedon

Clarion loam, 1 to 4 percent slopes, 1,700 feet south and 2,100 feet east of the northwest corner of sec. 15, T. 106 N., R. 32 W.

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

A—10 to 16 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; few roots; few

dark brown (10YR 3/3) streaks in ped interiors; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bw1—16 to 20 inches; brown (10YR 4/3) loam; moderate medium subangular blocky structure; friable; few very dark grayish brown (10YR 3/2) organic matter coatings on ped exteriors; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bw2—20 to 32 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

C1—32 to 40 inches; brown (10YR 5/3) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common light gray (10YR 7/2) carbonate coatings in channels; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—40 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; common light gray (10YR 7/2) carbonate coatings in channels; about 2 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 18 to 50 inches
Mollic epipedon thickness: 10 to 22 inches
Rock fragment content: 2 to 10 percent

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam, sandy loam, or clay loam

Bw horizon:
Hue—10YR
Value—4 or 5
Chroma—3 or 4
Texture—Loam or clay loam

C horizon:
Hue—10YR or 2.5Y
Value—5
Chroma—3 or 4
Texture—Loam or sandy loam

Taxadjunct feature: In map units 920C2 and 921C2, Clarion soils are a taxadjunct to the Clarion series because the dark surface layer is slightly thinner than is defined as the range for the series. This difference, however, does not alter the use and management of the soils.

Coland Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Flood plains
Parent material: Loamy alluvium
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Coland clay loam, occasionally flooded (fig. 11), 200 feet west and 850 feet south of the northeast corner of sec. 27, T. 105 N., R. 30 W.

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

A1—10 to 27 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; few roots; neutral; gradual smooth boundary.

A2—27 to 40 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.

Cg—40 to 60 inches; black (5Y 2/1) clay loam; massive; friable; mildly alkaline.

Range in Characteristics

Depth to carbonates: 48 inches or more
Mollic epipedon thickness: 36 inches or more

Ap horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Clay loam

A horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Clay loam, loam, or silty clay loam

Cg horizon:
Hue—2.5Y, 5Y, or N
Value—2 to 5
Chroma—0 or 1

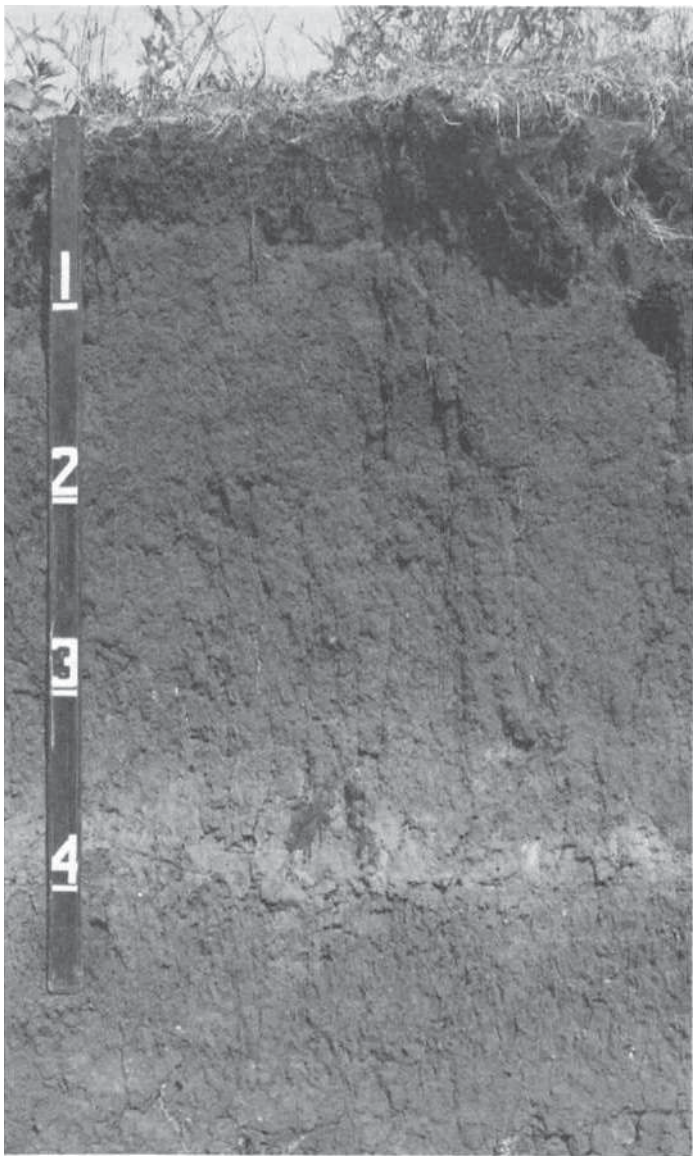

Figure 11.—Typical profile of Coland soils in Watonwan County. Depth is marked in feet.

Texture—Clay loam or loam

Corwith Series

Drainage class: Somewhat poorly drained
Permeability: Moderate
Landform: Lake plains
Parent material: Lacustrine sediments
Slope range: 1 to 3 percent
Taxonomic class: Coarse-silty, mixed, mesic Aquic Hapludolls

Typical Pedon

Corwith silt loam, 500 feet east and 1,900 feet north of the southwest corner of sec. 8, T. 107 N., R. 31 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 14 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; few roots; strong effervescence; moderately alkaline; gradual wavy boundary.

A2—14 to 17 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; common dark grayish brown (2.5Y 4/2) streaks in ped interiors; strong effervescence; moderately alkaline; gradual wavy boundary.

Bw—17 to 27 inches; dark grayish brown (2.5Y 4/2) silt loam; moderate medium subangular blocky structure; friable; common very dark gray (10YR 3/1) streaks on ped exteriors; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—27 to 40 inches; light olive brown (2.5Y 5/4) loamy very fine sand; few fine distinct olive yellow (2.5Y 6/6) mottles; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—40 to 55 inches; light olive brown (2.5Y 5/4) loamy very fine sand; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—55 to 60 inches; light brownish gray (2.5Y 6/2) very fine sandy loam; many medium distinct yellowish brown (10YR 5/6) mottles; weak medium platy structure; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 0 to 10 inches
Mollic epipedon thickness: 10 to 20 inches

Ap horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 to 2
Texture—Silt loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—Silt loam or loam

Bw horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—Silt loam, loam, or very fine sandy loam

C horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—Loamy very fine sand, very fine sandy loam, silt loam, or very fine sand

Crippin Series

Drainage class: Somewhat poorly drained
Permeability: Moderate
Landform: Till plains
Parent material: Glacial till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Crippin loam, 2,100 feet east and 800 feet north of the southwest corner of sec. 11, T. 106 N., R. 32 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common roots; about 2 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

AB—10 to 17 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; friable; common roots; few dark grayish brown (10YR 4/2) streaks in ped interiors; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Bw1—17 to 26 inches; grayish brown (2.5Y 5/2) loam; moderate medium subangular blocky structure; friable; few roots; few very dark gray (10YR 3/1) organic matter coatings on ped exteriors; common carbonate coatings in pores; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Bw2—26 to 33 inches; light olive brown (2.5Y 5/4) loam; few medium distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C—33 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 0 to 10 inches
Mollic epipedon thickness: 14 to 23 inches
Rock fragment content: 2 to 10 percent

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Loam

AB horizon:
Colors and textures of the A and B horizons

Bw horizon:
Hue—10YR or 2.5Y
Value—2 to 5
Chroma—2 to 4
Texture—Loam or clay loam

C horizon:
Hue—10YR to 5Y
Value—4 or 5
Chroma—2 to 4
Texture—Loam or clay loam

Darfur Series

Drainage class: Poorly drained
Permeability: Upper part—moderate or moderately rapid; lower part—moderately rapid
Landform: Outwash plains and lake plains
Parent material: Glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy, mixed, mesic Typic Haplaquolls

Typical Pedon

Darfur fine sandy loam, 1,600 feet east and 1,900 feet south of the northwest corner of sec. 8, T. 107 N., R. 32 W.

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

A1—10 to 18 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; common roots; neutral; gradual wavy boundary.

A2—18 to 23 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; few roots; neutral; gradual wavy boundary.

Bg—23 to 36 inches; dark grayish brown (2.5Y 4/2) fine sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Cg—36 to 60 inches; olive gray (5Y 5/2) loamy fine sand that has lenses of fine sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; neutral.

Range in Characteristics

Depth to carbonates: 20 to 70 inches
Mollic epipedon thickness: 14 to 24 inches

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Fine sandy loam

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Fine sandy loam, loam, loamy sand, loamy fine sand, loamy very fine sand, very fine sandy loam, or silt loam

Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—Loamy fine sand, fine sand, or fine sandy loam

Dassel Series

Drainage class: Very poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy, mixed, mesic Typic Haplaquolls

Typical Pedon

Dassel fine sandy loam, 300 feet north and 1,400 feet east of the southwest corner of sec. 25, T. 107 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) fine sandy loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; neutral; abrupt smooth boundary.
A1—10 to 19 inches; black (N 2/0) fine sandy loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; neutral; gradual wavy boundary.
A2—19 to 27 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; few fine faint dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Bg—27 to 37 inches; dark gray (5Y 4/1) sandy loam; few fine faint olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Cg1—37 to 50 inches; olive gray (5Y 5/2) loamy sand; common medium distinct olive yellow (5Y 6/6) mottles; massive; very friable; mildly alkaline; gradual wavy boundary.
Cg2—50 to 60 inches; olive gray (5Y 5/2) loamy sand; many medium distinct olive yellow (5Y 6/6) mottles; massive; very friable; mildly alkaline.

Range in Characteristics

Depth to carbonates: 18 to 70 inches
Mollic epipedon thickness: 24 to 30 inches

A horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 to 2
Texture—Fine sandy loam
Rock fragment content—0 to 5 percent

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Sandy loam, fine sandy loam, loamy sand, or loamy fine sand
Rock fragment content—0 to 5 percent

C horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—2 or 3
Texture—Loamy sand, loamy coarse sand, coarse sand, or sand
Rock fragment content—0 to 15 percent

Taxadjunct feature: The mollic epipedon is more than 24 inches thick. This difference, however, does not alter the use and management of the soils.

Delft Series

Drainage class: Poorly drained
Permeability: Moderately slow or moderate
Landform: Till plains

Parent material: Alluvium and the underlying glacial till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Delft loam, 600 feet north and 1,100 feet east of the southwest corner of sec. 33, T. 106 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; about 2 percent coarse fragments; many fine roots; slightly acid; abrupt smooth boundary.

A1—10 to 30 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; many fine roots; medium acid; gradual smooth boundary.

A2—30 to 37 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; gradual smooth boundary.

A3—37 to 43 inches; very dark grayish brown (2.5Y 3/1) clay loam, dark grayish brown (2.5Y 4/2) dry; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual smooth boundary.

Cg—43 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct dark yellowish brown (10YR 4/6) mottles; massive; firm; many very dark gray (10YR 3/1) streaks; about 2 percent coarse fragments; mildly alkaline; gradual wavy boundary.

Range in Characteristics

Depth to carbonates: 24 to 60 inches
Mollic epipedon thickness: 24 to 60 inches
Rock fragment content: 1 to 10 percent

Ap horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam

A horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam or clay loam

C horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Clay loam, loam, or sandy loam

Dickinson Series

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 6 percent
Taxonomic class: Coarse-loamy, mixed, mesic Typic Hapludolls

Typical Pedon

Dickinson fine sandy loam, 2 to 6 percent slopes, 1,500 feet east and 1,500 feet south of the northwest corner of sec. 23, T. 105 N., R. 31 W.

Ap—0 to 9 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common roots; slightly acid; abrupt smooth boundary.

A—9 to 14 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common roots; slightly acid; gradual wavy boundary.

Bw1—14 to 19 inches; dark grayish brown (10YR 4/2) fine sandy loam; moderate medium subangular blocky structure; friable; few roots; medium acid; gradual wavy boundary.

Bw2—19 to 36 inches; dark yellowish brown (10YR 4/4) fine sandy loam; moderate medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

Bw3—36 to 40 inches; dark yellowish brown (10YR 4/4) fine sandy loam; moderate medium subangular blocky structure; friable; medium acid; gradual wavy boundary.

C—40 to 60 inches; dark yellowish brown (10YR 4/4) fine sand; single grain; loose; medium acid.

Range in Characteristics

Depth to sandy sediments: 20 to 42 inches
Mollic epipedon thickness: 12 to 24 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2 in the upper part; 2 or 3 in the lower part
Texture—Fine sandy loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2 in the upper part; 2 or 3 in the lower part
Texture—Fine sandy loam, sandy loam, or loam

Bw horizon:
Hue—10YR
Value—3 or 4
Chroma—2 to 4
Texture—Fine sandy loam or sandy loam

BC horizon (not in all pedons)*:*
Colors and textures of the B and C horizons

C horizon:
Hue—7.5YR or 10YR
Value—4 or 5
Chroma—3 to 6
Texture—Loamy fine sand, loamy sand, or fine sand

Dickman Series

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 6 percent
Taxonomic class: Sandy, mixed, mesic Typic Hapludolls

Typical Pedon

Dickman sandy loam, 2 to 6 percent slopes, 1,100 feet east and 1,800 feet south of the northwest corner of sec. 23, T. 105 N., R. 31 W.

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

A—10 to 15 inches; very dark grayish brown (10YR 3/2) sandy loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; friable; few roots; medium acid; gradual wavy boundary.

Bw—15 to 20 inches; brown (10YR 4/3) loamy sand; weak medium subangular blocky structure; very friable; slightly acid; gradual wavy boundary.

BC—20 to 36 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; medium acid; gradual wavy boundary.

C—36 to 60 inches; brown (10YR 5/3) sand; single grain; loose; medium acid.

Range in Characteristics

Depth to carbonates: 30 inches or more
Mollic epipedon thickness: 10 to 20 inches
Depth to sandy sediments: 12 to 20 inches
Rock fragment content: 0 to 10 percent

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam, coarse sandy loam, or fine sandy loam

Bw horizon:
Hue—7.5YR or 10YR
Value—3 or 4
Chroma—3 or 4
Texture—Loamy sand, coarse sandy loam, fine sandy loam, sandy loam, loamy coarse sand, or loamy fine sand

BC horizon:
Colors and textures of the B and C horizons

C horizon:
Hue—7.5YR, 10YR, or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—Sand, coarse sand, or fine sand

Essexville Series

Drainage class: Poorly drained
Permeability: Upper part—rapid; lower part—moderately slow
Landform: Till plains and lake plains
Parent material: Sandy sediments overlying loamy glacial till
Slope range: 0 to 2 percent
Taxonomic class: Sandy over loamy, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Essexville sandy loam, 550 feet east and 2,300 feet north of the southwest corner of sec. 13, T. 107 N., R. 30 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common roots; about 8 percent coarse fragments; mildly alkaline; abrupt smooth boundary.

A—8 to 13 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; few roots; about 6 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

Bw—13 to 22 inches; dark grayish brown (2.5Y 4/2) sand; common medium distinct dark yellowish brown (10YR 4/6) mottles; single grain; loose; about 4 percent coarse fragments; slight effervescence; moderately alkaline; gradual wavy boundary.
2C—22 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct dark yellowish brown (10YR 4/6) mottles; massive; firm; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 0 to 10 inches
Mollic epipedon thickness: 10 to 20 inches
Rock fragment content: 1 to 10 percent
Depth to glacial till: 18 to 35 inches
Other profile features: A C horizon in some pedons

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam or loamy sand

B horizon:
Hue—10YR or 2.5Y
Value—4 to 5
Chroma—1 or 2
Texture—Sand, loamy sand, or loamy fine sand

2C horizon:
Hue—5Y or 2.5Y
Value—4 to 6
Chroma—1 or 2
Texture—Clay loam or loam

Estherville Series

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 1 to 12 percent
Taxonomic class: Sandy, mixed, mesic Typic Hapludolls

Typical Pedon

Estherville sandy loam, 1 to 6 percent slopes, 1,100 feet west and 1,100 feet north of the southeast corner of sec. 35, T. 106 N., R. 33 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few roots; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.
A—9 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; few roots; about 6 percent coarse fragments; slightly acid; gradual wavy boundary.
Bw—13 to 18 inches; dark yellowish brown (10YR 3/4) sandy loam; moderate medium subangular blocky structure; friable; about 8 percent coarse fragments; neutral; gradual wavy boundary.
2C—18 to 60 inches; variegated yellowish brown (10YR 5/4) and brown (10YR 5/3 and 4/3) gravelly coarse sand; single grain; loose; about 15 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 15 to 30 inches
Mollic epipedon thickness: 9 to 20 inches
Depth to sandy sediments: 12 to 20 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam
Rock fragment content—0 to 10 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam, loam, or coarse sandy loam
Rock fragment content—0 to 10 percent

Bw horizon:
Hue—7.5YR or 10YR
Value—3 or 4
Chroma—3 or 4
Texture—Sandy loam, coarse sandy loam, or loam
Rock fragment content—0 to 10 percent

2C horizon:
Hue—10YR
Value—4 to 7
Chroma—2 to 6
Texture—Gravelly coarse sand, gravelly sand, coarse sand, or sand
Rock fragment content—10 to 35 percent

Fedji Series

Drainage class: Well drained
Permeability: Upper part—rapid; lower part—moderate

Landform: Outwash plains and deltas
Parent material: Outwash over lacustrine sediments or glacial till
Slope range: 1 to 6 percent
Taxonomic class: Sandy over loamy, mixed, mesic Typic Hapludolls

Typical Pedon

Fedji loamy fine sand, 1 to 6 percent slopes, 900 feet east and 1,700 feet north of the southwest corner of sec. 28, T. 107 N., R. 30 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark brown (10YR 3/3) dry; weak fine granular structure; loose; slightly acid; clear smooth boundary.
AB—8 to 12 inches; dark brown (10YR 3/3) fine sand, dark brown (10YR 4/3) dry; weak fine granular structure; loose; slightly acid; clear smooth boundary.
Bw1—12 to 35 inches; dark yellowish brown (10YR 4/4) loamy fine sand; single grain; loose; neutral; clear smooth boundary.
2Bw2—35 to 42 inches; yellowish brown (10YR 5/4) clay loam; weak fine subangular blocky structure; friable; slightly acid; gradual wavy boundary.
2C—42 to 60 inches; light olive brown (2.5Y 5/4) clay loam; few fine distinct strong brown (7.5YR 4/6) mottles; massive; friable; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 60 inches
Mollic epipedon thickness: 10 to 24 inches
Rock fragment content: 0 to 8 percent
Depth to loamy sediments: 20 to 40 inches

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loamy fine sand

AB horizon:
Colors and textures of the A and B horizons

B horizon:
Hue—10YR
Value—3 to 5
Chroma—3 to 5
Texture—Loamy fine sand, sand, fine sand, or loamy sand

2B and 2C horizons:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—3 to 5
Texture—Loam, silt loam, or clay loam

Fieldon Series

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Landform: Glacial lake plains and outwash plains
Parent material: Calcareous glacial outwash sediments
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Fieldon loam, 300 feet north and 700 feet east of the southwest corner of sec. 25, T. 107 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; clear smooth boundary.
A—10 to 16 inches; black (10YR 2/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; gradual wavy boundary.
Bg1—16 to 20 inches; dark gray (10YR 4/1) fine sandy loam; weak medium subangular blocky structure; friable; few roots; strong effervescence; mildly alkaline; gradual wavy boundary.
Bg2—20 to 32 inches; olive gray (5Y 5/2) fine sandy loam; few fine distinct light yellowish brown (2.5Y 6/4) mottles; moderate medium subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual wavy boundary.
Cg1—32 to 43 inches; pale olive (5Y 6/3) loamy fine sand; common medium prominent dark yellowish brown (10YR 4/4) mottles; massive; friable; few very dark grayish brown (10YR 3/2) manganese coatings in channels; strong effervescence; mildly alkaline; gradual wavy boundary.
Cg2—43 to 60 inches; light olive gray (5Y 6/2) loamy fine sand; many medium distinct dark yellowish brown (10YR 4/4) mottles; massive; friable; few very dark grayish brown (10YR 3/2) manganese coatings in channels; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 14 to 24 inches

Ap horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1

Texture—Loam

A horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam, fine sandy loam, or very fine sandy loam

B horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 or 5
Chroma—1 to 4
Texture—Fine sandy loam, very fine sandy loam, or loam

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 to 4
Texture—Loamy fine sand, fine sand, or fine sandy loam

Glencoe Series

Drainage class: Very poorly drained
Permeability: Upper part—moderate or moderately slow; lower part—moderate
Landform: Till plains
Parent material: Glacial till
Slope range: 0 to 1 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Glencoe clay loam, 500 feet north and 800 feet west of the southeast corner of sec. 2, T. 107 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A—10 to 20 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; common roots; about 2 percent coarse fragments; neutral; gradual wavy boundary.

AB—20 to 28 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; few roots; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bg—28 to 46 inches; olive gray (5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; few faint dark olive gray (5Y 3/2) organic matter coatings on ped exteriors; about 1 percent coarse fragments; neutral; gradual wavy boundary.

Cg—46 to 60 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 6 percent coarse fragments; mildly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 60 inches
Mollic epipedon thickness: 24 to 46 inches
Rock fragment content: 1 to 8 percent

Ap horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Clay loam

A horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Clay loam or silty clay loam

AB horizon:
Colors and textures of the A and B horizons

B horizon:
Hue—5Y or 2.5Y
Value—4 or 5
Chroma—1 or 2
Texture—Clay loam, loam, or silty clay loam

C horizon:
Hue—5Y or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—Clay loam or loam

Granby Series

Drainage class: Very poorly drained
Permeability: Rapid
Landform: Outwash plains
Parent material: Sandy sediments
Slope range: 0 to 2 percent
Taxonomic class: Sandy, mixed, mesic Typic Haplaquolls

Typical Pedon

Granby loamy sand, 1,900 feet east and 2,050 feet south of the northwest corner of sec. 16, T. 107 N., R. 32 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; common roots;

medium acid; abrupt smooth boundary.
A1—10 to 21 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; few fine faint very dark grayish brown (10YR 3/2) mottles; weak fine subangular blocky structure; very friable; few roots; medium acid; gradual wavy boundary.
A2—21 to 26 inches; very dark grayish brown (10YR 3/2) loamy sand, gray (10YR 6/1) dry; few fine distinct dark yellowish brown (10YR 3/4) mottles; weak medium subangular blocky structure; very friable; medium acid; gradual wavy boundary.
Bg—26 to 32 inches; dark grayish brown (2.5Y 4/2) loamy sand that has lenses of loamy fine sand; few medium distinct brown (10YR 4/3) mottles; weak medium subangular blocky structure; very friable; slightly acid; gradual wavy boundary.
Cg—32 to 60 inches; grayish brown (2.5Y 5/2) loamy sand that has lenses of loamy fine sand; few fine distinct grayish brown (10YR 5/2) mottles; single grain; very friable; slightly acid.

Range in Characteristics

Mollic epipedon thickness: 10 to 24 inches

Ap horizon:
Hue—2.5Y, 10YR, or N
Value—2 or 3
Chroma—0 to 2
Texture—Loamy sand

A horizon:
Hue—2.5Y, 10YR, or N
Value—2 or 3
Chroma—0 to 2
Texture—Loamy sand, loamy fine sand, fine sand, sand, fine sandy loam, or sandy loam

B horizon:
Hue—2.5Y or 10YR
Value—4 to 6
Chroma—1 to 3
Texture—Fine sand, sand, loamy sand, or loamy fine sand

C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—5 to 7
Chroma—2 to 4
Texture—Sand, fine sand, or loamy sand

Grogan Series

Drainage class: Well drained and moderately well drained
Permeability: Moderately rapid
Landform: Lake plains
Parent material: Lacustrine sediments
Slope range: 0 to 12 percent
Taxonomic class: Coarse-silty, mixed, mesic Typic Hapludolls

Typical Pedon

Grogan silt loam, 2 to 6 percent slopes, 1,400 feet south and 2,200 feet west of the northeast corner of sec. 13, T. 106 N., R. 30 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; many fine roots; neutral; clear smooth boundary.
A—9 to 15 inches; dark brown (10YR 3/3) silt loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; friable; common fine roots; neutral; gradual wavy boundary.
Bw1—15 to 30 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Bw2—30 to 36 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual wavy boundary.
C1—36 to 41 inches; light olive brown (2.5Y 5/4) silt loam; few fine faint yellowish brown (10YR 5/8) mottles; massive; friable; strong effervescence; mildly alkaline; gradual wavy boundary.
C2—41 to 60 inches; light olive brown (2.5Y 5/4) very fine sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches
Mollic epipedon thickness: 10 to 18 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—Silt loam or loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—Loam or silt loam

B horizon:
Hue—10YR
Value—4 or 5
Chroma—3 to 5
Texture—Loam, silt loam, very fine sandy loam, or loamy very fine sand

C horizon:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—3 to 6
Texture—Silt loam, very fine sandy loam, or loamy very fine sand

Hanlon Series

Drainage class: Moderately well drained
Permeability: Moderately rapid
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 4 percent
Taxonomic class: Coarse-loamy, mixed, mesic Cumulic Hapludolls

Typical Pedon

Hanlon fine sandy loam, in an area of Hanlon-Kalmarville complex, 0 to 4 percent slopes, 800 feet west and 2,600 feet north of the southeast corner of sec. 26, T. 107 N., R. 30 W.

A1—0 to 15 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; neutral; many fine roots; clear wavy boundary.
A2—15 to 35 inches; very dark gray (10YR 3/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; few fine roots; neutral; gradual wavy boundary.
A3—35 to 40 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; neutral; gradual wavy boundary.
C1—40 to 50 inches; very dark grayish brown (10YR 3/2) loamy sand; single grain; loose; neutral; gradual wavy boundary.
C2—50 to 60 inches; dark grayish brown (10YR 4/2) loamy sand; single grain; loose; neutral.

Range in Characteristics

Depth to carbonates: 48 inches or more
Mollic epipedon thickness: 40 to 70 inches

A1 horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Fine sandy loam

A2 and A3 horizons:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Fine sandy loam or sandy loam

B horizon (not in all pedons):
Hue—10YR
Value—3 or 4
Chroma—1 or 2
Texture—Sandy loam

C horizon:
Hue—10YR or 2.5Y
Value—3 or 4
Chroma—1 or 2
Texture—Loamy sand, loam, or sandy loam

Hanska Series

Drainage class: Poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy, mixed, mesic Typic Haplaquolls

Typical Pedon

Hanska loam, 900 feet north and 1,200 feet east of the southwest corner of sec. 19, T. 107 N., R. 31 W.

Ap—0 to 10 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; many roots; neutral; abrupt smooth boundary.
A1—10 to 18 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; common roots; neutral; gradual wavy boundary.
A2—18 to 23 inches; very dark gray (10YR 3/1) sandy loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Bg—23 to 30 inches; dark grayish brown (2.5Y 4/2) sandy loam; few fine distinct light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.
2Cg1—30 to 38 inches; grayish brown (2.5Y 5/2) sand; few fine distinct light olive brown (2.5Y 5/6) mottles; single grain; neutral; gradual wavy boundary.
2Cg2—38 to 60 inches; grayish brown (2.5Y 5/2) sand; many medium distinct yellowish brown (10YR 5/6) mottles; single grain; neutral.

Range in Characteristics

Depth to carbonates: 30 to 60 inches
Mollic epipedon thickness: 12 to 24 inches

Ap horizon:
Hue—10YR, 2.5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam

A horizon:
Hue—10YR, 2.5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam, fine sandy loam, or sandy loam

Bg horizon:
Hue—2.5Y
Value—4 or 5
Chroma—1 or 2
Texture—Sandy loam, coarse sandy loam, or loam

2Cg horizon:
Hue—2.5Y
Value—3 to 5
Chroma—2 to 4
Texture—Sand or coarse sand

Harps Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Glacial till plains
Parent material: Glacial till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mesic Typic Calciaquolls

Typical Pedon

Harps clay loam, 200 feet west and 2,300 feet north of the southeast corner of sec. 15, T. 106 N., R. 32 W.

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

Ak—9 to 18 inches; very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; few roots; common dark gray (10YR 4/1) carbonate streaks in channels; about 2 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

Bg—18 to 36 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—36 to 60 inches; grayish brown (2.5Y 5/2) loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; violent effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 12 to 21 inches
Rock fragment content: 1 to 5 percent

Ap horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Clay loam

Ak horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Clay loam or loam

B horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2
Texture—Clay loam, loam, or sandy clay loam

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—Loam or sandy clay loam

Hoopeston Series

Drainage class: Somewhat poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Glacial outwash plains
Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Coarse-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Hoopeston fine sandy loam, 3,000 feet west and 600 feet south of the northeast corner of sec. 30, T. 107 N., R. 31 W.

Ap—0 to 12 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; many roots; slightly acid; abrupt smooth boundary.

A—12 to 18 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; common roots; slightly acid; gradual wavy boundary.

Bw1—18 to 26 inches; dark grayish brown (2.5Y 4/2) fine sandy loam; common fine faint olive brown (2.5Y 4/4) mottles; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Bw2—26 to 32 inches; olive brown (2.5Y 4/4) sandy loam; common medium faint dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.
Bw3—32 to 40 inches; light olive brown (2.5Y 5/4) loamy fine sand; common medium distinct light brownish gray (2.5Y 6/2) mottles; single grain; loose; neutral; gradual wavy boundary.
C—40 to 60 inches; dark yellowish brown (10YR 4/6) fine sand; common medium distinct grayish brown (2.5Y 5/2) mottles; single grain; loose; neutral.

Range in Characteristics

Depth to carbonates: More than 40 inches
Mollic epipedon thickness: 10 to 24 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Fine sandy loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Fine sandy loam or sandy loam

B horizon:
Hue—7.5YR, 10YR, or 2.5Y
Value—4 or 5
Chroma—2 to 6
Texture—Sandy loam, fine sandy loam, or loam

C horizon:
Hue—10YR or 2.5Y
Value—3 to 6
Chroma—2 to 6
Texture—Loamy sand, fine sand, or sandy loam

Kalmarville Series

Drainage class: Very poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Flood plains
Parent material: Recent alluvium
Slope range: 0 to 4 percent
Taxonomic class: Coarse-loamy, mixed, nonacid, mesic Mollic Fluvaquents

Typical Pedon

Kalmarville fine sandy loam, in an area of Hanlon-Kalmarville complex, 0 to 4 percent slopes, 850 feet east and 2,400 feet north of the southwest corner of sec. 26, T. 107 N., R. 30 W.

A1—0 to 12 inches; very dark gray (10YR 3/1) loam; very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; friable; neutral; gradual wavy boundary.
A2—12 to 20 inches; dark gray (10YR 4/1) fine sandy loam; grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; common dark grayish brown streaks on faces of peds and pores; neutral; gradual wavy boundary.
A3—20 to 30 inches; very dark gray (10YR 3/1) loam; dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; common dark grayish brown (10YR 4/2) streaks on faces of peds and pores; slight effervescence; mildly alkaline; gradual wavy boundary.
A4—30 to 55 inches; dark gray (10YR 4/1) fine sandy loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; common very dark grayish brown (10YR 3/2) streaks on faces of peds and pores; slight effervescence; mildly alkaline; clear wavy boundary.
2C—55 to 60 inches; very dark grayish brown (10YR 3/2) loamy sand; single grain; loose; slight effervescence; mildly alkaline.

Range in Characteristics

A1 horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Loam, fine sandy loam, or loam
Rock fragment content—0 to 5 percent

A2, A3, and A4 horizons:
Hue—10YR
Value—2 to 6
Chroma—1
Texture—loam or fine sandy loam

2C horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—1 or 2
Texture—coarse sand, sand, fine sand, loamy coarse sand, loamy sand, or loamy fine sand
Rock fragment content—0 to 10 percent

Taxadjunct feature: The soils do not have fine strata in the A horizon. This difference, however, does not alter the use and management of the soils.

Kingston Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Glacial lake plains
Parent material: Silty lacustrine sediments
Slope range: 1 to 3 percent
Taxonomic class: Fine-silty, mixed, mesic Aquic Hapludolls

Typical Pedon

Kingston silty clay loam, 2,400 feet east and 450 feet south of the northwest corner of sec. 2, T. 105 N., R. 30 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; many roots; slightly acid; abrupt smooth boundary.

A—10 to 16 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; common roots; slightly acid; gradual wavy boundary.

Bw—16 to 22 inches; dark grayish brown (2.5Y 4/2) silty clay loam; moderate medium subangular blocky structure; friable; common very dark grayish brown (10YR 3/2) organic matter coatings on ped exteriors; neutral; gradual wavy boundary.

C1—22 to 28 inches; light olive brown (2.5Y 5/4) silty clay loam; moderate medium subangular blocky structure; friable; few light gray (10YR 7/2) carbonate coatings in channels; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—28 to 40 inches; light olive brown (2.5Y 5/4) silt loam; few fine distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C3—40 to 60 inches; light olive brown (2.5Y 5/4) silt loam; common medium distinct light brownish gray (10YR 6/2) mottles; massive; friable; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches
Mollic epipedon thickness: 12 to 24 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Silty clay loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Silty clay loam, silt loam, or loam

B horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—2 to 4
Texture—Silty clay loam or silt loam

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2 to 4
Texture—Silt loam or silty clay loam

Knoke Series

Drainage class: Very poorly drained
Permeability: Moderately slow
Landform: Till plains
Parent material: Glacial sediments
Slope range: 0 to 1 percent
Taxonomic class: Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls

Typical Pedon

Knoke silty clay loam, 1,800 feet east and 900 feet north of the southwest corner of sec. 18, T. 107 N., R. 33 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; few snail shell fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 36 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; few snail shell fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

Bg—36 to 50 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; few snail shell fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

Cg—50 to 60 inches; black (5Y 2/1) silty clay loam that has strata of silt loam; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; few snail shell fragments; many soft white masses of carbonate coatings; violent effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 24 to 60 inches

Ap horizon:
Hue—2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam

A horizon:
Hue—2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam or clay loam

Bg horizon:
Hue—2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam

Cg horizon:
Hue—5Y
Value—2
Chroma—1
Texture—Silty clay loam, loam, silt loam, or clay loam

Lakefield Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Glacial lake plains
Parent material: Calcareous lacustrine sediments
Slope range: 1 to 3 percent
Taxonomic class: Fine-silty, mixed, mesic Aquic Hapludolls

Typical Pedon

Lakefield silty clay loam, 350 feet east and 1,700 feet north of the southwest corner of sec. 25, T. 106 N., R. 30 W.

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

A—10 to 18 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; common black (10YR 2/1) ped exteriors; moderate medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw—18 to 28 inches; olive brown (2.5Y 4/4) silt loam; few fine faint dark grayish brown (2.5Y 4/2) mottles; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C1—28 to 38 inches; light olive brown (2.5Y 5/4) silt loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—38 to 60 inches; light olive brown (2.5Y 5/4) silt loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderate alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 12 to 24 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Silty clay loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Silty clay loam or silt loam

Bw horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—Silt loam or silty clay loam

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2 to 4
Texture—Silt loam or silty clay loam

Lasa Series

Drainage class: Well drained
Permeability: Moderately rapid
Landform: Outwash plains and lake plains
Parent material: Glacial outwash
Slope range: 1 to 6 percent
Taxonomic class: Sandy, mixed, mesic Entic Hapludolls

Typical Pedon

Lasa loamy fine sand, 1 to 6 percent slopes, 200 feet south and 500 feet west of the northeast corner of sec. 19, T. 106 N., R. 30 W.

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

A—10 to 18 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.

Bw1—18 to 38 inches; dark yellowish brown (10YR 4/4) fine sand that has strata of loamy fine sand; weak medium subangular blocky structure; very friable; slightly acid; gradual wavy boundary.
Bw2—38 to 46 inches; brown (10YR 5/3) fine sand that has strata of loamy fine sand; weak medium subangular blocky structure; very friable; slightly acid; gradual wavy boundary.
Bw3—46 to 60 inches; yellowish brown (10YR 5/4) loamy fine sand; weak medium subangular blocky structure; friable; slightly acid.

Range in Characteristics

Mollic epipedon thickness: 10 to 24 inches
Other profile features: A C horizon in some pedons

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loamy fine sand

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loamy fine sand or fine sand

B horizon:
Hue—7.5YR or 10YR
Value—3 to 5
Chroma—3 to 5
Texture—Fine sand or loamy fine sand

Lasa Variant

Drainage class: Well drained
Permeability: Moderately rapid
Landform: Outwash plains and lake plains
Parent material: Calcareous lacustrine sediments and glacial outwash
Slope range: 2 to 12 percent
Taxonomic class: Sandy, mixed, mesic Entic Hapludolls

Typical Pedon

Lasa Variant loamy fine sand, in an area of Grogan-Lasa Variant complex, 2 to 6 percent slopes, eroded, 2,000 feet east and 2,000 feet north of the southwest corner of sec. 8, T. 107 N., R. 31 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) loamy fine sand, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; strong effervescence; mildly alkaline; abrupt smooth boundary.
Bw—10 to 36 inches; yellowish brown (10YR 5/4) loamy fine sand; weak very fine subangular blocky structure; very friable; strong effervescence; mildly alkaline; gradual wavy boundary.
C—36 to 60 inches; yellowish brown (10YR 5/4), stratified loamy fine sand and fine sand; single grain; loose; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 10 to 24 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loamy fine sand

Bw horizon:
Hue—7.5YR or 10YR
Value—3 to 5
Chroma—3 to 5
Texture—Fine sand or loamy fine sand

C horizon:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—2 to 4
Texture—Fine sand or loamy fine sand

Lemond Series

Drainage class: Poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains
Parent material: Calcareous glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Lemond loam, 1,000 feet north and 2,000 feet east of the southwest corner of sec. 19, T. 107 N., R. 31 W.

Ap—0 to 10 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; abrupt smooth boundary.
A1—10 to 18 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; gradual wavy boundary.
A2—18 to 23 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak medium

subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

Bg—23 to 28 inches; grayish brown (2.5Y 5/2) sandy loam; few fine distinct light yellowish brown (2.5Y 6/4) mottles; moderate medium subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

2Cg1—28 to 40 inches; light brownish gray (2.5Y 6/2) sand; few fine distinct light yellowish brown (2.5Y 6/4) mottles; single grain; loose; slight effervescence; mildly alkaline; gradual wavy boundary.

2Cg2—40 to 60 inches; light brownish gray (2.5Y 6/2) sand; many medium distinct dark yellowish brown (10YR 3/4) mottles; single grain; loose; slight effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 14 to 24 inches
Depth to sandy sediments: 20 to 40 inches

Ap horizon:
Hue—10YR, 2.5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam

A horizon:
Hue—10YR, 2.5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam or sandy loam

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Loam, sandy loam, or coarse sandy loam

2Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2
Texture—Sand, coarse sand, loamy sand, or loamy coarse sand

Linder Series

Drainage class: Somewhat poorly drained
Permeability: Upper part—moderate or moderately rapid; lower part—very rapid
Landform: Outwash plains and stream terraces
Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Coarse-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Linder sandy loam, 200 feet west and 2,600 feet south of the northeast corner of sec. 4, T. 107 N., R. 32 W.

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

A—10 to 18 inches; very dark grayish brown (10YR 3/2) sandy loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; few fine roots; neutral; gradual wavy boundary.

Bw—18 to 33 inches; grayish brown (2.5Y 5/2) sandy loam; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.

2C—33 to 60 inches; olive brown (2.5Y 4/4), light olive brown (2.5Y 5/4), and yellowish brown (10YR 5/6) coarse sand; single grain; loose; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 22 to 36 inches
Mollic epipedon thickness: 10 to 20 inches

Ap horizon:
Hue—10YR
Value—2
Chroma—1 or 2
Texture—Sandy loam
Rock fragment content—0 to 5 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam or loam
Rock fragment content—0 to 5 percent

B horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 or 3
Texture—Sandy loam
Rock fragment content—0 to 5 percent

BC horizon (not in all pedons):
Colors and textures of the B and C horizons

2C horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—2 to 6
Texture—Sand, coarse sand, or their gravelly or very gravelly analogs
Rock fragment content—5 to 50 percent

Litchfield Series

Drainage class: Moderately well drained
Permeability: Moderately rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 3 percent
Taxonomic class: Sandy, mixed, mesic Aquic Hapludolls

Typical Pedon

Litchfield loamy fine sand, 1,500 feet north and 2,400 feet east of the southwest corner of sec. 25, T. 107 N., R. 32 W.

Ap—0 to 9 inches; black (10YR 2/1) loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many roots; neutral; abrupt smooth boundary.

A1—9 to 15 inches; very dark gray (10YR 3/1) loamy fine sand, gray (10YR 5/1) dry; weak fine subangular blocky structure; very friable; few roots; neutral; gradual wavy boundary.

A2—15 to 21 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; neutral; gradual wavy boundary.

Bw1—21 to 30 inches; brown (10YR 4/3) loamy fine sand; few fine distinct dark yellowish brown (10YR 4/6) and few fine distinct dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; very friable; slightly acid; gradual wavy boundary.

Bw2—30 to 40 inches; grayish brown (2.5Y 5/2) fine sand; common medium distinct dark yellowish brown (10YR 4/6) mottles; weak medium subangular blocky structure; very friable; slightly acid; gradual wavy boundary.

C—40 to 60 inches; light brownish gray (2.5Y 6/2) fine sand; common medium distinct yellowish brown (10YR 5/4) mottles; single grain; loose; neutral.

Range in Characteristics

Depth to carbonates: More than 50 inches
Mollic epipedon thickness: 12 to 24 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loamy fine sand

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loamy fine sand, loamy sand, sandy loam, or fine sandy loam

B horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—Loamy fine sand, fine sand, loamy sand, or sand

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2 or 3
Texture—Sand, fine sand, loamy sand, or loamy fine sand

Madelia Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Glacial lake plains
Parent material: Silty lacustrine sediments
Slope range: 0 to 2 percent
Taxonomic class: Fine-silty, mixed, mesic Typic Haplaquolls

Typical Pedon

Madelia silty clay loam, 100 feet south and 2,300 feet west of the northeast corner of sec. 25, T. 106 N., R. 30 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; common roots; neutral; abrupt smooth boundary.

A—9 to 18 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common roots; neutral; gradual wavy boundary.

Bg—18 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; friable; few roots; common very dark grayish brown (2.5Y 3/2) organic matter coatings; neutral; gradual wavy boundary.

Cg1—25 to 40 inches; grayish brown (2.5Y 5/2) silt loam; common fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg2—40 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; many large distinct light olive brown (2.5Y 5/6) mottles; massive; friable; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches

Mollic epipedon thickness: 14 to 24 inches

Ap horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam

A horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam or silt loam

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 to 3
Texture—Silty clay loam or silt loam

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 to 4
Texture—Silt loam, silty clay loam, or loam

Mayer Series

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Mayer loam, 300 feet west and 1,100 feet north of the southeast corner of sec. 3, T. 107 N., R. 31 W.

Ap—0 to 8 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common roots; about 2 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

A1—8 to 12 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common roots; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

A2—12 to 19 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; friable; few roots; about 2 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

Bg—19 to 33 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual irregular boundary.

2BCg—33 to 38 inches; grayish brown (2.5Y 5/2) sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

2Cg—38 to 60 inches; grayish brown (10YR 5/2) gravelly coarse sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 15 percent coarse fragments; slight effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 14 to 24 inches
Depth to sandy sediments: 20 to 40 inches

Ap horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam
Rock fragment content—0 to 10 percent

A horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Loam or silt loam
Rock fragment content—0 to 10 percent

B horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 or 5
Chroma—1 to 3
Texture—Loam or sandy clay loam
Rock fragment content—0 to 10 percent

2BC horizon:
Colors and textures of the B and 2C horizons

2C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—3 to 5
Chroma—1 to 3
Texture—Gravelly coarse sand, coarse sand, gravelly sand, or sand
Rock fragment content—10 to 35 percent

Millington Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Flood plains
Parent material: Calcareous alluvium
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls

Typical Pedon

Millington clay loam, occasionally flooded, 200 feet west and 1,700 feet south of the northeast corner of sec. 8, T. 107 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; many roots; about 1 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 16 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; common roots; about 1 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

A2—16 to 30 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; few white (10YR 8/1) carbonate coatings in pores; about 1 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

A3—30 to 38 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; common very dark gray (10YR 3/1) streaks in ped interiors; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg—38 to 60 inches; dark grayish brown (2.5Y 4/2), stratified clay loam and loam; few fine distinct olive brown (2.5Y 4/4) mottles; massive; friable; few roots; about 2 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 24 to 50 inches
Rock fragment content: 0 to 5 percent
Other profile features: A B horizon in some pedons

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Clay loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam, silt loam, silty clay loam, or clay loam

Cg horizon:
Hue—2.5Y
Value—4 or 5
Chroma—2
Texture—Sandy loam, silty clay loam, clay loam, or loam

Nicollet Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Till plains
Parent material: Glacial till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Nicollet loam, 500 feet south and 1,100 feet east of the northwest corner of sec. 12, T. 105 N., R. 33 W.

Ap—0 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; many fine roots; about 2 percent coarse fragments; neutral; clear smooth boundary.

A—12 to 19 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; common fine roots; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bw1—19 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam; moderate medium subangular blocky structure; friable; few fine roots; about 3 percent coarse fragments; neutral; gradual wavy boundary.

Bw2—28 to 34 inches; olive brown (2.5Y 4/4) clay loam; few fine distinct olive yellow (2.5Y 6/6) and dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure; friable; few fine roots; about 2 percent coarse fragments; mildly alkaline; gradual wavy boundary.

C1—34 to 44 inches; light olive brown (2.5Y 5/4) loam; few fine distinct olive yellow (2.5Y 6/6) mottles; massive; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—44 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct yellowish brown (10YR

5/6) and grayish brown (10YR 5/2) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 48 inches
Mollic epipedon thickness: 10 to 24 inches
Rock fragment content: 1 to 8 percent

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam or clay loam

B horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—2 to 4
Texture—Clay loam or loam

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2 to 4
Texture—Loam or clay loam

Nishna Series

Drainage class: Poorly drained
Permeability: Slow
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 2 percent
Taxonomic class: Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls

Typical Pedon

Nishna silty clay loam, 150 feet east and 100 feet north of the southwest corner of sec. 5, T. 107 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; firm; many roots; few snail shell fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 25 inches; black (N 2/0) silty clay, black (10YR 2/1) dry; weak medium subangular blocky structure; firm; common roots; few snail shell fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

A2—25 to 37 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; firm; few roots; few snail shell fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg—37 to 60 inches; very dark gray (10YR 3/1) silty clay loam that has lenses of clay loam; gray (10YR 6/1) dry; few fine faint dark olive gray (5Y 3/2) mottles; massive; firm; few snail shell fragments; slight effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 24 to 46 inches

Ap horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam

A horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam or silty clay

Cg horizon:
Hue—10YR, 5Y, or N
Value—3 or 4
Chroma—0 or 1
Texture—Silty clay loam

Normania Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Till plains
Parent material: Glacial till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Haplustolls

Typical Pedon

Normania loam, 1,900 feet south and 100 feet east of the northwest corner of sec. 3, T. 107 N., R. 33 W.

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

A—10 to 16 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; common roots; about 3 percent coarse fragments; neutral; gradual wavy boundary.

Bw—16 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam; moderate medium subangular blocky structure; friable; few roots; about 3 percent coarse fragments; neutral; gradual wavy boundary.
Bk—24 to 32 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure; friable; many light brownish gray (2.5Y 6/2) carbonate coatings in channels; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.
C—32 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; common light brownish gray (2.5Y 6/2) carbonate coatings in channels; about 4 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 18 to 36 inches
Mollic epipedon thickness: 10 to 20 inches
Rock fragment content: 3 to 8 percent

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—Loam or clay loam

Bw horizon:
Hue—2.5Y or 10YR
Value—3 or 4
Chroma—2 to 4
Texture—Clay loam or loam

Bk horizon:
Hue—2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—Clay loam or loam

C horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 to 4
Texture—Loam, clay loam, or sandy loam

Okoboji Series

Drainage class: Very poorly drained
Permeability: Moderately slow
Landform: Glacial till plains
Parent material: Glacial sediments
Slope range: 0 to 1 percent
Taxonomic class: Fine, montmorillonitic, mesic Cumulic Haplaquolls

Typical Pedon

Okoboji silty clay loam, 2,400 feet west and 300 feet north of the southeast corner of sec. 29, T. 106 N., R. 32 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; neutral; abrupt smooth boundary.
A1—9 to 21 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; common roots; neutral; gradual wavy boundary.
A2—21 to 34 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; few roots; neutral; gradual wavy boundary.
Bg—34 to 48 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.
Cg—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct olive yellow (2.5Y 6/8) mottles; massive; friable; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 56 inches
Mollic epipedon thickness: 24 to 48 inches

Ap horizon:
Hue—10YR or N
Value—2
Chroma—0 or 1
Texture—Silty clay loam

A horizon:
Hue—10YR or N
Value—2
Chroma—0 or 1
Texture—Silty clay loam, silty clay, mucky silty clay loam, silt loam, or mucky silt loam

Bg horizon:
Hue—10YR, 2.5Y, or 5Y
Value—3 or 4
Chroma—1 or 2
Texture—Silty clay loam

Cg horizon:
Hue—2.5Y or 5Y
Value—4 or 5

Chroma—1 or 2
Texture—Silty clay loam, loam, or silt loam

Palms Series

Drainage class: Very poorly drained
Permeability: Upper part—moderate; lower part—moderately slow
Landform: Till plains, lake plains, and outwash plains
Parent material: Decomposed organic material overlying glacial deposits
Slope range: 0 to 1 percent
Taxonomic class: Loamy, mixed, euic, mesic Terric Medisaprists

Typical Pedon

Palms muck, 1,400 feet east and 2,200 feet north of the southwest corner of sec. 15, T. 107 N., R. 33 W.

Op—0 to 10 inches; black (10YR 2/1) sapric material, dark gray (10YR 4/1) dry; about 30 percent fiber, 10 percent rubbed; weak fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

Oa1—10 to 17 inches; black (10YR 2/1) sapric material, dark gray (10YR 4/1) dry; about 30 percent fiber, 5 percent rubbed; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

Oa2—17 to 31 inches; black (10YR 2/1) sapric material, dark gray (10YR 4/1) dry; about 25 percent fiber, 5 percent rubbed; moderate medium subangular blocky structure; very friable; neutral; gradual wavy boundary.

C1—31 to 49 inches; black (10YR 2/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; neutral; gradual wavy boundary.

C2—49 to 60 inches; very dark gray (10YR 3/1) silty clay loam; many coarse distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; slight effervescence; mildly alkaline.

Range in Characteristics

Depth to loamy material: 16 to 50 inches

Organic material:
Kind—Sapric
Fiber content—20 to 40 percent unrubbed; 0 to 10 percent rubbed
Reaction—Medium acid to neutral
Hue—10YR or N
Value—2 to 4
Chroma—0 to 4

C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—2 or 3
Chroma—1 or 2
Texture—Silty clay loam, loam, fine sandy loam, or clay loam

Revere Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Till plains
Parent material: Calcareous glacial till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mesic Typic Calciaquolls

Typical Pedon

Revere clay loam, 1,700 feet north and 2,500 feet east of the southwest corner of sec. 20, T. 107 N., R. 33 W.

Ap—0 to 9 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; about 3 percent gypsum occurring as fine masses of crystals 1 to 2 millimeters long and as powder in root channels; strong effervescence; mildly alkaline; abrupt smooth boundary.

Ay—9 to 18 inches; black (10YR 2/1) clay loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; about 20 percent gypsum occurring as fine masses of crystals 1 to 4 millimeters long and as powder in root channels; strong effervescence; mildly alkaline; gradual wavy boundary.

A—18 to 22 inches; very dark gray (10YR 3/1) clay loam; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; about 3 percent gypsum occurring as masses of crystals 1 to 2 millimeters long and as powder in root channels; strong effervescence; mildly alkaline; gradual wavy boundary.

Bg—22 to 36 inches; dark grayish brown (2.5Y 4/2) clay loam; common large distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg—36 to 60 inches; olive gray (5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile

Mollic epipedon thickness: 10 to 24 inches
Rock fragment content: 0 to 7 percent

A horizon:
Hue—10YR, 2.5Y, 5Y, or N
Value—2 or 3
Chroma—0 to 2
Texture—Clay loam or loam
Gypsum content—5 to 25 percent

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Clay loam or loam
Gypsum content—0 to 25 percent

Cg horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 or 2
Texture—Loam or clay loam
Gypsum content—5 to 25 percent

Ridgeport Series

Drainage class: Somewhat excessively drained
Permeability: Upper part—moderately rapid; lower part—very rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 1 to 6 percent
Taxonomic class: Coarse-loamy, mixed, mesic Typic Hapludolls

Typical Pedon

Ridgeport sandy loam, 1 to 6 percent slopes, 1,600 feet east and 1,700 feet south of the northwest corner of sec. 22, T. 107 N., R. 32 W.

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

A—10 to 16 inches; very dark brown (10YR 2/2) sandy loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; common roots; about 3 percent coarse fragments; medium acid; gradual wavy boundary.

Bw1—16 to 28 inches; dark yellowish brown (10YR 3/4) sandy loam; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; gradual wavy boundary.

Bw2—28 to 33 inches; brown (10YR 4/3) sandy loam that has lenses of loamy sand; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; gradual wavy boundary.

2C—33 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; about 15 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 46 inches
Mollic epipedon thickness: 10 to 18 inches
Depth to sandy sediments: 20 to 40 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam
Rock fragment content—3 to 10 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Sandy loam or fine sandy loam
Rock fragment content—3 to 10 percent

Bw horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—3 or 4
Texture—Sandy loam or gravelly sandy loam
Rock fragment content—3 to 10 percent

2C horizon:
Hue—10YR or 7.5YR
Value—4 or 5
Chroma—4 to 6
Texture—Gravelly coarse sand, gravelly loamy sand, sand, or gravelly sand
Rock fragment content—5 to 25 percent

Seaforth Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Till plains
Parent material: Calcareous glacial till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Calciustolls

Typical Pedon

Seaforth loam, 1,500 feet south and 150 feet west of the northeast corner of sec. 27, T. 107 N., R. 33 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark

gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; many roots; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

A—9 to 12 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; friable; many very dark grayish brown (2.5Y 3/2) streaks on ped exteriors; common roots; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Bk1—12 to 16 inches; dark grayish brown (2.5Y 4/2) clay loam; moderate medium subangular blocky structure; friable; many very dark grayish brown (2.5Y 3/2) streaks on ped exteriors; few roots; common grayish brown (2.5Y 5/2) carbonate coatings in channels; about 2 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

Bk2—16 to 24 inches; grayish brown (2.5Y 5/2) clay loam; moderate medium subangular blocky structure; friable; common dark grayish brown (2.5Y 4/2) streaks on ped exteriors; many light brownish gray (2.5 6/2) carbonate coatings in channels; about 3 percent coarse fragments; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—24 to 36 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few light brownish gray (2.5Y 6/2) carbonate coatings in channels; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—36 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; friable; common yellowish brown (10YR 5/6) streaks in ped interiors; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 10 to 20 inches
Rock fragment content: 3 to 8 percent

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam or clay loam

Bk horizon:
Hue—2.5Y or 10YR
Value—4 or 5
Chroma—2 to 4
Texture—Clay loam, loam, sandy clay loam, or sandy loam

C horizon:
Hue—2.5Y or 10YR
Value—4 or 5
Chroma—2 to 4
Texture—Loam or sandy loam

Shandep Series

Drainage class: Very poorly drained
Permeability: Upper part—moderate; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Shandep clay loam, 1,200 feet east and 150 feet south of the northwest corner of sec. 1, T. 107 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; many fine roots; about 2 percent coarse fragments; mildly alkaline; abrupt smooth boundary.

A1—10 to 22 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; neutral; few coarse roots; about 2 percent coarse fragments; gradual wavy boundary.

A2—22 to 32 inches; very dark gray (5Y 3/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bg—32 to 40 inches; dark gray (5Y 4/1) clay loam; few fine faint olive gray (5Y 4/2) mottles; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

2Cg—40 to 60 inches; gray (5Y 5/1) loamy sand; common medium distinct light olive brown (2.5Y 5/4) mottles; single grain; loose; about 10 percent coarse fragments; mildly alkaline.

Range in Characteristics

Depth to carbonates: 40 to 60 inches
Mollic epipedon thickness: 26 to 32 inches

Depth to sandy sediments: 40 to 60 inches

Ap horizon:
- Hue—5Y or N
- Value—2 or 3
- Chroma—0 or 1
- Texture—Clay loam
- Rock fragment content—0 to 5 percent

A horizon:
- Hue—5Y or N
- Value—2 or 3
- Chroma—0 or 1
- Texture—Clay loam, loam, or silty clay loam
- Rock fragment content—0 to 5 percent

Bg horizon:
- Hue—5Y or N
- Value—4 or 5
- Chroma—0 or 1
- Texture—Clay loam, loam, or silty clay loam
- Rock fragment content—0 to 5 percent

2C horizon:
- Hue—5Y
- Value—4 or 5
- Chroma—1 or 2
- Texture—Loamy sand, sand, loamy coarse sand, coarse sand, gravelly coarse sand, or gravelly loamy coarse sand
- Rock fragment content—5 to 25 percent

Sparta Series

Drainage class: Excessively drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains
Parent material: Glacial outwash sediments
Slope range: 1 to 6 percent
Taxonomic class: Sandy, mixed, mesic Entic Hapludolls

Typical Pedon

Sparta loamy sand, 1 to 6 percent slopes, 1,300 feet east and 1,500 feet south of the northwest corner of sec. 16, T. 107 N., R. 32 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy sand, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; very friable; common roots; slightly acid; abrupt smooth boundary.

A—10 to 23 inches; very dark brown (10YR 2/2) loamy sand, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; very friable; few roots; slightly acid; gradual wavy boundary.

Bw—23 to 38 inches; brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; very friable; medium acid; gradual wavy boundary.

C—38 to 60 inches; brown (7.5YR 4/4) sand; single grain; loose; medium acid.

Range in Characteristics

Mollic epipedon thickness: 10 to 24 inches

Ap horizon:
- Hue—10YR or 7.5YR
- Value—2 or 3
- Chroma—1 or 2
- Texture—Loamy sand

A horizon:
- Hue—7.5YR or 10YR
- Value—3 or 4
- Chroma—2 or 3
- Texture—Loamy sand, fine sand, sand, or loamy fine sand

Bw horizon:
- Hue—7.5YR or 10YR
- Value—3 to 6
- Chroma—3 to 6
- Texture—Loamy sand, fine sand, sand, or loamy fine sand

C horizon:
- Hue—7.5YR or 10YR
- Value—4 to 6
- Chroma—3 to 6
- Texture—Sand or fine sand

Spicer Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Glacial lake plains
Parent material: Calcareous glaciolacustrine sediments
Slope range: 0 to 2 percent
Taxonomic class: Fine-silty, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Spicer silty clay loam, 900 feet west and 1,550 feet south of the northeast corner of sec. 20, T. 105 N., R. 30 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 18 inches; black (10YR 2/1) silty clay loam, black (10YR 2/1) dry; moderate medium subangular blocky structure; friable; few roots; strong

effervescence; mildly alkaline; gradual wavy boundary.

Bg—18 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; common very dark grayish brown (10YR 3/2) streaks on ped exteriors; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg1—30 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—44 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; many large distinct yellowish brown (10YR 5/6) mottles; massive; friable; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 12 to 24 inches

Ap horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam

A horizon:
Hue—10YR or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam or silt loam

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Silty clay loam or silt loam

Cg horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—Silty clay loam or silt loam

Storden Series

Drainage class: Well drained
Permeability: Moderate
Landform: Till plains
Parent material: Calcareous glacial till
Slope range: 3 to 35 percent
Taxonomic class: Fine-loamy, mixed (calcareous), mesic Typic Udorthents

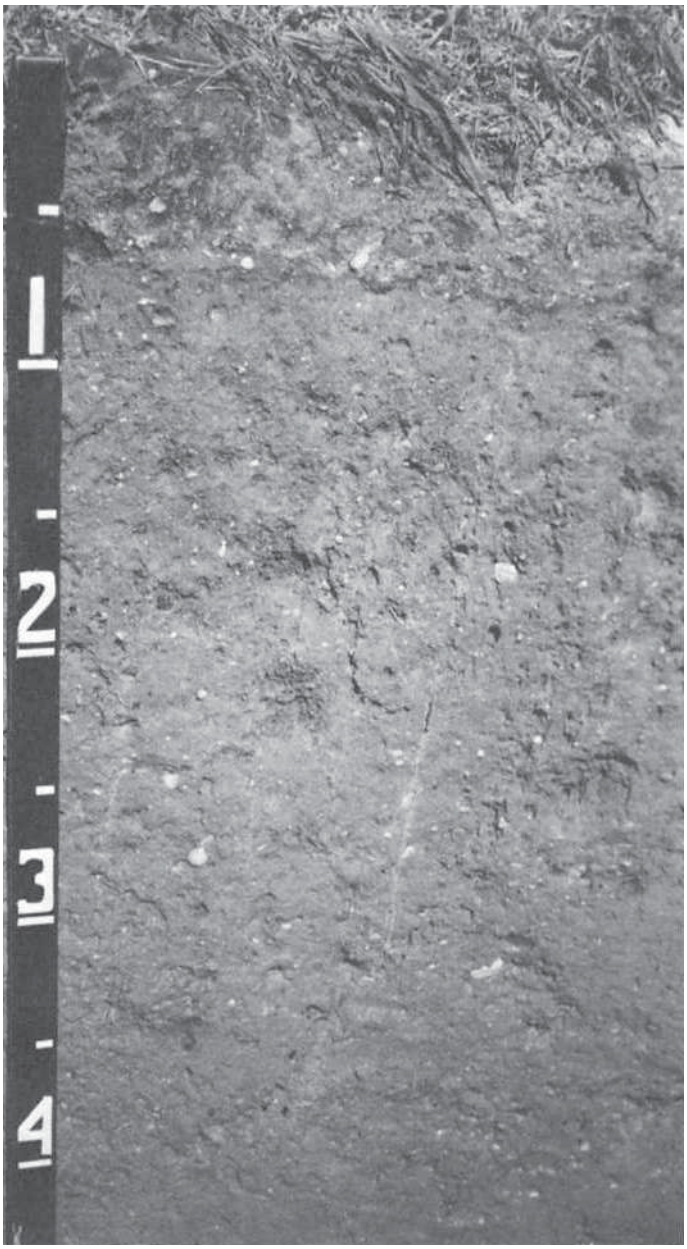

Figure 12.—Typical profile of Storden soils. Depth is marked in feet.

Typical Pedon

Storden loam, in an area of Clarion-Storden loams, 6 to 12 percent slopes, eroded (fig. 12), 300 feet west and 1,800 feet south of the northeast corner of sec. 5, T. 106 N., R. 33 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 6/1) dry; weak medium subangular blocky structure; friable; common roots; about 3 percent coarse fragments; slight effervescence;

mildly alkaline; clear smooth boundary.
C1—8 to 37 inches; brown (10YR 5/3) loam; weak medium subangular blocky structure; friable; few roots; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.
C2—37 to 60 inches; yellowish brown (10YR 5/4) loam; few medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Rock fragment content: 2 to 10 percent

A horizon:
Hue—10YR
Value—4 or 5
Chroma—2 or 3
Texture—Loam

C horizon:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—2 to 4
Texture—Loam

Swanlake Series

Drainage class: Well drained
Permeability: Moderate
Landform: Till plains
Parent material: Calcareous glacial till
Slope range: 2 to 4 percent
Taxonomic class: Fine-loamy, mixed, mesic Entic Hapludolls

Typical Pedon

Swanlake loam, in an area of Clarion-Swanlake loams, 1 to 4 percent slopes, 350 feet south and 900 feet west of the northeast corner of sec. 34, T. 105 N., R. 31 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common fine roots; about 2 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.
C1—9 to 30 inches; pale brown (10YR 6/3) loam; weak medium subangular blocky structure; friable; few fine roots; common light gray (10YR 7/2) carbonate coatings in channels; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.
C2—30 to 40 inches; light yellowish brown (10YR 6/4) loam; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.
C3—40 to 60 inches; light yellowish brown (10YR 6/4) loam; few fine distinct brownish yellow (10YR 6/8) mottles; massive; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: Throughout the profile
Mollic epipedon thickness: 7 to 14 inches
Rock fragment content: 1 to 15 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—Loam

C horizon:
Hue—10YR and 2.5Y
Value—4 to 6
Chroma—3 or 4
Texture—Loam

Truman Series

Drainage class: Well drained
Permeability: Moderate
Landform: Glacial lake plains
Parent material: Silty glacial sediments
Slope range: 1 to 12 percent
Taxonomic class: Fine-silty, mixed, mesic Typic Hapludolls

Typical Pedon

Truman silt loam, 1 to 4 percent slopes, 200 feet south and 400 feet west of the northeast corner of sec. 25, T. 106 N., R. 30 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; common roots; neutral; abrupt smooth boundary.
A—9 to 14 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common roots; neutral; gradual wavy boundary.
Bw1—14 to 22 inches; brown (10YR 4/3) silt loam; moderate medium subangular blocky structure; friable; few roots; common very dark grayish brown (10YR 3/2) organic matter coatings on ped exteriors; neutral; gradual wavy boundary.
Bw2—22 to 34 inches; brown (10YR 5/3) silt loam;

moderate medium subangular blocky structure; friable; neutral; gradual wavy boundary.

C1—34 to 40 inches; yellowish brown (10YR 5/4) silt loam; massive; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—40 to 60 inches; yellowish brown (10YR 5/4) silt loam; common medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; strong effervescence; mildly alkaline.

Range in Characteristics

Depth to carbonates: 18 to 56 inches
Mollic epipedon thickness: 10 to 18 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—Silt loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—Silt loam or silty clay loam

Bw horizon:
Hue—10YR
Value—3 to 5
Chroma—3 to 6
Texture—Silt loam or silty clay loam

C horizon:
Hue—10YR
Value—5 or 6
Chroma—4 to 6
Texture—Silt loam

Ves Series

Drainage class: Well drained
Permeability: Moderate
Landform: Till plains
Parent material: Glacial till
Slope range: 1 to 15 percent
Taxonomic class: Fine-loamy, mixed, mesic Udic Haplustolls

Typical Pedon

Ves loam, 1 to 4 percent slopes (fig. 13), 400 feet west and 1,800 feet south of the northeast corner of sec. 18, T. 107 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; common roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

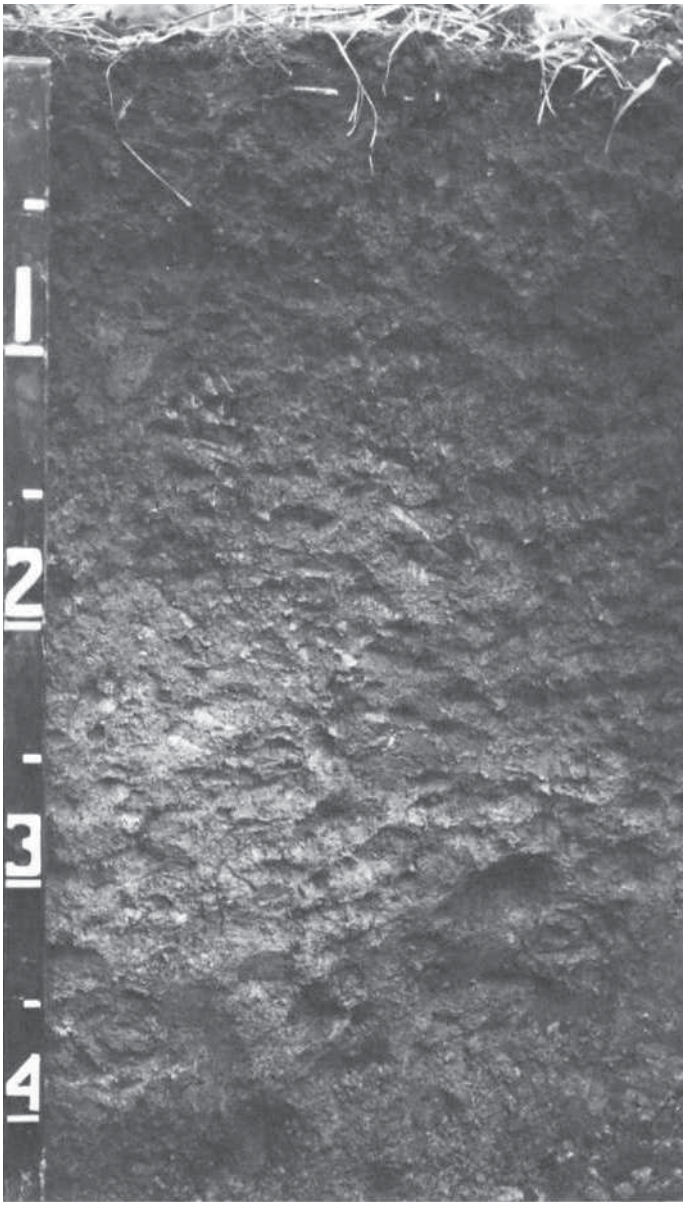

Figure 13.—Typical profile of Ves soils. Depth is marked in feet.

A—10 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; common roots; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bw1—14 to 18 inches; brown (10YR 4/3) loam; moderate medium subangular blocky structure; friable; few roots; common very dark gray (10YR 3/1) organic matter coatings in channels; about 2 percent coarse fragments; neutral; gradual smooth boundary.

Bw2—18 to 25 inches; dark yellowish brown (10YR 4/4)

loam; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; mildly alkaline; gradual wavy boundary.

Bk—25 to 36 inches; yellowish brown (10YR 5/4) loam; moderate medium subangular blocky structure; friable; many brown (10YR 5/3) streaks; common light brownish gray (10YR 6/2) carbonate coatings in channels; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

C—36 to 60 inches; brown (10YR 5/3) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; common light brownish gray (10YR 6/2) carbonate coatings in channels; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 14 to 33 inches
Mollic epipedon thickness: 10 to 20 inches
Rock fragment content: 2 to 8 percent

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—Loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—Loam or clay loam

Bw horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—3 or 4
Texture—Loam or clay loam

Bk horizon:
Hue—2.5Y or 10YR
Value—4 to 6
Chroma—3 or 4
Texture—Loam or clay loam

C horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—3 or 4
Texture—Loam or clay loam

Taxadjunct feature: In map units 954B2, 954C2, and 999B2, Ves soils are a taxadjunct to the Ves series because the dark surface layer is slightly thinner than is defined as the range for the series. This difference, however, does not alter the use and management of the soils.

Waldorf Series

Drainage class: Poorly drained
Permeability: Moderately slow
Landform: Glacial lake plains
Parent material: Glaciolacustrine sediments
Slope range: 0 to 1 percent
Taxonomic class: Fine, montmorillonitic, mesic Typic Haplaquolls

Typical Pedon

Waldorf silty clay loam, 200 feet south and 700 feet west of the northeast corner of sec. 14, T. 105 N., R. 30 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; common roots; neutral; abrupt smooth boundary.

A1—9 to 19 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate medium subangular blocky structure; firm; common roots; neutral; gradual wavy boundary.

A2—19 to 23 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; few fine distinct light olive brown (2.5Y 5/6) mottles; moderate medium prismatic structure parting to moderate medium angular blocky; firm; few roots; neutral; gradual wavy boundary.

Bg1—23 to 30 inches; olive gray (5Y 4/2) silty clay; few fine distinct olive yellow (2.5Y 6/8) mottles; moderate medium prismatic structure parting to moderate medium angular blocky; firm; common black (5Y 2/1) organic matter coatings in channels; neutral; gradual wavy boundary.

Bg2—30 to 38 inches; olive gray (5Y 5/2) silty clay; common medium distinct olive yellow (2.5Y 6/8) mottles; moderate medium prismatic structure parting to moderate medium angular blocky; firm; common black (5Y 2/1) organic matter coatings in channels; neutral; gradual wavy boundary.

Cg—38 to 60 inches; light olive gray (5Y 6/2) silty clay loam; many medium distinct olive yellow (2.5Y 6/8) mottles; massive; firm; common light gray (10YR 7/2) carbonate coatings in channels; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 26 to 55 inches
Mollic epipedon thickness: 16 to 24 inches

Ap horizon:
Hue—10YR, 2.5Y, or N
Value—2 or 3
Chroma—0 or 1

Texture—Silty clay loam

A horizon:
Hue—10YR, 2.5Y, or N
Value—2 or 3
Chroma—0 or 1
Texture—Silty clay loam or silty clay

B horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—Silty clay, silty clay loam, or clay

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—Silty clay loam, silty clay, clay, or silt loam

Webster Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Glacial till plains
Parent material: Glacial till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, mesic Typic Haplaquolls

Typical Pedon

Webster clay loam (fig. 14), 1,300 feet north and 2,500 feet west of the southeast corner of sec. 15, T. 107 N., R. 30

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; many roots; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A—10 to 16 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; common roots; about 3 percent coarse fragments; neutral; gradual smooth boundary.

AB—16 to 23 inches; black (10YR 2/1) and very dark grayish brown (2.5Y 3/2) clay loam, dark gray (10YR 4/1) and dark grayish brown (2.5Y 4/2) dry; moderate medium subangular blocky structure; friable; common very dark gray (10YR 3/1) streaks; few roots; about 3 percent coarse fragments; neutral; gradual smooth boundary.

Bg—23 to 33 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few roots; few very dark gray (10YR 3/1) organic matter coatings on ped exteriors; about 3 percent coarse fragments; neutral; gradual wavy boundary.

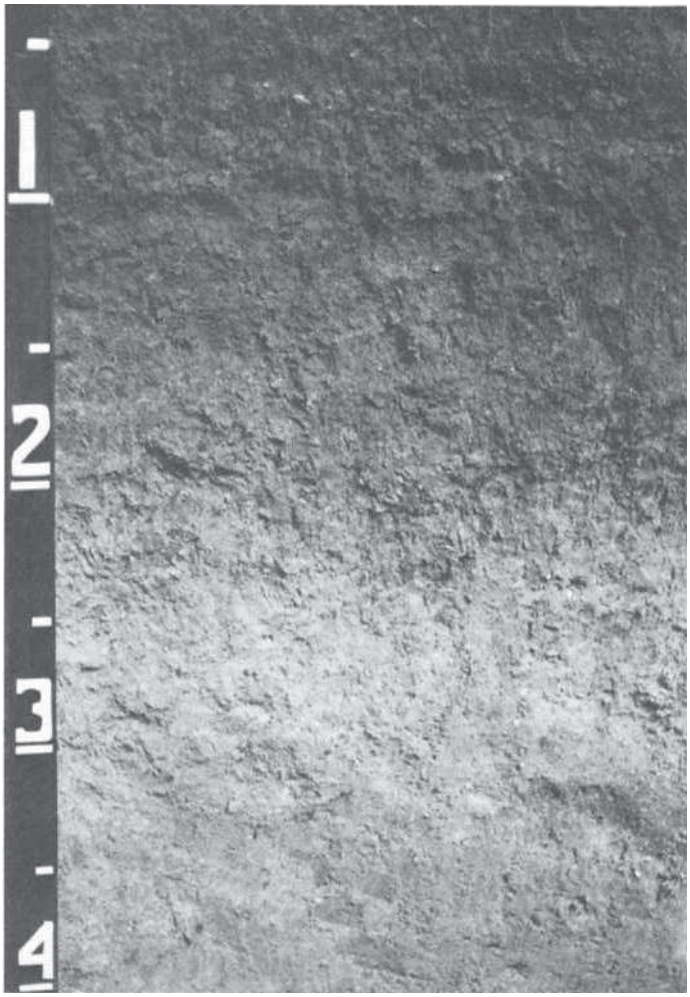

Figure 14.—Typical profile of Webster soils. Depth is marked in feet.

Cg1—33 to 40 inches; grayish brown (2.5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few white (10YR 8/1) carbonate coatings in channels; about 3 percent coarse fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—40 to 60 inches; grayish brown (2.5Y 5/2) loam; many large distinct yellowish brown (10YR 5/6) mottles; massive; friable; few white (10YR 8/1) carbonate coatings in channels; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 30 to 50 inches

Mollic epipedon thickness: 10 to 24 inches
Rock fragment content: 1 to 8 percent

Ap horizon:
Hue—10YR or N
Value—2
Chroma—0 or 1
Texture—Silty clay loam or loam

A horizon:
Hue—10YR or N
Value—2
Chroma—0 or 1
Texture—Clay loam, silty clay loam, or loam

AB horizon:
Colors and textures of the A and B horizons

Bg horizon:
Hue—5Y or 2.5Y
Value—4 or 5
Chroma—1 or 2
Texture—Clay loam, silty clay loam, or loam

C horizon:
Hue—5Y or 2.5Y
Value—4 to 6
Chroma—1 or 2
Texture—Loam, sandy loam, or clay loam

Formation of the Soils

This section relates the factors of soil formation to the soils in the survey area. It also describes the geology of the survey area.

Factors of Soil Formation

Soil-forming processes act on deposited or accumulated geologic material. The determinants of the characteristics of soil at any given point are 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 *(3)*.

Climate and plant and animal life, mainly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. Relief conditions the effects of climate and of plant and animal life. The parent material affects the kind of soil profile formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil. Some time is always required for the differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are very closely interrelated in their effects on the soil. Few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four.

Parent Material

The soils in Watonwan County formed in many different kinds of parent material, all of glacial origin. The major parent materials in the county are glacial till, glacial outwash, lacustrine deposits, alluvial deposits, and colluvium. About half the soils in the county formed in glacial till, and half in other kinds of parent material.

Glacial till of the Des Moines lobe, the most recent glacial parent material in the county, was deposited during the Wisconsinan Glaciation. This material is the New Ulm phase. The meltwater from the Des Moines lobe consisted of glacial outwash, lacustrine deposits, and alluvial deposits on flood plains. Runoff deposited colluvium at the base of slopes.

The New Ulm phase, which is the youngest till in Minnesota, contains unweathered shale fragments. The till plain consists mainly of irregularly shaped, low knolls that rise 1 to 10 feet above the lowland till plain. Ves, Clarion, Storden, Normania, Nicollet, Canisteo, Glencoe, and Okoboji soils formed in glacial till. They are medium or high in natural fertility.

Glacial outwash deposits of the Des Moines lobe are sandy and gravelly. These deposits have been mapped near the towns of LaSalle and Grogan and in scattered, less extensive areas in the central and eastern parts of the county. Lasa, Sparta, Litchfield, and Fieldon soils formed in outwash. These soils are mostly sandy loam or loamy sand over sandy outwash.

The lacustrine deposits of the Des Moines lobe are silty and clayey. Mapped south of Madelia and around Lewisville in Watonwan County, they also cover parts of Blue Earth, Martin, Waseca, and Faribault Counties. They were in the basin of proglacial Lake Minnesota *(13)*. Truman, Kingston, Madelia, and Spicer soils formed in these deposits.

Alluvium is material that is deposited on flood plains along streams and rivers. In most places it is dark and is several feet thick. The texture ranges from sand to clay loam. Coland and Millington soils formed in alluvium.

Relief and Drainage

The landscape in Watonwan County consists of nearly level to gently undulating plains and of steep areas along drainageways. Relief is the most important factor in the formation of different soils in the same kind of parent material. Soils that have fairly mature profiles, in which the horizons are distinct, formed wherever drainage is good and the slope is gentle. Steep soils are subject to excessive runoff and thus show little evidence of horizon development. Runoff on these soils reduces the amount of soil moisture available to plants.

Many steep soils, therefore, are droughty, have indistinct horizons, and support a poor cover of plants.

Topographic position is a partial key to the kind of soil and the soil drainage class at any place on the landscape. For example, the location of Storden, Clarion, Nicollet, Canisteo, and Glencoe soils, which make up the Clarion drainage sequence, can generally be predicted. Each of these soils is on a particular part of the landscape. The well drained Storden soils are on side slopes; the well drained Clarion soils are on the more gentle slopes; the moderately well drained Nicollet soils are at lower elevations than the Clarion soils or are in slightly convex, nearly level and gently sloping areas where they are surrounded by Clarion soils; the poorly drained Canisteo soils are on the rims of depressions; and the very poorly drained Glencoe soils are in the depressions.

Plant and Animal Life

In Watonwan County, soil formation began with the growth of plants in glacial till. The native vegetation consisted mainly of tall and mid prairie grasses, varying with the kind of soil, drainage, and other site factors. Plant roots loosened the soil and brought minerals up from the parent material. The plants then died and decayed, returning organic matter and plant nutrients to the soil.

Human activities have influenced soil formation in Watonwan County. Farming has affected most soil-forming processes. Colluvium, the material accelerated erosion has removed from the surface layer of some sloping soils, has been deposited on some soils in the lower lying positions. The strong, granular structure in the surface layer has been weakened or destroyed in many of these soils. Plowing has mixed the surface layer and subsoil and reduced the organic matter content of the soil; consequently, the surface layer has become browner. Increased runoff rates and reduced infiltration rates in cultivated areas have slowed the leaching of many soils. Human activities alter the drainage condition, maintain fertility, and change the kinds of vegetation. Consequently, they continue to have an important effect on the rate and course of soil formation.

Climate

Watonwan County has a subhumid, continental climate. Winters are cold, and summers hot. The climate has had a pronounced effect on soil formation. Freezing of the soil in winter slows the soil-forming processes. Alternate periods of freezing and thawing play a part in the development of soil structure. They also help to disintegrate parts of the glacial debris. Frost heave mixes the soil material. Rainfall has leached free lime from the soil. The depth to which soil has been leached has largely determined the thickness of the solum.

The climate of the county was responsible to a large degree for a native vegetation of grasses instead of trees. The soils that formed under the grass vegetation have a dark surface layer. The grass vegetation and the cool temperatures have helped in the accumulation of organic matter. Details about the climate are given in the section "General Nature of the County."

Time

The time required for soil formation depends to a large extent on the other factors of soil formation. Wherever relief and drainage are favorable, the soils have had enough time to develop mature profiles. The soil-forming processes are not effective in soils on steep slopes, which have immature or thin profiles. Soils that formed in alluvium along streams and rivers are immature or weakly developed because the parent material is young. Fresh deposits of alluvium continually are added to the surface when streams and rivers overflow. Distinct, mature horizons have not had enough time to develop in these soils.

In a geological sense, all the parent materials in the county are very young. Of these, the oldest material is the till of the New Ulm phase of the Des Moines lobe. The youngest is alluvium and colluvium.

Geology

Precambrian granite underlies quartzite in the western part of the county and white and blue shale and soft, clayey white sandstone in the central and eastern parts *(4)*. The city well in Butterfield penetrates about 400 feet of quartzite and terminates in light gray granite under the quartzite. Farther eastward, Paleozoic sandstone directly overlies the granite, which slopes gently eastward.

In Adrian Township, Sioux Quartzite crops out around Darfur. In Butterfield, it is about 400 feet thick. It becomes thicker where it crops out. The quartzite becomes thinner toward the east. Wells have penetrated the quartzite in the western part of the county.

Cambrian sandstone is nearly 200 feet thick at St. James. These Paleozoic rocks directly overlie Sioux Quartzite. They dip toward the southeast. The sandstone farthest west in the county represents the lower part of the Dresbath Formation, the younger strata of which underlie Cretaceous shale farther east. In the eastern half of the county, Cretaceous white sandstone is stratified with soft, white and blue shale that has thin layers of lignitic clay.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. 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:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

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.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

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 textura 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 (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

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.

Congeliturbate. Soil material disturbed by frost action.

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.

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.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for

significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

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.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

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.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

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.

Forb. Any herbaceous plant not a grass or a sedge.

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.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

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.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

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 capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

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.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. Where a sprinkler irrigation system is used, water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Karst (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

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.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

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, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or 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 three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, 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.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

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.

Pitting (in tables). Pits caused by melting ground ice. They form on the soil after plant cover is removed.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

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 outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

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 reactior because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

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

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

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.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

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.

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.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

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. The slope classes in this survey are:

Nearly level	0 to 2 percent
Gently sloping	2 to 6 percent
Sloping	6 to 12 percent
Moderately steep	12 to 18 percent
Steep	18 to 25 percent
Very steep	25 to 45 percent

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.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in 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, in millimeters, of separates recognized in the United States are as follows:

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.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

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.

Substratum. The part of the soil below the solum.

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.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

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.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

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.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

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Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1948-89 at St. James, Minnesota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	22.6	3.4	13.0	50	-25	0	0.54	0.19	0.85	1	7.7
February---	29.1	9.9	19.5	54	-20	0	.56	.20	.88	1	6.1
March------	40.8	21.9	31.3	73	-10	8	1.55	.59	2.36	3	10.2
April------	58.8	35.8	47.3	87	15	75	2.49	1.28	3.56	5	2.4
May--------	72.2	47.4	59.8	92	24	305	3.38	1.90	4.70	7	.0
June-------	81.3	56.9	69.1	97	35	564	4.13	2.42	5.65	6	.0
July-------	84.9	61.2	73.1	98	46	704	3.91	1.86	5.69	6	.0
August-----	82.6	59.0	70.8	96	43	587	3.52	1.94	4.92	5	.0
September--	73.7	49.8	61.7	93	30	334	3.08	1.28	4.60	5	.0
October----	62.2	39.0	50.6	91	17	127	1.78	.69	2.87	3	.5
November---	43.1	25.0	34.1	73	-4	7	1.19	.27	1.92	2	4.2
December---	28.1	10.5	19.3	55	-18	0	.74	.23	1.15	2	7.2
Yearly:											
Average---	56.6	35.0	45.8	---	---	---	---	---	---	---	---
Extreme---	102.0	-30.0	---	99	-26	---	---	---	---	---	---
Total-----	---	---	---	---	---	2,710	26.88	1.83	1.83	46	38.3

* 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 1948-89 at St. James, 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--	May 3	May 3	May 18
2 years in 10 later than--	Apr. 30	Apr. 30	May 12
5 years in 10 later than--	Apr. 25	Apr. 25	May 1
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 9	Oct. 9	Oct. 4
2 years in 10 earlier than--	Oct. 11	Oct. 11	Oct. 8
5 years in 10 earlier than--	Oct. 15	Oct. 15	Oct. 14

TABLE 3.--GROWING SEASON

(Recorded in the period 1948-89 at St. James, Minnesota)

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	169	149	133
8 years in 10	176	157	141
5 years in 10	190	171	155
2 years in 10	204	185	169
1 year in 10	211	193	177

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
8B	Sparta loamy sand, 1 to 6 percent slopes	2,471	0.9
27A	Dickinson fine sandy loam, 0 to 2 percent slopes	498	0.2
27B	Dickinson fine sandy loam, 2 to 6 percent slopes	1,393	0.5
31F	Storden loam, 20 to 35 percent slopes	745	0.3
35	Blue Earth mucky silt loam	1,216	0.4
41B	Estherville sandy loam, 1 to 6 percent slopes	1,372	0.5
69B	Fedji loamy fine sand, 1 to 6 percent slopes	1,365	0.5
84	Brownton silty clay loam	323	0.1
86	Canisteo clay loam	25,337	9.2
101B	Truman silt loam, 1 to 4 percent slopes	4,174	1.5
102B	Clarion loam, 1 to 4 percent slopes	21,579	7.8
112	Harps clay loam	501	0.2
113	Webster clay loam	30,161	10.8
114	Glencoe clay loam	9,708	3.5
118	Crippin loam	5,319	1.9
128A	Grogan silt loam, 0 to 2 percent slopes	467	0.2
128B	Grogan silt loam, 2 to 6 percent slopes	2,187	0.8
130	Nicollet loam	23,229	8.4
134	Okoboji silty clay loam	4,982	1.8
136	Madelia silty clay loam	6,557	2.4
140	Spicer silty clay loam	5,666	2.1
160	Fieldon loam	8,992	3.3
178	Granby loamy sand	254	0.1
181	Litchfield loamy fine sand	5,295	1.9
183	Dassel fine sandy loam	1,399	0.5
197	Kingston silty clay loam	5,852	2.1
222B	Lasa loamy fine sand, 1 to 6 percent slopes	3,519	1.3
227	Lemond loam	1,649	0.6
229	Waldorf silty clay loam	7,879	2.9
247	Linder sandy loam	1,054	0.4
255	Mayer loam	1,598	0.6
269	Millington clay loam, occasionally flooded	3,461	1.2
281	Darfur fine sandy loam	3,630	1.3
282	Hanska loam	517	0.2
327A	Dickman sandy loam, 0 to 2 percent slopes	1,875	0.7
327B	Dickman sandy loam, 2 to 6 percent slopes	2,043	0.7
336	Delft loam	2,115	0.8
362	Millington clay loam, frequently flooded	600	0.2
392	Biscay loam	292	0.1
421B	Ves loam, 1 to 4 percent slopes	4,010	1.5
423	Seaforth loam	834	0.3
446	Normania loam	2,057	0.7
487	Hoopeston fine sandy loam	1,225	0.4
517	Shandep clay loam	810	0.3
539	Palms muck	1,076	0.4
562	Knoke silty clay loam	354	0.1
575	Nishna silty clay loam	493	0.2
639B	Ridgeport sandy loam, 1 to 6 percent slopes	350	0.1
654	Revere clay loam	617	0.2
668	Corwith silt loam	272	0.1
789B2	Grogan-Lasa Variant complex, 2 to 6 percent slopes, eroded	787	0.3
789C2	Lasa Variant-Grogan complex, 6 to 12 percent slopes, eroded	219	0.1
790B	Grogan-Dickinson complex, 1 to 4 percent slopes	409	0.1
887B	Clarion-Swanlake loams, 1 to 4 percent slopes	928	0.3
909C2	Bold-Truman silt loams, 5 to 12 percent slopes, eroded	616	0.2
920B2	Clarion-Estherville complex, 2 to 6 percent slopes, eroded	2,189	0.8
920C2	Clarion-Estherville complex, 6 to 12 percent slopes, eroded	620	0.2
921B2	Clarion-Storden loams, 3 to 6 percent slopes, eroded	10,781	3.9
921C2	Clarion-Storden loams, 6 to 12 percent slopes, eroded	4,143	1.5
929	Fieldon-Canisteo complex	5,839	2.1
954B2	Ves-Storden loams, 3 to 6 percent slopes, eroded	2,532	0.9
954C2	Storden-Ves loams, 6 to 15 percent slopes, eroded	650	0.2
956	Canisteo-Glencoe clay loams	13,022	4.7
960D2	Storden-Clarion loams, 12 to 18 percent slopes, eroded	1,654	0.6

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
999B2	Ves-Estherville complex, 2 to 8 percent slopes, eroded	322	0.1
1016	Udorthents, loamy	956	0.3
1030	Udorthents-Pits, complex	498	0.2
1055	Palms-Glencoe complex, ponded	2,320	0.8
1833	Coland clay loam, occasionally flooded	9,459	3.4
1834	Coland clay loam, frequently flooded	2,594	0.9
1907	Lakefield silty clay loam	212	0.1
1931	Essexville sandy loam	355	0.1
1981	Hanlon-Kalmarville complex, 0 to 4 percent slopes	2,643	1.0
	Total	277,120	100.0

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
27A	Dickinson fine sandy loam, 0 to 2 percent slopes
27B	Dickinson fine sandy loam, 2 to 6 percent slopes
84	Brownton silty clay loam (where drained)
86	Canisteo clay loam (where drained)
101B	Truman silt loam, 1 to 4 percent slopes
102B	Clarion loam, 1 to 4 percent slopes
112	Harps clay loam (where drained)
113	Webster clay loam (where drained)
114	Glencoe clay loam (where drained)
118	Crippin loam
128A	Grogan silt loam, 0 to 2 percent slopes
128B	Grogan silt loam, 2 to 6 percent slopes
130	Nicollet loam
134	Okoboji silty clay loam (where drained)
136	Madelia silty clay loam (where drained)
140	Spicer silty clay loam (where drained)
160	Fieldon loam (where drained)
183	Dassel fine sandy loam (where drained)
197	Kingston silty clay loam
227	Lemond loam (where drained)
229	Waldorf silty clay loam (where drained)
247	Linder sandy loam
255	Mayer loam (where drained)
269	Millington clay loam, occasionally flooded (where drained)
281	Darfur fine sandy loam (where drained)
282	Hanska loam (where drained)
336	Delft loam (where drained)
362	Millington clay loam, frequently flooded (where drained and either protected from flooding or not frequently flooded during the growing season)
392	Biscay loam (where drained)
421B	Ves loam, 1 to 4 percent slopes
423	Seaforth loam
446	Normania loam
487	Hoopeston fine sandy loam
517	Shandep clay loam (where drained)
562	Knoke silty clay loam (where drained)
575	Nishna silty clay loam (where drained)
639B	Ridgeport sandy loam, 1 to 6 percent slopes
654	Revere clay loam (where drained)
668	Corwith silt loam
789B2	Grogan-Lasa Variant complex, 2 to 6 percent slopes, eroded
790B	Grogan-Dickinson complex, 1 to 4 percent slopes
887B	Clarion-Swanlake loams, 1 to 4 percent slopes
921B2	Clarion-Storden loams, 3 to 6 percent slopes, eroded
929	Fieldon-Canisteo complex (where drained)
954B2	Ves-Storden loams, 3 to 6 percent slopes, eroded
956	Canisteo-Glencoe clay loams (where drained)
1833	Coland clay loam, occasionally flooded (where drained)
1834	Coland clay loam, frequently flooded (where drained and either protected from flooding or not frequently flooded during the growing season)
1907	Lakefield silty clay 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	Grass-legume hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
8B Sparta	IVs	55	20	40	2.2	4.1
27A Dickinson	IIIs	90	32	62	3.5	5.4
27B Dickinson	IIIe	85	30	60	3.0	5.0
31F Storden	VIIe	---	---	---	---	---
35 Blue Earth	IIIw	100	32	73	4.3	6.3
41B Estherville	IIIs	60	20	45	2.6	4.5
69B Fedji	IIIs	115	35	50	2.9	4.8
84 Brownton	IIw	130	36	75	4.4	6.4
86 Canisteo	IIw	130	36	75	4.4	6.4
101B Truman	IIe	142	41	80	4.7	6.9
102B Clarion	IIe	142	41	80	4.7	6.9
112 Harps	IIw	120	33	75	4.4	6.4
113 Webster	IIw	135	42	85	5.0	7.3
114 Glencoe	IIIw	115	35	75	4.4	6.4
118 Crippin	I	140	40	80	4.7	6.9
128A Grogan	I	135	42	85	5.0	7.3
128B Grogan	IIe	130	40	80	5.9	6.9
130 Nicollet	I	145	44	85	5.0	7.3
134 Okoboji	IIIw	115	35	75	4.4	6.4

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	Grass-legume hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
136---------- Madelia	IIw	135	42	85	5.0	7.3
140---------- Spicer	IIw	130	36	75	4.4	6.4
160---------- Fieldon	IIw	120	32	75	4.4	6.4
178---------- Granby	IVw	95	30	70	4.0	6.0
181---------- Litchfield	IIs	85	28	55	3.2	5.1
183---------- Dassel	IIIw	115	35	70	4.0	6.0
197---------- Kingston	I	145	45	85	5.0	7.3
222B---------- Lasa	IIIs	70	22	42	2.5	4.4
227---------- Lemond	IIw	120	32	75	4.4	6.4
229---------- Waldorf	IIw	135	40	85	5.0	7.3
247---------- Linder	IIs	95	30	75	4.4	6.4
255---------- Mayer	IIw	120	32	75	4.4	6.4
269---------- Millington	IIw	120	32	75	4.4	6.4
281---------- Darfur	IIw	125	35	75	4.0	6.2
282---------- Hanska	IIw	125	35	75	4.4	6.4
327A---------- Dickman	IIIs	65	22	45	2.6	4.5
327B---------- Dickman	IIIe	60	20	40	2.5	4.4
336---------- Delft	IIw	135	40	85	5.0	7.3
362---------- Millington	Vw	---	---	---	---	---
392---------- Biscay	IIw	125	35	75	4.4	6.4

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	Grass-legume hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
421B---------- Ves	IIe	140	40	78	4.6	6.8
423---------- Seaforth	IIs	139	39	78	4.6	6.8
446---------- Normania	I	144	43	83	4.4	6.4
487---------- Hoopeston	IIs	100	30	75	3.8	6.0
517---------- Shandep	IIIw	115	35	70	4.0	6.0
539---------- Palms	IIIw	115	35	70	4.0	6.0
562---------- Knoke	IIIw	109	32	73	4.3	6.3
575---------- Nishna	IIIw	120	32	75	4.4	6.4
639B---------- Ridgeport	IIIe	75	25	58	3.5	5.4
654---------- Revere	IIw	115	28	75	4.0	6.0
668---------- Corwith	I	133	43	93	---	7.2
789B2**----------		71	26	53	---	5.2
Grogan----------	IIe					
Lasa Variant----------	IIIs					
789C2**----------		61	21	44	---	4.2
Lasa Variant----------	IVs					
Grogan----------	IIIe					
790B**----------		90	32	65	---	5.6
Grogan----------	IIe					
Dickinson----------	IIIe					
887B**---------- Clarion-Swanlake	IIe	135	38	78	4.6	6.8
909C2**---------- Bold-Truman	IIIe	115	32	70	4.0	6.0
920B2**----------		100	30	65	3.7	5.6
Clarion----------	IIe					
Estherville----------	IIIs					
920C2**----------		85	25	60	3.5	5.4
Clarion----------	IIIe					
Estherville----------	IVs					
921B2**---------- Clarion-Storden	IIe	130	36	76	4.5	6.5

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	Grass-legume hay	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*
921C2** Clarion-Storden	IIIe	115	33	63	3.6	5.5
929** Fieldon-Canisteo	IIw	125	34	70	4.4	6.4
954B2** Ves-Storden	IIe	128	35	74	4.3	6.3
954C2** Storden-Ves	IIIe	114	32	61	3.6	5.5
956** Canisteo Glencoe	 IIw IIIw	125	36	75	4.4	5.3
960D2** Storden-Clarion	IVe	90	24	58	3.5	4.5
999B2** Ves Estherville	 IIe IIIs	100	25	63	3.6	4.1
1016. Udorthents						
1030**. Udorthents-Pits						
1055** Palms-Glencoe	VIIIw	---	---	---	---	---
1833 Coland	IIw	125	35	77	4.6	7.6
1834 Coland	Vw	---	---	---	---	6.0
1907 Lakefield	I	140	40	80	4.7	6.9
1931 Essexville	IIIw	95	35	80	---	---
1981** Hanlon-Kalmarville	Vw	---	---	---	---	---

* 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 height, in feet, of--				
	<8	8-15	16-25	26-35	>35
8B---------- Sparta	Siberian peashrub	Eastern redcedar, lilac, Amur honeysuckle, Manchurian crabapple.	Austrian pine, jack pine, red pine, honeylocust, green ash, Russian olive, Siberian elm.	Eastern white pine	---
27A, 27B---------- Dickinson	Hedge cotoneaster	Eastern redcedar, Russian olive, Siberian peashrub, lilac, Amur honeysuckle.	Green ash, Norway spruce, Amur maple, hackberry, Black Hills spruce, Austrian pine.	Eastern white pine, Scotch pine.	---
31F---------- Storden	American plum, lilac.	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive, bur oak.	Siberian elm------	---
35---------- Blue Earth	---	Redosier dogwood	Black ash, tall purple willow, tamarack.	Golden willow, black willow.	---
41B---------- Estherville	Siberian peashrub	Eastern redcedar, lilac, Amur honeysuckle, Manchurian crabapple.	Honeylocust, jack pine, green ash, Russian olive, red pine, Austrian pine.	Eastern white pine, Siberian elm.	---
69B---------- Fedji	Hedge cotoneaster	Siberian peashrub, lilac, Amur honeysuckle.	Hackberry, Amur maple, Black Hills spruce, eastern redcedar, Russian olive, blue spruce, red splendor crabapple.	Eastern white pine, Norway spruce, Scotch pine, Siberian elm, green ash.	---
84---------- Brownton	---	Siberian peashrub, lilac, northern whitecedar.	White spruce, hackberry, bur oak, eastern redcedar, Black Hills spruce.	Honeylocust, golden willow, green ash, Siberian elm.	Eastern cottonwood.
86---------- Canisteo	---	Siberian peashrub, cotoneaster, lilac, northern whitecedar.	Hackberry, bur oak, white spruce, eastern redcedar, Black Hills spruce.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
101B---------- Truman	---	Gray dogwood, redosier dogwood, Siberian peashrub, lilac, Amur honeysuckle, American plum.	Northern whitecedar, blue spruce, hackberry, Russian olive, eastern redcedar, Amur maple.	Eastern white pine, green ash, black walnut, Scotch pine, Norway spruce, northern pin oak.	Silver maple.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
102B---------- Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub, Amur honeysuckle, American plum.	Northern whitecedar, blue spruce, Amur maple, Russian olive, eastern redcedar, hackberry.	Green ash, eastern white pine, black walnut, Scotch pine, Norway spruce, northern pin oak.	Silver maple.
112---------- Harps	---	Lilac, northern whitecedar, Siberian peashrub.	Hackberry, white spruce, eastern redcedar, bur oak, Black Hills spruce.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
113---------- Webster	---	Redosier dogwood, American plum, Amur honeysuckle, lilac, Siberian peashrub.	Hackberry, Amur maple, northern whitecedar, Black Hills spruce.	Golden willow, green ash, northern pin oak.	Eastern cottonwood, silver maple.
114---------- Glencoe	---	Redosier dogwood	Black ash, tall purple willow, tamarack.	Black willow, golden willow, white willow.	---
118---------- Crippin	American plum-----	Northern whitecedar, Siberian peashrub, lilac.	Hackberry, eastern redcedar, bur oak.	Golden willow, green ash, honeylocust, black walnut.	Eastern cottonwood.
128A, 128B-------- Grogan	Hedge cotoneaster	Redosier dogwood, gray dogwood, Siberian peashrub, lilac, Amur honeysuckle.	Northern whitecedar, blue spruce, Russian olive, hackberry, Amur maple, eastern redcedar.	Eastern white pine, green ash, black walnut, northern pin oak, bur oak.	Silver maple.
130---------- Nicollet	---	Redosier dogwood, lilac, Amur honeysuckle, Siberian peashrub, American plum.	Northern whitecedar, blue spruce, Amur maple, Black Hills spruce.	Austrian pine, eastern white pine, green ash, hackberry, black walnut.	Silver maple, eastern cottonwood, Siouxland cottonwood.
134---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow, tamarack.	Black willow, white willow, golden willow.	---
136---------- Madelia	---	American plum, redosier dogwood, Amur honeysuckle, lilac, Siberian peashrub.	Northern whitecedar, Black Hills spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash, northern pin oak, eastern white pine.	Silver maple, eastern cottonwood.
140---------- Spicer	---	Northern whitecedar, lilac, Siberian peashrub.	Bur oak, hackberry, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
160---------- Fieldon	---	Northern whitecedar, lilac, Siberian peashrub.	Black Hills spruce, eastern redcedar, bur oak, hackberry.	Honeylocust, green ash, golden willow.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
178---------- Granby	---	Redosier dogwood, Amur privet, American cranberrybush, lilac, nannyberry viburnum.	Northern whitecedar, red splendor crabapple, Black Hills spruce, Norway spruce.	Eastern white pine, white spruce, green ash.	Carolina poplar, silver maple, robusta poplar.
181---------- Litchfield	---	Redosier dogwood, lilac, Amur honeysuckle, Siberian peashrub.	Black Hills spruce, blue spruce, Amur maple, northern whitecedar, red splendor crabapple.	Austrian pine, hackberry, green ash, eastern white pine, black walnut.	Silver maple, eastern cottonwood, robusta poplar.
183---------- Dassel	---	Redosier dogwood, American plum, Amur honeysuckle.	Black Hills spruce, northern whitecedar, tall purple willow, Amur maple, hackberry.	Golden willow, green ash, northern pin oak.	Eastern cottonwood, silver maple, robusta poplar.
197---------- Kingston	---	Lilac, redosier dogwood, Amur honeysuckle.	Northern whitecedar, Black Hills spruce, Amur maple, blue spruce.	Austrian pine, eastern white pine, green ash, hackberry, black walnut.	Silver maple, eastern cottonwood, robusta poplar.
222B---------- Lasa	Siberian peashrub	Eastern redcedar, lilac, Amur honeysuckle.	Red pine, jack pine, Austrian pine, green ash, honeylocust, Russian olive.	Eastern white pine, Siberian elm.	---
227---------- Lemond	---	Northern whitecedar, lilac, Siberian peashrub, common chokecherry.	Bur oak, hackberry, Black Hills spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
229---------- Waldorf	---	Redosier dogwood, American plum, Amur honeysuckle, common ninebark.	Northern whitecedar, Black Hills spruce, Amur maple, tall purple willow, hackberry.	Golden willow, green ash, northern pin oak.	Eastern cottonwood, silver maple, robusta poplar.
247---------- Linder	---	Redosier dogwood, lilac, Amur honeysuckle.	Northern whitecedar, blue spruce, Amur maple, Black Hills spruce.	Austrian pine, green ash, hackberry, black walnut.	Silver maple, robusta poplar, eastern cottonwood.
255---------- Mayer	---	Lilac, northern whitecedar, Siberian peashrub.	Hackberry, bur oak, Black Hills spruce, eastern redcedar, blue spruce, Russian olive.	Golden willow, green ash, honeylocust.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
269---------- Millington	---	Northern whitecedar, lilac, Siberian peashrub.	Hackberry, Black Hills spruce, eastern redcedar, blue spruce, Russian olive.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
281---------- Darfur	---	Redosier dogwood, American plum, Amur honeysuckle, common chokecherry.	Northern whitecedar, Black Hills spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash, northern pin oak.	Eastern cottonwood, silver maple, robusta poplar.
282---------- Hanska	---	American plum, redosier dogwood, Tatarian honeysuckle.	Northern whitecedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
327A, 327B-------- Dickman	Siberian peashrub	Eastern redcedar, lilac, Amur honeysuckle.	Green ash, honeylocust, jack pine, Austrian pine, Russian olive, red pine.	Eastern white pine, Siberian elm.	---
336---------- Delft	---	American plum, redosier dogwood, Amur honeysuckle.	Hackberry, Amur maple, Black Hills spruce, northern whitecedar, tall purple willow.	Green ash, golden willow, northern pin oak, eastern white pine.	Silver maple, eastern cottonwood.
362---------- Millington	---	Northern whitecedar, lilac, Siberian peashrub.	Hackberry, Black Hills spruce, eastern redcedar, blue spruce, Russian olive.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
392---------- Biscay	---	Redosier dogwood, American plum, Amur honeysuckle.	Northern whitecedar, Amur maple, Black Hills spruce, hackberry, tall purple willow.	Green ash, golden willow, northern pin oak, eastern white pine.	Eastern cottonwood, silver maple.
421B---------- Ves	Hedge cotoneaster	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern whitecedar, Amur maple, blue spruce, hackberry, Russian olive.	Green ash, eastern white pine, black walnut, Norway spruce, Scotch pine.	Silver maple.
423---------- Seaforth	American plum-----	Siberian peashrub, lilac, northern whitecedar.	Eastern redcedar, Black Hills spruce, bur oak, hackberry.	Green ash, honeylocust, golden willow, black walnut.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
446---------- Normania	---	Lilac, redosier dogwood, Amur honeysuckle.	Northern whitecedar, Black Hills spruce, blue spruce, Amur maple.	Eastern white pine, Austrian pine, hackberry, green ash, black walnut.	Silver maple, robusta poplar, eastern cottonwood.
487---------- Hoopeston	---	Redosier dogwood, lilac, common ninebark, arrowwood.	Amur maple, Black Hills spruce, northern whitecedar, nannyberry viburnum.	Eastern white pine, hackberry, white ash, green ash, black walnut.	Silver maple, eastern cottonwood, robusta poplar.
517---------- Shandep	---	Redosier dogwood	Tall purple willow, black ash, tamarack.	Black willow, white willow, golden willow.	---
539---------- Palms	Common ninebark---	Amur privet, silky dogwood.	Tall purple willow, tamarack.	Golden willow, black willow.	Imperial Carolina poplar.
562---------- Knoke	---	Siberian peashrub, lilac, northern whitecedar.	Black Hills spruce, bur oak, eastern redcedar, hackberry.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
575---------- Nishna	---	Siberian peashrub, northern white cedar, lilac.	Russian olive, hackberry, eastern redcedar, blue spruce.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
639B---------- Ridgeport	Siberian peashrub, lilac, Peking cotoneaster, Amur honeysuckle.	Manchurian crabapple, eastern redcedar, Russian olive.	Siberian elm, honeylocust, green ash, hackberry.	---	---
654---------- Revere	---	Siberian peashrub, lilac, northern whitecedar.	Eastern redcedar, bur oak, Black Hills spruce, hackberry, blue spruce, Russian olive.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
668---------- Corwith	---	Lilac, northern whitecedar, Siberian peashrub.	White spruce, hackberry, bur oak, eastern redcedar.	Green ash, honeylocust, golden willow.	Eastern cottonwood.
789B2*: Grogan----------	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Northern whitecedar, blue spruce, Russian olive, hackberry, Amur maple, eastern redcedar.	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 height, in feet, of--				
	<8	8-15	16-25	26-35	>35
789B2*:					
Lasa Variant	Siberian peashrub	Lilac, common chokecherry, honeysuckle, late lilac, Manchurian crabapple, northern whitecedar, sargent crabapple, silver buffaloberry, red buckthorn.	Austrian pine, eastern redcedar, green ash, jack pine, ponderosa pine, Russian olive, silver maple, thornless honeylocust, white spruce.	Eastern cottonwood, eastern white pine, red pine, Scotch pine, Siberian elm.	---
789C2*:					
Lasa Variant	Siberian peashrub	Lilac, common chokecherry, honeysuckle, late lilac, Manchurian crabapple, northern whitecedar, sargent crabapple, silver buffaloberry, red buckthorn.	Austrian pine, eastern redcedar, green ash, jack pine, ponderosa pine, Russian olive, silver maple, thornless honeylocust, white spruce.	Eastern cottonwood, eastern white pine, red pine, Scotch pine, Siberian elm.	---
Grogan	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Northern whitecedar, blue spruce, Russian olive, hackberry, Amur maple, eastern redcedar.	Eastern white pine, green ash.	---
790B*:					
Grogan	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Northern whitecedar, blue spruce, Russian olive, hackberry, Amur maple, eastern redcedar.	Eastern white pine, green ash.	---
Dickinson	Lilac	Eastern redcedar, Russian olive, Siberian peashrub.	Eastern white pine, green ash, Norway spruce, honeylocust, red pine, Amur maple, hackberry.	---	---
887B*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub, Amur honeysuckle, American plum.	Northern whitecedar, blue spruce, Amur maple, Russian olive, eastern redcedar, hackberry.	Green ash, eastern white pine, black walnut, Scotch pine, Norway spruce, northern pin oak.	Silver maple.
Swanlake	American plum, lilac.	Eastern redcedar, Siberian peashrub, hackberry.	Honeylocust, green ash, Russian olive.	Siberian elm	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
909C2*:					
Bold	American plum, lilac.	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive.	Siberian elm	---
Truman	---	Gray dogwood, redosier dogwood, Siberian peashrub, lilac, Amur honeysuckle, American plum.	Northern whitecedar, blue spruce, hackberry, Russian olive, eastern redcedar, Amur maple.	Eastern white pine, green ash, black walnut, Scotch pine, Norway spruce, northern pin oak.	Silver maple.
920B2*, 920C2*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub, Amur honeysuckle, American plum.	Northern whitecedar, blue spruce, Amur maple, Russian olive, eastern redcedar, hackberry.	Green ash, eastern white pine, black walnut, Scotch pine, Norway spruce, northern pin oak.	Silver maple.
Estherville	Siberian peashrub	Eastern redcedar, lilac, Amur honeysuckle, Manchurian crabapple.	Honeylocust, jack pine, green ash, Russian olive, red pine, Austrian pine.	Eastern white pine, Siberian elm.	---
921B2*, 921C2*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub, Amur honeysuckle, American plum.	Northern whitecedar, blue spruce, Amur maple, Russian olive, eastern redcedar, hackberry.	Green ash, eastern white pine, black walnut, Scotch pine, Norway pine, northern pin oak.	Silver maple.
Storden	American plum, lilac.	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive, bur oak.	Siberian elm	---
929*:					
Fieldon	---	Northern whitecedar, lilac, Siberian peashrub.	Black Hills spruce, eastern redcedar, bur oak, hackberry.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
Canisteo	---	Siberian peashrub, lilac, northern whitecedar.	Hackberry, bur oak, white spruce, eastern redcedar, Black Hills spruce.	Golden willow, honeylocust, green ash, Siberian elm.	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 height, in feet, of--				
	<8	8-15	16-25	26-35	>35
954B2*:					
Ves	Hedge cotoneaster	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern whitecedar, Amur maple, blue spruce, hackberry, Russian olive.	Green ash, eastern white pine, black walnut, Norway spruce, Scotch pine.	Silver maple.
Storden	American plum, lilac.	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive, bur oak.	Siberian elm	---
954C2*:					
Storden	American plum, lilac.	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive, bur oak.	Siberian elm	---
Ves	Hedge cotoneaster	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern whitecedar, Amur maple, blue spruce, hackberry, Russian olive.	Green ash, eastern white pine, black walnut, Norway spruce, Scotch pine.	Silver maple.
956*:					
Canisteo	---	Siberian peashrub, lilac, northern whitecedar.	Hackberry, bur oak, white spruce, eastern redcedar, Black Hills spruce.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
Glencoe	---	Redosier dogwood	Black ash, tall purple willow, tamarack.	Black willow, golden willow, white willow.	---
960D2*:					
Storden	American plum, lilac.	Eastern redcedar, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian olive, bur oak.	Siberian elm	---
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub, Amur honeysuckle, American plum.	Northern whitecedar, blue spruce, Amur maple, Russian olive, eastern redcedar, hackberry.	Green ash, eastern white pine, black walnut, Scotch pine, Norway spruce, northern pin oak.	Silver maple.
999B2*:					
Ves	Hedge cotoneaster	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern whitecedar, Amur maple, blue spruce, hackberry, Russian olive.	Green ash, eastern white pine, black walnut, Norway spruce, Scotch pine.	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 height, in feet, of--				
	<8	8-15	16-25	26-35	>35
992B2*: Estherville	---	Eastern redcedar, lilac, Amur honeysuckle, Manchurian crabapple.	Honeylocust, jack pine, green ash, Russian olive, red pine, Austrian pine.	Eastern white pine, Siberian elm.	---
1016. Udorthents					
1030*: Udorthents.					
Pits.					
1055*: Palms.					
Glencoe.					
1833, 1834 Coland	---	Redosier dogwood, American plum, Amur honeysuckle.	Black Hills spruce, hackberry, northern whitecedar, tall purple willow, Amur maple.	Golden willow, green ash, northern pin oak, eastern white pine.	Eastern cottonwood, silver maple.
1907 Lakefield	American plum	Siberian peashrub, lilac, northern whitecedar.	Eastern redcedar, Black Hills spruce, bur oak, hackberry, blue spruce.	Green ash, honeylocust, golden willow, black walnut.	Eastern cottonwood.
1931 Essexville	---	Siberian peashrub, lilac, northern whitecedar.	Hackberry, eastern redcedar, Black Hills spruce, bur oak.	Golden willow, honeylocust, green ash, Siberian elm.	Eastern cottonwood.
1981*: Hanlon	---	Redosier dogwood, lilac.	Amur maple, blue spruce, white spruce, northern whitecedar.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
Kalmarville	---	American plum, redosier dogwood.	Tall purple willow, hackberry, northern whitecedar, white spruce, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.

* 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	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, small stones.	Moderate: too sandy.	Moderate: droughty.
27A Dickinson	Slight	Slight	Slight	Slight	Slight.
27B Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
31F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35 Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
41B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
69B Fedji	Slight	Slight	Moderate: slope.	Slight	Slight.
84 Brownton	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
86 Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
101B Truman	Slight	Slight	Moderate: slope.	Slight	Slight.
102B Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
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.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
118 Crippin	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Slight.
128A Grogan	Slight	Slight	Slight	Slight	Slight.
128B Grogan	Slight	Slight	Moderate: slope.	Slight	Slight.
130 Nicollet	Slight	Slight	Moderate: slope.	Slight	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
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.
160--Fieldon	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
178--Granby	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
181--Litchfield	Slight	Slight	Slight	Slight	Moderate: droughty.
183--Dassel	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
197--Kingston	Slight	Slight	Moderate: slope.	Slight	Slight.
222B--Lasa	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
227--Lemond	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
229--Waldorf	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
247--Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Moderate: droughty.
255--Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
269--Millington	Severe: flooding, ponding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
281--Darfur	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
282--Hanska	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
327A--Dickman	Slight	Slight	Slight	Slight	Moderate: droughty.
327B--Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
336--Delft	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
362--Millington	Severe: flooding.	Moderate: wetness.	Severe: wetness, flooding.	Severe: flooding.	Severe: flooding.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
392---------- Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
421B---------- Ves	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
423---------- Seaforth	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
446---------- Normania	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
487---------- Hoopeston	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
517---------- Shandep	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
539---------- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
562---------- Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
575---------- Nishna	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
639B---------- Ridgeport	Slight----------	Slight----------	Moderate: slope.	Slight----------	Moderate: droughty.
654---------- Revere	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
668---------- Corwith	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight----------	Slight.
789B2*:					
Grogan----------	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
Lasa Variant---------	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
789C2*:					
Lasa Variant---------	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
Grogan----------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
790B*:					
Grogan----------	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
Dickinson----------	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.

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
887B*:					
Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
Swanlake	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
909C2*:					
Bold	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
Truman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
920B2*:					
Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
920C2*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
921B2*:					
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.
929*:					
Fieldon	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
954B2*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.

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
954C2*:					
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
956*:					
Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
960D2*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
999B2*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
1016.					
Udorthents					
1030*:					
Udorthents.					
Pits.					
1055*:					
Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1833	Severe:	Moderate:	Severe:	Moderate:	Moderate:
Coland	flooding, wetness.	wetness.	wetness.	wetness.	wetness, flooding.
1834	Severe:	Moderate:	Severe:	Moderate:	Severe:
Coland	flooding, wetness.	flooding, wetness.	wetness, flooding.	wetness, flooding.	flooding.
1907	Slight	Slight	Moderate:	Slight	Slight.
Lakefield			slope.		
1931	Severe:	Severe:	Severe:	Severe:	Severe:
Essexville	wetness.	wetness.	wetness.	wetness.	wetness.

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
1981*:					
Hanlon	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
Kalmarville	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(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.
27A, 27B---------- Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
31F---------- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
35---------- Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
41B---------- Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
69B---------- Fedji	Fair	Fair	Good	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.
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.
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.
128A, 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.
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.

TABLE 9.--WILDLIFE HABITAT--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
160---- Fieldon	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
178---- Granby	Poor	Poor	Fair	Fair	Fair	Good	Good	Poor	Fair	Good.
181---- Litchfield	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
183---- Dassel	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
197---- Kingston	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
222B---- Lasa	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very 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	Good.
281---- Darfur	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
282---- Hanska	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
327A, 327B--- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
336---- Delft	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
362---- Millington	Poor	Fair	Fair	Good	Fair	Good	Good	Fair	Good	Good.
392---- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
421B---- Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
423---- Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
446---- Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
487---- Hoopeston	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.

TABLE 9.--WILDLIFE HABITAT--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
517---------- Shandep	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
539---------- Palms	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
562---------- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
575---------- Nishna	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
639B---------- Ridgeport	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
654---------- Revere	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
668---------- Corwith	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Poor.
789B2*:										
Grogan----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Lasa Variant------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
789C2*:										
Lasa Variant------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Grogan----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
790B*:										
Grogan----------	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Dickinson---------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very 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.
909C2*:										
Bold----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Truman----------	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
920B2*:										
Clarion----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--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
920B2*:										
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.
921B2*:										
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.
929*:										
Fieldon	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
954B2*:										
Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Storden	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
954C2*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
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	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
999B2*:										
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--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
999B2*:										
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
1016.										
Udorthents										
1030*:										
Udorthents.										
Pits.										
1055*:										
Palms	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
Glencoe	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
1833	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Coland										
1834	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
Coland										
1907	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Lakefield										
1931	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Poor	Fair.
Essexville										
1981*:										
Hanlon	Very poor.	Poor	Good	Good	Good	Poor	Fair	Poor	Good	Poor.
Kalmarville	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.

* 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. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

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.
27A Dickinson	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Slight.
27B Dickinson	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
31F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35 Blue Earth	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
41B Estherville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
69B Fedji	Slight	Slight	Slight	Slight	Moderate: low strength.	Slight.
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.
101B Truman	Slight	Slight	Slight	Slight	Severe: low strength, frost action.	Slight.
102B Clarion	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
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.
114 Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: 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.

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
128A---------- Grogan	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
128B---------- Grogan	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	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: shrink-swell, low strength, ponding.	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.
160---------- Fieldon	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
178---------- Granby	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
181---------- Litchfield	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Moderate: frost action.	Moderate: droughty.
183---------- Dassel	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
197---------- Kingston	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action, low strength.	Slight.
222B---------- Lasa	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
227---------- Lemond	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
229---------- Waldorf	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
247---------- Linder	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Moderate: droughty.
255---------- Mayer	Severe: wetness, cutbanks cave.	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
269---------- Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.	Moderate: wetness.
281---------- Darfur	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
282---------- Hanska	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
327A---------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
327B---------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
336---------- Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
362---------- Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding.	Severe: wetness, flooding.
392---------- Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
421B---------- Ves	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: low strength, frost action.	Slight.
423---------- Seaforth	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
446---------- Normania	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
487---------- Hoopeston	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
517---------- Shandep	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
539---------- Palms	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
562---------- Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.

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
575--Nishna	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, flooding.	Moderate: wetness, flooding.
639B--Ridgeport	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
654--Revere	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
668--Corwith	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
789B2*:						
Grogan	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Severe: frost action.	Slight.
Lasa Variant	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
789C2*:						
Lasa Variant	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Grogan	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
790B*:						
Grogan	Severe: cutbanks cave.	Slight	Slight	Slight	Severe: frost action.	Slight.
Dickinson	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Slight.
887B*:						
Clarion	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
Swanlake	Slight	Slight	Slight	Slight	Moderate: frost action, low strength.	Slight.
909C2*:						
Bold	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
Truman	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
920B2*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.

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
920C2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
921B2*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
921C2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
929*:						
Fieldon	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
954B2*:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
954C2*:						
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
956*:						
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.

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
960D2*:						
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.
999B2*:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
1016. Udorthents						
1030*: Udorthents.						
Pits.						
1055*:						
Palms	Severe: excess humus, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding.	Severe: subsides, ponding, low strength.	Severe: subsides, ponding, frost action.	Severe: ponding, excess humus.
Glencoe	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
1833 Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
1834 Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Severe: flooding.
1907 Lakefield	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: low strength, frost action.	Slight.
1931 Essexville	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
1981*:						
Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Kalmarville	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding.

* 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," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

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.
27A, 27B Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
31F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
35 Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
41B Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
69B Fedji	Moderate: percs slowly.	Severe: seepage.	Slight	Severe: seepage.	Good.
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.
101B Truman	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
102B Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
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.
128A Grogan	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Fair: 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
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, too clayey.	Severe: ponding.	Poor: too clayey, 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.
160---------- Fieldon	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
178---------- Granby	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
181---------- Litchfield	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy.
183---------- Dassel	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
197---------- Kingston	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness, too clayey.
222B---------- Lasa	Slight----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
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, too sandy, small stones.

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
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.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Poor: wetness.
281--- Darfur	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
282--- Hanska	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
327A, 327B--- Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
336--- Delft	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
362--- Millington	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Poor: ponding, wetness.
392--- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
421B--- Ves	Slight---	Moderate: seepage, slope.	Slight---	Slight---	Good.
423--- Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
446--- Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
487--- Hoopeston	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
517--- Shandep	Severe: ponding.	Severe: seepage, ponding.	Severe: seepage, ponding.	Severe: ponding.	Poor: hard to pack, ponding.
539--- Palms	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding.	Severe: ponding, seepage.	Poor: ponding.

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
562---------- Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: ponding, too clayey, hard to pack.
575---------- Nishna	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
639B---------- Ridgeport	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.
654---------- Revere	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
668---------- Corwith	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
789B2*:					
Grogan----------	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Lasa Variant-------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
789C2*:					
Lasa Variant-------	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Grogan----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
790B*:					
Grogan----------	Slight----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Dickinson----------	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
887B*:					
Clarion----------	Slight----------	Moderate: slope, seepage.	Slight----------	Slight----------	Good.
Swanlake----------	Slight----------	Moderate: seepage, slope.	Slight----------	Slight----------	Good.
909C2*:					
Bold----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Truman----------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: 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
920B2*:					
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.
921B2*:					
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
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.
929*:					
Fieldon	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
954B2*:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
954C2*:					
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

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
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	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
999B2*:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
1016.					
Udorthents					
1030*:					
Udorthents.					
Pits.					
1055*:					
Palms	Severe: subsides, ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
Glencoe	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
1833, 1834--- Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
1907--- Lakefield	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
1931--- Essexville	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, 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
1981*:					
Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
Kalmarville	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness, seepage.	Poor: 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," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
8B Sparta	Good	Probable	Improbable: too sandy.	Poor: too sandy.
27A, 27B Dickinson	Good	Probable	Improbable: too sandy.	Good.
31F Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
35 Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
41B Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
69B Fedji	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy, small stones.
84 Brownton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
86 Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
101B Truman	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
102B Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
112 Harps	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
113 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
114 Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
118 Crippin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
128A, 128B Grogan	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
130 Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
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.
160 Fieldon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
178 Granby	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
181 Litchfield	Fair: wetness.	Probable	Improbable: too sandy.	Fair: too sandy, thin layer.
183 Dassel	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
197 Kingston	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
222B Lasa	Good	Probable	Improbable: too sandy.	Poor: too sandy.
227 Lemond	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
229 Waldorf	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
247 Linder	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, 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.	Good.
281 Darfur	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
282 Hanska	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
327A, 327B Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
336 Delft	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
362--Millington	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
392--Biscay	Fair: wetness.	Probable	Probable	Poor: area reclaim.
421B--Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
423--Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
446--Normania	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
487--Hoopeston	Fair: wetness.	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
517--Shandep	Poor: wetness.	Probable	Probable	Poor: wetness.
539--Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
562--Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
575--Nishna	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
639B--Ridgeport	Good	Probable	Improbable: too sandy.	Fair: small stones, area reclaim, thin layer.
654--Revere	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
668--Corwith	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
789B2*:				
Grogan	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Lasa Variant	Good	Probable	Improbable: too sandy.	Poor: too sandy.
789C2*:				
Lasa Variant	Good	Probable	Improbable: too sandy.	Poor: too sandy.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
789C2*:				
Grogan	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
790B*:				
Grogan	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Dickinson	Good	Probable	Improbable: too sandy.	Good.
887B*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Swanlake	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
909C2*:				
Bold	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Truman	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
920B2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
920C2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
921B2*:				
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.
929*:				
Fieldon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
929*:				
Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
954B2*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
954C2*:				
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
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	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
999B2*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
1016. Udorthents				
1030*: Udorthents.				
Pits.				
1055*:				
Palms	Poor: wetness.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
Glencoe	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1833, 1834---------- Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1907---------- Lakefield	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1931---------- Essexville	Poor: thin layer, wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: wetness.
1981*:				
Hanlon----------	Good----------	Improbable: excess fines.	Improbable: excess fines.	Good.
Kalmarville----------	Poor: wetness.	Probable----------	Improbable: too sandy.	Poor: wetness.

* 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. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

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	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
27A---------- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing---	Too sandy, soil blowing.	Favorable.
27B---------- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Slope, soil blowing.	Too sandy, soil blowing.	Favorable.
31F---------- Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
35---------- Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
41B---------- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
69B---------- Fedji	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, fast intake, slope.	Soil blowing---	Favorable.
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.
101B---------- Truman	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
102B---------- Clarion	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
112---------- Harps	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
113---------- Webster	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
114---------- Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding--------	Ponding--------	Wetness.
118---------- Crippin	Moderate: seepage.	Moderate: wetness, piping.	Frost action---	Wetness--------	Wetness, erodes easily.	Erodes easily.
128A---------- Grogan	Severe: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.

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
128B---------- Grogan	Severe: seepage.	Severe: piping.	Deep to water	Slope----------	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, erodes easily.	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.
160---------- Fieldon	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
178---------- Granby	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Ponding, too sandy, soil blowing.	Wetness, droughty.
181---------- Litchfield	Severe: seepage.	Severe: piping.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, too sandy, soil blowing.	Droughty.
183---------- Dassel	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
197---------- Kingston	Moderate: seepage.	Severe: piping.	Frost action---	Wetness--------	Erodes easily, wetness.	Erodes easily.
222B---------- Lasa	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
227---------- Lemond	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	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, soil blowing.	Wetness, too sandy, soil blowing.	Droughty, rooting depth.
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--------	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
281---------- Darfur	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
282---------- Hanska	Severe: seepage.	Severe: seepage, wetness, piping.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
327A---------- Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
327B---------- Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
336---------- Delft	Slight---------	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
362---------- Millington	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action, wetness.	Flooding, wetness.	Wetness--------	Wetness.
392---------- Biscay	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
421B---------- Ves	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
423---------- Seaforth	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Favorable------	Favorable.
446---------- Normania	Moderate: seepage.	Moderate: piping, wetness.	Frost action---	Wetness--------	Wetness--------	Favorable.
487---------- Hoopeston	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
517---------- Shandep	Severe: seepage.	Severe: ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
539---------- Palms	Severe: seepage.	Severe: piping, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness, rooting depth.
562---------- Knoke	Slight---------	Severe: hard to pack, ponding.	Ponding, frost action.	Ponding--------	Ponding, erodes easily.	Wetness, erodes easily.
575---------- Nishna	Slight---------	Severe: wetness.	Percs slowly, flooding.	Wetness, percs slowly.	Wetness, percs slowly, erodes easily.	Wetness, percs slowly, erodes easily.
639B---------- Ridgeport	Severe: seepage.	Severe: piping.	Deep to water	Slope, droughty, soil blowing.	Soil blowing---	Droughty.

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
654---------- Revere	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness---------	Wetness---------	Wetness.
668---------- Corwith	Moderate: seepage.	Severe: piping.	Frost action---	Wetness, rooting depth.	Erodes easily, wetness.	Erodes easily, rooting depth.
789B2*:						
Grogan----------	Severe: seepage.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Lasa Variant-----	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Slope, droughty.
789C2*:						
Lasa Variant-----	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
Grogan----------	Severe: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
790B*:						
Grogan----------	Severe: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Dickinson--------	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing---	Too sandy, soil blowing.	Favorable.
887B*:						
Clarion----------	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Swanlake---------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
909C2*:						
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.
920B2*:						
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*:						
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.

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
921B2*:						
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.
929*:						
Fieldon	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
Canisteo	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
954B2*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
954C2*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
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.
999B2*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	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
999B2*: Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
1016. Udorthents						
1030*: Udorthents.						
Pits.						
1055*: Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, rooting depth.	Ponding	Wetness, rooting depth.
Glencoe	Moderate: seepage.	Severe: excess humus, hard to pack, ponding.	Ponding, frost action.	Ponding	Ponding	Wetness.
1833, 1834--- Coland	Severe: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
1907--- Lakefield	Moderate: seepage.	Severe: piping.	Frost action	Wetness	Wetness	Favorable.
1931--- Essexville	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
1981*: Hanlon	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing	Favorable.
Kalmarville	Severe: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, soil blowing, flooding.	Wetness, soil blowing.	Wetness.

* 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	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
8B---------- Sparta	0-38	Loamy sand-------	SM	A-2, A-4	0	85-100	85-100	50-95	15-50	---	NP
	38-60	Sand, fine sand	SP-SM, SM, SP	A-2, A-3	0	85-100	85-100	50-95	2-30	---	NP
27A, 27B---------- Dickinson	0-14	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	14-40	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	40-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
31F---------- Storden	0-10	Loam----------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	10-60	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
35---------- Blue Earth	0-10	Mucky silt 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
41B---------- 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 coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
69B---------- Fedji	0-12	Loamy fine sand	SM	A-2	0	100	95-100	50-75	15-30	---	NP
	12-35	Loamy fine sand, sand, loamy sand.	SM, SP-SM	A-2	0	100	95-100	50-75	10-30	---	NP
	35-42	Loam, silt loam, clay loam.	CL	A-6	0	95-100	90-100	80-95	60-75	20-40	10-20
	42-60	Loam, silt loam, clay loam.	CL, CL-ML	A-6, A-4	0	95-100	90-100	80-95	60-75	20-40	5-20
84---------- Brownton	0-22	Silty clay loam	MH, CH	A-7	0	100	95-100	90-100	85-95	50-65	20-35
	22-38	Silty clay, clay, silty clay loam.	MH, CH	A-7	0	100	95-100	90-100	85-95	50-80	25-40
	38-60	Clay loam, loam	CL	A-6, A-7	0-5	95-100	90-100	75-90	60-75	30-50	15-25
86---------- Canisteo	0-22	Clay loam--------	OL, CL	A-7	0	95-100	95-100	85-100	60-100	40-50	15-20
	22-36	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	36-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
101B---------- Truman	0-14	Silt loam--------	ML, CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	25-40	5-15
	14-34	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
	34-60	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	75-95	25-40	5-15

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
102B---------- Clarion	0-16	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	16-32	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	32-60	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
112---------- Harps	0-18	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	35-55	15-35
	18-36	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
	36-60	Loam, sandy clay loam.	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
113---------- Webster	0-23	Clay loam--------	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	23-33	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
	33-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
114---------- Glencoe	0-28	Clay loam--------	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	28-46	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
	46-60	Loam, clay loam	CL, ML	A-6, A-7	0	90-100	85-100	60-95	55-75	30-50	10-20
118---------- Crippin	0-17	Loam----------	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
	17-33	Loam, clay loam	CL	A-6	0-5	95-100	90-100	80-90	60-80	30-40	10-20
	33-60	Loam, clay loam	CL	A-6	2-5	90-100	85-100	75-90	55-80	30-40	10-20
128A, 128B------- Grogan	0-15	Silt loam--------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	15-36	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	36-60	Stratified loamy very fine sand to silt loam.	ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
130---------- Nicollet	0-19	Loam----------	ML, CL	A-6, A-7	0-5	95-100	90-100	85-100	55-85	30-45	10-25
	19-34	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
	34-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
134---------- Okoboji	0-9	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	9-34	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	34-48	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	48-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
136---------- Madelia	0-18	Silty clay loam	ML	A-7	0	100	100	100	90-100	40-50	10-20
	18-25	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	90-100	30-50	10-25
	25-60	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	0-18	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	18-30	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	30-60	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		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
160--------- Fieldon	0-16	Loam----------	CL-ML, CL, ML	A-4	0	100	100	85-95	50-75	20-35	NP-10
	16-32	Fine sandy loam, very fine sandy loam, loam.	ML, SM	A-4	0	100	100	70-90	35-60	<30	NP-5
	32-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	60-100	15-40	---	NP
178--------- Granby	0-26	Loamy sand-------	SM	A-2	0	100	100	50-80	15-35	---	NP
	26-32	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2, A-1	0	100	95-100	45-80	5-35	---	NP
	32-60	Sand, fine sand, loamy sand.	SP-SM, SM	A-3, A-2, A-1	0	100	95-100	45-80	5-35	---	NP
181--------- Litchfield	0-21	Loamy fine sand	SM	A-2	0	100	100	80-95	15-35	<20	NP-4
	21-40	Stratified fine sand to very fine sandy loam.	SM	A-2	0	100	100	80-95	20-35	<20	NP-4
	40-60	Loamy fine sand, loamy sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	70-95	5-30	<20	NP-4
183--------- Dassel	0-27	Fine sandy loam	SM, OL	A-4	0	100	95-100	70-85	40-50	<30	NP-4
	27-37	Stratified loamy fine sand to fine sandy loam.	SM	A-4, A-2	0	100	95-100	60-75	30-40	<30	NP-4
	37-60	Stratified loamy sand to coarse sand.	SM, SP-SM	A-2	0	100	80-100	50-80	10-35	---	NP
197--------- Kingston	0-16	Silty clay loam	CL	A-6	0	100	100	95-100	85-100	30-40	10-20
	16-22	Silty clay loam, silt loam.	CL, ML, CL-ML	A-6, A-7, A-4	0	100	100	95-100	85-100	25-50	6-20
	22-60	Silt loam, silty clay loam.	CL-ML, CL, ML	A-4, A-6, A-7	0	100	100	95-100	85-100	25-50	5-20
222B--------- Lasa	0-18	Loamy fine sand	SM	A-2	0	100	100	80-95	15-30	---	NP
	18-60	Fine sand, loamy fine sand.	SM	A-2	0	100	100	80-95	15-30	---	NP
227--------- Lemond	0-18	Loam----------	ML, CL, CL-ML	A-4	0	95-100	95-100	80-95	50-65	<25	2-10
	18-28	Sandy loam, loamy sand, loam.	SM, SM-SC	A-2, A-4	0	95-100	95-100	65-80	25-50	<25	NP-7
	28-60	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	0-23	Silty clay loam	ML, MH	A-7	0	100	100	95-100	90-100	45-65	14-30
	23-38	Silty clay, silty clay loam.	MH	A-7	0	100	100	95-100	95-100	50-70	20-35
	38-60	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	0-18	Sandy loam-------	SC, SM-SC, SM, ML	A-4	0	100	95-100	80-95	35-55	20-30	NP-10
	18-33	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	33-60	Gravelly sand, gravelly loamy sand, loamy coarse sand.	SP, SP-SM	A-1	0-5	75-95	30-95	25-50	2-12	---	NP

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
255---------- Mayer	0-19	Loam----------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	19-38	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
	38-60	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	0-16	Clay loam--------	CL, ML, OL	A-7, A-6	0	100	90-100	90-100	90-100	35-50	11-20
	16-38	Loam, silty clay loam, clay loam.	CL	A-7, A-6	0	95-100	90-100	80-100	70-95	28-50	10-22
	38-60	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
281---------- Darfur	0-23	Fine sandy loam	SM, ML	A-4	0	100	100	80-100	40-60	20-30	NP-7
	23-36	Fine sandy loam, loam, loamy fine sand.	SM	A-4	0	100	100	70-100	35-50	20-30	NP-5
	36-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	50-100	15-40	---	---
282---------- Hanska	0-18	Loam----------	ML, CL, CL-ML	A-4	0	95-100	95-100	80-95	50-65	<25	2-10
	18-30	Sandy loam, coarse sandy loam, loam.	SM, SM-SC, SC	A-4	0	95-100	95-100	65-80	35-50	<20	2-8
	30-60	Sand, coarse sand	SP-SM	A-3, A-1, A-2	0	95-100	85-100	45-70	5-10	<20	NP
327A, 327B------- Dickman	0-15	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	15-20	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	20-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
336---------- Delft	0-30	Loam----------	CL	A-6, A-7	0	95-100	90-100	75-90	60-80	30-45	10-20
	30-43	Loam, clay loam, silt loam.	CL	A-6, A-4	0	95-100	90-100	70-90	50-75	25-40	7-15
	43-60	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
362---------- Millington	0-36	Clay loam--------	CL, ML, OL	A-7, A-6	0	100	90-100	90-100	90-100	35-50	11-20
	36-60	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
392---------- Biscay	0-22	Loam----------	CL, ML	A-7, A-6	0	95-100	95-100	70-95	50-80	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
	32-36	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	36-60	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

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
421B---------- Ves	0-14	Loam----------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	14-25	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	25-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
423---------- Seaforth	0-12	Loam----------	ML, CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	25-40	5-15
	12-24	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-100	80-95	55-80	30-40	8-15
	24-60	Loam----------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
446---------- Normania	0-16	Loam----------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	16-32	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
	32-60	Loam, clay loam	CL	A-6, A-4	0-5	90-100	85-100	80-90	55-80	30-40	8-15
487---------- Hoopeston	0-18	Fine sandy loam	SM, SM-SC, SC	A-2, A-4	0	90-100	90-100	70-90	25-45	<25	NP-10
	18-32	Sandy loam, fine sandy loam.	SM, SC, SM-SC	A-2, A-4	0	90-100	90-100	60-85	25-50	<30	NP-10
	32-60	Loamy sand, sand, fine sand.	SP-SM, SM, SC, SM-SC	A-2, A-3	0	90-100	90-100	50-80	5-20	<25	NP-10
517---------- Shandep	0-22	Clay loam--------	CL, CH	A-7	0	95-100	95-100	90-100	85-95	40-55	20-30
	22-40	Silty clay loam, clay loam, loam.	CL	A-7	0	95-100	95-100	90-100	85-95	40-50	20-30
	40-60	Loamy sand, gravelly loamy coarse sand, gravelly coarse sand.	SW, SP, SP-SM	A-1	0-5	65-90	60-90	20-45	2-5	---	NP
539---------- Palms	0-10	Muck----------	PT	A-8	0	---	---	---	---	---	---
	10-31	Sapric material, muck.	PT	A-8	---	---	---	---	---	---	---
	31-60	Clay loam, silty clay loam, gravelly sandy loam.	CL-ML, CL, SC, SM-SC	A-4, A-6, A-7, A-2	0	85-100	60-100	35-95	15-90	20-45	5-20
562---------- Knoke	0-10	Silty clay loam	MH, CH	A-7	0	100	100	90-100	80-95	55-70	25-40
	10-50	Silty clay loam, mucky silty clay loam.	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	50-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
575---------- Nishna	0-10	Silty clay loam	CH, MH	A-7	0	100	100	95-100	90-100	55-65	25-35
	10-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	60-70	30-40
639B---------- Ridgeport	0-16	Sandy loam--------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	70-90	25-50	15-30	2-10
	16-33	Sandy loam, gravelly sandy loam.	SM, SC, SM-SC	A-2, A-4	0	95-100	85-100	65-85	20-45	15-30	2-10
	33-60	Gravelly loamy sand, gravelly sand, sand.	SW, SP, SW-SM, SP-SM	A-1	0-5	80-95	75-95	35-50	2-10	<25	NP-6
654---------- Revere	0-22	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-95	60-80	30-45	12-20
	22-36	Clay loam, loam	CL	A-6	0	95-100	95-100	65-90	60-80	25-40	10-20
	36-60	Loam, clay loam	CL	A-6	0-2	95-100	90-100	65-90	55-80	25-40	10-18

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
668----------	0-17	Silt loam--------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
Corwith	17-27	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	27-60	Silt loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
789B2*:											
Grogan----------	0-10	Loam----------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	10-36	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	36-60	Stratified loamy very fine sand to silt loam.	ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
Lasa Variant----	0-10	Loamy fine sand	SM	A-2	0	100	100	80-95	15-30	---	NP
	10-60	Fine sand, loamy fine sand.	SM	A-2	0	100	100	80-95	15-30	---	NP
789C2*:											
Lasa Variant----	0-10	Loamy fine sand	SM	A-2	0	100	100	80-95	15-30	---	NP
	10-34	Fine sand, loamy fine sand.	SM	A-2	0	100	100	80-95	15-30	---	NP
	34-60	Fine sand, loamy fine sand.	SP, SP-SM, SM	A-3, A-2	0	100	100	75-95	0-35	---	NP
Grogan----------	0-10	Silt loam--------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	10-32	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	32-60	Stratified loamy very fine sand to silt loam.	ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
790B*:											
Grogan----------	0-18	Loam----------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	18-35	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	35-60	Stratified loamy very fine sand to silt loam.	ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
Dickinson-------	0-14	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	14-36	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	36-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
887B*:											
Clarion---------	0-15	Loam----------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	15-30	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
Swanlake--------	0-9	Loam----------	CL-ML, CL	A-4, A-6	0-5	90-100	85-98	75-90	50-70	20-35	5-15
	9-60	Loam, clay loam	ML, CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	20-35	5-15
909C2*:											
Bold----------	0-6	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15
	6-60	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	100	90-100	20-35	3-15

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	
909C2*:											
Truman	0-9	Silt loam	ML, CL-ML, CL	A-4, A-6	0	100	100	95-100	80-100	25-40	5-15
	9-20	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
	20-60	Silt loam	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	75-95	25-40	5-15
920B2*:											
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
	9-28	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	28-60	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	0-9	Sandy loam	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	9-20	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, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
920C2*:											
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
	8-26	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	26-60	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	0-8	Sandy loam	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	8-21	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
	21-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
921B2*:											
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
	10-21	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	21-60	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	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
921C2*:											
Clarion	0-7	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	7-23	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	23-60	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	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam, 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	
929*:											
Fieldon	0-12	Loam	CL-ML, CL, ML	A-4	0	100	100	85-95	50-75	20-35	NP-10
	12-38	Fine sandy loam, very fine sandy loam, loam.	ML, SM	A-4	0	100	100	70-90	35-60	<30	NP-5
	38-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	60-100	15-40	---	NP
Canisteo	0-10	Clay loam	OL, CL	A-7	0	95-100	95-100	85-100	60-100	40-50	15-20
	10-20	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	20-32	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
	32-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
954B2*:											
Ves	0-9	Loam	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	9-32	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	32-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Storden	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	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
954C2*:											
Storden	0-7	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	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
Ves	0-8	Loam	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	8-30	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	30-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
956*:											
Canisteo	0-22	Clay loam	OL, CL	A-7	0	95-100	95-100	85-100	60-100	40-50	15-20
	22-28	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	28-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
Glencoe	0-26	Clay loam	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	26-38	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
	38-60	Loam, clay loam	CL, ML	A-6, A-7	0	90-100	85-100	60-95	55-75	30-50	10-20
960D2*:											
Storden	0-9	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, 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	0-8	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	8-25	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

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
999B2*:											
Ves	0-9	Loam	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	9-32	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	32-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Estherville	0-9	Sandy loam	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	9-20	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, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
1016. Udorthents											
1030*: Udorthents.											
Pits.											
1055*:											
Palms	0-30	Muck	PT	A-8	0	---	---	---	---	---	---
	30-60	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
Glencoe	0-30	Clay loam	OL, OH, MH, CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	30-60	Loam, clay loam	CL, ML	A-6, A-7	0	90-100	85-100	60-95	55-75	30-50	10-20
1833	0-10	Clay loam	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
Coland	10-60	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
1834	0-10	Clay loam	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
Coland	10-36	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	36-60	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
1907	0-18	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	70-95	30-45	10-20
Lakefield	18-60	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
1931	0-8	Sandy loam	SM, SM-SC	A-4	0	100	95-100	60-90	35-50	<25	NP-7
Essexville	8-22	Loamy fine sand, fine sand, sand.	SM, SM-SC, SP-SM	A-1-b, A-2-4, A-3, A-4	0	90-100	80-100	40-85	5-45	<25	NP-7
	22-60	Loam, clay loam, silty clay loam.	CL	A-4, A-6	0	95-100	90-100	80-95	55-90	20-38	8-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO	> 3 inches	4	10	40	200		
	In				Pct					Pct	
1981*:											
Hanlon----------	0-15	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	15-40	Fine sandy loam, sandy loam.	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	40-60	Loam, sandy loam, loamy sand.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2	0	100	100	80-90	20-60	15-35	5-15
Kalmarville-----	0-12	Fine sandy loam	SM	A-4	0	95-100	90-100	60-85	35-50	<25	NP-4
	12-55	Fine sandy loam, sandy loam, silt loam.	ML, SM, SM-SC, CL-ML	A-4, A-2	0	95-100	90-100	60-85	30-60	15-25	NP-5
	55-60	Coarse sand, sand, loamy fine sand.	SP, SM, SW, SP-SM	A-3, A-2, A-1	0-2	90-100	85-100	40-80	2-30	<25	NP

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
8B	0-38	3-10	1.20-1.40	2.0-6.0	0.09-0.12	5.1-7.3	Low	0.17	5	2	1-2
Sparta	38-60	0-5	1.50-1.70	6.0-20	0.04-0.07	5.1-7.3	Low	0.15			
27A, 27B	0-14	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low	0.20	4	3	1-2
Dickinson	14-40	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.20			
	40-60	4-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low	0.20			
31F	0-10	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
Storden	10-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
35	0-10	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	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	Low	0.28			
41B	0-13	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	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	Low	0.20			
	18-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	Low	0.10			
69B	0-12	2-10	1.40-1.55	6.0-20	0.10-0.13	5.6-6.5	Low	0.17	5	2	1-3
Fedji	12-35	2-10	1.45-1.65	6.0-20	0.09-0.11	6.1-7.3	Low	0.17			
	35-42	18-30	1.50-1.70	0.6-2.0	0.17-0.19	6.1-7.3	Low	0.32			
	42-60	16-30	1.55-1.75	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.32			
84	0-22	35-40	1.20-1.30	0.06-0.2	0.18-0.22	7.4-8.4	High	0.28	5	4	4-8
Brownton	22-38	35-60	1.20-1.30	0.06-0.2	0.13-0.16	7.4-8.4	High	0.28			
	38-60	25-35	1.45-1.70	0.2-2.0	0.14-0.16	7.4-8.4	Moderate	0.28			
86	0-22	27-35	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L	4-8
Canisteo	22-36	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	36-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	0.32			
101B	0-14	18-27	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	Low	0.32	5	6	4-8
Truman	14-34	18-32	1.30-1.45	0.6-2.0	0.18-0.21	5.6-7.8	Low	0.43			
	34-60	18-32	1.35-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Low	0.43			
102B	0-16	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	3-5
Clarion	16-32	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	32-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
112	0-18	27-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate	0.24	5	4L	4-5
Harps	18-36	18-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate	0.32			
	36-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
113	0-23	27-35	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate	0.24	5	6	6-7
Webster	23-33	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate	0.32			
	33-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
114	0-28	27-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	Moderate	0.28	5	6	5-10
Glencoe	28-46	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	Moderate	0.28			
	46-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low	0.28			
118	0-17	22-27	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	Low	0.28	5	4L	5-6
Crippin	17-33	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.28			
	33-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Low	0.37			
128A, 128B	0-15	8-18	1.25-1.40	2.0-6.0	0.22-0.24	5.6-7.3	Low	0.32	5	5	2-4
Grogan	15-36	8-18	1.40-1.50	2.0-6.0	0.17-0.19	6.1-7.8	Low	0.43			
	36-60	5-15	1.50-1.60	2.0-6.0	0.17-0.19	7.4-8.4	Low	0.43			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
130--Nicollet	0-19	24-27	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate	0.24	5	6	4-8
	19-34	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate	0.32			
	34-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low	0.32			
134--Okoboji	0-9	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High	0.37	5	4	7-10
	9-34	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High	0.37			
	34-48	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High	0.37			
	48-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28			
136--Madelia	0-18	27-35	1.20-1.30	0.6-2.0	0.18-0.24	6.1-7.3	Moderate	0.28	5	7	4-8
	18-25	18-35	1.25-1.35	0.6-2.0	0.16-0.22	6.6-7.8	Moderate	0.28			
	25-60	18-35	1.30-1.40	0.6-2.0	0.16-0.22	7.4-8.4	Low	0.37			
140--Spicer	0-18	29-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate	0.28	5	4L	4-8
	18-30	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate	0.37			
	30-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low	0.37			
160--Fieldon	0-16	15-22	1.25-1.40	0.6-2.0	0.18-0.20	7.4-8.4	Low	0.28	4	4L	5-8
	16-32	10-18	1.35-1.55	0.6-2.0	0.15-0.17	7.4-8.4	Low	0.20			
	32-60	5-15	1.40-1.60	6.0-20	0.05-0.07	7.4-8.4	Low	0.20			
178--Granby	0-26	2-14	1.20-1.60	6.0-20	0.10-0.12	5.6-7.3	Low	0.17	5	2	4-10
	26-32	0-14	1.45-1.60	6.0-20	0.05-0.12	5.6-7.8	Low	0.17			
	32-60	0-10	1.45-1.60	6.0-20	0.05-0.09	6.6-8.4	Low	0.17			
181--Litchfield	0-21	5-10	1.30-1.50	2.0-6.0	0.10-0.12	6.1-7.3	Low	0.17	5	2	2-4
	21-40	5-10	1.40-1.65	2.0-6.0	0.07-0.16	5.1-6.5	Low	0.17			
	40-60	1-8	1.45-1.65	2.0-6.0	0.08-0.10	6.1-7.8	Low	0.17			
183--Dassel	0-27	6-18	1.30-1.45	2.0-6.0	0.16-0.20	5.6-7.3	Low	0.20	4	3	3-15
	27-37	2-6	1.40-1.60	2.0-6.0	0.12-0.17	5.6-7.3	Low	0.20			
	37-60	2-8	1.45-1.65	6.0-20	0.08-0.10	6.1-7.8	Low	0.20			
197--Kingston	0-16	27-32	1.20-1.30	0.6-2.0	0.18-0.24	5.6-7.3	Low	0.28	5	7	4-8
	16-22	18-32	1.25-1.35	0.6-2.0	0.16-0.20	5.6-7.8	Low	0.37			
	22-60	18-32	1.25-1.35	0.6-2.0	0.16-0.20	7.4-8.4	Low	0.37			
222B--Lasa	0-18	2-10	1.45-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low	0.17	5	2	2-4
	18-60	2-10	1.55-1.70	2.0-6.0	0.07-0.09	6.1-7.3	Low	0.17			
227--Lemond	0-18	6-18	1.30-1.40	2.0-6.0	0.20-0.22	7.4-8.4	Low	0.24	4	4L	4-8
	18-28	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-8.4	Low	0.28			
	28-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	Low	0.15			
229--Waldorf	0-23	35-40	1.20-1.30	0.6-2.0	0.18-0.25	6.1-7.3	Moderate	0.28	5	4	6-8
	23-38	40-55	1.25-1.35	0.2-0.6	0.13-0.16	6.6-7.8	Moderate	0.28			
	38-60	24-45	1.25-1.35	0.2-2.0	0.20-0.22	7.4-8.4	Moderate	0.28			
247--Linder	0-18	14-18	1.40-1.45	0.6-2.0	0.15-0.20	5.6-7.8	Low	0.24	4	3	3-4
	18-33	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	Low	0.24			
	33-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	Low	0.10			
255--Mayer	0-19	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	4	4L	4-8
	19-38	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	Low	0.28			
	38-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low	0.15			
269--Millington	0-16	27-35	1.40-1.60	0.6-2.0	0.17-0.23	7.4-8.4	Moderate	0.28	5	4L	4-6
	16-38	18-35	1.40-1.60	0.6-2.0	0.17-0.20	7.4-8.4	Moderate	0.28			
	38-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	Moderate	0.28			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
281	0-23	13-20	1.25-1.40	0.6-2.0	0.16-0.18	6.1-7.3	Low	0.20	5	3	4-7
Darfur	23-36	13-18	1.35-1.50	2.0-6.0	0.15-0.17	6.6-7.8	Low	0.20			
	36-60	5-15	1.45-1.60	2.0-6.0	0.08-0.10	6.6-8.4	Low	0.20			
282	0-18	6-18	1.30-1.40	2.0-6.0	0.20-0.22	6.1-7.8	Low	0.28	4	5	4-8
Hanska	18-30	6-18	1.35-1.50	2.0-6.0	0.10-0.13	6.1-7.3	Low	0.28			
	30-60	1-10	1.50-1.60	6.0-20	0.03-0.05	6.6-7.8	Low	0.17			
327A, 327B	0-15	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low	0.20	3	3	2-4
Dickman	15-20	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low	0.20			
	20-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low	0.15			
336	0-30	24-27	1.40-1.55	0.6-2.0	0.18-0.20	5.6-7.8	Moderate	0.24	5	6	4-8
Delft	30-43	18-32	1.30-1.40	0.2-0.6	0.19-0.22	6.6-7.8	Low	0.32			
	43-60	15-32	1.40-1.55	0.2-2.0	0.15-0.19	7.4-8.4	Low	0.32			
362	0-36	27-35	1.40-1.60	0.6-2.0	0.17-0.23	7.4-8.4	Moderate	0.28	5	4L	4-6
Millington	36-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	Moderate	0.28			
392	0-22	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate	0.28	4	6	4-8
Biscay	22-32	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate	0.28			
	32-36	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-7.8	Low	0.28			
	36-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low	0.10			
421B	0-14	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
Ves	14-25	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	25-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
423	0-12	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Moderate	0.28	5	4L	3-6
Seaforth	12-24	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.28			
	24-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.28			
446	0-16	22-27	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate	0.24	5	6	4-8
Normania	16-32	22-32	1.30-1.40	0.6-2.0	0.17-0.19	6.6-7.8	Moderate	0.24			
	32-60	22-32	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.32			
487	0-18	8-18	1.35-1.70	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.20	4	3	2-3
Hoopeston	18-32	12-18	1.45-1.70	2.0-6.0	0.12-0.17	5.1-7.8	Low	0.28			
	32-60	2-10	1.50-1.70	6.0-20	0.05-0.10	4.5-8.4	Low	0.17			
517	0-22	27-32	1.35-1.40	0.6-2.0	0.20-0.23	6.1-7.8	Moderate	0.24	5	6	7-9
Shandep	22-40	26-32	1.40-1.60	0.6-2.0	0.17-0.20	6.1-7.8	Moderate	0.24			
	40-60	2-8	1.60-1.70	6.0-20	0.02-0.04	6.1-8.4	Low	0.15			
539	0-10	---	0.30-0.55	0.2-6.0	0.35-0.45	5.1-7.8	---	----	5	2	>75
Palms	10-31	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8	---	----			
	31-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low	0.37			
562	0-10	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High	0.37	5	4L	7-10
Knoke	10-50	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	High	0.37			
	50-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	High	0.37			
575	0-10	36-40	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	High	0.37	5	4	4-6
Nishna	10-60	38-46	1.35-1.40	0.06-0.2	0.11-0.13	7.4-8.4	High	0.28			
639B	0-16	10-18	1.50-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low	0.24	4	3	1-2
Ridgeport	16-33	10-18	1.55-1.60	2.0-6.0	0.07-0.09	5.6-7.3	Low	0.24			
	33-60	2-8	1.60-1.75	>20	0.01-0.03	7.4-8.4	Low	0.10			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
654	0-22	27-35	1.10-1.40	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L	4-8
Revere	22-36	22-35	1.35-1.55	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	36-60	18-32	1.35-1.65	0.6-2.0	0.14-0.16	7.4-8.4	Moderate	0.32			
668	0-17	18-24	1.35-1.40	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	6	5-6
Corwith	17-27	12-20	1.40-1.55	0.6-2.0	0.20-0.22	7.9-8.4	Low	0.28			
	27-60	5-15	1.40-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Low	0.43			
789B2*:											
Grogan	0-10	8-18	1.25-1.40	2.0-6.0	0.22-0.24	5.6-7.3	Low	0.32	5	5	1-2
	10-36	8-18	1.40-1.50	2.0-6.0	0.17-0.19	6.1-7.8	Low	0.43			
	36-60	5-15	1.50-1.60	2.0-6.0	0.17-0.19	7.4-8.4	Low	0.43			
Lasa Variant	0-10	2-10	1.45-1.55	2.0-6.0	0.10-0.12	7.4-8.4	Low	0.17	5	2	1-2
	10-60	2-10	1.55-1.75	2.0-6.0	0.07-0.09	7.4-8.4	Low	0.17			
789C2*:											
Lasa Variant	0-10	2-10	1.45-1.55	2.0-6.0	0.10-0.12	7.4-8.4	Low	0.17	5	2	1-2
	10-34	2-10	1.55-1.75	2.0-6.0	0.07-0.09	7.4-8.4	Low	0.17			
	34-60	2-10	1.55-1.75	6.0-20	0.06-0.08	7.4-8.4	Low	0.17			
Grogan	0-10	8-18	1.25-1.40	2.0-6.0	0.22-0.24	5.6-7.3	Low	0.32	5	5	1-2
	10-32	8-18	1.40-1.50	2.0-6.0	0.17-0.19	6.1-7.8	Low	0.43			
	32-60	5-15	1.50-1.60	2.0-6.0	0.17-0.19	7.4-8.4	Low	0.43			
790B*:											
Grogan	0-18	8-18	1.25-1.40	2.0-6.0	0.22-0.24	5.6-7.3	Low	0.32	5	5	2-4
	18-35	8-18	1.40-1.50	2.0-6.0	0.17-0.19	6.1-7.8	Low	0.43			
	35-60	5-15	1.50-1.60	2.0-6.0	0.17-0.19	7.4-8.4	Low	0.43			
Dickinson	0-14	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low	0.20	4	3	1-2
	14-36	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.20			
	36-60	4-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low	0.20			
887B*:											
Clarion	0-15	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	3-5
	15-30	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	30-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Swanlake	0-9	18-27	1.35-1.45	0.6-2.0	0.18-0.22	7.4-7.8	Low	0.28	5	4L	2-4
	9-60	18-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
909C2*:											
Bold	0-6	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	Low	0.43	5-4	4L	.5-1
	6-60	12-18	1.10-1.30	0.6-2.0	0.20-0.24	7.4-8.4	Low	0.43			
Truman	0-9	18-27	1.25-1.35	0.6-2.0	0.20-0.23	5.6-7.3	Low	0.32	5	6	2-4
	9-20	18-32	1.30-1.45	0.6-2.0	0.18-0.21	5.6-7.8	Low	0.43			
	20-60	18-32	1.35-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Low	0.43			
920B2*:											
Clarion	0-9	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	2-4
	9-28	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	28-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Estherville	0-9	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low	0.20	3	3	1-2
	9-20	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20			
	20-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	Low	0.10			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
920C2*:											
Clarion	0-8	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	2-4
	8-26	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	26-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Estherville	0-8	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low	0.20	3	3	1-2
	8-21	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20			
	21-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	Low	0.10			
921B2*:											
Clarion	0-10	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	2-4
	10-21	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	21-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Storden	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	.5-1
	8-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
921C2*:											
Clarion	0-7	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	2-4
	7-23	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	23-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Storden	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	.5-1
	8-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
929*:											
Fieldon	0-12	15-22	1.25-1.40	0.6-2.0	0.18-0.20	7.4-8.4	Low	0.28	4	4L	5-8
	12-38	10-18	1.35-1.55	0.6-2.0	0.15-0.17	7.4-8.4	Low	0.20			
	38-60	5-15	1.40-1.60	6.0-20	0.05-0.07	7.4-8.4	Low	0.20			
Canisteo	0-10	27-35	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L	4-8
	10-20	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	20-32	10-35	1.30-1.50	0.6-2.0	0.12-0.18	7.4-8.4	Low	0.32			
	32-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	0.32			
954B2*:											
Ves	0-9	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-4
	9-32	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	32-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Storden	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	.5-1
	7-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
954C2*:											
Storden	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	.5-1
	7-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Ves	0-8	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-4
	8-30	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	30-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
956*:											
Canisteo	0-22	27-35	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L	4-8
	22-28	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	28-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	0.32			
Glencoe	0-26	27-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	Moderate	0.28	5	6	5-10
	26-38	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	Moderate	0.28			
	38-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low	0.28			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
960D2*:											
Storden	0-9	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	.5-1
	9-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Clarion	0-8	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	2-4
	8-25	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	25-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
999B2*:											
Ves	0-9	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-4
	9-32	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	32-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Estherville	0-9	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low	0.20	3	3	1-2
	9-20	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20			
	20-60	0-8	1.50-1.65	>6.0	0.02-0.04	6.6-8.4	Low	0.10			
1016. Udorthents											
1030*: Udorthents.											
Pits.											
1055*:											
Palms	0-30	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-7.8			5	8	>75
	30-60	7-35	1.45-1.75	0.2-2.0	0.14-0.22	6.1-8.4	Low				
Glencoe	0-30	27-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	Moderate	0.28	5	8	5-10
	30-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low	0.28			
1833 Coland	0-10	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28	5	6	5-7
	10-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28			
1834 Coland	0-10	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28	5	6	5-7
	10-36	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.28			
	36-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low	0.28			
1907 Lakefield	0-18	27-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Low	0.32	5	7	4-8
	18-60	18-35	1.25-1.35	0.6-2.0	0.16-0.20	7.4-8.4	Low	0.32			
1931 Essexville	0-8	12-18	1.30-1.50	2.0-6.0	0.13-0.18	7.4-8.4	Low	0.20	5	3	4-8
	8-22	2-12	1.40-1.55	6.0-20	0.04-0.12	7.4-8.4	Low	0.17			
	22-60	10-35	1.45-1.70	0.2-0.6	0.12-0.20	7.4-8.4	Moderate	0.32			
1981*:											
Hanlon	0-15	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low	0.20	5	3	2-3
	15-40	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low	0.20			
	40-60	2-18	1.55-1.70	2.0-6.0	0.12-0.19	5.6-7.8	Low	0.20			
Kalmarville	0-12	8-15	1.35-1.50	2.0-6.0	0.13-0.18	6.6-7.8	Low	0.20	5	3	2-4
	12-55	8-18	1.40-1.50	2.0-6.0	0.13-0.18	6.6-7.8	Low	0.20			
	55-60	2-5	1.55-1.65	6.0-20	0.06-0.09	6.6-7.8	Low	0.10			

* 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 "frequent," "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 or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
8B Sparta	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
27A, 27B Dickinson	B	None	---	---	>6.0	---	---	Moderate	Low	Moderate.
31F Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
35 Blue Earth	B/D	None	---	---	+2-1.0	Apparent	Jan-Dec	High	High	Low.
41B Estherville	B	None	---	---	>6.0	---	---	Low	Low	Low.
69B Fedji	A	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.
101B Truman	B	None	---	---	>6.0	---	---	High	Low	Low.
102B Clarion	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
112 Harps	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
113 Webster	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jul	High	High	Low.
114 Glencoe	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
118 Crippin	B	None	---	---	2.0-4.0	Apparent	Nov-Jun	High	High	Low.
128A Grogan	B	None	---	---	3.0-6.0	Apparent	Apr-Jun	High	Low	Low.
128B Grogan	B	None	---	---	>6.0	---	---	High	Low	Low.
130 Nicollet	B	None	---	---	2.5-5.0	Apparent	Mar-Jun	High	High	Low.
134 Okoboji	B/D	None	---	---	+1-1.0	Apparent	Jan-Dec	High	High	Low.
136 Madelia	B/D	None	---	---	1.0-2.5	Apparent	Nov-Jul	High	High	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
140---------- Spicer	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
160---------- Fieldon	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
178---------- Granby	A/D	None--------	---	---	+1-1.0	Apparent	Nov-Jun	Moderate	High-----	Low.
181---------- Litchfield	A	None--------	---	---	2.5-5.0	Apparent	Apr-May	Moderate	Low------	Low.
183---------- Dassel	B/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	High-----	High-----	Low.
197---------- Kingston	B	None--------	---	---	2.5-5.0	Apparent	Apr-May	High-----	High-----	Low.
222B---------- Lasa	A	None--------	---	---	>6.0	---	---	Low------	Low------	Moderate.
227---------- Lemond	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
229---------- Waldorf	C/D	None--------	---	---	0-3.0	Apparent	Nov-Jul	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-Jul	High-----	High-----	Low.
269---------- Millington	B/D	Occasional	Brief-----	Mar-Nov	1.0-3.0	Apparent	Mar-Jul	High-----	High-----	Low.
281---------- Darfur	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
282---------- Hanska	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
327A, 327B-------- Dickman	A	None--------	---	---	>6.0	---	---	Low------	Low------	Moderate.
336---------- Delft	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	High-----	High-----	Low.
362---------- Millington	B/D	Frequent----	Brief-----	Mar-Nov	1.0-3.0	Apparent	Mar-Jul	High-----	High-----	Low.
392---------- Biscay	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jul	High-----	Moderate	Low.
421B---------- Ves	B	None--------	---	---	>6.0	---	---	Moderate	Moderate	Low.
423---------- Seaforth	B	None--------	---	---	3.0-6.0	Apparent	Mar-Jun	High-----	High-----	Low.
446---------- Normania	B	None--------	---	---	2.5-6.0	Apparent	Mar-Jun	High-----	High-----	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
487---------- Hoopeston	B	None--------	---	---	1.0-3.0	Apparent	Mar-Jun	High-----	Low------	Moderate.
517---------- Shandep	B/D	None--------	---	---	+1-1.0	Apparent	Jan-Dec	High-----	High-----	Moderate.
539---------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-May	High-----	High-----	Moderate.
562---------- Knoke	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Low.
575---------- Nishna	C/D	Occasional	Brief-----	Mar-Nov	1.0-3.0	Apparent	Nov-Jul	Moderate	High-----	Low.
639B---------- Ridgeport	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
654---------- Revere	B/D	None--------	---	---	1.0-3.0	Apparent	Mar-Jul	High-----	High-----	Moderate.
668---------- Corwith	B	None--------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Low.
789B2*:										
Grogan----------	B	None--------	---	---	>6.0	---	---	High-----	Low------	Low.
Lasa Variant-----	A	None--------	---	---	>6.0	---	---	Low------	High-----	Low.
789C2*:										
Lasa Variant-----	A	None--------	---	---	>6.0	---	---	Low------	High-----	Low.
Grogan----------	B	None--------	---	---	>6.0	---	---	High-----	Low------	Low.
790B*:										
Grogan----------	B	None--------	---	---	>6.0	---	---	High-----	Low------	Low.
Dickinson--------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
887B*:										
Clarion----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Swanlake---------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
909C2*:										
Bold----------	B	None--------	---	---	>6.0	---	---	High-----	Low------	Low.
Truman----------	B	None--------	---	---	>6.0	---	---	High-----	Low------	Low.
920B2*, 920C2*:										
Clarion----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Estherville------	B	None--------	---	---	>6.0	---	---	Low------	Low------	Low.
921B2*, 921C2*:										
Clarion----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
Storden----------	B	None--------	---	---	>6.0	---	---	Moderate	Low------	Low.
929*:										
Fieldon----------	B/D	None--------	---	---	1.0-3.0	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			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
929*:										
Canisteo	B/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	High	High	Low.
954B2*:										
Ves	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
954C2*:										
Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
956*:										
Canisteo	B/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	High	High	Low.
Glencoe	B/D	None	---	---	+1-1.0	Apparent	Oct-Jul	High	High	Low.
960D2*:										
Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Clarion	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
999B2*:										
Ves	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
Estherville	B	None	---	---	>6.0	---	---	Low	Low	Low.
1016.										
Udorthents										
1030*:										
Udorthents.										
Pits.										
1055*:										
Palms	D	None	---	---	+3-1.0	Apparent	Jan-Dec	High	High	Moderate.
Glencoe	D	None	---	---	+3-1.0	Apparent	Jan-Dec	High	High	Low.
1833	B/D	Occasional	Brief	Mar-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
Coland										
1834	B/D	Frequent	Brief	Mar-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
Coland										
1907	B	None	---	---	2.5-5.0	Apparent	Apr-May	High	High	Low.
Lakefield										
1931	A/D	None	---	---	0-1.0	Apparent	Nov-Jul	High	High	Low.
Essexville										
1981*:										
Hanlon	B	Frequent	Very brief	Mar-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	Moderate	Low.
Kalmarville	B/D	Frequent	Brief	Mar-Nov	0-1.0	Apparent	Nov-Jul	High	Moderate	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
Corwith	Coarse-silty, mixed, mesic Aquic Hapludolls
Crippin	Fine-loamy, mixed, mesic Aquic Hapludolls
Darfur	Coarse-loamy, mixed, mesic Typic Haplaquolls
*Dassel	Coarse-loamy, mixed, mesic Typic Haplaquolls
Delft	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Essexville	Sandy over loamy, mixed (calcareous), mesic Typic Haplaquolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Fedji	Sandy over loamy, mixed, mesic Typic Hapludolls
Fieldon	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Granby	Sandy, mixed, mesic Typic Haplaquolls
Grogan	Coarse-silty, mixed, mesic Typic Hapludolls
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Hanska	Coarse-loamy, mixed, mesic Typic Haplaquolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Hoopeston	Coarse-loamy, mixed, mesic Aquic Hapludolls
Kalmarville	Coarse-loamy, mixed, nonacid, mesic Mollic Fluvaquents
Kingston	Fine-silty, mixed, mesic Aquic Hapludolls
Knoke	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Lakefield	Fine-silty, mixed, mesic Aquic Hapludolls
Lasa	Sandy, mixed, mesic Entic Hapludolls
Lasa Variant	Sandy, mixed, mesic Entic Hapludolls
Lemond	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
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
Nishna	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Revere	Fine-loamy, mesic Typic Calciaquolls
Ridgeport	Coarse-loamy, mixed, mesic Typic Hapludolls
Seaforth	Fine-loamy, mixed, mesic Aquic Calciustolls
Shandep	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Sparta	Sandy, mixed, mesic Entic Hapludolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Swanlake	Fine-loamy, mixed, mesic Entic Hapludolls
Truman	Fine-silty, mixed, mesic Typic Hapludolls
Udorthents	Mixed, mesic Udorthents
*Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Waldorf	Fine, montmorillonitic, mesic Typic Haplaquolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls

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