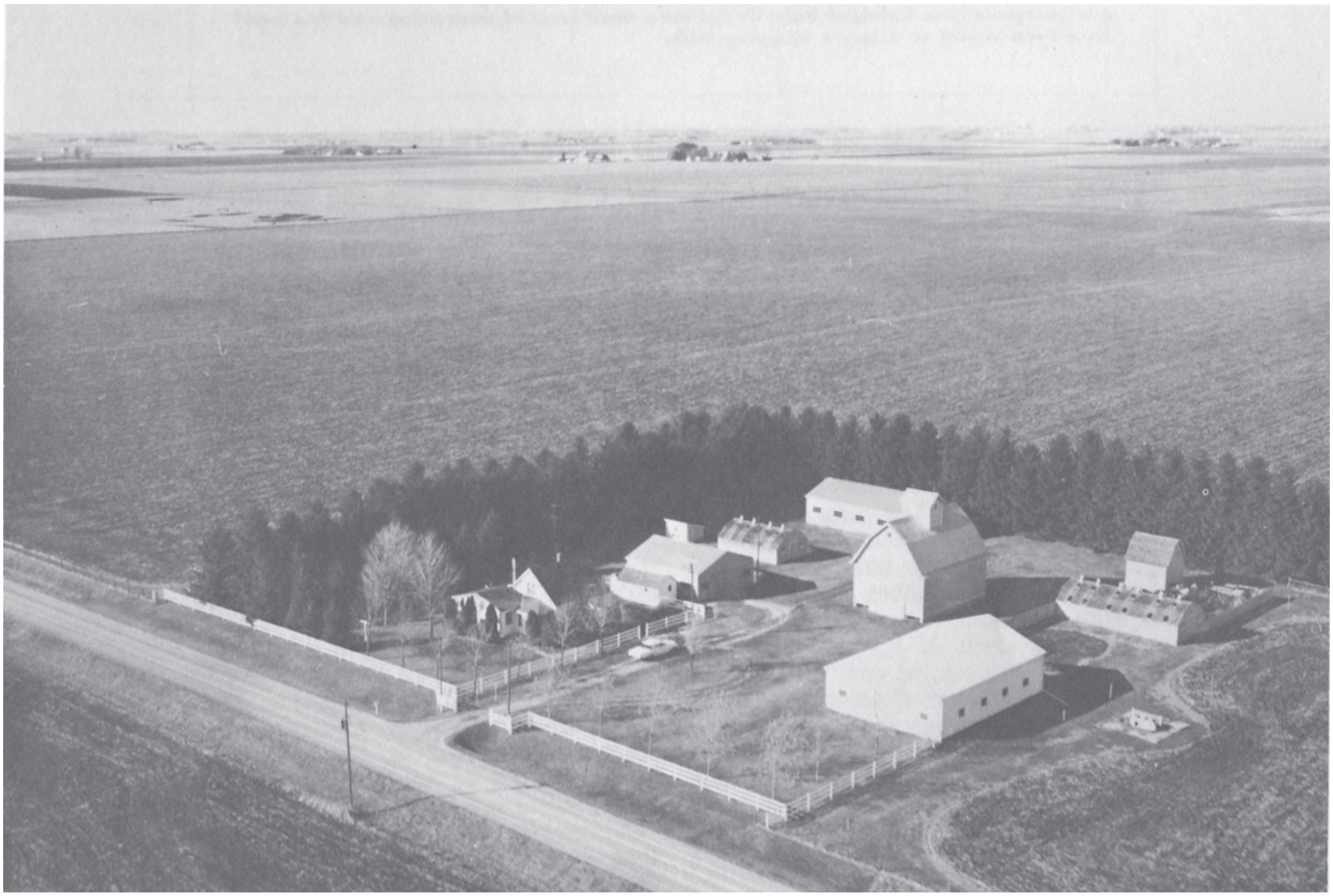
SOIL SURVEY OF

# Grundy County, Iowa



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station and the Cooperative Extension Service, Iowa State University
and the
Department of Soil Conservation, State of Iowa

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. 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 the period 1968–71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1970. This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station and the Cooperative Extension Service, Iowa State University; and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Grundy County Soil Conservation District. Funds appropriated by Grundy County were used to defray part of the cost of this survey.



# HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms; in selecting sites for roads, ponds, buildings, or other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

## Locating Soils

All the soils of Grundy County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

## Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all of the soils of the county in numerical order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability unit in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

*Farmers and those who work with farmers* can learn about use and management of the soils from the soil descriptions and from the discussions of interpretive groupings.

*Game managers, sportsmen, and others concerned with wildlife* can find information about soils and wildlife in the section "Wildlife."

*Community planners and others concerned with suburban development* can read about the soil properties that affect the choice of homesites, industrial sites, schools, and parks in the subsection "Nonfarm Use of the Soils."

*Engineers and builders* can find, under "Engineering Uses of the Soils," tables that give engineering descriptions of the soils in the county and information about soil features that affect engineering practices and structures.

*Scientists and others* can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

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

*Newcomers* in Grundy County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Information About the County."

**Cover: A farm in Muscatine-Tama-Garwin association.**

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Issued March 1977

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# SOIL SURVEY OF GRUNDY COUNTY, IOWA

BY WELLS F. ANDREWS, SOIL CONSERVATION SERVICE [1]

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION AND THE COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY; AND THE DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

GRUNDY COUNTY is near the central part of Iowa (fig. 1). It has a total area of 320,640 acres. Grundy Center, the county seat, is in the center of the county.

Farming is the main enterprise in Grundy County. The principal crops are corn, soybeans, oats, hay, and pasture. Except for seed corn and soybeans, most of the crops are fed to livestock. Corn, soybeans, seed corn, beef cattle, hogs, and dairy products are the principal sources of income.

## *How This Survey Was Made*

Soil scientists made this survey to learn what kinds of soil are in Grundy County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

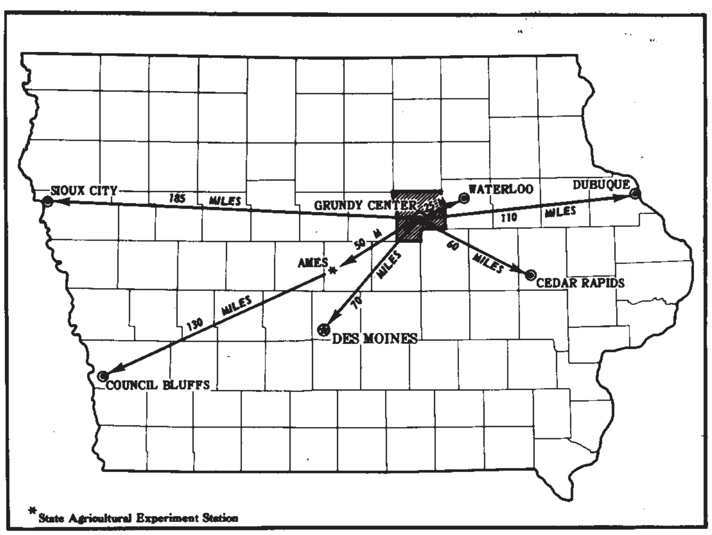


*Figure 1.*—Location of Grundy County in Iowa.

[1] Others who participated in the fieldwork for the soil survey were CHARLES E. BRANHAM and DARRYL L. TRICKLER, Soil Conservation Service.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Garwin and Tama, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior on the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Tama silty clay loam, 2 to 5 percent slopes, is one of several phases in the Tama series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit is shown on the soil map of Grundy County: the soil complex.

A soil complex consists of areas of two or more soils that are so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Clyde-Floyd complex, 1 to 4 percent slopes, is an example.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, such as farmers, homeowners, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, and then they adjust the groups according to the results of their studies and consultation. Thus, the groups that finally evolve reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

## General Soil Map

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

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

The seven soil associations in Grundy County are described in the following pages.

### 1. *Muscatine-Tama-Garwin association*

*Nearly level to gently sloping, well drained, somewhat poorly drained, and poorly drained silty soils; on uplands*

This association consists of broad uplands where differences in elevation are 3 to 15 feet (fig. 2). Potholes and wide, undefined drainageways are common.

This association makes up about 8 percent of the county. It is about 35 percent Muscatine soils, 25 percent Tama soils, 25 percent Garwin soils, and 15 percent less extensive soils.

Muscatine soils are nearly level on upland divides and gently sloping on foot slopes adjoining drainageways. These soils are somewhat poorly drained. The surface layer is black light silty clay loam and very dark brown medium silty clay loam about 16 inches thick. The subsoil extends to a depth of 48 inches. The upper part is very dark grayish-brown, friable medium silty clay loam, and the lower part is dark grayish-brown, friable medium silty clay loam. The substratum is calcareous, olive-gray, friable silt loam mottled with strong brown.

Tama soils are nearly level to gently sloping and are in convex areas on uplands. These soils are well drained. The surface layer is very dark brown and very dark grayish-brown silty clay loam about 16 inches thick. The subsoil extends to a depth of 46 inches. The upper part is brown to dark-brown, friable medium silty clay loam, and the lower part is dark yellowish-brown, friable medium and light silty clay loam. The substratum is yellowish-brown, friable heavy silt loam.

Garwin soils are nearly level and are in concave areas on uplands and at the heads of drainageways. These soils are poorly drained. The surface layer is black and very dark gray silty clay loam about 18 inches thick. The subsoil extends to a depth of 48 inches. The upper part is dark-gray, friable silty clay loam that has few distinct and prominent mottles; the middle part is gray, friable light silty clay loam that has many prominent mottles; and the lower part is olive-gray, friable silt loam that has prominent mottles. The substratum is olive-gray and light olive-gray, friable silt loam that has prominent mottles.

Less extensive in this association are Harpster, Sawmill, Sperry, and Garwin soils. The poorly drained Sawmill and Garwin soils are in drainageways. The poorly drained, calcareous Harpster soils are in concave depressions on broad upland divides. The very poorly drained, slowly permeable Sperry soils are in small, concave potholes.

The soils in this association are well suited to corn, soybeans, small grain, hay, and other cultivated crops commonly grown in the county. The organic-matter content is high, and the available water capacity is high. The main concerns of management are improving drainage, maintaining tilth and fertility, and controlling soil blowing.

Nearly all of the acreage is used for cultivated crops, but a few undrained wet areas are used for permanent pasture. The main enterprises are growing cash crops and feeding beef cattle and swine.

### 2. *Tama-Muscatine association*

*Nearly level to strongly sloping, well drained and somewhat poorly drained silty soils; on uplands*

This association consists of upland divides, ridges, and side slopes where differences in elevation are about 10 to 40 feet. Drainageways are well defined.

The association makes up about 37 percent of the

*Figure 2.*—Typical landscape in Muscatine-Tama-Garwin association.

county. It is about 60 percent Tama soils, 14 percent Muscatine soils, and 26 percent less extensive soils.

Tama soils are nearly level to strongly sloping and are on uplands. These soils are well drained. The surface layer is very dark brown and very dark grayish-brown silty clay loam about 16 inches thick. The subsoil extends to a depth of 46 inches. The upper part is brown to dark-brown, friable medium silty clay loam, and the lower part is dark yellowish-brown, friable medium light silty clay loam. The substratum is yellowish-brown, friable heavy silt loam.

Muscatine soils are nearly level on upland divides and gently sloping on foot slopes adjoining drainageways. These soils are somewhat poorly drained. The surface layer is black light silty clay loam and very dark brown medium silty clay loam about 16 inches thick. The subsoil extends to a depth of 48 inches. The upper part is very dark grayish-brown, friable medium silty clay loam, and the lower part is dark grayish-brown, friable medium silty clay loam. The substratum is calcareous, olive-gray, friable silt loam mottled with strong brown.

Less extensive in this association are Bolan, Colo, Dinsdale, Ely, Garwin, Klinger, and Sawmill soils. The more permeable Bolan soils are at higher elevations. The poorly drained Colo and Sawmill soils and the somewhat poorly drained Ely soils are in drainageways. Garwin soils are in depressions at the heads of drainageways. Dinsdale and Klinger soils are on upland divides, ridges, and back slopes where glacial till is at a depth of 20 to 40 inches.

The soils in this association are well suited to corn, soybeans, small grain, hay, and other cultivated crops commonly grown in the county. The organic-matter content is moderate to high. The available water capacity is high in all soils except for Bolan soils that have a loamy sand substratum. The main concerns of management are controlling water erosion and soil blowing, improving drainage, and maintaining tilth and fertility.

Nearly all of the acreage is used for cultivated crops, but a few undrained wet areas are used for permanent pasture. The main enterprises are growing cash crops, dairying, and feeding beef cattle and swine.

### 3. *Dinsdale-Tama-Klinger association*

*Nearly level to strongly sloping, well drained and somewhat poorly drained silty soils that are underlain by silty and loamy material; on uplands*

This association consists of upland divides, ridges, and back slopes where differences in elevation are 5 to 40 feet. Drainageways are well defined (fig. 3).

The association makes up 27 percent of the county. It is about 32 percent Dinsdale soils, 18 percent Tama

***Figure 3.*—Typical landscape of Dinsdale and Tama soils. The soils are protected by mulch.**

soils, 10 percent Klinger soils, and 40 percent less extensive soils.

Dinsdale soils are gently sloping to strongly sloping and are on uplands. These soils are well drained. The surface layer is black and very dark brown light silty clay loam about 12 inches thick. The subsoil extends to a depth of 48 inches. The upper part is dark-brown, friable silty clay loam, and the lower part is yellowish-brown, firm heavy loam. The substratum is calcareous, yellowish-brown, firm loam glacial till.

Tama soils are nearly level to strongly sloping and are on uplands. These soils are well drained. The surface layer is very dark brown and very dark grayish-brown silty clay loam about 16 inches thick. The subsoil extends to a depth of 46 inches. The upper part is brown to dark-brown, friable medium silty clay loam, and the lower part is dark yellowish-brown, friable medium and light silty clay loam. The substratum is yellowish-brown, friable heavy silt loam.

Klinger soils are nearly level on upland divides and gently sloping on upland foot slopes. These soils are somewhat poorly drained. The surface layer is black silty clay loam about 12 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil extends to a depth of 47 inches. The upper part is dark grayish-brown, mottled, friable silty clay loam; the middle part is grayish-brown, friable silty clay loam; and the lower part is yellowish-brown, firm heavy loam. The substratum is calcareous, yellowish-brown, mottled, firm, loam glacial till.

Less extensive in this association are Colo, Garwin, Kenyon, Maxfield, Muscatine, and Sawmill soils. The poorly drained Colo, Garwin, Maxfield, and Sawmill soils are in waterways and at the heads of drainageways. The somewhat poorly drained Muscatine soils are nearly level on upland divides and gently sloping on foot slopes. They are more than 40 inches deep to loamy glacial till. The loamy Kenyon soils are on uplands where glacial till is at a depth of less than 20 inches.

The soils in this association are well suited to corn, soybeans, small grain, hay, and other cultivated crops commonly grown in the county. The organic-matter content is moderate to high, and the available water capacity is high. The main concerns of management are controlling water erosion and soil blowing, maintaining tilth and fertility, and improving drainage on some of the less extensive soils.

Nearly all of the acreage is used for cultivated crops, but a few undrained wet areas are used for permanent pasture. The main enterprises are growing cash crops, dairying, and feeding beef cattle and swine.

### 4. *Kenyon-Clyde-Floyd association*

*Nearly level to moderately sloping, moderately well drained to poorly drained loamy and silty soils that are* *underlain by loamy glacial till; on uplands and in upland drainageways*

This association consists of upland divides, back slopes, and upland drainageways. Many areas have large granite boulders. Differences in elevation are about 5 to 35 feet. The steeper slopes are along the few larger drainageways.

This association makes up about 14 percent of the county. It is about 40 percent Kenyon soils, 20 percent Clyde soils, 20 percent Floyd soils, and 20 percent less extensive soils.

Kenyon soils are gently sloping to strongly sloping and are on upland divides. These soils are moderately well drained. The surface layer is very dark brown, very dark grayish-brown, and dark-brown loam about 18 inches thick. The subsoil extends to a depth of 60 inches. The upper part is dark yellowish-brown, friable heavy loam; the middle part is dark yellowish-brown, firm heavy loam; and the lower part is yellowish-brown, firm heavy loam. The substratum is yellowish-brown, firm loam glacial till.

Clyde soils are nearly level and are in concave areas in upland drainageways that have occasional boulders. These soils are poorly drained. The surface layer is black silty clay loam and clay loam about 24 inches thick. The subsoil extends to a depth of 60 inches. The upper part is dark-gray, friable light clay loam; the middle part is gray, firm light clay loam; and the lower part is mottled, gray and strong-brown, firm loam. The substratum is calcareous, gray, friable, loam glacial till.

Floyd soils are gently sloping and are on foot slopes along upland drainageways. These soils are somewhat poorly drained. The surface layer is black heavy loam about 23 inches thick. The subsoil extends to a depth of 46 inches. The upper part is dark grayish-brown, friable light clay loam; the middle part is grayish-brown, very friable gravelly heavy sandy loam; and the lower part is mottled, strong-brown and grayish-brown, firm loam. The substratum is mottled, strong-brown and gray, firm, loam glacial till.

Less extensive in this association are Dinsdale, Donnan, Ostrander, and Readlyn soils. The well-drained Ostrander soils have a very friable subsoil underlain by glacial till. They are on nose slopes. The well-drained Dinsdale soils are on upland ridges and back slopes. These soils are silty clay loam that is 20 to 40 inches deep to glacial till. The moderately well drained to somewhat poorly drained Donnan soils are on upland ridges and shoulder slopes. They have a dense clay subsoil. The somewhat poorly drained Readlyn soils are nearly level and are on upland divides.

The soils in this association are well suited to corn, soybeans, small grain, hay, and other cultivated crops commonly grown in the county. The organic-matter content is high to very high in the major soils, and the available water capacity is high. The main concerns of management are controlling water erosion, improving drainage, and maintaining tilth and fertility.

About 65 percent of the acreage is used for cultivated crops. The rest, most of which is undrained wet areas, is used for permanent pasture. The main enterprises are growing cash crops, dairying, and feeding beef cattle and swine.

### *5. Saude-Lilah association*

*Gently undulating to rolling, well drained and excessively drained loamy and sandy soils that are underlain by sand and gravel; on uplands*

This association consists of distinct upland hills and high knolls where differences in elevation are 10 to 50 feet. The soils range from gently sloping to strongly sloping but generally are moderately sloping.

The association makes up less than 1 percent of the county. It is about 54 percent Saude soils, 28 percent Lilah soils, and 18 percent less extensive soils.

Saude soils are gently undulating to rolling. These soils are somewhat excessively drained. The surface layer is very dark grayish-brown silt loam that is high in sand. It is about 10 inches thick. The subsoil extends to a depth of 43 inches. The upper part is brown to dark-brown, friable silt loam that is high in sand; the middle part is yellowish-brown, friable silt loam that is high in sand; and the lower part is yellowish-red, very friable loamy sand. The substratum is stratified yellowish-red and yellowish-brown, loose sand.

Lilah soils are gently sloping to moderately sloping and are on shoulder and nose slopes of uplands. These soils are excessively drained. The surface layer is very dark grayish-brown and dark yellowish-brown gravelly sandy loam about 7 inches thick. The subsoil extends to a depth of 35 inches. The upper part is brown to dark-brown, very friable gravelly sandy loam and loose loamy sand, and the lower part is strong-brown, loose loamy sand. The substratum is stratified brown, yellowish-brown, strong-brown, and pale-brown, loose gravelly coarse loamy sand and fine to medium sand.

Less extensive in this association are Dinsdale, Donnan, Palms, and Ostrander soils. Dinsdale soils are in areas that have more than 20 inches of loess on the surface. Donnan soils are on lower nose slopes and have a subsoil of dense, very firm clay glacial till. Palms soils are in wet, seepy areas on foot slopes. Ostrander soils have a subsoil and substratum of friable glacial till.

The soils in this association are not well suited to corn, soybeans, small grain, hay, or other cultivated crops commonly grown in the county. The organic-matter content is moderate to very low, and the available water capacity is low to very low. The main concerns of management are controlling water erosion and soil blowing and conserving soil water.

Nearly all of the acreage is used for permanent pasture, but a few small, gently sloping areas are used for cultivated crops, as are adjoining, more productive soils. The main enterprises are dairying and raising and feeding beef cattle and swine.

### *6. Colo-Wiota-Nevin association*

*Nearly level to gently sloping, well drained to poorly drained silty soils; on stream bottoms, benches, and alluvial fans*

This association consists of first and second bottoms where differences in elevation are 2 to 8 feet. Meander belts of major streams, alluvial fans, escarpments, and depressions are common.

This association makes up about 8 percent of the county. It is about 67 percent Colo soils, 6 percent

Wiota soils, 6 percent Nevin soils, and 21 percent less extensive soils.

Colo soils are nearly level and are on stream bottoms. These soils are poorly drained. The surface layer is black silty clay loam about 47 inches thick. The substratum is black and greenish-gray, firm heavy silty clay loam.

Wiota soils are nearly level and are on stream benches and alluvial fans. These soils are well drained and moderately well drained. The surface layer is very dark brown, very dark grayish-brown, and dark-brown silt loam and silty clay loam about 18 inches thick. The subsoil extends to a depth of 69 inches. The upper part is brown to dark-brown, friable silty clay loam, and the lower part is brown to dark-brown, very friable sandy loam.

Nevin soils are nearly level and are on bottom lands along major streams. These soils are somewhat poorly drained. The surface layer is black and very dark grayish-brown light silty clay loam about 23 inches thick. The subsoil extends to a depth of about 47 inches. The upper part is dark grayish-brown, friable silty clay loam; the middle part is grayish-brown, friable silty clay loam; and the lower part is mottled, grayish-brown, friable silty clay loam. The substratum is mottled, light brownish-gray, friable clay loam and loam that has lenses of sand.

Less extensive in this association are Bremer, Calco, Lawson, Waukee, and Zook soils. The poorly drained Bremer soils and the deep, silty, somewhat poorly drained Lawson soils are on low stream benches or high second bottoms. Calco soils are on first and second bottoms and are calcareous. The well drained Waukee soils are on second bottoms and stream benches. They are less than 40 inches deep to sand. The poorly drained Zook soils are in low concave areas on flood plains adjacent to foot slopes and bench escarpments.

The soils in this association are well suited to corn, soybeans, small grain, hay, and other cultivated crops commonly grown in the county. The organic-matter content is moderate to high, and the available water capacity is high. The main concerns of management are flooding, improving drainage, and maintaining tilth and fertility.

About 60 percent of the acreage is used for cultivated crops. About 40 percent, most of which is undrained wet areas, is used for permanent pasture. The main enterprises are growing cash crops, dairying, and feeding beef cattle and swine.

### 7. *Lawler-Marshan-Waukee association*

*Nearly level to gently sloping, well drained, somewhat poorly drained, and poorly drained loamy soils that are underlain by sand and gravel; on stream benches*

This association consists of benches and stream bottoms along stream channels where differences in elevation are 2 to 8 feet. Meander belts of major streams, alluvial fans, escarpments, and depressions are common (fig. 4).

The association makes up 5 percent of the county. It is about 30 percent Lawler soils, 30 percent Marshan soils, 20 percent Waukee soils, and 20 percent less extensive soils.

Lawler soils are nearly level and are on stream benches. These soils are somewhat poorly drained. The surface layer is very dark brown silt loam that is high in sand. It is about 14 inches thick. The subsoil extends to a depth of 36 inches. The upper part is mottled, dark grayish-brown, friable heavy silt loam that is high in sand; the middle part is mottled, dark grayish-brown, friable light silty clay loam and clay loam; and the lower part is mottled, dark grayish-brown, very friable gravelly sandy loam. The substratum is mottled, brown to dark-brown, loose gravelly loamy sand.

Marshan soils are nearly level and are on stream benches. These soils are poorly drained. The surface layer is black and very dark gray, friable silty clay loam that is high in sand. It is about 16 inches thick. The subsoil extends to a depth of 38 inches. The upper part is very dark gray, friable silty clay loam that is high in sand; the middle part is prominently mottled, dark-gray, friable silty clay loam that is high in sand; and the lower part is gray, very friable loam. The substratum is brown to dark-brown, loose loamy sand to a depth of 48 inches and mottled, yellowish-brown and grayish-brown, loose loamy sand below.

Waukee soils are nearly level to gently sloping and are on stream benches. These soils are well drained. The surface layer is black and very dark brown loam about 17 inches thick. The subsoil extends to a depth of 37 inches. The upper part is brown, friable loam and light clay loam; the middle part is dark yellowish-brown, friable loam; and the lower part is dark yellowish-brown, very friable light sandy loam. The substratum is yellowish-brown, loose loamy sand that has some gravel.

Less extensive in this association are Clyde, Coland, Colo, and Saude soils. The poorly drained Clyde, Coland, and Colo soils are more than 40 inches deep to sand. The well-drained Saude soils have a substratum of sand and gravel.

The soils in this association are well suited to corn, soybeans, small grain, hay, and other cultivated crops commonly grown in the county. The organic-matter content is high, and the available water capacity is moderate to moderately high. The main concerns of management are improving drainage and maintaining tilth and fertility.

About 70 percent of the acreage is used for cultivated crops. About 30 percent, most of which is undrained wet areas, is used for permanent pasture. The main enterprises are growing cash crops, dairying, and feeding beef cattle and swine.

## *Descriptions of the Soils*

This section describes the soil series and mapping units in Grundy County. Each soil series is described in considerable detail, and each mapping unit in that series is then briefly described. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil

***Figure 4.*—Typical landscape in Lawler-Marshan-Waukee association.**

series is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is detailed and in technical terms; it is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the descriptions are those of a moist soil.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit in which the mapping unit has been placed. The page for the description of each capability unit can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*13*).[2]

## Bolan Series

The Bolan series consists of deep, gently sloping, well-drained soils on upland divides. These soils formed in loamy eolian material and the underlying sandy eolian material. The native vegetation was prairie grasses. Slopes are 2 to 5 percent.

In a representative profile the surface layer is very dark brown loam about 14 inches thick. The subsoil extends to a depth of 37 inches. The upper part is very dark grayish-brown, very friable silty clay loam that is high in sand; the middle part is dark-brown, very friable silty clay loam and loam; and the lower part is dark yellowish-brown, very friable sandy loam and loamy sand. The substratum is dark-brown, loose loamy sand to a depth of 50 inches and mottled brownish-yellow and strong-brown, loose loamy sand below.

Bolan soils have moderate permeability to a depth of about 27 inches and moderately rapid and rapid permeability below. Available water capacity is moderate. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Bolan soils are used mainly for cultivated crops and hay. The main hazard is erosion. These soils are droughty in places during years of low rainfall or when rainfall is not timely.

Representative profile of Bolan loam, 2 to 5 percent slopes, in a cornfield, 1,315 feet south and 200 feet west of the northeast corner of SE¼ sec. 32, T. 88 N., R. 18 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; moderate, medium, granular structure; friable; neutral; clear boundary.

[2] Italic numbers in parentheses refer to Literature Cited, p. 82.

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

| Soil | Area | Extent |
|---|---|---|
| | *Acres* | *Percent* |
| Bolan loam, 2 to 5 percent slopes | 651 | 0.2 |
| Bremer silty clay loam, 0 to 2 percent slopes | 1,644 | .5 |
| Calco silty clay loam, 0 to 2 percent slopes | 2,914 | .9 |
| Clyde silty clay loam, 0 to 3 percent slopes | 11,721 | 3.7 |
| Clyde-Floyd complex, 1 to 4 percent slopes | 4,434 | 1.4 |
| Coland silty clay loam, 0 to 2 percent slopes | 2,181 | .7 |
| Colo silty clay loam, 0 to 2 percent slopes | 13,699 | 4.4 |
| Colo silty clay loam, channeled, 0 to 2 percent slopes | 4,502 | 1.4 |
| Dickinson fine sandy loam, 2 to 5 percent slopes | 148 | (1) |
| Dickinson fine sandy loam, 5 to 9 percent slopes | 164 | .1 |
| Dinsdale silty clay loam, 2 to 5 percent slopes | 22,677 | 7.1 |
| Dinsdale silty clay loam, 5 to 9 percent slopes | 2,746 | .9 |
| Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded | 4,094 | 1.3 |
| Dinsdale silty clay loam, 9 to 14 percent slopes, moderately eroded | 396 | .1 |
| Donnan loam, 2 to 6 percent slopes | 768 | .2 |
| Ely silty clay loam, 2 to 5 percent slopes | 1,246 | .4 |
| Floyd loam, 1 to 4 percent slopes | 9,400 | 2.9 |
| Garwin silty clay loam, 0 to 2 percent slopes | 6,298 | 2.0 |
| Harpster silty clay loam, 0 to 2 percent slopes | 1,319 | .4 |
| Kenyon loam, 2 to 5 percent slopes | 19,624 | 6.1 |
| Kenyon loam, 5 to 9 percent slopes | 642 | .2 |
| Kenyon loam, 5 to 9 percent slopes, moderately eroded | 2,195 | .7 |
| Kenyon loam, 9 to 14 percent slopes, moderately eroded | 972 | .3 |
| Klinger silty clay loam, 0 to 2 percent slopes | 2,559 | .8 |
| Klinger silty clay loam, 2 to 5 percent slopes | 6,549 | 2.0 |
| Lawler silt loam, deep, 0 to 2 percent slopes | 3,862 | 1.2 |
| Lawler silt loam, moderately deep, 0 to 2 percent slopes | 309 | .1 |
| Lawson silt loam, 0 to 2 percent slopes | 641 | .2 |
| Lilah sandy loam, 3 to 9 percent slopes, moderately eroded | 206 | .1 |
| Marshan silty clay loam, deep, 0 to 2 percent slopes | 4,153 | 1.3 |
| Maxfield silty clay loam, 0 to 2 percent slopes | 2,446 | .8 |
| Muscatine silty clay loam, 0 to 2 percent slopes | 17,382 | 5.4 |
| Muscatine silty clay loam, 2 to 5 percent slopes | 15,614 | 5.0 |
| Muscatine silty clay loam, benches, 0 to 2 percent slopes | 676 | .2 |
| Nevin silty clay loam, 0 to 2 percent slopes | 1,827 | .6 |
| Ostrander loam, 2 to 5 percent slopes | 2,815 | .9 |
| Ostrander loam, 5 to 9 percent slopes | 853 | .3 |
| Ostrander loam, 5 to 9 percent slopes, moderately eroded | 1,018 | .3 |
| Palms muck, 1 to 3 percent slopes | 526 | .2 |
| Port Byron silt loam, 5 to 9 percent slopes, moderately eroded | 100 | (1) |
| Port Byron silt loam, 9 to 18 percent slopes, severely eroded | 135 | (1) |
| Readlyn loam, 0 to 2 percent slopes | 1,292 | .4 |
| Saude loam, 0 to 2 percent slopes | 998 | .3 |
| Saude loam, 2 to 5 percent slopes | 680 | .2 |
| Saude loam, 5 to 9 percent slopes | 188 | .1 |
| Saude loam, 5 to 9 percent slopes, moderately eroded | 393 | .1 |
| Saude-Lilah complex, 2 to 5 percent slopes | 1,642 | .5 |
| Saude-Lilah complex, 5 to 14 percent slopes, moderately eroded | 139 | (1) |
| Sawmill silty clay loam, 0 to 2 percent slopes | 2,065 | .6 |
| Sawmill-Garwin silty clay loams, 1 to 4 percent slopes | 35,937 | 11.2 |
| Sparta loamy fine sand, 2 to 5 percent slopes | 306 | .1 |
| Sperry silt loam, 0 to 1 percent slopes | 231 | .1 |
| Tama silty clay loam, 0 to 2 percent slopes | 1,038 | .3 |
| Tama silty clay loam, 2 to 5 percent slopes | 76,107 | 23.6 |
| Tama silty clay loam, 5 to 9 percent slopes | 6,553 | 2.0 |
| Tama silty clay loam, 5 to 9 percent slopes, moderately eroded | 7,577 | 2.4 |
| Tama silty clay loam, benches, 0 to 2 percent slopes | 2,643 | .8 |
| Thorp silt loam, 0 to 2 percent slopes | 247 | .1 |
| Turlin loam, 0 to 2 percent slopes | 423 | .1 |
| Waukee loam, 0 to 2 percent slopes | 2,408 | .8 |
| Waukee loam, 2 to 5 percent slopes | 666 | .2 |
| Wiota silt loam, 0 to 2 percent slopes | 2,217 | .7 |
| Zook silty clay loam, 0 to 1 percent slopes | 784 | .2 |
| Total | 320,640 | 100.0 |

[1] Less than 0.05 percent.

A12—8 to 14 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; moderate, medium, granular structure; friable; medium acid; gradual boundary.

B1—14 to 18 inches very dark grayish-brown (10YR 3/2) silty clay loam that is high in sand; very dark brown (10YR 2/2) coatings on peds; weak, medium, granular structure; very friable; strongly acid; gradual boundary.

B21—18 to 22 inches, dark-brown (10YR 4/3) silty clay loam that is high in sand; dark yellowish-brown (10YR 3/4) coatings on peds; weak, medium, granular structure; very friable; very strongly acid; gradual boundary.

B22—22 to 27 inches, dark-brown (10YR 4/3) loam; weak, medium, granular structure; very friable; very strongly acid; abrupt boundary.

IIB31—27 to 33 inches, dark yellowish-brown (10YR 4/4) sandy loam; single grained; loose; very strongly acid; clear boundary.

IIB32—33 to 37 inches, dark yellowish-brown (10YR 4/4) loamy sand to sandy loam; single grained; loose; very strongly acid; clear boundary.

IIC1—37 to 50 inches, dark-brown (7.5YR 4/4) loamy sand; single grained; loose; strongly acid; clear, smooth boundary.

IIC2—50 to 60 inches, mottled brownish-yellow (10YR 6/6) and strong-brown (7.5YR 5/6) loamy sand; single grained; loose; medium acid.

The solum ranges from 30 to 48 inches in thickness. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) loam to silt loam that is high in sand. It is 10 to 15 inches thick and ranges from neutral to medium acid. The B2 horizon is brown to dark-brown (10YR 4/3) light silty clay loam that is high in sand to loam. The IIB3 horizon ranges from sandy loam to loamy sand. The B2 and IIB3 horizons range from medium acid to very strongly acid. The IIC horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 2 to 8. It is loamy sand that has lenses of silt loam below a depth of 50 inches in some profiles. It ranges from slightly acid to very strongly acid.

These soils contain a slightly higher content of silt and clay and are more acid than is defined as within the range of the series. These differences, however, do not affect the use and behavior of the soil.

Bolan soils formed in parent material similar to that of Dickinson and Tama soils. Bolan soils have more clay in the upper part of the solum than Dickinson soils. They have more fine and medium sand, particularly in the lower part of the solum, than Tama soils.

**174B—Bolan loam, 2 to 5 percent slopes.** This gently sloping soil is on upland divides and side slopes above adjacent Tama soils. Areas are 10 to 30 acres in size and irregular in shape.

Included with this soil in mapping are some areas of sandy soils that have low available water capacity and rapid permeability. These soils are identified on the soil map by a spot symbol.

This Bolan soil is suited to corn, soybeans, small grain, and alfalfa. It is droughty during periods of low rainfall. It is subject to soil blowing and water erosion when cultivated and unprotected. The organic-matter content is moderate. Capability unit IIe–2.

## Bremer Series

The Bremer series consists of deep, nearly level, poorly drained soils on first and second bottoms along major streams. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam about 2 inches thick. The subsoil extends to a depth of 58 inches. The upper part is very dark gray, firm heavy silty clay loam; the middle part is olive-gray, firm silty clay that has strong-brown mottles; and the lower part is gray, firm silty clay loam that has strong-brown mottles. The substratum is stratified, gray clay loam, silty clay loam, and loamy sand that has strong-brown mottles.

Bremer soils have slow permeability. Available water capacity is high. The subsoil is low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Bremer soils are used mainly for cultivated crops and hay. They have a seasonal high water table and slow runoff and are subject to short periods of flooding in some years.

Representative profile of Bremer silty clay loam, 0 to 2 percent slopes, in a hayfield, 83 feet east and 1,230 feet south of the northwest corner of SW¼ sec. 18, T. 87 N., R. 15 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; black (N 2/0) coatings on peds; moderate, medium, subangular blocky structure; friable; slightly acid; clear boundary.

A12—8 to 14 inches, black (10YR 2/1) silty clay loam; black (N 2/0) coatings on peds; strong, fine, granular structure; friable; slightly acid; gradual boundary.

A13—14 to 22 inches, black (N 2/0) heavy silty clay loam; moderate, fine, granular structure; firm; neutral; gradual boundary.

B1—22 to 27 inches, very dark gray (5Y 3/1) heavy silty clay loam; black (5Y 2/1) coatings on peds; moderate, very fine, subangular blocky structure; firm; neutral; clear boundary.

B21g—27 to 30 inches, olive-gray (5Y 4/2) silty clay; dark-gray (5Y 4/1) coatings on peds; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, fine, subangular blocky structure; firm; few manganese concretions; neutral; gradual boundary.

B22g—30 to 38 inches, olive-gray (5Y 5/2) silty clay; gray (5Y 5/1) coatings on peds; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure parting to moderate, fine, subangular blocky; firm; few manganese concretions; neutral; clear boundary.

B3g—38 to 58 inches, gray (5Y 5/1) silty clay loam; many, large, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; firm; neutral; few manganese concretions; abrupt boundary.

C1—58 to 59 inches, gray (5Y 5/1) clay loam that is high in coarse sand; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; massive; very friable; neutral; abrupt boundary.

C2—59 to 74 inches, gray (5Y 5/1) silty clay loam; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; massive; friable; neutral; abrupt boundary.

IIC3—74 to 78 inches, gray (5Y 5/1) loamy sand; single grained; very friable; neutral.

The solum ranges from 40 to 60 inches in thickness. The A horizon is generally black (10YR 2/1 or N 2/0), but in places it is very dark gray (5Y 3/1) in the lower part. The A horizon is silty clay loam to heavy silty clay loam 17 to 22 inches thick and ranges from neutral to medium acid. The Bg horizon has hue of 5Y, value of 4 or 5, and chroma of 1 or 2. It is prominently mottled heavy silty clay loam to light silty clay 18 to 33 inches thick and is slightly acid to neutral. The C horizon is stratified clay loam, silty clay loam, and loamy sand.

These soils have less increase in clay content from the A horizon to the B horizon than is defined as within the range for the series. This difference, however, does not alter the use and behavior of the soil.

Bremer soils are near Colo, Sawmill, and Zook soils. They have a thinner A horizon than Colo soils and have more clay in the B horizon than Sawmill soils. They have a thinner A horizon than Zook soils.

**43—Bremer silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on bottom lands along major streams. Areas generally are 20 to 40 acres in size and irregular in shape.

Included with this soil in mapping in a few concave depressions are soils that have more clay in the subsoil than this Bremer soil. These areas are subject to ponding and are difficult to drain.

This Bremer soil is well suited to corn, soybeans, and alfalfa if adequately drained. It is wet because of a high water table and slow surface runoff. It is subject to flooding in lower areas in some years. The organic-matter content is high. Capability unit IIw–3.

## Calco Series

The Calco series consists of deep, nearly level, poorly drained soils on low benches and flood plains. These soils formed in calcareous silty alluvium. The native vegetation was prairie grasses. Slopes are 0 to 22 percent.

In a representative profile the surface layer is black silty clay loam about 45 inches thick. The subsoil extends to a depth of 57 inches. It is very dark gray, friable silty clay loam that is high in sand. The substratum is mottled olive-gray, gray, and dark-gray, friable silty clay loam to a depth of 66 inches and gray, friable sandy clay loam below. The profile is calcareous from the surface to a depth of 57 inches.

Calco soils have moderately slow permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is moderately alkaline and generally does not need lime.

Calco soils are used for cultivated crops and hay where they are adequately drained. The main limitations are wetness due to a seasonal high water table and slow surface runoff. The soils contain excess lime.

Representative profile of Calco silty clay loam, 0 to 2 percent slopes, in a pasture, 412 feet east and 85 feet south of the northwest corner of SE¼ sec. 5, T. 87 N., R. 17 W.:

A11—0 to 7 inches, black (10YR 2/1) light silty clay loam; strong, medium, granular structure; friable; moderately alkaline; strong effervescence; clear boundary.

A12—7 to 12 inches, black (10YR 2/1) light silty clay loam; black (N 2/0) coatings on peds; strong, medium, granular structure; friable; moderately alkaline; violent effervescence; clear boundary.

A13—12 to 19 inches, black (N 2/0) silty clay loam; strong, medium, granular structure; friable; moderately alkaline; strong effervescence; gradual boundary.

A14—19 to 25 inches, black (N 2/0) silty clay loam; moderate, medium, granular structure; friable; moderately alkaline; slight effervescence; clear boundary.

A15—25 to 31 inches, black (N 2/0) silty clay loam; moderate, medium, subangular blocky structure; friable; moderately alkaline; slight effervescence; gradual boundary.

A16—31 to 45 inches, black (N 2/0) silty clay loam; strong, medium, subangular blocky structure; friable; moderately alkaline; slight effervescence; gradual boundary.

Bg—45 to 57 inches, very dark gray (N 3/0) silty clay loam that is high in sand; black (5Y 2/1) coatings on peds; strong, medium, subangular blocky structure; friable; moderately alkaline; slight effervescence; clear boundary.

C1g—57 to 66 inches, mottled dark-gray (5Y 4/1), gray (5Y 5/1), and olive-gray (5Y 4/2) silty clay loam; massive; friable; mildly alkaline; clear boundary.

IIC2g—66 to 68 inches, gray (5Y 5/1) sandy clay loam; massive; friable; mildly alkaline.

The solum generally is more than 40 inches thick, and its content of lime decreases as depth increases. The A horizon is black; hue is 10YR or neutral. It is light to medium silty clay loam 30 to 50 inches thick. The Bg horizon ranges from very dark gray to gray. It has hue of 10YR, 5Y, or neutral, value of 3 to 5, and chroma of 0 or 1. It is 5 to 20 inches thick. The Cg horizon has hue of 5Y, value of 4 or 5, and chroma of 1 or 2. It ranges from loamy sand to sandy clay loam.

Calco soils are near and similar to Colo and Sawmill soils and are similar to Harpster soils. They are moderately alkaline and calcareous throughout the solum, whereas Colo and Sawmill soils are medium acid to neutral throughout the solum. Calco soils have a thicker A horizon than Harpster soils.

**733—Calco silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on stream benches and flood plains. Areas generally are 5 to 20 acres in size and irregular in shape.

Included with this soil in mapping are areas of soils where the surface layer is very high in lime. These soils respond to potassium and phosphorus fertilizers.

This Calco soil is suited to corn, soybeans, and hay if adequately drained and fertilized. It is wet because of a high water table and slow surface runoff. It contains excess lime. The organic-matter content is high. Capability unit IIw-4.

## Clyde Series

The Clyde series consists of deep, poorly drained soils in concave upland drainageways that have boulders in places. These soils formed in local alluvium and the underlying glacial till. The native vegetation was prairie grasses. Slopes are 0 to 3 percent.

In a representative profile the surface layer is black silty clay loam and clay loam about 24 inches thick. The subsoil extends to a depth of 60 inches. The upper part is dark-gray, friable light clay loam; the middle part is gray, firm light clay loam; and the lower part is mottled gray and strong-brown, firm loam. The substratum is gray, firm, calcareous, loam glacial till.

Clyde soils have moderate permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is slightly acid or neutral and generally does not need lime.

Clyde soils are used mainly for cultivated crops where they are drained and are cleared of boulders. The main limitation is wetness.

Representative profile of Clyde silty clay loam, 0 to 3 percent slopes, in a permanent pasture, 40 feet south and 400 feet east of the northwest corner of the SW¼ sec. 8, T. 89 N., R. 15 W.:

A11—0 to 7 inches, black (N 2/0) silty clay loam; moderate, medium, subangular blocky structure parting to moderate, medium, granular; friable; neutral; gradual boundary.

A12—7 to 19 inches, black (10YR 2/1) clay loam; black (N 2/0) coatings on peds; moderate, medium, subangular blocky structure parting to moderate, medium, granular; friable; neutral; gradual boundary.

A3—19 to 24 inches, black (10YR 2/1) clay loam; moderate, medium, subangular blocky structure; friable; mildly alkaline; gradual boundary.

B21g—24 to 32 inches, dark-gray (5Y 4/1) light clay loam; very dark gray (5Y 3/1) coatings on peds; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; mildly alkaline; clear boundary.

B22g—32 to 49 inches, gray (5Y 5/1) light clay loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure; friable; mildly alkaline; clear boundary.

IIB3g—49 to 60 inches, mottled gray (5Y 5/1) loam and strong-brown (7.5YR 5/8) loam; weak, coarse, prismatic structure; firm; mildly alkaline; gradual boundary.

IIC—60 to 78 inches, gray (5Y 5/1) loam; massive; firm; moderately alkaline; slight effervescence.

The solum ranges from 40 to 60 inches in thickness. Depth to carbonates ranges from 45 to 70 inches. The A horizon is black (N 2/0 or 10YR 2/1) in the upper part and grades to very dark gray (10YR 3/1) in the lower part. It ranges from loam to light clay loam and silty clay loam. It is 20 to 24 inches thick and ranges from slightly acid to neutral. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2 and has strong-brown and yellowish-brown mottles. It is clay loam or loam and shows some stratification. It is 12 to 38 inches thick and is neutral to mildly alkaline. The C horizon is mildly alkaline or moderately alkaline.

Clyde soils are near Colo, Coland, and Marshan soils and formed in parent material similar to that of Floyd soils. They contain more sand and have higher color value within a depth of 36 inches than Colo soils. They have higher chroma at a shallower depth than Coland soils and lower chroma in the B horizon than Floyd soils. They are not underlain by sand and gravel, as are Marshan soils.

**84—Clyde silty clay loam, 0 to 3 percent slopes.** This nearly level soil is in concave upland drainageways. In most places it is adjacent to Floyd soils and below Kenyon soils. Areas are 10 to 30 acres in size and long and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few areas of muck and areas of soils that are high in lime. These soils are identified on the soil map by a spot symbol.

This Clyde soil is suited to cultivated crops if adequately drained. It is wet because of a seasonal high water table and runoff from soils above. Stones and boulders are common in many undrained pastures and must be removed for this soil to be used for cultivated crops. They also interfere in places with tile installation. The organic-matter content is high. Capability unit IIw–1.

**391B—Clyde-Floyd complex, 1 to 4 percent slopes.** This complex is in upland drainageways. It is about 50 percent Clyde silty clay loam and 50 percent Floyd loam. Areas are 10 to 30 acres in size and are long, narrow, and irregular in shape. The Clyde soil is in the middle of drainageways, and the Floyd soil is at the edges of drainageways.

Included with this complex in mapping are a few small areas of sandy soils and some areas where the surface layer is organic. These soils are identified on the soil map by a spot symbol.

This complex is well suited to corn, soybeans, small grain, hay, and pasture if adequately drained. The soils are wet because of seepage and runoff from adjacent steeper soils. The Clyde soil has a seasonal high water table. If cultivated, the soils of this complex are subject to a slight hazard of erosion in the upper part of drainageways and siltation in the lower part. Stones and boulders are common in many undrained pastures and must be removed for these soils to be used for cultivated crops. They also interfere with tile installation. The organic-matter content is high. Capability unit IIw–2.

## Coland Series

The Coland series consists of deep, nearly level, poorly drained soils. These soils are on bottom lands and in adjacent drainageways on uplands. They formed in loamy sediment. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black light silty clay loam and clay loam about 47 inches thick. The next layer, to a depth of 55 inches, is very dark gray, friable clay loam. The substratum is mottled, very dark gray, friable sandy clay loam to a depth of 62 inches and very dark gray, very friable sandy loam below.

Coland soils have moderately slow permeability. Available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Coland soils are used mainly for cultivated crops where they are adequately drained. Areas that are subject to flooding generally are in pasture. The main limitation is wetness because of a seasonal high water table. The lower lying unprotected areas are subject to flooding.

Representative profile of Coland silty clay loam, 0 to 2 percent slopes, in a cultivated field 200 feet south and 360 feet west of the northeast corner of NW¼NE¼ sec. 15, T. 89 N., R. 17 W.:

Ap—0 to 8 inches, black (10YR 2/1) light silty clay loam that is high in sand; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A12—8 to 17 inches, black (10YR 2/1) clay loam; moderate, fine, granular structure; friable; slightly acid; gradual, smooth boundary.

A13—17 to 27 inches, black (10YR 2/1) light silty clay loam that is high in sand; moderate, medium, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

A14—27 to 47 inches, black (10YR 2/1) clay loam; moderate, medium, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

AC—47 to 55 inches, very dark gray (5Y 3/1) clay loam; black (10YR 2/1) coatings on peds; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable, few fine manganese and iron concretions; neutral; clear, smooth boundary.

C1—55 to 62 inches, very dark gray (5Y 3/1) heavy sandy clay loam; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; common fine manganese and iron concretions; neutral; abrupt, smooth boundary.

IIC2—62 to 75 inches, very dark gray (5Y 3/1) sandy loam; few, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; very friable; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The A horizon is generally black but is very dark gray in the lower part in places. Hue is 10YR or neutral. The A horizon ranges from silty clay loam that is high in sand to clay loam. It is 36 to 48 inches thick and ranges from medium acid to neutral. The AC horizon ranges from black to very dark gray. It has hue of 5Y or neutral and prominent mottles. The AC horizon is 4 to 12 inches thick and is slightly acid to neutral. The C horizon ranges from sandy loam to clay loam that has lenses of sand below a depth of 50 inches.

Coland soils are near Colo, Marshan, and Sawmill soils. They have more sand throughout than Colo and Sawmill soils. They are deeper to sand and gravel and have a thicker dark-colored A horizon than Marshan soils.

**135—Coland silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on stream bottoms, in adjacent upland drainageways, and along stream channels. Areas are 20 to 40 acres in size and long and narrow in shape.

Included with this soil in mapping are some areas of concave depressions and oxbows that are subject to ponding and are difficult to drain. These areas are identified on the soil map by a spot symbol.

This Coland soil is well suited to corn, soybeans, and alfalfa if adequately drained. It is wet because of a seasonal high water table and slow surface runoff. It is subject to flooding in the lower areas if unprotected. The organic-matter content is high. Capability unit IIw–1.

## Colo Series

The Colo series consists of deep, nearly level, poorly drained soils on stream bottoms. These soils formed in mixed alluvium that is high in silt. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam about 47 inches thick. The substratum is firm heavy silty clay loam. It is black to a depth of 60 inches and greenish gray below.

Colo soils have moderately slow permeability. Available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Colo soils are used mainly for cultivated row crops, hay, and pasture where they are adequately drained. The main limitations are wetness and occasional flooding.

Representative profile of Colo silty clay loam, 0 to 2 percent slopes, in a hayfield, 450 feet west and 420 feet south of the northeast corner of NW¼ sec. 7, T. 87 N., R. 16 W.:

Ap—0 to 7 inches, black (N 2/0) light silty clay loam; moderate, fine, subangular blocky structure; friable; neutral; clear boundary.

A12—7 to 17 inches, black (N 2/0) light silty clay loam; moderate, medium, subangular blocky structure; friable; neutral; gradual boundary.

A13—17 to 27 inches, black (N 2/0) silty clay loam; moderate, very fine, subangular blocky structure; friable; slightly acid; clear boundary.

A14—27 to 39 inches, black (N 2/0) silty clay loam; weak, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; slightly acid; clear boundary.

AC—39 to 47 inches, black (N 2/0) heavy silty clay loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; neutral; clear boundary.

C1—47 to 60 inches, black (N 2/0) heavy silty clay loam; massive; firm; neutral; abrupt boundary.

C2—60 to 65 inches, greenish-gray (5BG 5/1) heavy silty clay loam; massive; firm; neutral.

The solum ranges from 36 to 50 inches in thickness. Depth to carbonates is 60 inches or more. The A horizon ranges from black (N 2/0) to very dark gray (10YR 3/1) and from silty clay loam to heavy silt loam. It is 36 to 50 inches thick and neutral to slightly acid. The C horizon ranges from black (N 2/0) to dark gray (10YR 4/1) and greenish gray (5BG 5/1). The C horizon ranges from silt loam to heavy silty clay loam that has lenses of sandy loam and clay loam below a depth of 40 inches. The C horizon is slightly acid to neutral.

Colo soils are near Bremer, Calco, Ely, Sawmill, and Zook soils and formed in similar parent material. They have a thicker dark-colored A horizon than Bremer, Ely, and Sawmill soils. Colo soils are neutral to slightly acid throughout the solum, whereas Calco soils are moderately alkaline and are calcareous throughout the solum. They contain less clay than Zook soils.

**133—Colo silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on stream bottoms in upland drainageways and along major streams. Areas generally are 10 to 30 acres in size and long and narrow to moderately wide in shape.

This soil has the profile described as representative of the series. Included in mapping are some small, very wet areas that have lime and are more than 25 percent organic matter and some areas of sandy soils. These soils are identified on the soil map by a spot symbol. Also included are some small areas of concave depressions that are subject to ponding and are difficult to drain. The depressional areas are identified on the soil map by a spot symbol.

This Colo soil is well suited to corn, soybeans, small grain, and alfalfa if adequately drained. It is wet because of a seasonal high water table and slow surface runoff. The organic-matter content is high. Capability unit IIw–1.

**C133—Colo silty clay loam, channeled, 0 to 2 percent slopes.** This nearly level soil is on bottom lands along meander belts of major streams and in old stream channels. Areas generally are 20 to 30 acres in size and are long, narrow, and irregular in shape. They have many potholes and old stream channels that pond water for long periods.

This soil has a profile similar to the one described as representative of the series, but the upper 8 to 10 inches of the surface layer is very dark gray heavy silt loam or silty clay loam. Included in mapping are small areas of soils that are high in lime or muck, or are marshy. These soils are identified on the soil map by a spot symbol. Also included are a few areas of soils that stay wet longer because they are high in clay to a depth of 40 inches and a few areas that have sand and gravel at a depth of 3 to 4 feet and are more easily drained.

This Colo soil is used for pasture because it has many channels and is frequently flooded. Some areas must be cleared of brush and young trees to make suitable pasture. This soil has a seasonal high water table and slow surface runoff and is subject to flooding. The organic-matter content is high. Capability unit Vw–1.

## Dickinson Series

The Dickinson series consists of deep, gently sloping to moderately sloping, somewhat excessively drained soils on upland ridges and stream benches. These soils formed in dominantly eolian sand. The native vegetation was prairie grasses. Slopes are 2 to 9 percent.

In a representative profile the surface layer is very dark brown fine sandy loam, but it is very dark grayish brown in the lower part. It is about 22 inches thick. The subsoil extends to a depth of 46 inches. The upper part is dark-brown, very friable fine sandy loam; the middle part is brown to dark-brown, very friable fine sandy loam; and the lower part is yellowish-brown, loose loamy fine sand. The substratum is stratified yellowish-brown and light yellowish-brown sand.

Dickinson soils have moderately rapid permeability. Available water capacity is moderate. Content of available phosphorus and available potassium is very low. The surface layer generally is acid where it has not been limed in the past 5 years.

Dickinson soils are used mainly for cultivated crops and pasture. The main limitation is moderate available water capacity. These soils are subject to soil blowing and water erosion if they are unprotected.

Representative profile of Dickinson fine sandy loam, 2 to 5 percent slopes, in an old orchard, 130 feet south and 40 feet east of the northwest corner of NE¼ sec. 1, T. 89 N., R. 15 W.:

A11—0 to 14 inches, very dark brown (10YR 2/2) fine sandy loam; weak, medium, subangular blocky structure; very friable; medium acid; gradual boundary.

A12—14 to 18 inches, very dark brown (10YR 2/2) fine sandy loam; weak, medium, subangular blocky structure parting to weak, fine, granular; very friable; medium acid; gradual boundary.

A3—18 to 22 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, medium, subangular blocky structure; very friable; medium acid; gradual boundary.

B1—22 to 30 inches, dark-brown (10YR 3/3) fine sandy loam; weak, medium, subangular blocky structure; very friable; medium acid; gradual boundary.

B2—30 to 37 inches, brown to dark-brown (10YR 4/3) fine sandy loam; weak, medium, subangular blocky structure; very friable; medium acid; abrupt boundary.

B3—37 to 46 inches, yellowish-brown (10YR 5/4) loamy fine sand; weak, medium, subangular blocky structure; loose; medium acid; clear boundary.

C—46 to 60 inches, stratified yellowish-brown (10YR 5/6) and light yellowish-brown (10YR 6/4) sand; single grained; loose; medium acid.

The solum ranges from 30 to 50 inches in thickness. Depth to loamy sand and sand is 24 to 40 inches. The A1 horizon ranges from very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) sandy loam to loam and is less than 18 percent clay. It is 16 to 20 inches thick and is slightly acid to medium acid. The B horizon generally ranges from brown (10YR 5/3) to dark brown (10YR 3/3) but is yellowish brown (10YR 5/4) in the lower part. It is 15 to 25 inches thick and ranges from slightly acid to strongly acid. The C horizon is stratified and has hue of 10YR, value of 5 or 6, and chroma of 4 to 8.

Dickinson soils are near Sparta and Tama soils and formed in parent material similar to that of Bolan soils. They have more sand throughout than Tama soils, less sand in the A and B horizons than Sparta soils, and more sand in the A and B horizons than Bolan soils.

**175B—Dickinson fine sandy loam, 2 to 5 percent slopes.** This soil is on convex slopes of upland ridges and stream benches. Areas are 5 to 20 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few areas of soils north of Wellsburg that have lenses of silt at a depth of about 36 to 40 inches. Available water capacity is moderate to high, and permeability is moderate.

This Dickinson soil is suited to cultivated row crops if rainfall is normal and timely. It is somewhat excessively drained and is droughty if rainfall is below normal or is untimely. It is subject to soil blowing and water erosion if unprotected. The organic-matter content is medium. Capability unit IIIe–3.

**175C—Dickinson fine sandy loam, 5 to 9 percent slopes.** This soil is on convex upland side slopes and benches. Areas are 5 to 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is 12 to 16 inches thick. Included in mapping are a few areas of soils north of Wellsburg that have lenses of silt at a depth of 36 to 40 inches. Available water capacity is moderate to high and permeability is moderate in these included soils.

This Dickinson soil is moderately well suited to cultivated row crops if rainfall is normal and is timely. It is somewhat excessively drained and is droughty if rainfall is below normal or is untimely. It is subject to soil blowing and a slight to moderate hazard of water erosion if unprotected. The organic-matter content is medium. Capability unit IIIe–3.

## Dinsdale Series

The Dinsdale series consists of deep, gently sloping to strongly sloping, well-drained soils on uplands. These soils formed in loess and the underlying glacial till. The native vegetation was prairie grasses. Slopes are 2 to 14 percent.

In a representative profile the surface layer is black and very dark-brown light silty clay loam about 12 inches thick. The subsoil extends to a depth of 48 inches. The upper part is dark-brown, friable silty clay loam, and the lower part is yellowish-brown, firm, heavy loam. The substratum is calcareous, yellowish-brown, firm, loam glacial till.

Dinsdale soils have moderate permeability to a depth of about 30 inches and moderately slow permeability below. Available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Dinsdale soils are used mainly for cultivated crops and hay. The main limitation to cultivation is erosion.

Representative profile of Dinsdale silty clay loam, 2 to 5 percent slopes, in an alfalfa hayfield, 537 feet east and 539 feet south of the northwest corner of NE¼ sec. 20, T. 88 N., R. 15 W.:

Ap—0 to 6 inches, black (10YR 2/1) light silty clay loam; cloddy parting to weak, fine, subangular blocky and to weak, fine, granular; friable; medium acid; gradual boundary.

A3—6 to 12 inches, very dark brown (10YR 2/2) silty clay loam; many black (10YR 2/1) coatings on peds and worm casts; compound structure of moderate, very fine, subangular blocky and moderate, fine, granular; friable; strongly acid; gradual boundary.

B1—12 to 16 inches, dark-brown (10YR 3/3) silty clay loam; few, fine, black (10YR 2/1) coatings on peds; moderate, fine and very fine, subangular blocky structure; friable; strongly acid; gradual boundary.

B21t—16 to 21 inches, dark-brown (10YR 4/3) silty clay loam; moderate, fine, subangular blocky structure; friable; few, faint, discontinuous clay films on faces of peds; strongly acid; gradual boundary.

B22t—21 to 26 inches, dark-brown (10YR 4/3), light silty clay loam; weak, medium, prismatic structure parting to medium, fine, subangular blocky; friable; few, faint, discontinuous clay films on faces of peds; strongly acid; gradual boundary.

B23t—26 to 30 inches, dark-brown (10YR 4/3) light silty clay loam; weak, medium, prismatic structure parting to weak and moderate, fine, subangular blocky; friable; few, faint clay films in some root channels; strongly acid; clear boundary.

IIB24t—30 to 37 inches, yellowish-brown (10YR 5/4) heavy loam; brown (10YR 5/3) coatings on peds; few, fine, faint, yellowish-brown (10YR 5/6) mottles and few fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; firm; few pebbles 1 to 3 inches in diameter in the upper 3 inches; medium acid; gradual boundary.

IIB31—37 to 44 inches, yellowish-brown (10YR 5/4) heavy loam; dark-brown (10YR 4/3) coatings on peds; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium to coarse, prismatic structure parting to very weak, coarse, subangular blocky; firm; neutral; gradual boundary.

IIB32—44 to 48 inches, yellowish-brown (10YR 5/4) heavy loam; dark-brown (10YR 4/3) coatings on peds; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium to coarse, prismatic structure parting to very weak, coarse, subangular blocky; firm; mildly alkaline; gradual boundary.

IIC1—48 to 58 inches, yellowish-brown (10YR 5/6) medium loam; few, fine, distinct, grayish-brown (2.5YR 5/2) and strong-brown (7.5YR 5/6) mottles; massive; discontinuous vertical cleavage planes having common, medium, dark reddish-brown (5YR 3/2) stains on faces of peds; firm; moderately alkaline; slight effervescence; gradual boundary.

IIC2—58 to 70 inches, yellowish-brown (10YR 5/6) loam; common, fine, distinct, grayish-brown (2.5YR 5/2) mottles and few, fine, distinct, strong-brown (7.5YR 5/8) mottles; massive; faint, discontinuous, vertical cleavage planes having medium, distinct, very dark gray (10YR 3/1) stains on faces of planes; firm; moderately alkaline.

The solum ranges from 42 to 60 inches in thickness. The loess ranges from 22 to 38 inches in thickness. The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) and from light silty clay loam to medium silty clay loam. It is 10 to 20 inches thick and is medium acid to strongly acid. The B horizon has hue of 10YR, value of 3 or 4, and chroma of 3 or 4. The B horizon is light silty clay loam or medium silty clay loam 12 to 24 inches thick and is medium acid to strongly acid. The IIB horizon has hue of 10YR, value of 5, and chroma of 4 to 8. The IIB horizon is heavy loam to sandy clay loam or light clay loam 8 to 18 inches thick and ranges from mildly alkaline to strongly acid. The IIC horizon has hue of 10YR, value of 5 or 6, and chroma of 4 to 8. The IIC horizon ranges from loam to sandy clay loam that has lenses of sand and is neutral to moderately alkaline.

Dinsdale soils are near Klinger, Kenyon, and Tama soils and formed in parent material similar to that of Klinger soils. They are deeper to glacial till and have less sand in the A horizon than Kenyon soils. They are shallower to glacial till than Tama soils and higher in chroma in the upper part of the B horizon than Klinger soils.

**377B—Dinsdale silty clay loam, 2 to 5 percent slopes.** This soil is on upland divides and side slopes. Areas are 20 to 40 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few small, severely eroded areas of soils where the surface layer is sandy or gravelly or where glacial till is exposed. Available water capacity is moderate, and organic-matter content is moderate to low in these included soils. These soils are identified on the soil map by a spot symbol.

This Dinsdale soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing and a slight hazard of erosion if unprotected. The organic-matter content is high. Capability unit IIe–1.

**377C—Dinsdale silty clay loam, 5 to 9 percent slopes.** This moderately sloping soil is on upland side slopes. Areas are 10 to 20 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but depth to glacial till is less. Included in mapping are a few small, severely eroded areas of soils where the surface layer is sandy or where glacial till is exposed. Available water capacity is moderate and organic-matter content is low in these included soils. These soils are identified on the soil map by a spot symbol.

This Dinsdale soil is moderately well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing and a moderate hazard of erosion if unprotected. The organic-matter content is moderate to high. Capability unit IIIe–1.

**377C2—Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded.** This moderately sloping soil is on upland side slopes. Areas are less than 10 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and depth to glacial till is less. Included in mapping are a few small, severely eroded areas of soils where the surface layer is sandy or gravelly or where glacial till is exposed. Available water capacity is moderate and organic-matter content is low in these included soils. These soils are identified on the soil map by a spot symbol.

This Dinsdale soil is moderately well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing and a moderate hazard of erosion. The organic-matter content is moderate to moderately low. Capability unit IIIe–1.

**377D2—Dinsdale silty clay loam, 9 to 14 percent slopes, moderately eroded.** This strongly sloping soil is on upland side slopes. Areas are less than 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and depth to glacial till is less. Included in mapping are a few severely eroded areas of soils where glacial till or sand and gravel are exposed. Available water capacity is moderate and organic-matter content is low to very low in these included soils. These soils are identified on the soil map by a spot symbol.

This Dinsdale soil is moderately well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing and a moderate to severe hazard of erosion and has rapid runoff. The organic-matter content is moderate to moderately low. Capability unit IIIe–2.

## Donnan Series

The Donnan series consists of deep, somewhat poorly drained to moderately well-drained soils. These soils are on gently sloping, convex ridges and side slopes of uplands. They formed in loamy material 20 to 36 inches deep and the underlying highly weathered glacial till. The native vegetation was deciduous trees and prairie grasses. Slopes are 2 to 6 percent.

In a representative profile the surface layer is very dark gray and dark grayish-brown loam and clay loam about 11 inches thick. The subsoil extends to a depth of 66 inches. The upper part, to a depth of about 24 inches, is brown, friable clay loam; the middle part, to a depth of 52 inches, is olive-gray and gray, very firm silty clay; and the lower part, to a depth of 66 inches, is mottled gray, olive, light olive-brown, and yellowish-brown clay.

Donnan soils have moderate or moderately slow permeability in the upper part of the subsoil and very slow permeability in the lower part. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Donnan soils are used mainly for cultivated crops and pasture. They are subject to a moderate hazard of erosion and a wetness problem caused by a seasonal high water table that is perched over the very slowly permeable lower part of the subsoil.

Representative profile of Donnan loam, 2 to 6 percent slopes, in a pasture, 640 feet east and 900 feet north of the southwest corner of SE¼ sec. 26, T. 88 N., R. 15 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam; black (10YR 2/1) coatings on peds; moderate, fine, subangular blocky structure; friable; slightly acid; abrupt boundary.

A3—7 to 11 inches, dark grayish-brown (10YR 4/2) clay loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, subangular blocky structure parting to moderate, fine, granular; friable; medium acid; abrupt, smooth boundary.

B1—11 to 16 inches, brown (10YR 4/3) clay loam; dark grayish-brown (10YR 4/2) coatings on peds; moderate, fine, subangular blocky structure; friable; strongly acid; gradual, smooth boundary.

B21t—16 to 24 inches, brown (10YR 5/3) clay loam; dark grayish-brown (2.5Y 4/2) coatings on peds; strong, fine, subangular blocky structure; friable; many thin clay films on faces of peds and in pores; strongly acid; abrupt, wavy boundary.

IIB22t—24 to 27 inches, gray (10YR 5/1) silty clay that is high in sand; dark grayish-brown (10YR 4/2) coatings on peds; strong, very fine to fine, subangular blocky structure; firm; many thin clay films as bridges; light-gray (N 7/0) sand and silt grains on faces of peds; medium acid; clear, smooth boundary.

IIB23t—27 to 38 inches, olive-gray (5Y 5/2) silty clay; strong, coarse, prismatic structure; very firm; continuous clay films on faces of peds and in pores; medium acid; clear, smooth boundary.

IIB24t—38 to 52 inches, olive-gray (5Y 5/2) silty clay; gray (5Y 5/1) coatings on peds; strong, coarse, prismatic structure; very firm; continuous clay films on faces of peds and in pores; medium acid; gradual, smooth boundary.

IIB3t—52 to 66 inches, mottled gray (5Y 5/1), olive (5Y 5/4), light olive-brown (2.5Y 5/4), and yellowish-brown (10YR 5/6) clay; strong, coarse, prismatic structure; very firm; continuous clay films on faces of peds and in pores; medium acid.

The solum ranges from 40 to 80 inches in thickness. The depth to the clayey part of the profile ranges from 20 to 36 inches. The A horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in the upper part and dark grayish brown (10YR 4/2) in the lower part. The A horizon ranges from loam or silt loam to clay loam. It is 6 to 11 inches thick and ranges from neutral to strongly acid. The B2t horizon has hue of 10YR to 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is loam to light silty clay loam or light clay loam 8 to 10 inches thick and is medium acid to strongly acid. The IIB2t horizon has hue of 10YR to 5Y, value of 5 or 6, and chroma of 1 or 2 and has prominent mottles. It is clay or silty clay that is 24 to 48 inches thick and is slightly acid. The IIB3t horizon is mottled clay or heavy clay loam. It ranges from neutral to medium acid.

These soils have less increase in content of clay in the upper part of the IIB horizon than is defined as within the range for the series. This difference, however, does not alter the use and behavior of the soil.

Donnan soils are near Kenyon, Ostrander, and Readlyn soils. They have a firmer, more clayey B horizon than Kenyon, Ostrander, and Readlyn soils.

**782B—Donnan loam, 2 to 6 percent slopes.** This gently sloping soil is on convex upland ridges. Areas are 10 to 30 acres in size and irregular in shape.

Included with this soil in mapping are a few areas of moderately well-drained soils where depth to a clayey subsoil is more than 36 inches.

This Donnan soil is moderately well suited to corn, soybeans, small grain, or pasture if adequately drained. It is subject to a slight to moderate hazard of erosion and is wet because the very slowly permeable lower part of the subsoil restricts internal drainage. The organic-matter content is moderately low. Capability unit IIe-4.

## Ely Series

The Ely series consists of deep, gently sloping, somewhat poorly drained soils on foot slopes and in upland drainageways adjacent to perennial streams. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slopes are 2 to 5 percent.

In a representative profile the surface layer is very dark brown, light silty clay loam about 26 inches thick. The subsoil extends to a depth of 60 inches. The upper part is very dark grayish-brown, friable light silty clay loam; the middle part is dark grayish-brown, friable silty clay loam; and the lower part is mottled, grayish-brown, friable silty clay loam.

Ely soils have moderate permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Ely soils are used mainly for cultivated crops, hay, and pasture. They are subject to a slight hazard of deposition in places and are wet because of an intermittent seasonal high water table and runoff from soils upslope.

Representative profile of Ely silty clay loam, 2 to 5 percent slopes, in an asparagus field, 30 feet west and 500 feet south of the northwest corner of SW¼NE¼ sec. 15, T. 87 N., R. 15 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) coatings on peds; moderate, medium to fine, subangular blocky structure parting to moderate, medium, granular; friable; medium acid; gradual, smooth boundary.

A12—8 to 18 inches, very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) coatings on peds; moderate, medium to fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

A3—18 to 26 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; very dark gray (10YR 3/1) coatings on peds; moderate, medium to fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B1—26 to 31 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; very dark gray (10YR 3/1) coatings on peds; common, fine, faint, dark grayish-brown (10YR 4/2) and dark yellowish-brown (10YR 4/4) mottles; moderate, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B21—31 to 38 inches, dark grayish-brown (10YR 4/2) light silty clay loam; very dark grayish-brown (10YR 3/2) coatings on peds; many, fine, distinct, yellowish-brown (10YR 5/4) mottles; strong, medium, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B22—38 to 48 inches, dark-brown (10YR 4/3) silty clay loam; dark grayish-brown (10YR 4/2) coatings on peds; many, fine, distinct, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/4) mottles and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; strong, medium, subangular blocky structure; friable; few soft manganese concretions; neutral; clear, smooth boundary.

B3—48 to 60 inches, grayish-brown (2.5Y 5/2) light silty clay loam; common, fine, distinct, strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure; friable; few soft iron and manganese concretions; neutral.

The solum ranges from 40 to 66 inches in thickness. The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) and is silt loam or light silty clay loam. It is 20 to 26 inches thick and ranges from neutral to medium acid. The B2 horizon has hue of 10YR to 2.5Y, value of 4 or 5, and chroma of 2 or 3 and has mottles. It is light or medium silty clay loam 10 to 20 inches thick and ranges from neutral to medium acid.

Ely soils are near Muscatine soils and formed in parent material similar to that of Colo, Lawson, Nevin, and Sawmill soils. They have a thinner A horizon and a browner B horizon than Colo soils. They have more clay in the B horizon than Lawson soils and have a thicker A horizon than Muscatine soils. They have less contrast in clay content between the A and B horizons than Nevin soils. Ely soils are better drained and have a browner B horizon than Sawmill soils.

**428B—Ely silty clay loam, 2 to 5 percent slopes.** This gently sloping soil is on upland foot slopes and in upland drainageways adjacent to perennial streams. Areas are 10 to 30 acres in size and long and irregular in shape.

Included with this soil in mapping are a few areas of Colo soils that are more poorly drained than this Ely soil.

This Ely soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to a slight hazard of deposition if the soils above erode. It is wet because of an intermittent seasonal high water table and seepage and runoff from soils above. The organic-matter content is high. Capability unit IIe–5.

## Floyd Series

The Floyd series consists of deep, gently sloping, somewhat poorly drained soils on concave foot slopes along upland drainageways. These soils formed in local alluvium and the underlying glacial till. The native vegetation was prairie grasses. Slopes are 1 to 4 percent.

In a representative profile the surface layer is black heavy loam about 23 inches thick. The subsoil extends to a depth of 46 inches. The upper part is dark grayish-brown, friable light clay loam; the middle part is grayish-brown, very friable gravelly heavy sandy loam; and the lower part is mottled strong-brown and grayish-brown, firm loam. The substratum is mottled strong-brown and light-brownish gray, firm, loam glacial till.

Floyd soils have moderate permeability. Available water capacity is high. Content of available phosphorus and potassium is very low. The surface layer generally is acid where it has not been limed within the past 5 years.

Floyd soils are used mainly for cultivated row crops, hay, and pasture. The main limitation is wetness because of seepage from soils upslope and a seasonal high water table. The hazard of erosion is slight in places when these soils are unprotected.

Representative profile of Floyd loam, 1 to 4 percent slopes, in a hayfield, 200 feet west and 305 feet north of the southeast corner of SW¼SE¼ sec. 30, T. 89 N., R. 15 W.:

Ap—0 to 8 inches, black (N 2/0) heavy loam; moderate, medium, subangular blocky structure parting to moderate, medium, granular; friable; slightly acid; clear, smooth boundary.

A12—8 to 14 inches, black (10YR 2/1) heavy loam; black (N 2/0) coatings on peds; moderate, medium to fine, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

A13—14 to 18 inches, very dark gray (10YR 3/1) heavy loam; black (10YR 2/1) coatings on peds; moderate, medium to fine, subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—18 to 23 inches, very dark grayish-brown (10YR 3/2) light clay loam; very dark gray (10YR 3/1) coatings on peds; moderate, medium, subangular blocky structure; friable; neutral; clear, smooth boundary.

B21—23 to 28 inches, dark grayish-brown (2.5Y 4/2) light clay loam; dark-gray (10YR 4/1) coatings on peds; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few iron and manganese concretions; neutral; abrupt, smooth boundary.

B22—28 to 35 inches, grayish-brown (2.5Y 5/2) gravelly heavy sandy loam; dark grayish-brown (2.5Y 4/2) coatings on peds; common, medium, prominent, strong-brown (7.5YR 5/8) and dark-brown (7.5YR 4/4) mottles; moderate, medium, subangular blocky structure; very friable; neutral; abrupt, smooth boundary.

IIB3—35 to 46 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) loam; weak, medium, subangular blocky structure; firm; neutral; gradual, smooth boundary.

IIC1—46 to 57 inches, mottled light brownish-gray (2.5Y 6/2) and strong-brown (7.5YR 5/6) loam; massive; firm; neutral; gradual, smooth boundary.

IIC2—57 to 70 inches, light brownish-gray (2.5Y 6/2) loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; massive; firm; neutral.

The solum ranges from 40 to 55 inches in thickness. Depth to firm glacial till ranges from 30 to 45 inches. The A horizon generally is black (N 2/0 or 10YR 2/1) but becomes very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2 or 2.5Y 3/2) with depth. The A horizon ranges from loam to light silty clay loam that is high in sand. It is 16 to 24 inches thick and ranges from slightly acid to neutral. The B2 horizon has hue of 10YR to 2.5Y, value of 4 or 5, and chroma of 2. The B2 horizon ranges from clay loam to loam and in places has gravelly sandy loam in the lower part. It is 10 to 20 inches thick and ranges from slightly acid to neutral. The IIB horizon ranges from olive brown (2.5Y 4/4) to grayish brown (2.5Y 5/2) and has prominent mottles. It ranges from loam or clay loam to gravelly sandy clay loam and is 7 to 20 inches thick. The IIC horizon ranges from yellowish brown (10YR 5/6) to grayish brown (2.5Y 5/2) and has prominent mottles. It ranges from neutral to moderately alkaline.

Floyd soils are near Kenyon, Ostrander, and Readlyn soils and formed in parent material similar to that of Clyde soils. They are more stratified and deeper to glacial till than Kenyon and Readlyn soils and are more poorly drained than Ostrander soils. They have a browner B horizon than Clyde soils.

**198B—Floyd loam, 1 to 4 percent slopes.** This gently sloping soil is on concave foot slopes along drainageways and at the heads of upland drainageways. It is below Kenyon, Ostrander, and Readlyn soils and above Clyde soils. Areas are 20 to 30 acres in size and long and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few areas of soils that are poorly drained and have a dense clay subsoil that is very slowly permeable. These soils are identified on the soil map by a spot symbol. Also included are some areas of soils where the surface layer is sandy.

This Floyd soil is well suited to corn, soybeans, small grain, and hay if adequately drained. It is wet because of a seasonal high water table and seepage from soils above. It is subject to a slight hazard of erosion in some areas when unprotected. The organic-matter content is high. Capability unit IIw–2.

## Garwin Series

The Garwin series consists of deep, nearly level, poorly drained soils on concave uplands and at the heads of upland drainageways. These soils formed in loess. The native vegetation was tall grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black and very dark gray silty clay loam about 18 inches thick. The subsoil extends to a depth of 48 inches. The upper part is dark-gray, friable silty clay loam that has a few distinct and prominent mottles; the middle part is gray, friable light silty clay loam that has prominent mottles; and the lower part is olive-gray, friable silt loam that has prominent mottles. The substratum is olive-gray and light olive-gray, friable silt loam that has prominent mottles.

Garwin soils have moderately slow permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Garwin soils are used mainly for cultivated crops and hay. The main limitation is wetness because of a seasonal high water table and slow surface runoff.

Representative profile of Garwin silty clay loam, 0 to 2 percent slopes, in a cultivated field, 1,200 feet west and 208 feet north of the southeast corner of SW¼ sec. 29, T. 87 N., R. 17 W.:

Ap—0 to 7 inches, black (N 2/0) silty clay loam; moderate, fine and medium, granular structure; friable; medium acid; clear, smooth boundary.

A12—7 to 12 inches, black (10YR 2/1) silty clay loam; moderate, fine and medium, granular structure; friable; medium acid; gradual, smooth boundary.

A3—12 to 18 inches, very dark gray (10YR 3/1) heavy silty clay loam; moderate, fine and medium, granular structure; friable; slightly acid; gradual, smooth boundary.

B1g—18 to 22 inches, dark-gray (10YR 4/1) silty clay loam; very dark gray (10YR 3/1) coating on faces of peds; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; moderate, fine, subangular blocky structure parting to moderate, medium, granular; friable; slightly acid; gradual, smooth boundary.

B21g—22 to 27 inches, dark-gray (5Y 4/1) silty clay loam; very dark gray (10YR 3/1) coatings on faces of peds; few, fine, distinct, yellowish-brown (10YR 5/4) mottles; moderate, very fine and fine, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

B22g—27 to 36 inches, dark-gray (5Y 4/1) silty clay loam; common, fine, prominent, yellowish-brown (10YR 5/6) mottles; moderate, very fine and fine, subangular blocky structure; friable; few fine, black manganese concretions; slightly acid; gradual, smooth boundary.

B31g—36 to 42 inches, gray (5Y 5/1) light silty clay loam; common, fine, prominent, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure parting to weak, fine and medium, subangular blocky; friable; neutral; gradual, smooth boundary.

B32g—42 to 48 inches, olive-gray (5Y 5/2) silt loam; many, fine, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to weak, fine and medium, subangular blocky; friable; few, fine, black manganese concretions; neutral; gradual, smooth boundary.

C1—48 to 60 inches, olive-gray (5Y 5/2) silt loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, coarse, prismatic structure grading to massive with depth; friable; few, fine, black manganese concretions; darker coatings on edge of filled crawfish hole from 54 to 60 inches; deoxidized and leached weathering zone; neutral; gradual, smooth boundary.

C2—60 to 75 inches, light olive-gray (5Y 6/2) silt loam; few, medium, prominent, strong-brown (7.5YR 5/6) and yellowish-red (5YR 5/6) mottles; massive; friable; common, fine, black manganese concretions; deoxidized and leached weathering zone; neutral.

The solum ranges from 40 to 60 inches in thickness. The A1 horizon is black (10YR 2/1 or N 2/0) medium silty clay loam or light silty clay loam that is 13 to 24 inches thick and ranges from neutral to medium acid. The B horizon has dominant hue of 5Y, value of 3 to 5, and chroma of 1 or 2, and has distinct and prominent mottles. The B horizon is medium silty clay loam or light silty clay loam that is 21 to 48 inches thick and neutral or slightly acid. The C horizon is olive gray (5Y 5/2) or gray (5Y 5/1) and has distinct or prominent mottles. It is silt loam or light silty clay loam and is neutral in reaction.

Garwin soils are near Colo and Sawmill soils and formed in parent material similar to that of Harpster, Muscatine, and Sperry soils. They are in the same drainage class as Maxfield soils. They have a thinner A horizon than Colo and Sawmill soils. Garwin soils are acid, whereas Harpster soils are moderately alkaline. They have a grayer B horizon and are more poorly drained than Muscatine soils. They have less clay in the B horizon than Sperry soils and are deeper to glacial till than Maxfield soils.

**118—Garwin silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on concave uplands and at the heads of upland drainageways. Areas generally are 5 to 40 acres in size and irregular in shape.

Included with this soil in mapping are some areas of soils on loess-covered benches along perennial streams. Also included are some areas of soils that have a dense clay subsoil, are subject to ponding, and are difficult to drain. These soils are identified on the soil map by a spot symbol.

This Garwin soil is well suited to corn, soybeans, small grain, and alfalfa. It is wet because of a high water table and slow surface runoff. Artificial drainage is needed for optimum production. The organic-matter content is high. Capability unit IIw-1.

## Harpster Series

The Harpster series consists of deep, nearly level, poorly drained, calcareous soils on generally slightly concave uplands. These soils formed in loess. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam about 23 inches thick. The subsoil extends to a depth of 48 inches. The upper part is dark olive-gray, friable silty clay loam; the middle part is olive-gray, friable silty clay loam; and the lower part is gray, friable silty clay loam. The substratum is gray, friable, calcareous silt loam.

Harpster soils have moderately slow permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. These soils are calcareous throughout.

Harpster soils are used mainly for cultivated crops. The main limitations for crops are wetness and excess lime.

Representative profile of Harpster silty clay loam, 0 to 2 percent slopes, in a cultivated field, 911 feet south and 500 feet west of the northeast corner of SW¼ sec. 20, T. 87 N., R. 17 W.:

Apca—0 to 7 inches, black (N 2/0) silty clay loam; moderate, fine to medium, granular structure; friable; moderately alkaline; violent effervescence; clear boundary.

A12ca—7 to 12 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure;

friable; moderately alkaline; violent effervescence; gradual boundary.

A13ca—12 to 23 inches, black (10YR 2/1) silty clay loam; weak, fine, subangular blocky structure parting to weak, fine, granular; friable; moderately alkaline; violent effervescence; gradual boundary.

B1gca—23 to 27 inches, dark olive-gray (5Y 3/2) silty clay loam; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, granular structure; friable; moderately alkaline; violent effervescence; clear boundary.

B21gca—27 to 30 inches, olive-gray (5Y 4/2) and olive (5 Y 4/3) silty clay loam; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, granular structure; friable; moderately alkaline; violent effervescence; clear boundary.

B22gca—30 to 39 inches, olive-gray (5Y 5/2) silty clay loam; many medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; moderately alkaline; violent effervescence; clear boundary.

B3gca—39 to 48 inches, gray (5Y 5/1) silty clay loam; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure; friable; maganese and lime concretions; moderately alkaline; violent effervescence; clear boundary.

Cgca—48 to 60 inches, gray (5Y 5/1) silt loam; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; massive; friable; manganese and lime concretions; moderately alkaline; violent effervescence.

The solum ranges from 40 to 50 inches in thickness. The Apca horizon is black (10YR 2/1 or N 2/0) light silty clay loam or medium silty clay loam 10 to 25 inches thick. The Bgca horizon ranges from very dark gray (10YR 3/1) to gray (5Y 5/1). It is light silty clay loam or medium silty clay loam that is 18 to 30 inches thick. The Cgca horizon is gray (N 5/0) to light olive-gray (5Y 6/2) light silty clay loam or silt loam.

These soils are dark-colored to a greater depth than is defined as within the range for the series, but this difference does not affect the use and behavior of the soil.

Harpster soils are near Garwin, Muscatine, Sperry, and Tama soils and formed in similar parent material. They are similar to Calco soils. They are more calcareous than Garwin, Muscatine, Sperry, and Tama soils and have a thinner A horizon than Calco soils.

**595—Harpster silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on concave uplands. Areas generally are 10 acres or less in size and irregular in shape. There is a large area, of about 200 acres, south and west of Conrad (fig. 5).

Included with this soil in mapping are a few small areas of soils that have less lime than this Harpster soil. Also included are depressional areas that are subject to ponding and are difficult to drain. These areas are indicated on the soil map by a special symbol.

This Harpster soil is well suited to corn, soybeans, and alfalfa when adequately drained and fertilized. It is wet because of a seasonal high water table and slow surface runoff. It is subject to ponding and is difficult to drain. The soil contains excess lime. The organic-matter content is high. Capability unit IIw–4.

## Kenyon Series

The Kenyon series consists of deep, gently sloping to strongly sloping, moderately well-drained soils on

*Figure 5.*—An area of Harpster and Garwin soils. Harpster soils, which are high in lime, are in the light-colored areas.

long, convex upland divides and side slopes. These soils formed in loamy material and the underlying firm glacial till. The native vegetation was prairie grasses. Slopes are 2 to 14 percent.

In a representative profile the surface layer is very dark brown, very dark grayish-brown, and dark-brown loam about 18 inches thick. The subsoil extends to a depth of 60 inches. The upper part is dark yellowish-brown, friable heavy loam; the middle part is dark yellowish-brown, firm heavy loam; and the lower part is yellowish-brown, firm heavy loam. The substratum is yellowish-brown, firm, loam glacial till.

Kenyon soils have moderately slow permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Kenyon soils are used mainly for cultivated crops and hay. The main limitation is a slight to moderate hazard of erosion.

Representative profile of Kenyon loam, 2 to 5 percent slopes, in a meadow, 845 feet west and 87 feet north of southeast corner of NE1/4 sec. 8, T. 89 N., R. 15 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) heavy loam; black (10YR 2/1) coatings on peds; moderate, medium, subangular blocky structure; friable; slightly acid; clear boundary.

A12—7 to 13 inches, very dark grayish-brown (10YR 3/2) heavy loam; very dark brown (10YR 2/2) coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; clear boundary.

A3—13 to 18 inches, dark-brown (10YR 3/3) heavy loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; clear boundary.

B21—18 to 21 inches, dark yellowish-brown (10YR 4/4) heavy loam; dark-brown (10YR 3/3) coatings on peds; moderate, medium, subangular blocky structure; friable; strongly acid; clear boundary.

IIB22—21 to 31 inches, dark yellowish-brown (10YR 4/4) heavy loam; dark-brown (10YR 4/3) coatings on peds; moderate, coarse, subangular blocky structure; friable; strongly acid; abrupt boundary.

IIB23—31 to 42 inches, dark yellowish-brown (10YR 4/4) heavy loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; moderate, medium, subangular blocky structure; firm; slightly acid; abrupt boundary.

IIB3—42 to 60 inches, yellowish-brown (10YR 5/6) heavy loam; few, fine, prominent, yellowish-red (5YR 5/8) mottles; common, medium, distinct, grayish-brown (2.5Y 5/2) mottles on ped surfaces; moderate, coarse, angular blocky structure; firm; neutral; abrupt boundary.

IIC—60 to 62 inches, yellowish-brown (10YR 5/4) loam; many, medium, distinct, grayish-brown (2.5Y 5/2) mottles; massive; firm; moderately alkaline.

The solum ranges from 45 to 66 inches in thickness. The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) loam to light clay loam or silt loam that is high in sand. It is 14 to 20 inches thick and ranges from slightly acid to medium acid. The B horizon has hue of 10YR, value of 3 to 5, and chroma of 2 to 6. The B horizon ranges from medium clay loam to heavy loam. It is 31 to 46 inches thick and ranges from neutral to strongly acid. The C horizon is yellowish-brown (10YR 5/6) to light brownish-gray (10YR 6/2) medium to heavy loam. It is slightly acid to moderately alkaline.

Kenyon soils are near Floyd and Dinsdale soils and formed in parent material similar to that of Ostrander and Readlyn soils. They have a firmer B horizon than Floyd and Ostrander soils. They have more sand in the A horizon and are shallower to glacial till than Dinsdale soils. They are browner in the upper part of the B horizon than Floyd and Readlyn soils.

**83B—Kenyon loam, 2 to 5 percent slopes.** This gently sloping soil is on convex upland ridges and side slopes. Areas generally are 10 to 30 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few small areas of soils that are eroded. Organic-matter content and fertility are lower than those of this Kenyon soil. Also included are a few areas of soils that have a dense clay subsoil similar to that of Donnan soils and that generally benefit from drainage. These soils are identified on the soil map by a spot symbol.

This Kenyon soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to a slight hazard of erosion when cultivated. The organic-matter content is high. Capability unit IIe–1.

**83C—Kenyon loam, 5 to 9 percent slopes.** This moderately sloping soil is on convex upland ridges and side slopes. Areas generally are less than 10 acres in size and narrow and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and is heavy loam that has a few more pebbles and small stones. Included in mapping are a few areas of soils that are eroded. Organic-matter content, fertility, and productivity are lower than those of this Kenyon soil. These soils are identified on the soil map by a spot symbol. Also included are a few areas of soils that have a dense clay subsoil similar to that of Donnan soils and that generally benefit from drainage.

This Kenyon soil is moderately well suited to corn, soybeans, small grain, and alfalfa if properly managed. It is subject to medium runoff and a moderate hazard of erosion when cultivated and unprotected. The organic-matter content is moderate. Capability unit IIIe–1.

**83C2—Kenyon loam, 5 to 9 percent slopes, moderately eroded.** This moderately sloping soil is on convex upland ridges and side slopes. Areas are less than 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and is gravelly loam or light clay loam. Included in mapping are a few areas of soils that are severely eroded; organic-matter content and fertility are very low. These soils are identified on the soil map by a spot symbol. Also included are a few areas of soils that have a dense clay subsoil similar to that of Donnan soils and that generally benefit from drainage.

This Kenyon soil is suited to corn, soybeans, small grain, and hay if properly managed. It is subject to medium runoff and a moderate to severe hazard of erosion when cultivated and unprotected. The organic-matter content is moderately low. Capability unit IIIe–1.

**83D2—Kenyon loam, 9 to 14 percent slopes, moderately eroded.** This strongly sloping soil is on convex upland side slopes. Areas are less than 10 acres in size and narrow and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and is gravelly loam or gravelly light clay loam. Included in mapping are a few severely eroded areas of soils that have a sandy and gravelly surface layer and are less productive than this Kenyon soil. These soils are identified on the soil map by a spot symbol.

This Kenyon soil is suited to corn, soybeans, small grain, and hay if properly managed and if erosion is controlled. It is subject to medium runoff and a severe hazard of erosion when cultivated and unprotected. The organic-matter content is low. Capability unit IIIe-2.

## Klinger Series

The Klinger series consists of deep, somewhat poorly drained soils. These soils are nearly level on upland divides and gently sloping on foot slopes of uplands. They formed in loess and the underlying glacial till. The native vegetation was prairie grasses. Slopes are 0 to 5 percent.

In a representative profile the surface layer is clay loam about 21 inches thick. It is black in the upper 14 inches and very dark grayish brown below. The subsoil extends to a depth of 47 inches. The upper part is mottled, dark grayish-brown, friable silty clay loam; the middle part is mottled, grayish-brown, friable silty clay loam; and the lower part is yellowish-brown, firm heavy loam. The substratum is mottled, yellowish-brown, firm, calcareous, loam glacial till.

Klinger soils have moderate permeability to a depth of about 30 inches and moderately slow permeability below. Available water capacity is high. The subsoil is very low in available phosphorus and available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Klinger soils are used mainly for cultivated crops and hay. The gently sloping areas of these soils receive runoff from soils upslope.

Representative profile of Klinger silty clay loam, 0 to 2 percent slopes, in a small grainfield, 60 feet south and 380 feet west of the northeast corner of SE1/4 sec. 1, T. 89 N., R. 17 W.:

Ap—0 to 8 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure; friable; neutral; clear boundary.

A12—8 to 14 inches, black (10YR 2/1) silty clay loam; moderate, medium, subangular blocky structure; friable; medium acid; clear boundary.

A13—14 to 21 inches, very dark grayish-brown (10YR 3/2) silty clay loam; very dark brown (10YR 2/2) coatings on peds; strong, fine, subangular blocky structure; friable; medium acid; clear boundary.

B1—21 to 26 inches, dark grayish-brown (2.5Y 4/2) silty clay loam; very dark grayish-brown (2.5Y 3/2) coatings on peds; common, fine, prominent, strong-brown (7.5YR 5/8) mottles and common, medium, fine, olive-brown (2.5Y 4/4) mottles; strong, medium, subangular blocky structure; friable; medium acid; clear boundary.

B21t—26 to 30 inches, grayish-brown (2.5Y 5/2) silty clay loam; dark grayish-brown (2.5Y 4/2) coatings on peds; many, medium, prominent, strong-brown (7.5YR 5/6) mottles and many, medium, distinct, olive (5Y 5/3) mottles; strong, medium, subanbular blocky structure; friable; many moderately thick clay films in pores; few manganese concretions; medium acid; abrupt boundary.

IIB22t—30 to 40 inches, yellowish-brown (10YR 5/6) heavy loam; gray (5Y 5/1) coatings on peds; moderate, medium, subangular blocky structure; firm; many moderately thick clay films in pores; few manganese concretions; neutral; clear boundary.

IIB3—40 to 47 inches, yellowish-brown (10YR 5/4) heavy loam; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure; firm; few manganese concretions; moderately alkaline; strongly effervescent lime in seams; clear boundary.

IIC—47 to 64 inches, yellowish-brown (10YR 5/6) loam; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure; firm; few manganese concretions; moderately alkaline; strongly effervescent lime in seams.

The solum ranges from 40 to 60 inches in thickness. Depth to glacial till ranges from 20 to 40 inches. The A1 horizon generally ranges from black (10YR 2/1) to very dark brown (10YR 2/2) but is very dark grayish brown (10YR 3/2) in the lower part. The A1 horizon is 14 to 22 inches thick and is medium acid to strongly acid unless limed. The Bt horizon has hue of 10YR to 2.5Y, value of 4 or 5, and chroma of 2 to 4. The Bt horizon is 5 to 15 inches thick and is medium acid to strongly acid. The IIBt horizon has hue of 10YR to 2.5Y, value of 5 or 6, and chroma of 2 to 6. It ranges from loam to clay loam and is 8 to 20 inches thick. The IIC horizon has chroma of 4 to 6.

Klinger soils are near Dinsdale, Kenyon, Maxfield, Muscatine, and Tama soils. They have a grayer B horizon and are more poorly drained than Dinsdale, Kenyon, and Tama soils. They have a browner B horizon and are better drained than Maxfield soils. They have more sand in the lower part of the B horizon and are shallower to glacial till than Muscatine soils.

**184—Klinger silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on slightly convex upland divides above Dinsdale and Maxfield soils. Areas generally are 20 to 40 areas in size and are irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few areas of soils that are wet and that generally benefit from drainage. These soils are identified on the soil map by a spot symbol. Also included are some areas of soils that have a sandy surface layer. Available water capacity is lower than that of this Klinger soil.

This Klinger soil is well suited to corn, soybeans, small grain, and hay. Surface runoff is slow, and the flatter areas generally benefit from tile drainage in wet years. The organic-matter content is high. Capability unit I-1.

**184B—Klinger silty clay loam, 2 to 5 percent slopes.** This gently sloping soil is on slightly concave upland foot slopes below Dinsdale soils. Areas are 10 to 30 acres in size and long and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but depth to glacial till is less and the substratum is grayer. Included in mapping are a few small, wet areas of soils that are high in organic-matter content and generally benefit from drainage. These soils are identified on the soil map by a spot symbol. Also included are some small areas of soils that have a sandy surface layer. Available water capacity is lower than that of this Klinger soil.

This Klinger soil is well suited to corn, soybeans, small grain, and hay. Runoff and seepage from soils above generally delay farming operations in wet years. Tile drainage makes earlier field operations possible. The organic-matter content is high. Capability unit IIe-5.

## Lawler Series

The Lawler series consists of nearly level, somewhat poorly drained soils that are deep to moderately deep over sand and gravel. These soils are on benches along major streams. They formed in loamy alluvium and the underlying sand and gravel. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is about 14 inches of very dark brown silt loam that is high in sand. The subsoil extends to a depth of 36 inches. The upper part is mottled, dark grayish-brown, friable silt loam that is high in sand; the middle part is mottled, dark grayish-brown, friable silty clay loam and clay loam; and the lower part is mottled, dark grayish-brown, very friable gravelly sandy loam. The substratum is mottled, brown to dark-brown, loose gravelly loamy sand.

Lawler soils have moderate permeability in the loamy upper part of the profile and rapid permeability in the underlying sand and gravel. Available water capacity is moderate to low. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Lawler soils are used mainly for cultivated crops and hay. Field operations are delayed at times because of wetness. During periods of below-normal rainfall, these soils are droughty at times, especially where they are less than 30 inches deep to sand and gravel.

Representative profile of Lawler silt loam, deep, 0 to 2 percent slopes, in a cornfield, 100 feet east and 470 feet south of the northeast corner of SE¼ sec. 5, T. 88 N., R. 15 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) silt loam that is high in sand; black (10YR 2/1) coatings on peds; moderate, medium, subangular blocky structure parting to moderate, fine, granular; friable; neutral; clear, smooth boundary.

A12—8 to 14 inches, very dark brown (10YR 2/2) silt loam that is high in sand; black (10YR 2/1) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B1—14 to 19 inches, dark grayish-brown (10YR 4/2) silt loam that is high in sand; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B21—19 to 25 inches, dark grayish-brown (10YR 4/2) silty clay loam that is high in sand; moderate, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B22—25 to 32 inches, dark grayish-brown (10YR 4/2) clay loam; few, fine, distinct, dark grayish-brown (2.5Y 4/2), brown to dark-brown (7.5YR 4/4), and strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; medium acid; abrupt, smooth boundary.

IIB3—32 to 36 inches, dark grayish-brown (10YR 4/2) gravelly sandy loam; common, fine, distinct, brown to dark-brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; very friable; medium acid; abrupt, smooth boundary.

IIC—36 to 60 inches, brown to dark-brown (10YR 4/3) gravelly loamy sand; common, fine, faint, brown to dark-brown (7.5YR 4/4) and dark grayish-brown (10YR 4/2) mottles; single grained; loose; slightly acid.

Depth to sand and gravel ranges mainly from 24 to 40 inches, but for the moderately deep phase it is 20 to 30 inches. The solum extends into the upper part of sand and gravel strata. The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) or very dark brown (10YR 2/2). It ranges from silt loam or loam to light silty clay loam that is high in sand. It is 12 to 20 inches thick and ranges from neutral to medium acid. The B2 horizon has hue of 10YR to 2.5Y, value of 3 to 5, and chroma of 2 to 4, and it has mottles. The B2 horizon ranges from loam to light sandy clay loam or silty clay loam that is high in sand. It is 8 to 16 inches thick and ranges from slightly acid to strongly acid. The IIB3 horizon ranges from loamy sand to coarse sandy loam. The IIC horizon has hue of 10YR to 2.5Y, value of 4 to 5, and chroma of 2 to 4, and it has mottles. The IIC horizon ranges from gravelly loamy sand to sand and some gravel is neutral to medium acid.

Lawler soils are near Marshan, Saude, and Waukee soils and formed in similar parent material. They are not so gray in the upper part of the B horizon as poorly drained Marshan soils and are grayer in the B horizon than well-drained Saude and Waukee soils.

**226—Lawler silt loam, deep, 0 to 2 percent slopes.** This nearly level soil is on stream benches along major streams. Areas generally are 10 to 20 acres in size and are long and narrow or irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few poorly drained spots and marshy areas that generally benefit from tile drainage. These areas are identified on the soil map by a spot symbol. Also included are a few areas of soils that are sandy or gravelly and are droughty.

This Lawler soil is well suited to corn, soybeans, small grain, and alfalfa. Available water capacity is moderate. The soil generally has a slight wetness limitation in years when rainfall is above normal, and it tends to be droughty in years when rainfall is below normal. The organic-matter content is high. Capability unit I–2.

**225—Lawler silt loam, moderately deep, 0 to 2 percent slopes.** This nearly level soil is on stream benches along major streams. Areas are less than 10 acres in size and are long and narrow or irregular in shape.

This soil has a profile similar to the one described as representative of the series, but depth to sand and gravel is 20 to 30 inches. Included in mapping are a few poorly drained spots that benefit from artificial drainage. These areas are identified on the soil map by a spot symbol. Also included are a few areas of soils that are sandy or gravelly and are droughty.

This Lawler soil is moderately well suited to corn, soybeans, small grain, and alfalfa. Available water capacity is low, and the soil is droughty if rainfall is average or below average or is untimely. It is subject to wetness because of a high water table. The organic-matter content is high. Capability unit IIs–1.

## Lawson Series

The Lawson series consists of deep, nearly level, somewhat poorly drained soils on first and second bottoms along major streams. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is silt loam about 32 inches thick. It is black and very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil extends to a depth of 45 inches. It is mottled, dark grayish-brown, friable silt loam and loam. The substratum is mottled, dark grayish-brown, very friable sandy loam.

Lawson soils have moderate permeability. Available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium. The surface layer generally is slightly acid to neutral.

Lawson soils are used mainly for cultivated row crops. They have a seasonal high water table in places and are subject to flooding.

Representative profile of Lawson silt loam, 0 to 2 percent slopes, in a hayfield, 700 feet west and 1,000 feet south of the northeast corner of NW¼ sec. 14, T. 87 N., R. 16 W.:

Ap—0 to 7 inches, black (10YR 2/1) silt loam; moderate, medium, subangular blocky structure; friable; slightly acid; clear boundary.

A12—7 to 13 inches, very dark brown (10YR 2/2) silt loam; black (10YR 2/1) coatings on peds; moderate, fine, subangular blocky structure; friable; slightly acid; gradual boundary.

A13—13 to 20 inches, very dark grayish-brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) coatings on peds; moderate, medium to fine, subangular blocky structure; friable; slightly acid; clear boundary.

A14—20 to 32 inches, very dark grayish-brown (10YR 3/2) silt loam; very dark gray (10YR 3/1) coatings on peds; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; moderate, fine, subangular blocky structure; friable; slightly acid; gradual boundary.

B2—32 to 41 inches, dark grayish-brown (10YR 4/2) silt loam; very dark gray (10YR 3/1) coatings on peds; few, fine, distinct strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; common fine manganese concretions; slightly acid; clear boundary.

B3—41 to 45 inches, dark grayish-brown (2.5Y 4/2) loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; common fine manganese concretions; neutral; clear boundary.

C—45 to 60 inches, dark grayish-brown (2.5Y 4/2) sandy loam; many medium, prominent, strong-brown (7.5YR 5/6) mottles; massive; very friable; common fine manganese concretions; neutral.

The solum ranges from 40 to 60 inches in thickness. The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), and very dark brown (10YR 2/2). It is silt loam to light silty clay loam 24 to 40 inches thick and is slightly acid to neutral. The B horizon ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (10YR 5/2) and has mottles. The B horizon generally ranges from silt loam to silty clay loam but in places is loam below a depth of 40 inches. It is 0 to 13 inches thick. The C horizon has hue of 10YR to 2.5Y, value of 4 or 5, and chroma of 2 or 3, and it has mottles. It ranges from silt loam to sandy loam.

Lawson soils are near Colo, Ely, and Nevin soils and formed in similar parent material. They have less clay in the lower part of the solum than Colo, Ely, and Nevin soils.

**484—Lawson silt loam, 0 to 2 percent slopes.** This nearly level soil is on first and second bottoms that are subject to flooding. Areas are 10 to 20 acres in size and irregular in shape.

Included with this soil in mapping are a few areas of soils that have a silty clay subsoil that is wet and difficult to drain.

This Lawson soil is well suited to corn, soybeans, small grain, and hay. It has a seasonal high water table in some places that delays farming operations in some wet years. Tiling improves timeliness of field operations in areas that need it. The organic-matter content is high. Capability unit I–1.

## Lilah Series

The Lilah series consists of gently sloping and moderately sloping, excessively drained soils on shoulder and nose slopes of uplands. They are shallow to sandy material. They formed in stratified sandy loam material and the underlying gravelly loamy sand or sand. The native vegetation was grasses. Slopes are 3 to 9 percent.

In a representative profile the surface layer is very dark grayish-brown and dark yellowish-brown sandy loam about 7 inches thick. The subsoil extends to a depth of 35 inches. The upper part is brown to dark-brown, very friable gravelly sandy loam and loose loamy sand, and the lower part is strong-brown, loose loamy sand. The substratum is stratified brown, yellowish-brown, strong-brown, and pale-brown, loose gravelly coarse loamy sand and fine to medium sand.

Lilah soils have rapid permeability in the subsoil and very rapid permeability in the substratum. Available water capacity is very low. Content of available phosphorus and available potassium is very low. The surface layer generally is acid where it has not been limed in the past 5 years.

Lilah soils are used mainly for pasture, but some areas are cultivated in connection with neighboring soils. The main limitations are very low available water capacity and very low fertility.

Representative profile of Lilah sandy loam, 3 to 9 percent slopes, moderately eroded, in a pasture, 500 feet east and 600 feet north of the southwest corner of sec. 34, T. 89 N., R. 16 W.:

Ap—0 to 4 inches, very dark grayish-brown (10YR 3/2) heavy sandy loam; some small pebbles; weak, medium, subangular blocky structure; friable; neutral; abrupt boundary.

B&A—4 to 7 inches, dark yellowish-brown (10YR 4/4) gravelly sandy loam; weak, fine, subangular blocky structure; very friable; medium acid; abrupt boundary.

B1—7 to 15 inches, brown to dark-brown (7.5YR 4/4) gravelly sandy loam; weak, fine, granular structure; very friable; strongly acid; gradual boundary.

B21t—15 to 21 inches, brown to dark-brown (7.5YR 4/4) gravelly heavy loamy sand; weak, medium, subangular blocky structure parting to single grained; loose; clay bridging between sand grains; strongly acid; abrupt boundary.

B22t—21 to 25 inches, strong-brown (7.5YR 5/6) light loamy sand; weak, medium or fine, subangular blocky structure parting to single grained; loose; clay bridging between sand grains; strongly acid; abrupt boundary.

B31t—25 to 30 inches, strong-brown (7.5YR 5/8) heavy loamy sand; weak, medium, subangular blocky structure parting to single grained; loose; clay bridging between sand grains; medium acid; abrupt boundary.

B32t—30 to 35 inches, stratified strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/4) loamy sand and heavy loamy sand; single grained; loose; clay films on sand grains; iron bands in strata; medium acid; abrupt boundary.

C1—35 to 49 inches, brown to dark-brown (7.5YR 4/4) gravelly coarse loamy sand; single grained; loose; medium acid; abrupt boundary.

C2—49 to 54 inches, strong-brown (7.5YR 5/6) medium loamy sand; single grained; loose; medium acid; abrupt boundary.

C3—54 to 61 inches, yellowish-brown (10YR 5/6) medium to coarse loamy sand; single grained; loose; medium acid; abrupt boundary.

C4—61 to 70 inches, mottled yellowish-brown (10YR 5/6) and pale-brown (10YR 6/3) medium to fine sand; single grained; loose; medium acid.

The solum ranges from 30 to 45 inches in thickness. The A1 horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) in the upper part and from dark yellowish brown (10YR 4/4) to dark brown (10YR 3/3) in the lower part. The A1 horizon ranges from gravelly sandy loam to loam 4 to 8 inches thick. It ranges from medium acid to neutral. The Bt horizon ranges from dark brown (10YR 4/3) to brown (7.5YR 4/4) and from light loamy sand to heavy loamy sand that has gravel strata. The Bt horizon is 15 to 35 inches thick and ranges from medium acid to very strongly acid. The C horizon is stratified and has hue of 10YR to 5YR, value of 4 to 6, and chroma of 3 to 6. It is stratified loamy sand to sand and has few pebbles.

The Lilah soils in the Saude-Lilah complex, 2 to 5 percent slopes, and in the Saude-Lilah complex, 5 to 14 percent slopes, moderately eroded, have a redder B horizon than is defined as within the range for the Lilah series. This difference, however, does not affect the use and behavior of the soil.

Lilah soils are near Saude soils and formed in similar parent material. They are shallower to sandy material and have a thinner A horizon then Saude soils.

**776C2—Lilah sandy loam, 3 to 9 percent slopes, moderately eroded.** This gently sloping to moderately sloping soil is on upland shoulder slopes and nose slopes. Areas generally are less than 10 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are some severely eroded areas of soils that have a high concentration of pebbles and cobbles and have very sparse vegetation.

This Lilah soil is poorly suited to cultivated crops and is used mainly for pasture. It is subject to soil blowing and a hazard of water erosion and is very droughty. The organic-matter content is low to very low. Capability unit IVs-2.

## Marshan Series

The Marshan series consists of deep, nearly level, poorly drained soils on stream benches. These soils formed in moderately fine-textured alluvium and the underlying sand and gravel. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black and very dark gray silty clay loam that is high in sand. It is about 16 inches thick. The subsoil extends to a depth of 38 inches. The upper part is very dark gray, friable silty clay loam that is high in sand; the middle part is prominently mottled, dark-gray, friable silty clay loam that is high in sand; and the lower part is gray, very friable loam. The substratum is brown to dark-brown, loose loamy sand to a depth of 48 inches and mottled yellowish-brown and grayish-brown, loose loamy sand below.

Marshan soils have moderate permeability to a depth of about 33 inches and moderately rapid to rapid permeability below. Available water capacity is moderate. The subsoil is very low in available phosphorus and potassium. These soils generally are neutral to slightly acid throughout.

Marshan soils are used mainly for cultivated crops, hay, and pasture. The main limitation is wetness.

Representative profile of Marshan silty clay loam, deep, 0 to 2 percent slopes, in a hayfield, 1,280 feet south and 102 feet east of the northwest corner of sec. 31, T. 89 N., R. 15 W., 108 feet south of the railroad:

Ap—0 to 7 inches, black (10YR 2/1) silty clay loam that is high in sand; strong, coarse, subangular blocky structure; friable; neutral; clear boundary.

A12—7 to 12 inches, very dark gray (10YR 3/1) silty clay loam that is high in sand; black (10YR 2/1) coatings on peds; moderate, coarse, subangular blocky structure; friable; neutral; clear boundary.

A3—12 to 16 inches, very dark gray (10YR 3/1) silty clay loam that is high in sand; weak, medium, subangular blocky structure; friable; neutral; gradual boundary.

B1—16 to 20 inches, very dark gray (10YR 3/1) silty clay loam that is high in sand; few fine, distinct, olive-gray (5Y 5/2) mottles; weak, medium, subangular blocky structure; friable; neutral; clear boundary.

B2g—20 to 33 inches, dark-gray (5Y 4/1) silty clay loam that is high in sand; many fine, prominent, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure; friable; neutral; abrupt boundary.

B3g—33 to 38 inches, gray (5Y 5/1) loam; many medium, prominent, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; very friable; neutral; abrupt boundary.

IIC1—38 to 48 inches, brown (10YR 4/3) loamy sand; single grained; loose; neutral; abrupt boundary.

IIC2—48 to 60 inches, mottled yellowish-brown (10YR 5/4-5/6) and grayish-brown (2.5Y 5/2) loamy sand; single grained; loose; neutral.

The thickness of the solum and the depth to coarse-textured materials range from about 32 to 40 inches. The A1 horizon ranges from black (N 2/0 or 10YR 2/1) in the upper part to very dark gray (10YR 3/1) in the lower part. It is 12 to 24 inches thick and ranges from neutral to slightly acid. The B2g horizon has hue of 5Y, value of 4 or 5, and chroma of 1 or 2, and it has distinct, prominent mottles. It ranges from silty clay loam that is high in sand to loam or sandy clay loam. The B2g horizon is 6 to 24 inches thick and ranges from neutral to slightly acid. The IIC horizon has hue of 10YR to 5Y, value of 5 or 6, and chroma of 1 to 6. In places it has prominent mottles that have hue of 7.5YR. The IIC horizon ranges from loamy sand to gravelly sand and is neutral to slightly acid.

Marshan soils are near Bremer, Clyde, Coland, and Colo soils and formed in parent material similar to that of Lawler soils. They are sandier than Bremer and Colo soils and have a thinner dark-colored A horizon than Colo soils. They have a coarser C horizon than Clyde and Coland soils and have lower chroma in the upper part of the B horizon than Lawler soils.

**152—Marshan silty clay loam, deep, 0 to 2 percent slopes.** This soil is on stream benches. Areas are 30 acres or less in size and are long, narrow, and irregular in shape.

Included with this soil in mapping are a few small areas of soils where the surface layer has lime, where the surface layer is more than 25 percent organic matter, or that have a dense clayey subsoil. Also included are a few areas of soils where depth to sand and gravel is 24 inches; their available water capacity is lower than that of this Marshan soil.

This Marshan soil is moderately well suited to corn, soybeans, small grain, and hay if adequately drained. It is subject to wetness because of a seasonal high water table and occasional flooding. The organic-matter content is high. Capability unit IIw-5.

## Maxfield Series

The Maxfield series consists of deep, nearly level, poorly drained soils on broad upland divides and at heads of drainageways. These soils formed in loess and the underlying glacial till. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black and very dark gray, friable silty clay loam about 22 inches thick. The subsoil extends to a depth of 56 inches. The upper part is mottled, olive-gray, friable silty clay loam; the middle part is mottled, olive-gray, friable sandy clay loam and heavy loam; and the lower part is mottled, strong-brown and gray, firm loam. The substratum is mottled strong-brown and gray, firm, calcareous, loam glacial till.

Maxfield soils have moderately slow permeability. Available water capacity is high. Content of available phosphorus and potassium is very low. The surface layer generally is neutral.

Maxfield soils are used mainly for cultivated crops. The main limitation is wetness because of a seasonal high water table and slow runoff.

Representative profile of Maxfield silty clay loam, 0 to 2 percent slopes, in an oatfield, 150 feet south and 1,100 feet west of the northeast corner of SE¼ sec. 1, T. 89 N., R. 17 W.:

Ap—0 to 10 inches, black (N 2/0) silty clay loam; moderate, medium, subangular blocky structure; friable; neutral; clear boundary.

A12—10 to 16 inches, black (10YR 2/1) silty clay loam; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; strong, fine, subangular blocky structure parting to strong, medium, granular; friable; neutral; gradual boundary.

A3—16 to 22 inches, very dark gray (10YR 3/1) silty clay loam; black (5Y 2/1) coatings on peds; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; strong, fine, subangular blocky structure parting to strong, medium, granular; friable; neutral; clear boundary.

B21g—22 to 30 inches, olive-gray (5Y 4/2) silty clay loam; common, medium, prominent, strong-brown (7.5YR 5/6) mottles and moderate, medium, distinct, olive (5Y 5/4) mottles; strong, fine, subangular blocky structure; friable; few manganese concretions; neutral; abrupt boundary.

IIB22g—30 to 34 inches, olive-gray (5Y 4/2) sandy clay loam; many, large, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few to common manganese concretions; neutral; clear boundary.

IIB23g—34 to 40 inches, mottled strong-brown (7.5YR 5/6) and olive-gray (5Y 5/2) heavy loam; moderate, medium, subangular blocky structure; firm; many manganese concretions; neutral; abrupt boundary.

IIB24—40 to 44 inches, yellowish-brown (10YR 5/4) heavy sandy loam; weak, medium to fine, subangular blocky structure; very friable; few manganese concretions; neutral; abrupt boundary.

IIB3—44 to 56 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 6/1) heavy loam; weak, medium, subangular blocky structure; firm; common manganese concretions; mildly alkaline; clear boundary.

IIC—56 to 70 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 6/1) loam; massive; firm; common manganese and lime concretions; moderately alkaline; slight effervescence.

The solum ranges from 35 to 56 inches in thickness. Depth to glacial till ranges from 24 to 35 inches. The A1 horizon ranges from black (N 2/0 or 10YR 2/1) to very dark gray (10YR 3/1) and has mottles in the lower part. It is 16 to 24 inches thick. The Bg horizon ranges from olive gray (5Y 4/2 or 5/2) to gray (5Y 5/1) and has prominent mottles. It is 8 to 12 inches thick. The IIBg horizon is olive gray (5Y 4/2 or 5/2) and has prominent mottles. It ranges from loam to clay loam and sandy clay loam and is 5 to 10 inches thick. The IIB and C horizons are yellowish-brown (10YR 5/6 or 5/4) to brown (10YR 5/3) loam that has lenses of sandy loam and clay. These horizons are mottled strong brown (7.5YR 5/6 or 5/8) and gray (5Y 6/1).

Maxfield soils are near Dinsdale and Klinger soils and formed in similar parent material. They are in the same drainage class as Garwin soils. They have a grayer B horizon than Dinsdale and Klinger soils and are shallower to glacial till than Garwin soils.

**382—Maxfield silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on upland divides or at the heads of upland drainageways. Areas generally are 10 to 30 acres in size and irregular in shape.

Included with this soil in mapping are a few areas of soils that are high in lime and that benefit from special applications of fertilizer. These soils are identified on the soil map by a spot symbol. Also included are some areas of soils that have a subsoil of dense clay glacial till and are more difficult to drain than this Maxfield soil.

This Maxfield soil is well suited to corn, soybeans, small grain, and hay if adequately drained. It is wet because of a high water table and slow surface runoff. The organic-matter content is high. Capability unit IIw-1.

## Muscatine Series

This series consists of deep, somewhat poorly drained soils. These soils are nearly level on upland divides and gently sloping on foot slopes of uplands. They formed in loess. The native vegetation was prairie grasses. Slopes are 0 to 5 percent.

In a representative profile the surface layer is black light silty clay loam and very dark brown medium silty clay loam about 16 inches thick. The subsoil extends to a depth of 48 inches. The upper part is very dark grayish-brown, friable medium silty clay loam, and the lower part is dark grayish-brown, friable medium silty clay loam. The substratum is olive-gray, friable, calcareous silt loam that has strong-brown mottles.

Muscatine soils have moderate permeability. Available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Muscatine soils are used mainly for cultivated crops and hay. They have in places a slight wetness limitation in wet years, particularly in areas on foot slopes.

Representative profile of Muscatine silty clay loam, 0 to 2 percent slopes, in a cultivated field, 33 feet west and 190 feet south of the northeast corner of SW¼ sec. 29, T. 87 N., R. 17 W.:

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; moderate, fine and medium, granular structure; friable; strongly acid; abrupt, smooth boundary.

A12—7 to 12 inches, black (10YR 2/1) light to medium silty clay loam; moderate, fine and medium, granular structure; friable; strongly acid; gradual, smooth boundary.

A13—12 to 16 inches, very dark brown (10YR 2/2) medium silty clay loam; moderate, fine and medium, granular structure; friable; strongly acid; gradual, smooth boundary.

B1—16 to 20 inches, very dark grayish-brown (10YR 3/2) medium silty clay loam; moderate, fine and very fine, subangular blocky structure; friable; few very dark brown to black organic coats on peds; strongly acid; gradual, smooth boundary.

B21t—20 to 26 inches, dark grayish-brown (10YR 4/2) medium silty clay loam; weak, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; discontinuous thin clay films; very dark grayish-brown organic coats on peds; medium acid; gradual, smooth boundary.

B22t—26 to 32 inches, dark grayish-brown (10YR 4/2) medium silty clay loam; weak, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; discontinuous thin clay films; medium acid; gradual, smooth boundary.

B31t—32 to 42 inches, dark grayish-brown (10YR–2.5Y 4/2) medium silty clay loam; few, fine, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; slightly acid; gradual, smooth boundary.

B32—42 to 48 inches, grayish-brown (2.5Y 5/2) to light olive-brown (2.5Y 5/4) heavy silt loam; few, fine, yellowish-red (5YR 4/6) mottles and common, fine, strong-brown (7.5YR 5/6) mottles; very weak, medium, prismatic structure; friable; many, fine, soft, dark-colored oxides; neutral; gradual, smooth boundary.

C—48 to 64 inches, olive-gray (5Y 5/2) to light olive-gray (5Y 6/2) silt loam; many, fine, strong-brown (7.5YR 5/6) mottles; some vertical cleavage; friable; krotovina at a depth of 60 to 65 inches; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) medium silty clay loam or silt loam 14 to 20 inches thick and is medium acid to strongly acid. The B horizon is dark grayish brown (10YR or 2.5Y 4/2) in the upper part and has value of 5 or 6 and chroma of 2 to 4 in the lower part. The B horizon is medium silty clay loam in the upper part and heavy silt loam in the lower part. It is 30 to 40 inches thick and is medium acid to strongly acid in the upper part and medium acid to neutral in the lower part. The C horizon has dominant hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2, and its mottles have hue of 10YR, 7.5YR, or 5YR and high value and chroma. The C horizon is silt loam or light silty clay loam.

Muscatine soils are near Sawmill soils and formed in parent material similar to that of Tama and Garwin soils. They are in the same drainage class as Klinger soils. Muscatine soils have a grayer B horizon than the well-drained Tama soils and a browner B horizon than the poorly drained Garwin and Sawmill soils. They are deeper to glacial till than Klinger soils.

**119—Muscatine silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on broad, slightly convex upland divides. Areas are more than 30 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few small areas of soils that are more poorly drained than this Muscatine soil and that benefit from artificial drainage. These areas are identified on the soil map by a special symbol.

This Muscatine soil is well suited to corn, soybeans, and alfalfa. It has a seasonal high water table that delays field operations in some wet years. The organic-matter content is high. Capability unit I–1.

**119B—Muscatine silty clay loam, 2 to 5 percent slopes.** This gently sloping soil is on slightly concave upland foot slopes. It is below Tama soils and above Sawmill and Garwin silty clay loams. Areas are 10 to 30 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker.

This Muscatine soil is well suited to corn, soybeans, and alfalfa. It is subject to seepage and runoff from soils above, and it requires drainage for optimum production in wet years. The organic-matter content is high. Capability unit IIe–5.

**T119—Muscatine silty clay loam, benches, 0 to 2 percent slopes.** This nearly level soil is on loess-covered stream benches. Areas generally are 10 to 30 acres in size and oblong in shape.

This soil has a profile similar to the one described as representative of the series, but in places it contains some very fine and fine sand. It commonly is underlain by sand and gravel below a depth of about 75 inches and has very rapid permeability. Included in mapping are a few small areas of soils that are sandier throughout and have lower available water capacity than this Muscatine soil.

This Muscatine soil is well suited to corn, soybeans, small grain, and alfalfa. It has a seasonal high water table that delays field operations in some wet years. The organic-matter content is high. Capability unit I–1.

## Nevin Series

The Nevin series consists of deep, nearly level, somewhat poorly drained soils on bottom lands along major streams. These soils formed in alluvium, mainly from a loess source. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black and very dark grayish-brown light silty clay loam about 23 inches thick. The subsoil extends to a depth of 47 inches. The upper part is dark grayish-brown, friable silty clay loam; the middle part is grayish-brown, friable silty clay loam; and the lower part is mottled, grayish-brown, friable silty clay loam. The substratum is mottled, light brownish-gray, friable clay loam and loam that has lenses of sand.

Nevin soils have moderately slow permeability. Available water capacity is high. The subsoil is medium in available phosphorus and high in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Nevin soils are used mainly for cultivated crops. Farming operations are delayed in places because of wetness in years of above normal rainfall.

Representative profile of Nevin silty clay loam, 0 to 2 percent slopes, in a soybean field, 1,250 feet south and 1,320 feet east of the northwest corner of sec. 13, T. 87 N., R. 15 W., 70 feet north of T intersection.

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; moderate, fine, subangular blocky structure; friable; slightly acid; clear boundary.

A12—7 to 13 inches, black (10YR 2/1) light silty clay loam; moderate, fine, subangular blocky structure; friable; slightly acid; clear boundary.

A13—13 to 17 inches, very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; clear boundary.

A3—17 to 23 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; very dark gray (10YR 3/1) coatings on peds; moderate, fine, subangular blocky structure; friable; few light-gray sand and silt grains on faces of peds; medium acid; clear boundary.

B21—23 to 30 inches, dark grayish-brown (10YR 4/2) silty clay loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B22t—30 to 34 inches, grayish-brown (10YR 5/2) silty clay loam; dark grayish-brown (10YR 4/2) coatings on peds; moderate, fine, subangular blocky structure; friable; few thin clay films on faces of peds and in pores; few manganese concretions; medium acid; clear boundary.

B23t—34 to 40 inches, grayish-brown (2.5Y 5/2) silty clay loam; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure; friable; few thin clay films on faces of peds and common, moderately thick clay films in pores; few manganese concretions; medium acid; gradual boundary.

B3t—40 to 47 inches, grayish-brown (2.5Y 5/2) silty clay loam; many, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few thin clay films in pores; few manganese concretions; medium acid; abrupt boundary.

C1—47 to 50 inches, light brownish-gray (2.5Y 6/2) light clay loam; many, fine, prominent, strong-brown (7.5YR 5/6) mottles; massive; friable; few manganese concretions; medium acid; abrupt boundary.

C2—50 to 60 inches, light brownish-gray (2.5Y 6/2) loam, with sand lenses; many, fine, prominent, strong-brown (7.5YR 5/6) mottles; massive; friable; few manganese concretions; medium acid.

The solum ranges from 40 to 48 inches in thickness. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) silt loam to light silty clay loam. It is 18 to 24 inches thick and is medium acid to slightly acid. The B horizon has dominant hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is 18 to 38 inches thick and is medium acid to slightly acid. The C horizon generally has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 and has prominent mottles. It ranges from silty clay loam to silt loam and has lenses of loamy sand and sand below a depth of 50 inches. It is medium acid.

Nevin soils are near Lawler soils and formed in parent material similar to that of Bremer, Ely, Lawson, Sawmill, and Wiota soils. They have a thinner A horizon than the somewhat poorly drained Ely and Lawson soils and the poorly drained Sawmill soils. They have less clay and are better drained than Bremer soils. They are more silty and are deeper to stratified loamy material than Lawler soils. They have a thicker and darker colored A horizon and a grayer B horizon than the moderately well drained Wiota soils.

**88—Nevin silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on second bottoms and alluvial fans. Areas generally are less than 10 acres in size and irregular in shape.

Included with this soil in mapping are a few areas of soils that are wetter than this Nevin soil and benefit from artificial drainage. These soils are identified on the soil map by a spot symbol. Also included are a few areas of soils that have a slowly permeable subsoil and are wet and difficult to drain.

This Nevin soil is very well suited to corn, soybeans, small grain, and alfalfa. It is subject to wetness that delays farm operations in some years. The organic-matter content is high. Capability unit I–1.

## Ostrander Series

The Ostrander series consists of deep, gently sloping to moderately sloping, well-drained soils on convex nose slopes and side slopes of uplands, downslope from Kenyon and Readlyn soils. These soils formed in loamy material and the underlying friable glacial till. The native vegetation was prairie grasses. Slopes are 2 to 9 percent.

In a representative profile the surface layer is very dark brown and very dark grayish-brown, friable loam about 14 inches thick. The subsoil extends to a depth of 44 inches. The upper part is brown to dark-brown, friable loam; the middle part is dark yellowish-brown, very friable sandy loam; and the lower part is yellowish-brown, friable loam. The substratum is yellowish-brown, firm loam.

Ostrander soils have moderate permeability to a depth of about 20 inches, moderately rapid permeability between depths of 20 and 36 inches, and moderately slow permeability below a depth of 36 inches. Available water capacity is high. Content of available phosphorus and potassium is very low. The surface layer generally is acid where it has not been limed within the past 5 years.

Ostrander soils are used mainly for cultivated crops. The main hazard is erosion. The soils are droughty at times in years of below normal rainfall.

Representative profile of Ostrander loam, 2 to 5 percent slopes, in a hayfield, 246 feet west and 100 feet south of the northeast corner of SE¼ of sec. 9, T. 89 N., R. 15 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; moderate, medium, granular structure; friable; slightly acid; clear boundary.

A12—7 to 10 inches, very dark brown (10YR 2/2) loam; moderate, medium, granular structure; friable; slightly acid; clear boundary.

A13—10 to 14 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate, medium, subangular blocky structure; friable; slightly acid; gradual boundary.

B1—14 to 20 inches, brown to dark-brown (10YR 4/3) loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, subangular blocky structure; friable; slightly acid; clear boundary.

IIB21—20 to 29 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; dark-brown (10YR 4/3) coatings on peds; weak, medium, subangular blocky structure; very friable; 2 to 5 percent 2-millimeter pebbles; medium acid; clear boundary.

IIB22—29 to 36 inches, dark yellowish-brown (10YR 4/4) sandy loam; dark-brown (10YR 4/3) coatings on peds; weak, medium, subangular blocky structure; 2 to 5 percent 2-millimeter pebbles; very friable; medium acid; abrupt boundary.

IIB23—36 to 44 inches, yellowish-brown (10YR 5/4) light loam; moderate to medium, subangular blocky structure; friable; neutral; abrupt boundary.

IIIC—44 to 60 inches, yellowish-brown (10YR 5/4) loam; few, medium, distinct, strong-brown (7.5YR 5/6) and light brownish-gray (2.5Y 6/2) mottles; weak, medium, subangular blocky structure; firm; moderately alkaline.

The solum ranges from 44 to 65 inches in thickness. The A1 horizon ranges from black (10YR 2/1 or N 2/0) to very dark brown (10YR 2/2). It is loam to light silty clay loam that is high in sand. It is 10 to 20 inches thick and is slightly acid to medium acid. The B1 horizon is brown or dark-brown (10YR 4/3 to 3/3) loam to light clay loam that is 4 to 6 inches thick and is slightly acid to medium acid. The IIB horizon has hue of 10YR, value of 4 or 5, and chroma of 4 to 8. It is sandy loam to light clay loam that is 15 to 30 inches thick and is slightly acid to strongly acid. The IIIC horizon ranges from loam to clay loam and sandy clay loam and is neutral to moderately alkaline.

Ostrander soils are near Clyde, Floyd, Kenyon, and Readlyn soils. They have a browner B horizon than the more poorly drained Clyde, Floyd, and Readlyn soils. They have a more friable B horizon that has fewer mottles than the B horizon of Kenyon soils.

**394B—Ostrander loam, 2 to 5 percent slopes.** This gently sloping soil is on convex upland nose slopes and side slopes. Areas generally are 10 to 20 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few areas of severely eroded soils that have lower organic-matter content and fertility than this Ostrander soil. Also included are some areas of soils that have a sandy subsoil 20 to 25 inches thick. Available water capacity is moderate to low in these included soils.

This Ostrander soil is well suited to corn, soybeans, small grain, and hay. It is subject to a slight hazard of erosion when cultivated. This soil is droughty in some years of below-normal rainfall. The organic-matter content is moderate to high. Capability unit IIe–2.

**394C—Ostrander loam, 5 to 9 percent slopes.** This moderately sloping soil is on convex upland nose slopes and side slopes. Areas generally are 5 to 20 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and is very dark grayish brown in color. Included in mapping are a few areas of eroded soils that have lower organic-matter content and fertility than this Ostrander soil. Also included are some areas of soils that have a sandy subsoil 20 to 25 inches thick. Available water capacity is moderate to low in these included soils.

This Ostrander soil is moderately well suited to corn, soybeans, small grain, and hay. It is subject to a slight to moderate hazard of erosion when cultivated. This soil is droughty in years of low rainfall. The organic-matter content is moderate to high. Capability unit IIIe–3.

**394C2—Ostrander loam, 5 to 9 percent slopes, moderately eroded.** This moderately sloping soil is on convex upland nose slopes and side slopes. Areas generally are 5 to 20 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but it is moderately eroded and the surface layer is thinner and is dark brown in color. Included in mapping are a few areas of soils that have a dense clay subsoil and are very slowly permeable and somewhat poorly drained. These soils are identified on the soil map by a spot symbol. Also included are some areas of severely eroded soils that are low in organic-matter content and fertility and some areas of soils that have a sandy subsoil 20 to 25 inches thick and are moderate to low in available water capacity.

This Ostrander soil is suited to corn, soybeans, small grain, and hay if properly managed. It is subject to a moderate hazard of erosion when cultivated. This soil is droughty in years of low rainfall. The organic-matter content is moderately low. Capability unit IIIe–3.

## Palms Series

The Palms series consists of nearly level, very poorly drained organic soils that are 16 to 48 inches thick over mineral soil material. These soils are in upland drainageways, on sidehill seeps, and on stream benches. They formed in organic material over alluvial sediment or glacial till. The native vegetation was grasses, sedges, and other water-tolerant plants. Slopes are 1 to 3 percent.

In a representative profile the organic surface layer is black and very dark brown muck about 18 inches thick. The underlying mineral material extends to a depth of 63 inches. The upper part is 4 inches of very dark gray, friable silty clay loam; the middle part is 14 inches of olive-gray, friable light silty clay loam and heavy silt loam; and the lower part is 27 inches of greenish-gray and dark greenish-gray, friable heavy silt loam.

Palms soils have moderately rapid to rapid permeability in the organic material and moderately slow to moderate permeability in the underlying mineral soil material. Available water capacity is very high. Content of available phosphorus and potassium is very low. The surface layer is slightly acid to moderately alkaline.

Palms soils are used mainly for cultivated crops where they are adequately drained. The main limitation is wetness.

Representative profile of Palms muck, 1 to 3 percent slopes, in a pasture, 1,290 feet west and 1,200 feet north of the southeast corner of NW1/4 of sec. 19, T. 88 N., R. 18 W.:

Oa1—0 to 7 inches, black (10YR 2/1, broken face and pressed) and very dark gray (10YR 3/1, rubbed) muck sapric material; less than 10 percent undisturbed fiber content; 60 percent mineral content; common fine to very fine roots and many micro roots; very friable; moderately alkaline; clear boundary.

Oa2—7 to 13 inches, very dark brown (10YR 2/2, broken face and pressed) and very dark grayish-brown (10YR 3/2, rubbed) muck sapric material; less than 10 percent undisturbed fiber content; 60 percent mineral content; common fine and micro roots; very friable; moderately alkaline; abrupt boundary.

Oa3—13 to 18 inches, black (N 2/0 broken face) and black (10YR 2/1 rubbed and pressed) muck sapric material; less than 10 percent undisturbed fiber content; 65 percent mineral content; many very fine to micro roots; friable; neutral; clear boundary.

IIA1b—18 to 22 inches, very dark gray (5Y 3/1) silty clay loam; common, medium, prominent, yellowish-brown (10YR 5/6) mottles; strong, medium, subangular blocky structure; friable; neutral; abrupt boundary.

IIB21g—22 to 27 inches, olive-gray (5Y 4/2) light silty clay loam; many, medium, prominent, yellowish-brown (10YR 5/6) mottles; strong, medium, subangular blocky structure; friable; neutral; abrupt boundary.

IIB22g—27 to 36 inches, gray (5Y 5/1) heavy silt loam; strong, medium, subangular blocky structure; friable; neutral; abrupt boundary.

IIC1g—36 to 55 inches, greenish-gray (5BG 5/1) heavy silt loam; massive; friable; moderately alkaline; gradual boundary.

IIC2g—55 to 63 inches, dark greenish-gray (5BG 4/1) heavy silt loam; massive; friable; moderately alkaline.

The organic material generally ranges from 16 to 40 inches in thickness, but in places it is as thick as 48 inches. It is black (10YR 2/1 or N 2/0) to dark brown (10YR 3/3). The underlying material ranges from black (10YR 2/1) to olive gray and light olive gray (5Y 6/2 to 5/2). This material is variable in texture but is typically silty clay loam, loam, or silt loam. It has sand strata in places. It is typically neutral but ranges from slightly acid to moderately alkaline.

Palms soils are near Clyde, Colo, Marshan, and Sawmill soils. They have an Oa horizon of decomposed organic material more than 16 inches thick that is not present in Clyde, Colo, Marshan, or Sawmill soils. They are more poorly drained than any of these soils.

**221—Palms muck, 1 to 3 percent slopes.** This soil generally occurs on seepy, wet upland foot slopes, in broad upland drainageways, and on stream benches. It is near Clyde and Sawmill soils in upland drainageways, Marshan and Colo soils along streams, and Dickinson, Saude variant, or Ostrander soils on sidehill seeps.

Included with this soil in mapping are a few areas of soils that have been drained and that have a thinner organic surface layer than this Palms soil.

This Palms soil is moderately suited to cultivated row crops if drained. If not, it generally is used for permanent pasture or is left idle. The water table is at or near the surface during much of the year. Outlets for drainage are difficult to obtain in some areas. Considerable settling takes place when this soil is drained. The organic-matter content is very high. Capability unit IIIw-1.

## Port Byron Series

The Port Byron series consists of deep, gently rolling to hilly, well-drained soils on ridges and side slopes high on the landscape. These soils formed in loess. The native vegetation was prairie grasses. Slopes are 5 to 18 percent.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silt loam about 12 inches thick. The subsoil extends to a depth of 41 inches. The upper part is brown to dark-brown, friable silt loam; the middle part is dark yellowish-brown, friable silt loam; and the lower part is yellowish-brown, friable silt loam. The substratum is mottled, yellowish-brown and dark yellowish-brown, friable silt loam.

Port Byron soils have moderate permeability. Available water capacity is high. Content of available phosphorus is medium, and content of available potassium is very low. The surface layer generally is acid where it has not been limed within the past 5 years.

Port Byron soils are used mainly for cultivated crops and pasture. The main hazard is erosion.

Representative profile of Port Byron silt loam, 5 to 9 percent slopes, moderately eroded, in an uneroded area in pasture, 100 feet north and 200 feet west of the southeast corner of SW¼NE¼ sec. 12, T. 89 N., R. 18 W.:

A11—0 to 7 inches, very dark brown (10YR 2/2) silt loam; black (10YR 2/1) coatings on peds; strong, medium, granular structure; friable; medium acid; clear boundary.

A12—7 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) coatings on peds; strong, medium, granular structure; friable; slightly acid; clear boundary.

B1—12 to 18 inches, brown (10YR 4/3) silt loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, granular structure; friable; slightly acid; gradual boundary.

B2—18 to 28 inches, dark yellowish-brown (10YR 4/4) silt loam; brown to dark-brown (10YR 4/3) coatings on peds; moderate, medium, subangular blocky structure; friable; slightly acid; gradual boundary.

B3—28 to 41 inches, yellowish-brown (10YR 5/6) silt loam; brown to dark-brown (10YR 4/3) coatings on peds; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; moderate, coarse, subangular blocky structure; friable; slightly acid; clear boundary.

C1—41 to 48 inches, yellowish-brown (10YR 5/4) silt loam; dark yellowish-brown (10YR 4/4) coatings on peds; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, subangular blocky structure; friable; light-gray very fine sand grains on faces of peds; medium acid; abrupt boundary.

C2—48 to 51 inches, mottled reddish-brown (5YR 5/4) and yellowish-brown (10YR 5/6) silt loam; weak, medium, subangular blocky structure; friable; slightly acid; abrupt boundary.

C3—51 to 63 inches, dark yellowish-brown (10YR 4/4) silt loam; many, large, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; neutral.

The solum ranges from 36 to 60 inches in thickness. The A1 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). It is 10 to 14 inches thick and is medium acid to slightly acid. The B horizon ranges from brown (10YR 4/3) to dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4). It is 26 to 46 inches thick and ranges from medium acid to neutral. The C horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/4 to 5/8) and reddish brown (5YR 4/4) and has mottles. It ranges from slightly acid to moderately alkaline.

Port Byron silt loam, 9 to 18 percent slopes, severely eroded, has a thinner, darker colored A horizon than is defined as within the range for the series. This difference, however, does not affect the use and behavior of the soil.

Port Byron soils formed in parent material similar to that of Tama soils. They have less clay in the B horizon than Tama soils.

**620C2—Port Byron silt loam, 5 to 9 percent slopes, moderately eroded.** This moderately sloping soil is on ridgetops on gently rolling to hilly uplands. Areas are 10 to 40 acres in size and irregular in shape.

A profile of this soil in an uneroded area has the profile described as representative of the series. Included in mapping are a few small areas of soils that are severely eroded or are high in sand and benefit from additional fertilizer. These soils are identified on the soil map by a spot symbol. Also included are a few areas of noneroded soils on ridgetops.

This Port Byron soil is moderately well suited to cultivated crops if properly managed. It is subject to soil blowing and has a moderate hazard of erosion when cultivated. The subsoil responds very well to fertilizer. The organic-matter content is moderate. Capability unit IIIe-1.

**620E3—Port Byron silt loam, 9 to 18 percent slopes, severely eroded.** This moderately steep soil is on side slopes on hilly uplands. Areas generally are 10 to 30 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is severely eroded, and the present surface layer generally is brown. Included in mapping are a few areas of soils where the surface layer has lime. These soils require more phosphate than this Port Byron soil but do not require lime.

This Port Byron soil is better suited to pasture than to cultivated crops. It is subject to soil blowing and a severe hazard of erosion if cultivated or if the pasture is overgrazed. The organic-matter content is moderately low. Capability unit VIe-1.

## Readlyn Series

The Readlyn series consists of deep, nearly level, somewhat poorly drained soils on upland divides. These soils formed in loamy material and the underlying glacial till. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black and very dark grayish-brown loam about 23 inches thick. The subsoil extends to a depth of 45 inches. The upper part is mottled, grayish-brown, firm heavy loam. The substratum is mottled strong-brown and olive-gray, firm, loamy, calcareous till.

Readlyn soils have moderately slow permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Readlyn soils are used mainly for cultivated crops and hay. Farming operations are delayed in places because of wetness in some years.

Representative profile of Readlyn loam, 0 to 2 percent slopes, in a cultivated field, 75 feet west and 75 feet south of the northeast corner of SE¼ sec. 24, T. 89 N., R. 15 W.:

Ap—0 to 9 inches, black (10YR 2/1) heavy loam; moderate, medium, subangular blocky structure; friable; medium acid; clear boundary.

A12—9 to 16 inches, very dark gray (10YR 3/1) heavy loam; black (10YR 2/1) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; clear boundary.

A3—16 to 23 inches, very dark grayish-brown (10YR 3/2) heavy loam; black (10YR 2/1) coatings on peds; strong, medium, subangular blocky structure; friable; medium acid; clear boundary.

IIB2—23 to 31 inches, dark grayish-brown (2.5Y 4/2) heavy loam; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; medium acid; clear boundary.

IIB3—31 to 45 inches, grayish-brown (2.5Y 5/2) heavy loam; dark grayish-brown (2.5Y 4/2) coatings on peds; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure; firm; few, soft, black oxides; slightly acid; abrupt boundary.

IIC—45 to 60 inches, mottled strong-brown (7.5YR 5/6) and olive-gray (5Y 5/2) loam; massive; firm; few, soft, black oxides; moderately alkaline; slightly effervescent.

The solum ranges from 42 to 60 inches in thickness. The A horizon is black (10YR 2/1) to very dark grayish-brown (10YR 3/2) light silty clay loam or loam. It is 14 to 24 inches thick and is slightly acid to medium acid. The IIB horizon has hue of 10YR to 2.5Y, value of 4 to 5, and chroma of 2 to 8. It ranges from heavy loam to light clay loam 26 to 44 inches thick and is medium acid to strongly acid. The IIC horizon has mottles that have hue of 7.5Y to 5Y, value of 5 or 6, and chroma of 2 to 8. It ranges from loam to light clay loam or sandy clay loam and is neutral to moderately alkaline.

Readlyn soils are near Clyde and Floyd soils and formed in parent material similar to that of Kenyon soils. They have a browner B horizon than Clyde soils. They have a firmer B2 horizon than Floyd soils and are shallow to glacial till. They have lower chroma in the upper part of the B horizon than Kenyon soils and are more poorly drained.

**399—Readlyn loam, 0 to 2 percent slopes.** This nearly level soil is on upland divides. Areas generally are 10 to 30 acres in size and irregular in shape.

Included with this soil in mapping are a few small areas of soils that have concave slopes and are poorly drained.

The Readlyn soil is well suited to corn, soybeans, small grain, and alfalfa. It has slow runoff, and wetness delays farming operations in some years. The organic-matter content is high. Capability unit I–1.

## Saude Series

The Saude series consists of nearly level to moderately sloping, well-drained soils that are moderately deep to sand and gravel. These soils are on stream terraces and escarpments along major streams. They formed in loamy alluvial material and the underlying sand and gravel. The native vegetation was prairie grasses. Slopes are 0 to 9 percent.

In a representative profile the surface layer is very dark brown, very dark grayish-brown, and dark-brown loam about 21 inches thick. The subsoil extends to a depth of 37 inches. The upper part is brown to dark-brown, very friable light loam, and the lower part is dark yellowish-brown, loose gravelly loamy sand. The substratum is stratified very dark yellowish-brown, yellowish-brown, and light yellowish-brown, loose gravelly loamy sand and fine to very coarse sand.

Saude soils have moderate to moderately rapid permeability to a depth of about 30 inches and rapid to very rapid permeability below. Available water capacity is moderate to low. Content of available phosphorus is low, and content of available potassium is very low. The surface layer generally is acid where it has not been limed within the past 5 years.

Saude soils are used mainly for cultivated crops. The main limitation is low available water capacity. The gently sloping to moderately sloping soils are subject to a slight to moderate hazard of erosion.

Representative profile of Saude loam, 0 to 2 percent slopes, in a hayfield, 1,100 feet north and 55 feet east of the southwest corner of SE¼ sec. 6, T. 88 N., R. 15 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak, medium, subangular blocky structure; friable; medium acid; clear boundary.

A12—8 to 16 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate, medium to fine, granular structure; friable; medium acid; clear boundary.

A3—16 to 21 inches, dark-brown (10YR 3/3) loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, subangular blocky structure parting to strong, medium, granular; very friable; medium acid; clear boundary.

B2—21 to 30 inches, brown to dark-brown (10YR 4/3) light loam; moderate, medium, subangular blocky structure; very friable; medium acid; abrupt boundary.

IIB3—30 to 37 inches, dark yellowish-brown (10YR 4/4) gravelly loamy sand; weak. medium, subangular blocky structure parting to . ngle grained; loose; slightly acid; abrupt boundaıy.

IIC1—37 to 50 inches, dark yellowish-brown (10YR 4/4) gravelly coarse sand to medium loamy sand; single grained; loose; neutral; abrupt boundary.

IIC2—50 to 60 inches, mottled yellowish-brown (10YR 5/4) and light yellowish-brown (10YR 6/4) medium to very coarse sand; single grained; loose; neutral.

The solum ranges from 20 to 45 inches in thickness.

Depth to sand and gravel ranges from 20 to 36 inches. The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2). It is 11 to 16 inches thick and is medium acid to neutral. The B2 horizon ranges from brown or dark brown (10YR 4/3 or 7.5YR 4/4) to dark yellowish brown (10YR 4/4) and from light loam to sandy loam. It is 7 to 12 inches thick and slightly acid to strongly acid. The IIB horizon ranges from gravelly sandy loam to loamy sand. The C horizon ranges from dark yellowish brown (10YR 4/4) to light yellowish brown (10YR 6/4) and is gravelly loamy sand or fine sand to very coarse sand.

Saude soils are near Lawler, Marshan, Waukee, and Wiota soils and formed in parent material similar to that of Lawler, Marshan, and Waukee soils. They are shallower to sand and gravel and contain more sand in the A horizon than Wiota soils. They have a browner B horizon than Lawler and Marshan soils and are shallower to sand and gravel than Waukee soils.

**177—Saude loam, 0 to 2 percent slopes.** This nearly level soil is on terraces along major streams. Areas generally are 5 to 20 acres in size and irregular in shape, but some are more than 40 acres.

This soil has the profile described as representative of the series. Included in mapping are a few areas of soils where the surface layer is sandy and available water capacity is very low.

This Saude soil is well suited to corn, soybeans, small grain, and pasture. It is droughty in years when rainfall is average or below-normal or is untimely. The organic-matter content is high. Capability unit IIs–1.

**177B—Saude loam, 2 to 5 percent slopes.** This gently sloping soil is on terraces along major streams. Areas are 5 to 20 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. Included in mapping are a few areas of soils where the surface layer is sandy or gravelly. Organic-matter content, fertility, and available water capacity are lower in these soils than in this Saude soil.

This Saude soil is well suited to corn, soybeans, small grain, and pasture. It is droughty in years when rainfall is average or below normal or is untimely. It is subject to a slight hazard of erosion when cultivated. The organic-matter content is high. Capability unit IIe–3.

**177C—Saude loam, 5 to 9 percent slopes.** This moderately sloping soil is on stream terraces and on escarpments along major streams. Areas generally are 5 to 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and depth to sand and gravel is less. Included in mapping are some areas of soils where the surface layer is sandy or gravelly, organic-matter content and fertility are lower than those of this Saude soil, and available water capacity is low.

This Saude soil is moderately well suited to corn, soybeans, small grain, and pasture. It is subject to a slight to moderate hazard of erosion when cultivated. It is droughty in years when rainfall is average or below normal or is untimely. The organic-matter content is moderate. Capability unit IIIe–3.

**177C2—Saude loam, 5 to 9 percent slopes, moderately eroded.** This moderately sloping soil is on stream terrace escarpments along major streams. Areas generally are 5 to 20 acres in size and long and narrow in shape.

This soil has a profile similar to the one described as representative of the series, but it is moderately eroded. The surface layer is thinner, sandier, and dark brown and dark yellowish brown in color. Included in mapping are a few severely eroded areas of soils where the surface layer is sandy and gravelly, organic-matter content and fertility are lower than those of this Saude soil, and available water capacity is low.

This Saude soil is moderately well suited to corn, soybeans, small grain, and pasture. It is subject to a moderate hazard of erosion when cultivated. It is droughty in years when rainfall is average or below normal or is untimely. The organic-matter content is moderately low. Capability unit IIIe–3.

**241B—Saude-Lilah complex, 2 to 5 percent slopes.** This complex is on upland ridgetops, knolls, and side slopes. It is about 60 percent Saude silt loam and about 25 percent Lilah sandy loam. Areas are 5 to 10 acres in size and irregular in shape. The Saude soil is on gently sloping ridgetops and side slopes, and the Lilah soil is on shoulders and nose slopes. The Saude soil has a profile similar to the one described as representative of the series, but the surface layer and the upper part of the subsoil are silt loam, and the subsoil is redder.

Included with this complex in mapping are a number of areas from which sand and gravel have been quarried, leaving depressions. Some of these have been smoothed over and are being farmed or pastured, but they are quite distinct on the landscape. The depressional areas are identified on the soil map by a special symbol.

This complex is poorly suited to cultivated row crops and is used mainly for pasture. It is subject to erosion when cultivated, and it is droughty. The organic-matter content is moderately low to low. Capability unit IVe–1.

**241C2—Saude-Lilah complex, 5 to 14 percent slopes, moderately eroded.** This complex is on side slopes of upland ridges and knolls. It is about 55 percent Saude silt loam, about 35 percent Lilah sandy loam, and 10 percent areas of soils where the surface layer is very gravelly sand. Areas are 5 to 15 acres in size and irregular in shape. The Saude silt loam is on side slopes, and the Lilah sandy loam is on shoulders and nose slopes.

The Saude soil has a profile similar to the one described as representative of the series, but the surface layer and the upper part of the subsoil are silt loam, and the subsoil is redder. Included in mapping are a few depressional areas from which sand and gravel have been quarried. Some of these areas have been smoothed out and planted to pasture. The depressional areas are identified on the soil map by a special symbol.

This complex is not suited to cultivated row crops. It is used mainly for pasture. Available water capacity is moderate to very low, and the soils are very droughty. The soils are subject to a moderate hazard of erosion if pastures are overgrazed. The organic-matter content is low. Capability unit VIs–1.

## Sawmill Series

The Sawmill series consists of deep, nearly level, poorly drained soils on alluvial fans in upland drainageways and on bottom lands along perennial streams.

These soils formed in silty alluvium. The native vegetation was prairie grasses. Slopes are 0 to 4 percent.

In a representative profile the surface layer is black silty clay loam about 27 inches thick. The subsoil extends to a depth of 52 inches. The upper part is dark-gray, friable silty clay loam, and the lower part is gray, friable silty clay loam. The substratum is gray, friable silty clay loam that is high in sand.

Sawmill soils have moderately slow permeability. Available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium. The surface layer is neutral to medium acid where it has not been limed in the past 5 years.

Sawmill soils are used mainly for cultivated crops and hay. The main limitation is wetness.

Representative profile of Sawmill silty clay loam, 0 to 2 percent slopes, in a pasture, 280 feet north and 100 feet east of the southwest corner of NW¼ sec. 16, T. 88 N., R. 15 W.:

A11—0 to 9 inches, black (N 2/0) silty clay loam; moderate, fine, granular structure; friable; neutral; clear boundary.

A12—9 to 15 inches, black (N 2/0) silty clay loam; moderate, medium, subangular blocky structure parting to moderate, fine, granular; friable; neutral; clear boundary.

A13—15 to 27 inches, black (10YR 2/1) silty clay loam; black (N 2/0) coatings on peds; moderate, medium, subangular blocky structure; friable; neutral; clear boundary.

B1—27 to 36 inches, dark-gray (5Y 4/1) silty clay loam; very dark gray (10YR 3/1) coatings on peds; moderate, medium to fine, subangular blocky structure; friable; neutral; clear boundary.

B21g—36 to 41 inches, gray (5Y 5/1) silty clay loam; dark-gray (5Y 4/1) coatings on peds; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few fine iron and manganese concretions; neutral; clear boundary.

B22g—41 to 46 inches, gray (5Y 5/1) silty clay loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few fine iron and manganese concretions; neutral; clear boundary.

B3g—46 to 52 inches, gray (5Y 5/1) silty clay loam; common, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few fine iron and manganese concretions; neutral; clear boundary.

Cg—52 to 63 inches, gray (5Y 5/1) silty clay loam that is high in sand; few, medium, prominent, strong-brown (7.5YR 5/6) mottles; massive; friable; few fine iron and manganese concretions; neutral.

The solum ranges from 40 to 60 inches in thickness. The A horizon ranges from black (N 2/0) to very dark brown (10YR 2/2), is 24 to 36 inches thick, and is neutral to medium acid. The Bg horizon has hue of 10YR to 5Y, value of 4 to 5, and chroma of 1 or 2, and it has prominent mottles. The Bg horizon ranges from heavy silt loam to medium silty clay loam. It is 10 to 30 inches thick and is slightly acid to neutral. The Cg horizon has hue of 2.5Y to 5G, value of 4 to 6, and chroma of 0 to 2. It ranges from silt loam to heavy silty clay loam. Strata of sandy loam to clay are below a depth of 50 inches in places. The Cg horizon ranges from neutral to moderately alkaline.

Sawmill soils are near Garwin soils and formed in parent material similar to that of Bremer, Colo, and Ely soils. They have a thicker A horizon than Garwin soils, less clay in the B horizon than Bremer soils, and a thinner A horizon than Colo soils. They have lower chroma in the upper part of the B horizon than Ely soils.

**933—Sawmill silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on alluvial fans and bottom lands along perennial streams. Areas are 10 to 30 acres in size and generally long and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few areas of soils that are calcareous, and some areas of soils that have sand and are better drained than this Sawmill soil. These soils are identified on the soil map by a spot symbol. Also included are some areas of soils where the surface layer is less than 20 inches thick.

This Sawmill soil is well suited to corn, soybeans, small grain, and alfalfa if adequately drained. It is subject to wetness and siltation if the soils above erode. The organic-matter content is high. Capability unit IIw–1.

**933B—Sawmill-Garwin silty clay loams, 1 to 4 percent slopes.** This complex is in upland drainageways. It is about 60 percent Sawmill silty clay loam and about 40 percent Garwin silty clay loam. Acres are 10 to 30 acres in size and long and narrow in shape. The Sawmill soil is in the lower part of drainageways, and the Garwin soil is at the heads of drainageways. The Sawmill soil has a thicker surface layer than the Garwin soil.

The Sawmill and Garwin soils in this complex have profiles similar to those described as representative of their respective series. Included in mapping are a few small areas of soils that are high in lime and do not require liming; they have a sandy surface layer that has lower available water capacity or a mucky surface layer that is more difficult to drain than these Sawmill and Garwin soils. These included soils are identified on the soil map by a spot symbol.

This complex is well suited to corn, soybeans, small grain, and alfalfa if adequately drained. It is wet because of a seasonal high water table and seepage and overflow from steeper soils. The organic-matter content is high. Capability unit IIw–2.

## Sparta Series

The Sparta series consists of deep, gently sloping, excessively drained soils on uplands and stream benches. These soils formed in sand deposited by wind on uplands and by water on stream benches. The native vegetation was prairie grasses. Slopes are 2 to 5 percent.

In a representative profile the surface layer is very dark brown and very dark grayish-brown, loose loamy fine sand and fine sand about 37 inches thick. The subsoil extends to a depth of 44 inches. It is dark-brown, loose fine sand. The substratum is stratified brown to dark-brown and dark yellowish-brown fine sand that has strong-brown iron bands below a depth of 60 inches.

Sparta soils have rapid permeability. Available water capacity is very low. Content of available phosphorus and potassium is very low. The surface layer generally is acid where it has not been limed in the past 5 years.

Sparta soils are used mainly for cultivated crops. The main limitation is very low available water capacity. These soils are subject to both soil blowing and water erosion if they are unprotected.

Representative profile of Sparta loamy fine sand, 2 to 5 percent slopes, in a pasture, 50 feet east and 520 feet south of the northwest corner of sec. 2, T. 89 N., R. 15 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) loamy fine sand; weak, medium, subangular blocky structure; very friable; medium acid; diffuse boundary.

A12—6 to 11 inches, very dark brown (10YR 2/2) loamy fine sand; weak, medium, subangular blocky structure; very friable; neutral; diffuse boundary.

A13—11 to 21 inches, very dark grayish-brown (10YR 3/2) fine sand; weak, medium, subangular blocky structure; loose; strongly acid; gradual boundary.

A3—21 to 37 inches, very dark grayish-brown (10YR 3/2) fine sand; weak, medium, subangular blocky structure parting to single grained; loose; medium acid; gradual boundary.

B—37 to 44 inches, dark-brown (10YR 3/3) fine sand; weak, medium, subangular blocky structure parting to single grained; loose; medium acid; gradual boundary.

C—44 to 77 inches, stratified brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) fine sand; strong-brown (7.5YR 5/6) iron bands below a depth of 60 inches; single grained; loose; slightly acid.

The solum ranges from 30 to 45 inches in thickness. The A1 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) loamy sand to fine sand and is 16 to 24 inches thick and medium acid to neutral. The A3 horizon is fine sand or sand. The B horizon is dark brown (10YR 3/3) or dark yellowish brown (10YR 3/4) and ranges from slightly acid to strongly acid. The C horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It contains strong-brown (7.5YR 5/6) to yellowish-red (5YR 5/6) iron bands in the lower part.

Sparta soils are near Saude and Waukee soils on the stream benches and formed in parent material similar to that of Dickinson soils on uplands. They have more sand in the upper part of the profile than Dickinson, Saude, and Waukee soils.

**41B—Sparta loamy fine sand, 2 to 5 percent slopes.** This gently sloping soil is on uplands and stream benches. Areas are 5 to 20 acres in size and irregular in shape.

Included with this soil in mapping are a few soils on stream benches that are underlain by silt loam above a depth of 40 inches. Available water capacity is higher than that of this Sparta soil. Also included are areas of soils, on stream benches, that have a surface layer of coarse sand.

This Sparta soil is poorly suited to cultivated row crops. The amount and timeliness of the rainfall determine production. This soil is droughty and is subject to soil blowing and a slight hazard of water erosion if not protected. The organic-matter content is moderately low. Capability unit IVs–1.

## Sperry Series

The Sperry series consists of deep, nearly level, very poorly drained soils on concave upland divides. These soils formed in loess. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

In a representative profile the surface layer is black and very dark gray silt loam about 10 inches thick. The subsurface layer is grayish-brown and light brownish-gray, friable silt loam about 8 inches thick. The subsoil extends to a depth of 48 inches. The upper part is gray, firm heavy silty clay loam; the middle part is gray, firm silty clay; and the lower part is dark-gray and olive-gray, firm light silty clay and heavy silty clay loam. The substratum is olive-gray, firm light silty clay loam.

Sperry soils have slow permeability. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Sperry soils are used mainly for cultivated crops. The main limitations are wetness because of ponding and very slow permeability.

Representative profile of Sperry silt loam, 0 to 1 percent slopes, in a hayfield, 53 feet north and 540 feet west of the southeast corner of SW¼ sec. 27, T. 87 N., R. 17 W.:

Ap—0 to 7 inches, black (10YR 2/1) silt loam, moderate, fine, subangular blocky structure; friable; neutral; clear boundary.

A12—7 to 10 inches, very dark gray (10YR 3/1) silt loam; moderate, fine, platy structure; friable; slightly acid; abrupt boundary.

A21—10 to 16 inches, grayish-brown (10YR 5/2) silt loam; dark-gray (10YR 4/1) coatings on peds; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; moderate, medium, platy structure; friable; medium acid; abrupt boundary.

A22—16 to 18 inches, light brownish-gray (10YR 6/2) silt loam; gray (10YR 5/1) coatings on peds; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; strongly acid; abrupt boundary.

B21tg—18 to 23 inches, gray (10YR 5/1) heavy silty clay loam; very dark gray (10YR 3/1) coatings on peds; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; strong, fine, angular blocky structure; firm, continuous, moderately thick clay films on faces of peds and in pores; strongly acid; abrupt boundary.

B22tg—23 to 31 inches, gray (5Y 5/1) silty clay; very dark gray (10YR 3/1) coatings on peds; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; strong, fine, prismatic structure; firm; many moderately thick clay films on faces of peds and in pores; very strongly acid; gradual boundary.

B23tg—31 to 40 inches, dark-gray (5Y 4/1) light silty clay; many, large, prominent, strong-brown (7.5YR 5/6) mottles; moderate, fine, prismatic structure; firm; many moderately thick clay films on faces of peds and in pores; strongly acid; gradual boundary.

B3tg—40 to 48 inches, olive-gray (5Y 5/2) heavy silty clay loam; common, large, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure; firm; continuous thin clay films on faces of peds and continuous moderately thick clay films in pores; medium acid; gradual boundary.

Cg—48 to 60 inches, olive-gray (5Y 5/2) light silty clay loam; common, large, prominent, strong-brown (7.5YR 5/8) mottles; weak, coarse, prismatic structure; firm; neutral.

The solum ranges from 40 to 68 inches in thickness. The Ap horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1). The Ap and A1 horizons combined are 7 to 12 inches thick and range from medium acid to neutral. The A2 horizon ranges from dark gray (10YR 4/1) to light brownish gray (10YR 6/2) and has distinct mottles. It is 6 to 8 inches thick and ranges from strongly acid to medium acid. The B2tg horizon has hue of 10YR to 5Y, value of 4 to 5, and chroma of 1. It ranges from heavy silty clay loam to silty clay, is 17 to 30 inches thick, and is medium acid to very strongly acid. The C horizon is olive-gray silty clay loam to silt loam and is slightly acid to neutral.

These Sperry soils do not have an abrupt textural change between the A and B horizons and, in places, have a thinner dark-colored A horizon than is defined as within the range for the series, but these differences do not affect the use and behavior of the soil.

Sperry soils are near Garwin, Harpster, and Muscatine soils. Unlike these soils, they have an A2 horizon. They have more clay in the B horizon than Garwin, Harpster, and Muscatine soils.

**122—Sperry silt loam, 0 to 1 percent slopes.** This nearly level soil is on concave uplands. Areas are less than 5 acres in size and rounded in shape.

This Sperry soil is suited to corn, soybeans, and alfalfa if adequately drained. It is subject to wetness and a hazard of ponding. It has a very slowly permeable subsoil and is difficult to drain. The organic-matter content is medium to high. Capability unit IIIw–2.

## Tama Series

The Tama series consists of deep, well-drained soils. These soils are nearly level to moderately sloping on broad convex uplands and nearly level on loess-covered stream benches. They formed in deep loess. The native vegetation was prairie grasses. Slopes are 0 to 9 percent.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silty clay loam about 16 inches thick. The subsoil extends to a depth of 46 inches. The upper part is brown to dark-brown, friable medium silty clay loam, and the lower part is dark yellowish-brown, friable medium and light silty clay loam. The substratum is yellowish-brown, friable heavy silt loam.

Tama soils have moderate permeability. Available water capacity is high. The subsoil is medium in available phosphorus and very low in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Tama soils are used mainly for cultivated crops and hay. The main hazard when they are cultivated is erosion in the sloping areas.

Representative profile of Tama silty clay loam, 2 to 5 percent slopes, in a cultivated field, 22 feet south and 140 feet west of the northeast corner of SW¼ sec. 29, T. 87 N., R. 17 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) light silty clay loam; moderate, medium, granular structure; friable; strongly acid; abrupt boundary.

A12—7 to 11 inches, very dark brown (10YR 2/2) medium silty clay loam; moderate, fine and medium, granular structure; friable; strongly acid; clear boundary.

A3—11 to 16 inches, very dark grayish-brown (10YR 3/2) medium silty clay loam; moderate, medium, granular structure; friable; strongly acid; gradual boundary.

B21—16 to 25 inches, brown to dark-brown (10YR 4/3) medium silty clay loam; dark-brown (10YR 3/3) coatings on peds; weak, medium and coarse, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; few gray very fine sand and silt grains on peds; strongly acid; gradual boundary.

B22—25 to 29 inches, dark yellowish-brown (10YR 4/4) medium silty clay loam; brown (10YR 4/3) coatings on peds; weak, medium and coarse, prismatic structure parting to moderate, medium, subangular blocky; friable; few gray very fine sand and silt grains on peds when dry; strongly acid; gradual boundary.

B23—29 to 34 inches, dark yellowish-brown (10YR 4/4) medium silty clay loam; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium and coarse, prismatic structure parting to moderate, medium, subangular blocky; friable; few fine manganese concretions; few gray very fine sand and silt grains on peds when dry; medium acid; gradual boundary.

B31—34 to 40 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium and coarse, prismatic structure parting to weak, medium, subangular blocky; friable; few fine manganese concretions; few gray very fine sand and silt grains on peds when dry; medium acid; gradual boundary.

B32—40 to 46 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/4) light silty clay loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles and few, medium, distinct, light brownish-gray (10YR 6/2) mottles; weak, medium, prismatic structure; friable; many fine manganese concretions; continuous gray very fine sand silt grains on faces of prisms when dry; medium acid; gradual boundary.

C—46 to 60 inches, yellowish-brown (10YR 5/4) heavy silt loam; weak, coarse, prismatic structure; friable; many fine manganese concretions; continuous gray very fine sand and silt grains on faces of prisms when dry; slightly acid.

The solum ranges from 36 to 60 inches or more in thickness. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) in the lower part. The A horizon ranges from heavy silt loam to medium silty clay loam. It is 10 to 20 inches thick and is medium acid to strongly acid. The B2 horizon is brown (10YR 4/3), dark yellowish-brown (10YR 4/4), or yellowish-brown (10YR 5/4) light or medium silty clay loam. It is 22 to 44 inches thick and is medium acid or strongly acid. The C horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It is silt loam or light silty clay loam and is medium acid to neutral.

Tama soils are near Dinsdale, Garwin, Klinger, and Muscatine soils and formed in parent material simiiar to that of Garwin and Muscatine soils. They are deeper to till than Dinsdale and Klinger soils, and they have higher chroma in the upper part of the B horizon than Garwin and Muscatine soils.

**120—Tama silty clay loam, 0 to 2 percent slopes.** This nearly level soil is on upland divides. Areas are less than 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is 16 to 20 inches thick. Included in mapping are a few small areas of soils that are somewhat poorly drained.

This Tama soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing if unprotected. The organic-matter content is high. Capability unit I–1.

**120B—Tama silty clay loam, 2 to 5 percent slopes.** This gently sloping soil is on upland divides. Areas are more than 30 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few small areas of soils that are somewhat poorly drained.

This Tama soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing and a slight hazard of erosion when cultivated. The organic-matter content is high. Capability unit IIe–1.

**120C—Tama silty clay loam, 5 to 9 percent slopes.** This moderately sloping soil is on upland side slopes. Areas are 10 to 30 acres in size and long and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner. Included in mapping are a few small areas of soils that are eroded. They have exposures of glacial till or sandy spots. Organic-matter content is lower than that of this Tama soil, and additional fertilizer is needed in these included soils.

This Tama soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing and a slight to moderate hazard of water erosion when cultivated. The organic-matter content is high. Capability unit IIIe-1.

**120C2—Tama silty clay loam, 5 to 9 percent slopes, moderately eroded.** This moderately sloping soil is on upland side slopes. Areas are 10 to 30 acres in size and long and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and is dark grayish brown in color. Included in mapping are a few small, severely eroded areas of soils where glacial till is exposed. Organic-matter content is lower than that of this Tama soil, and additional fertilizer is needed in these included soils. These soils are identified on the soil map by a spot symbol.

This Tama soil is well suited to corn, soybeans, small grain, alfalfa, or pasture. It is subject to soil blowing and a moderate hazard of erosion when cultivated. The organic-matter content is moderate. Capability unit IIIe-1.

**T120—Tama silty clay loam, benches, 0 to 2 percent slopes.** This nearly level soil is on loess-covered benches along major streams. Areas are 10 to 20 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thicker, and coarse-textured material is present in places below a depth of 48 inches. Included in mapping are a few areas of soils that are poorly drained and require artificial drainage for crop production. These soils are identified on the soil map by a spot symbol.

This Tama soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to soil blowing if unprotected. The organic-matter content is high. Capability unit I-1.

## Thorp Series

The Thorp series consists of deep, nearly level, poorly drained soils in concave depressions on stream benches. These soils formed in mixed alluvium. The native vegetation was grasses and scattered trees. Slopes are 0 to 2 percent.

In a representative profile the surface layer is very dark grayish-brown heavy silt loam about 10 inches thick. The subsurface layer is dark grayish-brown, friable silt loam about 8 inches thick. The subsoil extends to a depth of 60 inches. The upper part is mottled, dark grayish-brown, friable light silty clay loam; the middle part is mottled, dark grayish-brown and grayish-brown, very firm silty clay loam; and the lower part is mottled strong-brown and dark grayish-brown, friable sandy loam.

Thorp soils have slow permeability. Available water capacity is high. Content of available phosphorus is low, and content of available potassium is very low. The surface layer generally is acid where it has not been limed within the past 5 years.

Thorp soils are used mainly for cultivated crops and pasture. The main limitation is wetness.

Representative profile of Thorp silt loam, 0 to 2 percent slopes, in a permanent pasture, with scattered trees, 51 feet west and 350 feet south of the northeast corner of NW¼ sec. 23, T. 87 N., R. 15 W.:

A11—0 to 6 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; very dark gray (10YR 3/1) coatings on peds; strong, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A12—6 to 10 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; very dark gray (10YR 3/1) coatings on peds; strong, medium to fine, subangular blocky structure; friable; medium acid; abrupt, smooth boundary.

A2—10 to 18 inches, dark grayish-brown (10YR 4/2) silt loam; dark-gray (10YR 4/1) coatings on peds; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, thin, platy structure; friable; light-gray (10YR 6/1) sand and silt grains on faces of peds; medium acid; abrupt, smooth boundary.

B1—18 to 24 inches, dark grayish-brown (10YR 4/2) silty clay loam; dark-gray (10YR 4/1) coatings on peds; strong, medium, angular blocky structure; friable; light-gray (10YR 7/1) silt grains on faces of peds; medium acid; abrupt, smooth boundary.

B21tg—24 to 35 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam; dark-gray (10YR 4/1) coatings on peds; many, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; very firm; many moderately thick clay films on faces of peds; common fine iron and manganese concretions; medium acid; clear, smooth boundary.

B22tg—35 to 48 inches, grayish-brown (2.5Y 5/2) silty clay loam; dark-gray (10YR 4/1) coatings on peds; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; strong, medium to coarse, angular blocky structure; very firm; many thick clay films on faces of peds; many fine iron and manganese concretions; medium acid; clear, smooth boundary.

B23tg—48 to 56 inches, grayish-brown (2.5YR 5/2) light silty clay loam; olive-gray (5Y 5/2) coatings on peds; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; strong, medium to coarse, subangular blocky structure; very firm; many moderately thick clay films on faces of peds; many fine iron and manganese concretions; medium acid; abrupt, smooth boundary.

IIB3tg—56 to 60 inches, mottled strong-brown (7.5YR 5/6) and dark-gray (5Y 4/1) sandy loam; weak, medium, subangular blocky structure; friable; common thin clay films on faces of peds; many fine manganese concretions; medium acid.

The solum ranges from 45 to 65 inches in thickness. Depth to stratified alluvium is 55 inches or more. The A1 horizon ranges from very dark gray (10YR 3/1) to very dark brown (10YR 2/2). It is 9 to 13 inches thick and medium acid to slightly acid. The A2 horizon ranges from dark gray (10YR 4/1) to gray (10YR 5/1), dark grayish brown (10YR 4/2), or grayish brown (10YR 5/2). It is 6 to 9 inches thick and is medium acid to strongly acid. The B2tg horizon has hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2, and it has prominent mottles. It ranges from silty clay loam to heavy silty clay loam 20 to 40 inches thick and is slightly acid to medium acid.

These Thorp soils are slightly deeper to stratified loamy material than is defined as within the range for the series, but this difference does not affect the use and behavior of the soil.

Thorp soils are near Lawler, Marshan, Nevin, and Waukee soils. Unlike these soils, they have an A2 horizon. They contain more clay in the B horizon than Lawler, Marshan, and Waukee soils, and they have a firmer B horizon and are shallower to stratified loamy material than Nevin soils.

**404—Thorp silt loam, 0 to 2 percent slopes.** This nearly level soil is on concave stream benches. Areas generally are less than 10 acres in size and rounded in shape.

Included with this soil in mapping are a few areas of soils that have been filled in and have a thicker surface layer than this Thorp soil. These soils have better surface drainage because they do not pond water.

This Thorp soil is suited to corn, soybeans, and small grain if adequately drained. It is wet because of poor internal drainage caused by the slowly permeable subsoil, very slow surface runoff, and ponding. The organic-matter content is high. Capability unit IIIw–2.

## Turlin Series

The Turlin series consists of deep, nearly level, somewhat poorly drained soils on bottom lands along perennial streams. These soils formed in loamy alluvial sediment. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loam about 25 inches thick. The subsoil extends to a depth of 53 inches. The upper part is very dark grayish-brown, friable loam; the middle part is brown and olive-brown, friable light silty clay loam and light clay loam; and the lower part is olive-gray, friable light clay loam. The substratum is brown to dark-brown, loose loamy sand.

Turlin soils have moderate permeability. Available water capacity is high. Content of available phosphorus and potassium is very low. The surface layer is medium acid to neutral and requires lime in places.

Turlin soils are used mainly for cultivated crops. They are wet at times because of a seasonal high water table and slow runoff. Flooding occurs in lower areas in some years if they are not protected.

Representative profile of Turlin loam, 0 to 2 percent slopes, in a beanfield, 270 feet west and 213 feet south of the northeast corner of SW¼NE¼ sec. 1, T. 89 N., R. 15 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak, moderate to fine, granular structure; friable; slightly acid; clear boundary.

A12—7 to 15 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; moderate, fine, subangular blocky structure parting to moderate, medium, granular; friable; medium acid; gradual boundary.

A13—15 to 25 inches, very dark grayish-brown (10YR 3/2) loam; black (10YR 2/1) coatings on peds; moderate, fine, subangular blocky structure parting to moderate, medium, granular; friable; medium acid; gradual boundary.

B1—25 to 33 inches, very dark grayish-brown (10YR 3/2) loam; strong, medium to fine, subangular blocky structure; friable; medium acid; clear boundary.

B21—33 to 38 inches, brown (10YR 4/3) light silty clay loam that is high in sand; dark grayish-brown (10YR 4/2) coatings on peds; few, fine, prominent, strong-brown (7.5YR 5/6) mottles; strong, medium to fine, subangular blocky structure; friable; medium acid; clear boundary.

B22—38 to 46 inches, olive-brown (2.5Y 4/4) light clay loam; dark grayish-brown (10YR 4/2) coatings on peds; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; strong, medium to fine, subangular blocky structure; friable; medium acid; clear boundary.

B3—46 to 53 inches, olive-gray (5Y 5/2) light clay loam; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, angular blocky structure; friable; few manganese concretions; slightly acid; abrupt boundary.

IIC—53 to 63 inches, brown to dark-brown (10YR 4/3) loamy sand; weak, medium, subangular blocky structure parting to single grained; loose; medium acid.

The solum ranges from 40 to 60 inches in thickness. Depth to coarse-textured material is more than 50 inches. The A1 horizon is black (10YR 2/1 or 2/0) or very dark brown (10YR 2/2) in the upper part and very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in the lower part. The A1 horizon ranges from loam to light silty clay loam that is high in sand. It is 24 to 30 inches thick and ranges from medium acid to neutral. The B horizon is dark very grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2 or 2.5Y 4/2) in the upper part. It dominantly is grayish brown (10YR 5/2 or 2.5Y 5/2) and has prominent mottles in the lower part, but it is olive gray (5Y 5/2) below a depth of 40 inches. The B horizon ranges from loam to light silty clay loam that is high in sand and light clay loam. It is 20 to 30 inches thick and ranges from medium acid to neutral.

Turlin soils are near Lawler and Marshan soils and formed in parent material similar to that of Coland soils. They have a thicker A horizon and are deeper to coarse-textured or contrasting material than Lawler and Marshan soils. They have a thinner A horizon and a browner B horizon than Coland soils.

**96—Turlin loam, 0 to 2 percent slopes.** This nearly level soil is on bottom lands along perennial streams. Areas generally are 5 to 10 acres in size and irregular in shape.

Included with this soil in mapping are a few small areas of soils that have sand throughout and are low in available water capacity. Also included are some areas of wet, poorly drained soils that require artificial drainage.

This Turlin soil is well suited to corn, soybeans, small grain, and hay. Farming operations are delayed in some years because of wetness caused by a seasonal high water table, slow surface runoff, or occasional flooding in the lower unprotected areas. The organic-matter content is high. Capability unit I–1.

## Waukee Series

The Waukee series consists of deep, nearly level to gently sloping, well-drained soils on stream benches. These soils formed in loamy alluvium and the underlying sand and gravel. The native vegetation was prairie grasses. Slopes are 0 to 5 percent.

In a representative profile the surface layer is black and very dark brown loam about 17 inches thick. The subsoil extends to a depth of 37 inches. The upper part is brown, friable loam and light clay loam; the middle part is dark yellowish-brown, friable loam; and the lower part is dark yellowish-brown, very friable light sandy loam. The substratum is yellowish-brown, loose, loamy sand that has some gravel.

Waukee soils have moderate permeability in the surface layer and subsoil and rapid to very rapid permeability in the substratum. Available water capacity is moderate. The subsoil is low in available phosphorus and very low in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Waukee soils are used mainly for cultivated crops and hay. The gently sloping areas are subject to a slight hazard of erosion. These soils are droughty in places during years of below-normal rainfall.

Representative profile of Waukee loam, 0 to 2 percent slopes, in a hayfield, 410 feet north and 123 feet east of the southwest corner of NW¼ sec. 31, T. 89 N., R. 15 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; moderate, medium, subangular blocky structure; friable; slightly acid; clear boundary.

A12—7 to 17 inches, very dark brown (10YR 2/2) loam; strong, very fine to fine, subangular blocky structure; friable; strongly acid; clear boundary.

B1—17 to 25 inches, brown (10YR 4/3) loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, fine, subangular blocky structure; friable; strongly acid; clear boundary.

B21—25 to 29 inches, brown (10YR 4/3) light clay loam; moderate, medium, subangular blocky structure; friable; medium acid; gradual boundary.

B22—29 to 33 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; abrupt boundary.

B3—33 to 37 inches, dark yellowish-brown (10YR 4/4) light sandy loam; weak, coarse, subangular blocky structure; very friable; strongly acid; abrupt boundary.

IIC—37 to 60 inches, yellowish-brown (10YR 5/6) loamy sand that has some gravel; single grained; loose; strongly acid.

The solum ranges from 24 to 48 inches in thickness. Depth to sand and gravel ranges from 24 to 40 inches. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) loam or silt loam that is high in sand. It is 12 to 20 inches thick and is slightly acid to medium acid. The B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 to 6. It generally ranges from light sandy loam to loam, light clay loam, or sandy clay loam, but in places it is loamy sand in the lower part. The B horizon is 15 to 20 inches thick and is medium acid to strongly acid. The IIC horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 to 8. It ranges from loamy sand to gravelly sand and is slightly acid to strongly acid.

Waukee soils are near Lawson, Nevin, Turlin, and Wiota soils and formed in parent material similar to that of Lawler and Saude soils. They have more sand and gravel within a depth of 40 inches than Lawson, Nevin, Turlin, and Wiota soils. They have higher chroma in the upper part of the B horizon than Lawler soils and have more clay in the A horizon and upper part of the B horizon than Saude soils.

**178—Waukee loam, 0 to 2 percent slopes.** This nearly level soil is on stream benches along major streams. Areas generally are less than 10 acres in size and irregular in shape.

This soil has the profile described as representative of the series. Included in mapping are a few small areas of soils that are sandy. Available water capacity is lower than that of this Waukee soil. These soils are identified on the soil map by a spot symbol.

This Waukee soil is well suited to corn, soybeans, small grain, and alfalfa. It is droughty in years when rainfall is below normal or is untimely. Available water capacity is moderate. The organic-matter content is high. Capability unit I–2.

**178B—Waukee loam, 2 to 5 percent slopes.** This gently sloping soil is on stream benches along major streams. Areas generally are less than 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 10 inches thick. Included in mapping are a few small areas of soils that have a sandy surface layer and are low in available water capacity.

This Waukee soil is well suited to corn, soybeans, small grain, and alfalfa. It is subject to a slight hazard of erosion and generally is droughty in years when rainfall is below normal or is untimely. Available water capacity is moderate. The organic-matter content is high. Capability unit IIe–2.

## Wiota Series

The Wiota series consists of deep, nearly level, well-drained and moderately well-drained soils on stream benches and alluvial fans above flood plains. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is very dark brown, very dark grayish-brown, and dark-brown silt loam and silty clay loam about 18 inches thick. The upper part of the subsoil, to a depth of 59 inches, is brown to dark-brown, very friable sandy loam.

Wiota soils have moderate permeability. Available water capacity is high. Content of available phosphorus is very low, and content of available potassium is low. The surface layer generally is acid where it has not been limed within the past 5 years.

Wiota soils are used mainly for cultivated row crops, small grain, and hay. They are not subject to any significant hazards or limitations.

Representative profile of Wiota silt loam, 0 to 2 percent slopes, in an asparagus field, 66 feet north and 1,040 feet west of the southeast corner of SE¼ sec. 18, T. 87 N., R. 15 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) silt loam; black (10YR 2/1) coatings on peds; moderate, medium, subangular blocky structure parting to weak, medium, granular; friable; neutral; clear, smooth boundary.

A12—8 to 13 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; very dark gray (10YR 3/1) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; clear; smooth boundary.

A3—13 to 18 inches, dark-brown (10YR 3/3) silty clay loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B1—18 to 25 inches, brown to dark-brown (10YR 4/3) silty clay loam; dark-brown (10YR 3/3) coatings on peds; moderate, medium, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B21t—25 to 35 inches, brown to dark-brown (10YR 4/3) silty clay loam; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; friable; many thin clay films on faces of peds and in pores; few, light-gray very fine sand and silt grains on faces of peds when dry; medium acid; clear, smooth boundary.

B22t—35 to 45 inches, brown to dark-brown (10YR 4/3) silty clay loam; few fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; many thin clay films on faces of peds and in pores; common, light-gray (10YR 7/1) very fine sand and silt grains on faces of peds when dry; medium acid; clear, smooth boundary.

B23t—45 to 53 inches, brown to dark-brown (10YR 4/3) silty clay loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; many thin clay films on faces of peds and in pores; many, light-gray (10YR 7/1) very fine sand and silt grains on faces of peds when dry; medium acid; clear smooth boundary.

B31—53 to 59 inches, brown to dark-brown (10YR 4/3) silty clay loam; weak, medium, subangular blocky structure; friable; common thin clay films on faces of peds and in pores; many, light-gray (10YR 7/1) very fine sand and silt grains on faces of peds when dry; medium acid; abrupt, smooth boundary.

IIB32—59 to 69 inches, brown to dark-brown (10YR 4/3) sandy loam; weak, medium, subangular blocky structure; very friable; medium acid.

The solum ranges from 36 inches to more than 60 inches in thickness. Depth to coarse-textured material is more than 50 inches. The A1 horizon ranges from black (10YR 2/1 or N 2/0) to very dark brown (10YR 2/2) in the upper part and very dark gray (10YR 3/1) to dark brown (10YR 3/3) in the lower part. It is silt loam to silty clay loam 8 to 24 inches thick and ranges from slightly acid to strongly acid unless limed. The B2t horizon is 10 to 30 inches thick and is slightly acid or medium acid. The B3 horizon ranges from silt loam to silty clay loam and in places has sandy strata below a depth of 50 inches.

These Wiota soils have less increase in content of clay from the A horizon to the B horizon than is defined as within the range for the series, but this difference does not affect the use and behavior of the soil.

Wiota soils are near Bremer, Colo, Lawson, and the bench phase of Tama soils and formed in parent material similar to that of Nevin soils. They have a browner B horizon than poorly drained Bremer and Colo soils and somewhat poorly drained Lawson and Nevin soils. They contain more very fine sand than Tama soils.

**7—Wiota silt loam, 0 to 2 percent slopes.** This nearly level soil is on stream benches and alluvial fans. Areas generally are 10 to 30 acres in size and irregular in shape.

Included with this soil in mapping are a few small areas of soils that have loamy sand throughout or have a sandy substratum within a depth of 40 inches. These soils are somewhat excessively drained and are droughty. Also included are a few areas of wet soils that delay farming operations in places and require artificial drainage.

This Wiota soil is very well suited to corn, soybeans, small grain, and hay. The organic-matter content is high. Capability unit I–1.

## Zook Series

The Zook series consists of deep, nearly level, poorly drained soils on concave bottom land at the foot of escarpments. These soils formed in silty alluvium that contains less than 15 percent sand. The native vegetation was prairie grasses. Slopes are 0 to 1 percent.

In a representative profile the surface layer is black heavy silty clay loam and silty clay about 28 inches thick. The subsoil extends to a depth of 60 inches. The upper part is black, firm silty clay that has distinct mottles, and the lower part is black, firm heavy silty clay loam that has distinct mottles.

Zook soils have slow permeability. Available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium. The surface layer generally is acid where it has not been limed within the past 5 years.

Zook soils are used mainly for cultivated crops, hay, and pasture. The main limitations are wetness and occasional ponding or flooding.

Representative profile of Zook silty clay loam, 0 to 1 percent slopes, in a hayfield, 260 feet west and 300 feet south of the northeast corner of SE¼NW¼ sec. 7, T. 87 N., R. 16 W.:

Ap—0 to 7 inches, black (N 2/0) heavy silty clay loam; moderate, medium, subangular blocky structure; friable; neutral; clear boundary.

A12—7 to 11 inches, black (N 2/0) silty clay; moderate, fine, granular structure; friable; slightly acid; gradual boundary.

A13—11 to 20 inches, black (N 2/0) silty clay; moderate, fine, granular structure; friable; neutral; clear boundary.

A3—20 to 28 inches, black (N 2/0) silty clay; strong, fine, prismatic structure parting to strong, fine, subangular blocky; firm; sheen on faces of peds; neutral; gradual boundary.

B2g—28 to 42 inches, black (5Y 2/1) silty clay; few, fine, distinct, olive-gray (5Y 5/2) mottles; strong, medium, prismatic structure parting to moderate, medium, angular and subangular blocky; firm; sheen on faces of peds; neutral; diffuse boundary.

B3g—42 to 60 inches, mottled black (5Y 2/1) and olive (5Y 5/6) heavy silty clay loam; common, fine, prominent, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure parting to moderate, medium, angular and subangular blocky; sheen on faces of peds; neutral.

The solum ranges from 36 to 64 inches in thickness. The A horizon is black (10YR 2/1 or N 2/0) silty clay loam to silty clay 26 to 40 inches thick and is neutral to medium acid. The B horizon ranges from black (5Y 2/2 or 2/1) to very dark gray (10YR 3/1) or dark gray (10YR 4/1). It is 10 or more inches thick and ranges from medium acid to mildly alkaline.

Zook soils are near Bremer and Colo soils and formed in similar parent material. They have more clay in the A horizon and lower color value in the B horizon than Bremer soils. They have more clay throughout than Colo soils.

**54—Zook silty clay loam, 0 to 1 percent slopes.** This nearly level soil is on concave bottoms adjacent to upland foot slopes or bench escarpments. Areas are less than 10 acres in size and long and narrow in shape.

This Zook soil is moderately well suited to corn, soybeans, small grain, asparagus, and hay if adequately drained. It is subject to wetness because of a high water table, ponding, and occasional flooding. Tile may not sufficiently drain the areas in places. In these places, surface drains may be needed. The organic-matter content is high. Capability unit IIw–3.

## *Use and Management of the Soils*

This section briefly discusses the use and management of the soils in the county for crops and pasture. It explains the capability classfication system used by the Soil Conservation Service; describes the use and management of groups of soils by capability units; and gives predicted yields for the principal crops grown in the county. In addition, it briefly discusses wildlife and gives facts about the soils that affect their suitability for engineering (fig. 6) and some nonfarm uses.

The information given in this section is not a substitute for the detailed advice that can be provided by

*Figure 6.*—**Pollution-control structure designed for cattle-feeding operation.**

a local representative of the Soil Conservation Service or by the County Extension Director. It may, however, help farmers or others plan suitable management for the soils.

## General Management for Crops

According to the 1970 census, 98 percent of Grundy County, or 315,234 acres, is in farms, of which 235,750 acres is used for crops. More than 99 percent of the cropland is in corn, soybeans, oats, and hay.

The main concerns in management are controlling erosion and soil blowing, draining wet areas, and maintaining tilth and the level of fertility.

Most pastures are in permanent bluegrass. They are naturally wet, but many are drained and used for crops each year. The Clyde-Floyd complex and the Clyde, Coland, Colo, Garwin, Marshan, and Sawmill silty clay loams are the main soils that benefit from tile drainage. Many of these soils have been drained.

Erosion control is needed mainly on Dickinson, Dinsdale, Kenyon, Lilah, Ostrander, Port Byron, Saude, and Tama soils (fig. 7). The most effective erosion-control measures are use of terraces that have tile outlets, minimum tillage (fig. 8), crop-residue management, contour farming, and grassed waterways.

Stones need to be removed before soils in the Clyde-Floyd complex can be cropped. Lime is needed on some soils.

### *Capability grouping*

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering. A complete discussion of the capability classification is given in Agriculture Handbook 210, Land Capability Classification (*15*).

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

*Figure 7.*—**Rill erosion on Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded.**

- Class I soils have few limitations that restrict their use.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat. (None in Grundy County)
- Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes. (None in Grundy County)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage) ; *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in some parts of the United States but not in Iowa, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w, s,* and *c,* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIs–3. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Grundy County are described, and suggestions for the management of the soils are given. The names of soil series are mentioned in the description of each capability unit, but this does not mean that all the soils of a given series are in the unit.

#### CAPABILITY UNIT I–1

This unit consists of deep, nearly level, well drained to somewhat poorly drained soils of the Klinger, Lawson, Muscatine, Nevin, Readlyn, Tama, Turlin, and Wiota series. These soils have a surface layer of loam, silty clay loam, or silt loam. The subsoil is loam, clay loam, silt loam, or silty clay loam. Available water capacity is high, and permeability is moderate or moderately slow. Runoff is slow to medium. Turlin soils are subject to occasional flooding.

The soils in this unit have good tilth. Klinger, Lawson, Muscatine, Nevin, Readlyn, and Turlin soils benefit from tile drainage in some years.

These soils are used mainly for corn and soybeans. They are occasionally used for small grain and alfalfa.

#### CAPABILITY UNIT I–2

This unit consists of deep, nearly level, well drained to somewhat poorly drained soils of the Lawler and Waukee series. These soils have a surface layer of

*Figure 8.*—**Contour minimum tillage on Tama silty clay loam, 2 to 5 percent slopes.**

loam or silt loam and a subsoil of heavy sandy loam, stratum is loamy sand or gravelly loamy sand. Available water capacity is moderate. Permeability is moderate in the upper part of the profile and rapid to very rapid in the lower part. Runoff is slow to medium.

The soils in this unit have good tilth. Lawler soils benefit from tile drainage in some years when rainfall is above normal. The soils in this unit are droughty in some years when rainfall is below normal.

These soils are used mainly for corn, soybeans, small grain, and alfalfa.

#### CAPABILITY UNIT IIe-1

This unit consists of deep, gently sloping, well drained to moderately well drained soils of the Dinsdale, Kenyon, and Tama series. These soils have a surface layer of loam, silt loam, or silty clay loam. The subsoil is loam, clay loam, or silty clay loam. Available water capacity is high. Permeability is moderate and moderately slow. Runoff is medium.

The soils in this unit generally have good tilth, which is maintained by returning crop residue to the soil. Water erosion and soil blowing are hazards on all of these soils (fig. 9). Terrace cuts should be held to a minimum to avoid exposure of the less productive glacial till subsoil of the Kenyon soils.

These soils are used mainly for corn, soybeans, small grain, and alfalfa.

#### CAPABILITY UNIT IIe-2

This unit consists of deep, gently sloping, well-drained soils of the Bolan, Ostrander, and Waukee series. These soils have a surface layer of loam or silt loam and a subsoil of sandy loam, loam, silt loam, silty clay loam, or clay loam. The substratum is loam, sandy loam, or loamy sand. Available water capacity is moderate. Permeability is moderate in the upper part of the Bolan and Waukee soils and moderately rapid to very rapid in the lower part. The Ostrander soils are moderately permeable to a depth of about 20 inches, moderately rapidly permeable between depths of 20 and 36 inches, and moderately slowly permeable below. Runoff is medium.

The soils in this unit generally have good tilth, which is maintained by returning crop residue to the soil. Water erosion and soil blowing are hazards on all of these soils. These soils are droughty in some years when rainfall is below normal or is untimely.

These soils are used mainly for corn, soybeans, small grain, and alfalfa.

#### CAPABILITY UNIT IIe-3

This unit consists of moderately deep, gently sloping, well-drained Saude loam, 2 to 5 percent slopes. This soil has a surface layer of loam and a subsoil of light loam and gravelly loamy sand. The substratum is gravelly loamy sand or sand. Available water capacity is low. Permeability is moderate to moderately rapid in the upper part of the profile and rapid to very rapid in the lower part. Runoff is medium.

The soil in this unit generally has good tilth, which is maintained by returning plant residue to the soil. It is droughty in years when rainfall is average or below normal. Water erosion is a slight hazard.

This soil is used mainly for corn, soybeans, small grain, and pasture.

*Figure 9.*—**Soil blowing in area of Dinsdale soils.**

CAPABILITY UNIT IIe-4

This unit consists of deep, gently sloping, somewhat poorly drained Donnan loam, 2 to 6 percent slopes. This soil has a surface layer of loam and clay loam. The subsoil is clay loam and silty clay. Available water capacity is high. Permeability is moderate to moderately slow in the upper part of the subsoil and very slow in the lower part. Runoff is slow to medium.

The soil in this unit is difficult to work, and it stays wet for a longer period than its associated soils. Tile drainage is difficult unless the tile is placed above the very slowly permeable lower part of the subsoil. Water erosion is a slight to moderate hazard. The problems of providing adequate drainage and controlling erosion are difficult because they conflict to some extent.

This soil is used mainly for corn, soybeans, small grain, and pasture.

CAPABILITY UNIT IIe-5

This unit consists of deep, gently sloping, somewhat poorly drained soils of the Ely, Klinger, and Muscatine series. These soils have a surface layer of silty clay loam. The subsoil is silty clay loam and clay loam. Available water capacity is high, and permeability is moderate to moderately slow. These soils receive medium runoff from soils above.

The soils in this unit have good tilth, which is maintained by returning crop residue to the soil. Seepage and runoff from soils above cause a wetness problem in some years. Water erosion is a slight hazard when these soils are cultivated. The more nearly level slopes are subject to siltation when the soils above erode.

These soils are used mainly for corn, soybeans, small grain, and hay.

CAPABILITY UNIT IIw-1

This unit consists of deep, nearly level, poorly drained soils of the Clyde, Coland, Colo, Garwin, Maxfield, and Sawmill series. These soils have a surface layer of silty clay loam and clay loam and a subsoil of clay loam, sandy clay loam, or silty clay loam. The substratum is loam, silt loam, silty clay loam, clay loam, or sandy clay loam. Strata of sand occur in places below a depth of 50 inches. Available water capacity is high, and permeability is moderate to moderately slow. Runoff is slow.

The soils in this unit are difficult to work, and tillage must be performed at the proper moisture content to achieve good tilth. Artificial drainage is beneficial on all of these soils (fig. 10). The Clyde soils have stones and boulders in places that require removal before cultivation is practical.

These soils are used mainly for corn, soybeans, small grain, and hay when adequately drained. The undrained areas of Clyde, Coland, Colo, and Sawmill soils generally are in permanent pasture.

CAPABILITY UNIT IIw-2

This unit consists of deep, gently sloping, poorly drained to somewhat poorly drained soils of the Clyde, Floyd, Garwin, and Sawmill series. These soils have a surface layer of loam, silt loam, or silty clay loam. The subsoil is sandy loam, sandy clay loam, light clay loam, or silty clay loam. Available water capacity is high, and permeability is moderate to moderately slow. Runoff is slow to medium.

The soils in this unit require artificial drainage, and tillage must be performed at the proper moisture content to achieve good tilth. Water erosion is a slight hazard on all of these soils, and siltation is a problem on the more level slopes (fig. 11). The Clyde-Floyd complex has stones and boulders in many undrained areas that require removal before cultivation is practical.

These soils are used mainly for corn, soybeans, and small grain or grassed waterways when drained (fig. 12). Undrained areas are generally in permanent pasture (fig. 13).

CAPABILITY UNIT IIw-3

This unit consists of deep, nearly level, poorly drained soils of the Bremer and Zook series. These soils have a surface layer of silty clay loam. The subsoil is heavy silty clay loam or silty clay. Available water capacity is high, and permeability is slow. Runoff is slow to very slow.

The soils in this unit are difficult to work, and tillage must be performed at the proper moisture content to achieve good tilth. Artificial drainage is beneficial on these soils.

These soils are used mainly for corn, soybeans, asparagus, small grain, and hay when adequately drained. The undrained areas generally are in permanent pasture.

CAPABILITY UNIT IIw-4

This unit consists of deep, nearly level, poorly drained soils of the Calco and Harpster series. These soils have a surface layer and subsoil of silty clay loam. They are highly calcareous. Available water ca-

***Figure 10.*—Drainage tile ready for installation on Sawmill-Garwin silty clay loams. Muscatine and Tama soils are in the background.**

pacity is high, and permeability is moderately slow. Runoff is very slow.

The soils in this unit require artificial drainage, and tillage must be performed at the proper moisture content to keep good tilth. These soils contain excess lime and require special applications of phosphorus and potassium fertilizer.

These soils are used mainly for corn, soybeans, small grain, and hay when adequately drained. Undrained areas of Calco soils are used mainly for pasture.

###### CAPABILITY UNIT IIw-5

This unit consists of deep, nearly level, poorly drained Marshan silty clay loam, deep, 0 to 2 percent slopes. This soil has a surface layer of silty clay loam to clay loam and a subsoil of light clay loam and sandy loam. The substratum is loose gravelly loamy sand. Available water capacity is moderate. Permeability is moderate in the upper part of the profile and moderately rapid in the lower part. Runoff is very slow.

The soil in this unit requires artificial drainage, and tillage must be performed at the proper moisture content to achieve good tilth. This soil is flooded at times in the lower, unprotected areas.

This soil is used mainly for corn, soybeans, small grain, and hay when adequately drained. The undrained areas are used mainly for pasture.

###### CAPABILITY UNIT IIs-1

This unit consists of moderately deep, nearly level, well drained or somewhat poorly drained soils of the Lawler and Saude series. These soils have a surface layer of silt loam and loam. The subsoil is light silty clay loam to loam in the upper part and gravelly loamy sand in the lower part. Available water capacity is low or moderate. Permeability is moderate in the upper part of the profile and rapid to very rapid in the lower part. Runoff is slow.

The soils in this unit generally have good tilth, which is maintained or improved by returning crop residue to the soil. These soils are droughty in years when rainfall is average or below normal. Field operations on the Lawler soils are delayed because of wetness in some years.

These soils are used mainly for corn, soybeans, small grain, and hay.

###### CAPABILITY UNIT IIIe-1

This unit consists of deep, moderately sloping, well drained and moderately well drained soils of the Dinsdale, Kenyon, Port Byron, and Tama series. These soils have a surface layer of loam, silt loam, and silty clay loam. The subsoil is loam, clay loam, and silty clay loam. Available water capacity is high, and permeability is moderate and moderately slow. Runoff is

*Figure 11.*—Erosion and siltation on Sawmill-Garwin silty clay loams.

*Figure 12.*—Grassed waterway, drop structure, and tile outlet on Sawmill-Garwin silty clay loams.

*Figure 13.*—**Poorly drained areas of Clyde-Floyd complex used for permanent pasture.**

medium to rapid. Some of these soils are moderately eroded.

The soils in this unit generally have good tilth, which is maintained by returning crop residue to the soil. Water erosion is a moderate hazard on all of these soils. Conservation practices are necessary to control erosion and prevent siltation (fig. 14) when these soils are used for row crops.

These soils are used mainly for corn, soybeans, small grain, and alfalfa.

#### CAPABILITY UNIT IIIe-2

This unit consists of deep, strongly sloping, well-drained soils of the Dinsdale and Kenyon series. These soils have a surface layer of silty clay loam and loam. The subsoil is loam, clay loam, or silty clay loam. Available water capacity is high, and permeability is moderate and moderately slow. Runoff is rapid. These soils are moderately eroded.

The soils in this unit have fairly good tilth, which is maintained and improved by returning crop residue to the soil. Water erosion is a moderate to severe hazard on all of these soils. Conservation practices are necessary to control erosion and reduce siltation when these soils are used for row crops.

These soils are used mainly for corn, soybeans, small grain, and alfalfa.

#### CAPABILITY UNIT IIIe-3

This unit consists of moderately deep to deep, gently sloping to moderately sloping, well drained to somewhat excessively drained soils of the Dickinson, Ostrander, and Saude series. These soils have a surface layer of fine sandy loam and loam, and a subsoil of loam, sandy loam, and gravelly loamy sand. The substratum is loam, sand, and gravelly coarse sand. Available water capacity is moderate to low. Permeability of the Dickinson and Saude soils is moderate or moderately rapid in the upper part of the profile and rapid to very rapid in the lower part. The Ostrander soils are moderately permeable to a depth of 20 inches, moderately rapidly permeable between depths of 20 and 36 inches, and moderately slowly permeable below. Runoff is medium. Some of these soils are moderately eroded.

The soils in this unit generally have good tilth, which is maintained or improved by returning crop residue to the soil. These soils are droughty. Water erosion is a slight hazard on the gently sloping Dickinson soils and a slight to moderate hazard on all of the

*Figure 14.*—Parallel terraces provided with tile outlets on Tama soils. The backslope of the terraces is seeded to grass.

other soils. Soil blowing is also a slight hazard on the Dickinson soils.

These soils are used for corn, soybeans, small grain, and pasture.

#### CAPABILITY UNIT IIIw–1

This unit consists only of Palms muck, 1 to 3 percent slopes. This is a deep, concave, nearly level to gently sloping, very poorly drained, organic soil. The surface layer is muck. The underlying mineral soil material is silty clay loam. Available water capacity is very high. Permeability is moderately rapid to rapid in the organic material and moderately slow to moderate in the underlying mineral soil material. Runoff is very slow, and ponding is frequent.

This soil is very difficult to till unless it is drained (fig. 15). Artificial drainage is difficult but beneficial on this soil.

This soil is used mainly for pasture and is suited to other less intensive uses. When sufficiently drained it is suited to corn, soybeans, small grain, and hay.

#### CAPABILITY UNIT IIIw–2

This unit consists of deep, concave, nearly level, poorly drained to very poorly drained soils of the Sperry and Thorp series. These soils have a surface layer of silt loam. The subsoil is silty clay or heavy silty clay loam. Available water capacity is high, and permeability is slow. Runoff is very slow, and ponding is frequent.

The soils in this unit are difficult to work, and tillage must be performed at the proper moisture content to achieve good tilth. Artificial drainage on these soils is necessary for good production.

These soils are used mainly for the same crops as adjoining soils. They are moderately well suited to corn, soybeans, small grain, and hay when adequately drained. The undrained areas are suited to pasture and to other less intensive uses.

#### CAPABILITY UNIT IVe–1

This unit consists of moderately deep to shallow, gently sloping to moderately sloping, somewhat excessively drained to excessively drained soils of the Saude-Lilah complex, 2 to 5 percent slopes. These soils have a surface layer and subsoil of silt loam that is high in sand and of gravelly sandy loam. The substratum is loamy sand to fine and coarse sand. Available water capacity is moderate to very low. Permeability is moderate to rapid in the upper part of the profile and rapid to very rapid in the lower part. Runoff is medium to slow. These soils are moderately eroded.

The soils in this unit generally have good tilth, which is maintained or improved by returning crop residue to the soil. These soils are droughty, and water erosion is a moderate to severe hazard. Conservation practices are necessary to control erosion and conserve moisture for optimum production. Exposure of the subsoil in terrace construction should be avoided, because

***Figure 15.*—Undrained area of Palms muck.**

it is very droughty and does not respond well to fertilization.

These soils are used mainly for pasture. They are poorly suited to row crops and hay.

#### CAPABILITY UNIT $IV_s$-1

This unit consists of deep, gently sloping, excessively drained Sparta loamy fine sand, 2 to 5 percent slopes. This soil has a surface layer of loamy fine sand. The subsoil is fine sand. Available water capacity is very low, and permeability is rapid. Runoff is slow.

The soil in this unit generally has good tilth, which is improved by returning crop residue to the soil. This soil is droughty. Soil blowing is a moderate hazard, and water erosion is a slight hazard. Practices to conserve moisture and control soil blowing are beneficial on this soil.

This soil is used mainly for pasture. It is poorly suited to row crops and hay.

#### CAPABILITY UNIT $IV_s$-2

This unit consists of shallow, gently sloping to moderately sloping, excessively drained Lilah sandy loam, 3 to 9 percent slopes, moderately eroded. This soil has a surface layer of gravelly sandy loam and a subsoil of gravelly loamy sand and loamy sand. The substratum is gravelly loamy sand and fine to medium sand. Available water capacity is very low. Permeability is rapid in the upper part of the profile and very rapid in the lower part. Runoff is slow. Some areas of the moderately sloping soils are severely eroded.

The soil in this unit is droughty and generally has good tilth, which is improved by returning crop residue to the soil. Water erosion is a slight to moderate hazard. Practices are necessary to conserve moisture for optimum production.

This soil is used mainly for pasture and is suited to less intensive uses. It is poorly suited to cultivated crops and hay.

#### CAPABILITY UNIT $V_w$-1

This unit consists only of deep, nearly level, poorly drained Colo silty clay loam, channeled, 0 to 2 percent slopes. This soil has a surface layer and subsoil of silty clay loam. Available water capacity is high, and permeability is moderately slow. Runoff is very slow. The soil is subject to ponding and frequent flooding and is dissected by meandering stream channels (fig. 16).

The soil in this unit is poorly suited to cultivated crops because of frequent flooding and the need for major reclamation. Water erosion and deposition are moderate to severe hazards.

This soil is not cultivated, because of the meandering stream channels, the oxbows, and the frequency of flooding. It is used mainly for pasture or other less intensive uses.

#### CAPABILITY UNIT $VI_e$-1

This unit consists of deep, hilly, well-drained Port Byron silt loam, 9 to 18 percent slopes, severely eroded. This soil is silt loam throughout. Available water capacity is high, and permeability is moderate. Runoff is rapid. This soil is severely eroded and has a thin surface layer. Some areas have accumulations of lime on the surface.

The soil is subject to a severe hazard of erosion. If cultivated, it should be terraced to prevent washing out of crops and to reduce siltation below and in streams. The cuts made by terracing respond well to fertilizer and the addition of organic matter by such means as growing green-manure crops and returning all crop residue to the soil.

This soil is best suited to pasture and hay. It is not suited to cultivated crops unless conservation practices are used. It is planted to a rotation that includes meadow crops.

#### CAPABILITY UNIT $VI_s$-1

This unit consists of moderately deep to shallow, strongly sloping, somewhat excessively drained to excessively drained, rolling soils of the Saude-Lilah complex, 5 to 14 percent slopes, moderately eroded. These soils have a surface layer of gravelly sandy loam or silt loam that is high in sand, and a subsoil of sandy loam, gravelly loamy sand, or silt loam that is high in sand. The substratum is loamy sand to fine and coarse sand. Available water capacity is moderate to very low. Permeability is moderate to rapid in the upper part of the profile and rapid to very rapid in the lower part. Runoff is medium. These soils are moderately eroded.

*Figure 16.*—Area of Colo silty clay loam, channeled. This soil is subject to frequent overflow.

The soils in this unit are limited by a severe hazard of erosion and by droughtiness. Terraces are not recommended where cuts expose the subsoil, because it is very droughty. Plants growing on the exposed subsoil do not respond well to fertilizer. Overgrazing of pastures increases the hazard of erosion on these soils.

These soils are better suited to permanent pasture than to most other uses. They are not suited to cultivated crops and hay. In small areas near more productive soils, these soils are used for cultivated crops or hay, but yields are low to very low.

### *Predicted yields*

Table 2 lists the average yields per acre of the principal crops under a high level of management. Under this level of management: (1) seedbed preparation, planting, and tillage practices provide for adequate stands of adapted varieties; (2) erosion is controlled; (3) organic-matter content and tilth are maintained; (4) the level of fertility for each crop is maintained (as indicated by soil tests and field trials); (5) the water level in wet soils is controlled; (6) excellent weed and pest control are provided; (7) and operations are timely.

Many available sources of yield information were used to make these estimates, including data from the Federal census, the Iowa farm census, experimental farms, cooperative experiments with farmers, and on-farm experiences of soil scientists, extension workers, and others.

The yield predictions are meant to serve as guides and are only approximate values. Many users will consider a comparison of yields between soils to be of more value than the actual yields. On the other hand, actual yields have been increasing in recent years. If they continue to increase as expected, predicted yields in this table will soon be too low.

## Wildlife[3]

Proper plant cover, determined mainly by soil characteristics, is a basic requirement of all wildlife populations. Other soil characteristics, such as slope, permeability, and drainage, determine the potential for developing natural wet areas for waterfowl or constructing ponds for fish. This combination of plant cover and specific soil characteristics allows identification of the three kinds of wildlife in Grundy County: woodland, wetland, and open-land wildlife. Other factors, such as disease, extreme weather conditions, predation, and hunting pressure, affect wildlife populations. Therefore, good wildlife habitat is not a guarantee of abundant wildlife populations.

Table 3 shows the suitability of each soil series in

[3] This section was prepared by BILL D. WELKER, biologist, Soil Conservation Service.

TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*

[Absence of a yield indicates that the crop is not suited to the soil or generally is not grown]

| Soil | Corn | Soybeans | Oats | Alfalfa-brome | |
|---|---|---|---|---|---|
| | | | | Hay | Pasture |
| | *Bu* | *Bu* | *Bu* | *Tons* | *AUD* [1] |
| Bolan loam, 2 to 5 percent slopes | 96 | 36 | 77 | 3.7 | 185 |
| Bremer silty clay loam, 0 to 2 percent slopes | 106 | 40 | 80 | 4.5 | 225 |
| Calco silty clay loam, 0 to 2 percent slopes | 99 | 38 | 84 | 4.0 | 200 |
| Clyde silty clay loam, 0 to 3 percent slopes | 102 | 39 | 82 | 4.0 | 200 |
| Clyde-Floyd complex, 1 to 4 percent slopes | 104 | 40 | 83 | 4.2 | 210 |
| Coland silty clay loam, 0 to 2 percent slopes | 104 | 40 | 78 | 4.2 | 210 |
| Colo silty clay loam, 0 to 2 percent slopes | 104 | 40 | 78 | 4.2 | 210 |
| Colo silty clay loam, channeled, 0 to 2 percent slopes | | | | | |
| Dickinson fine sandy loam, 2 to 5 percent slopes | 81 | 31 | 60 | 3.0 | 150 |
| Dickinson fine sandy loam, 5 to 9 percent slopes | 76 | 29 | 57 | 2.8 | 140 |
| Dinsdale silty clay loam, 2 to 5 percent slopes | 119 | 45 | 89 | 5.0 | 250 |
| Dinsdale silty clay loam, 5 to 9 percent slopes | 114 | 43 | 85 | 4.8 | 240 |
| Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded | 111 | 42 | 83 | 4.6 | 230 |
| Dinsdale silty clay loam, 9 to 14 percent slopes, moderately eroded | 102 | 39 | 76 | 4.4 | 220 |
| Donnan loam, 2 to 6 percent slopes | 70 | 26 | 56 | 2.8 | 140 |
| Ely silty clay loam, 2 to 5 percent slopes | 124 | 47 | 93 | 5.3 | 265 |
| Floyd loam, 1 to 4 percent slopes | 106 | 40 | 85 | 4.5 | 225 |
| Garwin silty clay loam, 0 to 2 percent slopes | 125 | 47 | 94 | 5.0 | 250 |
| Harpster silty clay loam, 0 to 2 percent slopes | 115 | 44 | 92 | 4.8 | 240 |
| Kenyon loam, 2 to 5 percent slopes | 113 | 43 | 90 | 4.7 | 235 |
| Kenyon loam, 5 to 9 percent slopes | 108 | 41 | 86 | 4.5 | 225 |
| Kenyon loam, 5 to 9 percent slopes, moderately eroded | 105 | 40 | 84 | 4.4 | 220 |
| Kenyon loam, 9 to 14 percent slopes, moderately eroded | 96 | 36 | 76 | 4.0 | 200 |
| Klinger silty clay loam, 0 to 2 percent slopes | 125 | 47 | 93 | 5.2 | 260 |
| Klinger silty clay loam, 2 to 5 percent slopes | 123 | 46 | 92 | 5.1 | 255 |
| Lawler silt loam, deep, 0 to 2 percent slopes | 100 | 38 | 80 | 4.2 | 210 |
| Lawler silt loam, moderately deep, 0 to 2 percent slopes | 85 | 32 | 68 | 3.6 | 180 |
| Lawson silt loam, 0 to 2 percent slopes | 119 | 45 | 90 | 5.0 | 250 |
| Lilah sandy loam, 3 to 9 percent slopes, moderately eroded | 36 | 13 | 28 | 1.2 | 60 |
| Marshan silty clay loam, deep, 0 to 2 percent slopes | 101 | 38 | 81 | 4.0 | 200 |
| Maxfield silty clay loam, 0 to 2 percent slopes | 119 | 45 | 89 | 5.0 | 250 |
| Muscatine silty clay loam, 0 to 2 percent slopes | 131 | 50 | 98 | 5.5 | 275 |
| Muscatine silty clay loam, 2 to 5 percent slopes | 129 | 49 | 96 | 5.5 | 275 |
| Muscatine silty clay loam, benches, 0 to 2 percent slopes | 131 | 50 | 98 | 5.5 | 275 |
| Nevin silty clay loam, 0 to 2 percent slopes | 114 | 43 | 85 | 4.8 | 240 |
| Ostrander loam, 2 to 5 percent slopes | 113 | 43 | 90 | 4.7 | 235 |
| Ostrander loam, 5 to 9 percent slopes | 108 | 41 | 86 | 4.5 | 225 |
| Ostrander loam, 5 to 9 percent slopes, moderately eroded | 105 | 40 | 84 | 4.4 | 220 |
| Palms muck, 1 to 3 percent slopes | 80 | 30 | 64 | 3.2 | 160 |
| Port Byron silt loam, 5 to 9 percent slopes, moderately eroded | 117 | 44 | 88 | 4.9 | 245 |
| Port Byron silt loam, 9 to 18 percent slopes, severely eroded | | | 57 | 3.0 | 150 |
| Readlyn loam, 0 to 2 percent slopes | 115 | 44 | 92 | 4.8 | 240 |
| Saude loam, 0 to 2 percent slopes | 85 | 32 | 68 | 3.6 | 180 |
| Saude loam, 2 to 5 percent slopes | 83 | 31 | 67 | 3.5 | 175 |
| Saude loam, 5 to 9 percent slopes | 78 | 29 | 62 | 3.3 | 165 |
| Saude loam, 5 to 9 percent slopes, moderately eroded | 75 | 28 | 60 | 3.2 | 160 |
| Saude-Lilah complex, 2 to 5 percent slopes | 50 | 19 | 37 | 2.0 | 100 |
| Saude-Lilah complex, 5 to 14 percent slopes, moderately eroded | | | | 1.0 | 50 |
| Sawmill silty clay loam, 0 to 2 percent slopes | 104 | 40 | 83 | 4.4 | 220 |
| Sawmill-Garwin silty clay loams, 1 to 4 percent slopes | 108 | 41 | 81 | 4.5 | 225 |
| Sparta loamy fine sand, 2 to 5 percent slopes | 61 | 23 | 45 | 2.6 | 130 |
| Sperry silt loam, 0 to 1 percent slopes | 97 | 37 | 53 | 3.5 | 175 |
| Tama silty clay loam, 0 to 2 percent slopes | 127 | 48 | 96 | 5.3 | 265 |
| Tama silty clay loam, 2 to 5 percent slopes | 125 | 48 | 95 | 5.2 | 260 |
| Tama silty clay loam, 5 to 9 percent slopes | 120 | 46 | 90 | 5.0 | 250 |
| Tama silty clay loam, 5 to 9 percent slopes, moderately eroded | 117 | 44 | 88 | 4.9 | 245 |
| Tama silty clay loam, benches, 0 to 2 percent slopes | 127 | 48 | 96 | 5.3 | 265 |
| Thorp silt loam, 0 to 2 percent slopes | 90 | 35 | 72 | 3.8 | 160 |
| Turlin loam, 0 to 2 percent slopes | 120 | 45 | 96 | 5.0 | 250 |
| Waukee loam, 0 to 2 percent slopes | 98 | 37 | 78 | 4.1 | 205 |
| Waukee loam, 2 to 5 percent slopes | 96 | 36 | 77 | 4.0 | 200 |
| Wiota silt loam, 0 to 2 percent slopes | 110 | 42 | 88 | 4.6 | 230 |
| Zook silty clay loam, 0 to 1 percent slopes | 96 | 36 | 54 | 3.8 | 190 |

[1] Animal-unit-days (AUD) is a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of days the pasture is grazed during a single grazing season without injury to the sod. An acre of pasture that provides 30 days of grazing for two cows has a carrying capacity of 60 animal-unit-days.

Grundy County for seven habitat elements. Suitability is expressed as good, fair, poor, and very poor. This evaluation is then used to determine the suitability of each soil series for open-land, woodland, or wetland wildlife. Only the soils rated good or fair will adequately sustain wildlife.

In the following paragraphs the suitability of the soil associations, shown on the general soil map, for the kinds of wildlife in Grundy County is evaluated.

The Tama-Muscatine and Dinsdale-Tama-Klinger soil associations are more productive of woodland habitat than others in Grundy County. White-tailed deer are scarce in Grundy County because of a general lack of woodland habitat. The 1973 population was estimated at five deer. The other significant wildlife species that uses woodland habitat is fox squirrel, and its population is low to moderate.

The Tama-Muscatine and Dinsdale-Tama-Klinger soil associations are more productive of open-land wildlife habitat than others in Grundy County. The pheasant population is moderate to high, and most pheasant are produced in the intensively farmed areas. The red fox and cottontail rabbit are also in these associations, and their population is moderate.

The Muscatine-Tama-Garwin soil association is more productive of wetland habitat than others in Grundy County. Waterfowl populations are only moderate because of a general lack of good quality wetland. Farm ponds in the county provide good fishing for largemouth bass, bullhead, bluegill, and channel catfish.

## Engineering Uses of the Soils [4]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the soil properties that are highly important in engineering are permeability, strength, compaction characteristics, drainage condition, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and sewage and refuse disposal systems.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreation areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures that control water and conserve soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4, 5, and 6, which show, respectively, several estimated soil properties significant in engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in table 5, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigation at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially small ones, is needed, because many delineated areas of a given soil mapping unit contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The Glossary defines many of these terms as they are commonly used in soil science.

### *Engineering classification systems*

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*5, 16*), used by the SCS engineers, Department of Defense, and others, and the AASHTO system (*1, 5*), adopted by the American Association of State Highway and Transportation Officials.

In the Unified system, soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 13 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, ML–CL.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7 are clay soils that have low strength when wet and are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5,

[4] DONALD A. ANDERSON, soil engineer, Iowa State Highway Commission, and VOLNEY H. SMITH, assistant State conservation engineer, assisted in preparing this section.

TABLE 3.—*Suitability of the soils for elements*

| Soil series and map symbols | Elements of wildlife habitat | | | |
|---|---|---|---|---|
| | Grain and seed crops | Grasses and legumes | Wild herbaceous plants | Hardwood trees and shrubs |
| Bolan: 174B | Good | Good | Good | Good |
| Bremer: 43 | Fair | Fair | Fair | Fair |
| Calco: 733 | Fair | Fair | Fair | Fair |
| Clyde: | | | | |
| 84 | Fair | Good | Fair | Fair |
| 391B | Fair | Fair | Fair | Fair |
| Coland: 135 | Fair | Fair | Fair | Fair |
| Colo: | | | | |
| 133 | Fair | Fair | Fair | Fair |
| C133 | Poor | Fair | Fair | Fair |
| Dickinson: 175B, 175C | Fair | Fair | Fair | Fair |
| Dinsdale: | | | | |
| 377B | Good | Good | Good | Good |
| 377C, 377C2, 377D2 | Fair | Good | Good | Good |
| Donnan: 782B | Fair | Fair | Fair | Fair |
| Ely: 428B | Fair | Good | Good | Good |
| Floyd: 198B | Fair | Good | Good | Good |
| Garwin: 118 | Fair | Fair | Fair | Fair |
| Harpster: 595 | Fair | Fair | Fair | Fair |
| Kenyon: | | | | |
| 83B | Good | Good | Good | Good |
| 83C, 83C2, 83D2 | Fair | Good | Good | Good |
| Klinger: 184, 184B | Fair | Good | Good | Good |
| Lawler: 225, 226 | Fair | Good | Good | Good |
| Lawson: 484 | Fair | Good | Good | Good |
| Lilah: 776C2 | Poor | Poor | Fair | Poor |
| Marshan: 152 | Fair | Fair | Good | Fair |
| Maxfield: 382 | Fair | Fair | Fair | Fair |
| Muscatine: | | | | |
| 119, T119 | Good | Good | Good | Good |
| 119B | Good | Good | Good | Good |
| Nevin: 88 | Good | Good | Good | Good |
| Ostrander: | | | | |
| 394B | Good | Good | Good | Good |
| 394C, 394C2 | Good | Good | Good | Good |
| Palms: 221 | Poor | Poor | Poor | Poor |
| Port Byron: | | | | |
| 620C2 | Fair | Good | Good | Good |
| 620E3 | Poor | Fair | Good | Good |
| Readlyn: 399 | Fair | Good | Good | Good |
| Saude: | | | | |
| 177, 177B | Good | Good | Good | Good |
| 177C, 177C2 | Fair | Good | Good | Good |
| 241B | Fair to poor | Poor | Poor | Poor |
| 241C2 | Poor | Poor | Poor | Poor |
| Sawmill: | | | | |
| 933 | Fair | Fair | Fair | Fair |
| 933B | Fair | Fair | Fair | Fair |
| Sparta: 41B | Very poor | Poor | Poor | Very poor |
| Sperry: 122 | Very poor | Poor | Poor | Poor |
| Tama: | | | | |
| T120, 120, 120B | Good | Good | Good | Good |
| 120C, 120C2 | Fair | Good | Good | Good |
| Thorp: 404 | Poor | Fair | Fair | Fair |
| Turlin: 96 | Fair | Good | Good | Good |
| Waukee: 178, 178B | Good | Good | Good | Good |
| Wiota: 7 | Good | Good | Good | Good |
| Zook: 54 | Fair | Fair | Fair | Fair |

*of wildlife habitat and kinds of wildlife*

| Elements of wildlife habitat—continued | | | Kinds of wildlife | | |
|---|---|---|---|---|---|
| Coniferous plants and shrubs | Wetland plants | Shallow water areas | Open-land | Woodland | Wetland |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Poor | Good | Good | Fair | Fair | Good. |
| Fair | Good | Fair | Fair | Fair | Fair. |
| Poor | Good | Fair | Fair to good | Fair | Good. |
| Poor | Good | Fair | Fair | Fair | Fair. |
| Poor | Good | Fair | Fair | Fair | Fair. |
| Fair | Good | Fair | Fair | Fair | Fair. |
| Fair | Good | Fair | Fair | Fair | Fair. |
| Fair | Very poor | Very poor | Fair | Fair | Very poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Poor to very poor | Very poor | Good | Good | Very poor. |
| Fair | Poor | Very poor | Fair | Fair | Fair. |
| Fair | Poor | Very poor | Good | Good | Very poor. |
| Fair | Poor | Very poor | Good | Good | Very poor. |
| Poor | Good | Fair | Fair | Fair | Fair. |
| Fair | Good | Fair | Fair | Fair | Fair. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Poor to very poor | Very poor | Good | Good | Very poor. |
| Fair | Fair to poor | Fair to poor | Good | Good | Fair to poor. |
| Fair | Fair | Very poor | Good | Good | Poor. |
| Fair | Fair | Fair | Good | Good | Fair. |
| Poor | Very poor | Very poor | Poor | Very poor | Very poor. |
| Poor | Good | Fair | Fair | Fair | Fair. |
| Poor | Good | Fair | Fair | Fair | Fair. |
| Fair | Fair | Fair | Good | Good | Fair. |
| Fair | Poor | Poor to very poor | Good | Good | Very poor. |
| Fair | Fair | Fair | Good | Good | Fair. |
| Good | Poor | Poor | Good | Good | Poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Poor | Good | Fair | Poor | Poor | Fair. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Very poor | Very poor | Fair | Good | Very poor. |
| Fair | Fair | Fair | Good | Good | Fair. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Poor | Very poor | Very poor | Fair | Very poor | Very poor. |
| Poor | Very poor | Very poor | Poor | Very poor | Very poor. |
| Fair | Good | Fair | Fair | Fair | Fair. |
| Fair | Good | Poor | Fair | Fair | Fair. |
| Very poor | Very poor | Very poor | Poor | Poor | Poor. |
| Very poor | Good | Good | Poor | Poor | Good. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Fair | Good | Good | Fair | Fair | Good. |
| Fair | Poor | Poor | Good | Good | Poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Good | Poor | Very poor | Good | Good | Very poor. |
| Poor | Good | Good | Fair | Fair | Good. |

TABLE 4.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of

| Soil series and map symbols | Depth to seasonal high water table | Depth from surface | Dominant USDA texture | Classification | |
|---|---|---|---|---|---|
| | | | | Unified | AASHTO |
| | *Ft* | *In* | | | |
| Bolan: 174B | >10 | 0–14 | Loam | CL | A–6 |
| | | 14–27 | Silty clay loam | CL | A–6 |
| | | 27–37 | Sandy loam | SM–SC, SM, or SC | A–4 or A–2 |
| | | 37–60 | Loamy sand | SM, SM–SP | A–2–4 |
| Bremer: 43 | 1–3 | 0–27 | Silty clay loam | CL or CH | A–7–6 |
| | | 27–58 | Silty clay and silty clay loam. | CH | A–7–6 |
| | | 58–78 | Silty clay loam | CL | A–6 |
| Calco: 733 | 1–3 | 0–12 | Light silty clay loam | CL or OL | A–7–6 |
| | | 12–45 | Silty clay loam | CL or CH | A–7–6 |
| | | 45–68 | Silty clay loam | CL or CH | A–7–6 |
| *Clyde: 84, 391B<br>For Floyd part of 391B, see Floyd series. | 1–3 | 0–24 | Clay loam | OH, MH, or ML | A–7–5 |
| | | 24–49 | Light clay loam | CL | A–6 |
| | | 49–78 | Loam | CL | A–6 |
| Coland: 135 | 1–3 | 0–27 | Light silty clay loam | CL, CH, or OL | A–7–6 |
| | | 27–55 | Clay loam | CL | A–6 or A–7–6 |
| | | 55–62 | Heavy sandy clay loam | CL, CL–ML, or SC | A–4 or A–6 |
| Colo: 133, C133 | 1–3 | 0–39 | Silty clay loam | CL, OH, or CH | A–7–6 |
| | | 39–65 | Heavy silty clay loam | CL or CH | A–7–6 |
| Dickinson: 175B, 175C | >10 | 0–37 | Fine sandy loam | SM–SC or SM | A–4 |
| | | 37–60 | Loamy fine sand and sand. | SM or SP | A–2–4 or A–3 |
| Dinsdale: 377B, 377C, 377C2, 377D2. | >5 | 0–16 | Silty clay loam | CL or OL | A–6 or A–7–6 |
| | | 16–30 | Silty clay loam | CL | A–7–6 |
| | | 30–48 | Heavy loam | CL | A–6 |
| | | 48–70 | Loam | CL | A–6 |
| Donnan: 782B | ([2]) | 0–7 | Loam | CL | A–6 |
| | | 7–27 | Clay loam | CL | A–6 or A–7–6 |
| | | 27–66 | Silty clay and clay | CH | A–7–6 |
| Ely: 428B | 3–5 | 0–31 | Silty clay loam | CL or OL | A–7–6 |
| | | 31–60 | Silty clay loam and silt loam. | CL | A–7–6 or A–6 |
| Floyd: 198B | 2–4 | 0–18 | Loam | ML or MH | A–7–5 |
| | | 18–28 | Light clay loam | CL | A–6 |
| | | 28–35 | Gravelly sandy loam | SM or SC | A–2 or A–4 |
| | | 35–70 | Heavy loam | CL | A–6 |
| Garwin: 118 | 1–3 | 0–18 | Silty clay loam | OH, MH, or OL | A–7–5 |
| | | 18–42 | Silty clay loam | CL or CH | A–7–6 |
| | | 42–60 | Silt loam | CL | A–6 or A–7–6 |
| Harpster: 595 | 1–3 | 0–23 | Silty clay loam | ML, OH, CH, or OL | A–7–5 to A–7–6 |
| | | 23–48 | Silty clay loam | CH or CL | A–7–6 |
| | | 48–60 | Silt loam | CL | A–6 to A–7–6 |
| Kenyon: 83B, 83C, 83C2, 83D2 | ([3]) | 0–18 | Loam | CL | A–6 |
| | | 18–42 | Loam | CL | A–6 |
| | | 42–62 | Loam | CL | A–6 |
| Klinger: 184, 184B | 3–5 | 0–21 | Silty clay loam | CL or OL | A–7–6 |
| | | 21–30 | Silty clay loam | CL | A–7–6 |
| | | 30–64 | Heavy loam | CL | A–6 |

*significant in engineering*

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the this table. The symbol < means less than; the symbol > means more than]

| Percentage less than 3 inches passing sieve— | | | | Liquid limit | Plasticity index | Permeability | Available water capacity | Reaction | Shrink-swell potential |
|---|---|---|---|---|---|---|---|---|---|
| No. 4 (4.7 mm) | No. 10 (2.0 mm) | No. 40 (0.42 mm) | No. 200 (0.074 mm) | | | | | | |
| | | | | *Pct* | | *In per hr* | *In per in of soil* | *pH* | |
| -------- | 100 | 95–100 | 70–85 | 25–40 | 11–15 | 0.6–2.0 | 0.18–0.20 | 5.6–7.3 | Moderate. |
| -------- | 100 | 95–100 | 75–85 | 25–40 | 11–15 | 0.6–2.0 | 0.17–0.19 | 4.5–5.5 | Moderate. |
| -------- | 100 | 85–95 | 20–40 | 10–30 | 3–10 | 2.0–6.0 | 0.11–0.13 | 4.5–6.0 | Low to none. |
| -------- | 100 | 80–90 | 10–35 | [1] NP | NP | 6.0–20 | 0.08–0.10 | 5.1–6.0 | None. |
| | | | | | | | | | |
| -------- | -------- | 100 | 95–100 | 45–55 | 20–35 | 0.2–0.6 | 0.19–0.21 | 6.1–7.3 | High. |
| -------- | -------- | 100 | 95–100 | 50–65 | 30–40 | 0.06–0.2 | 0.17–0.19 | 6.6–7.3 | High. |
| | | | | | | | | | |
| -------- | -------- | 100 | 95–100 | 20–40 | 20–35 | 0.2–0.6 | 0.16–0.18 | 6.6–7.3 | Moderate to high. |
| | | | | | | | | | |
| -------- | 100 | 95–100 | 85–95 | 41–50 | 15–25 | 0.2–0.6 | 0.20–0.22 | 7.9–8.4 | High. |
| -------- | -------- | 95–100 | 90–95 | 41–65 | 20–40 | 0.2–0.6 | 0.18–0.20 | 7.9–8.4 | High. |
| -------- | 100 | 95–100 | 80–95 | 41–65 | 20–40 | 0.2–0.6 | 0.18–0.20 | 7.4–8.4 | High. |
| | | | | | | | | | |
| 100 | 95–100 | 85–95 | 60–75 | 45–60 | 15–25 | 0.6–2.0 | 0.21–0.23 | 6.6–7.8 | High. |
| 90–95 | 80–90 | 75–85 | 55–70 | 30–40 | 15–25 | 0.6–2.0 | 0.17–0.19 | 7.4–7.8 | Moderate. |
| 90–95 | 80–90 | 75–85 | 55–70 | 25–40 | 11–20 | 0.2–0.6 | 0.15–0.17 | 7.4–8.4 | Low. |
| | | | | | | | | | |
| 95–100 | 80–100 | 75–85 | 60–85 | 45–55 | 20–30 | 0.6–2.0 | 0.20–0.22 | 6.1–7.3 | High. |
| 95–100 | 80–100 | 75–85 | 55–85 | 35–45 | 11–20 | 0.2–0.6 | 0.18–0.20 | 6.1–7.3 | Moderate. |
| 95–100 | 80–100 | 65–85 | 40–60 | 20–30 | 5–15 | 0.6–2.0 | 0.14–0.16 | 6.1–7.3 | Low. |
| | | | | | | | | | |
| -------- | 100 | 95–100 | 95–100 | 41–65 | 20–40 | 0.2–0.6 | 0.21–0.23 | 6.1–7.3 | High. |
| -------- | 100 | 95–100 | 90–100 | 41–65 | 20–40 | 0.2–0.6 | 0.18–0.20 | 6.6–7.3 | High. |
| | | | | | | | | | |
| -------- | 100 | 85–90 | 35–50 | 15–35 | 5–10 | 2.0–6.0 | 0.14–0.16 | 5.6–6.0 | Low. |
| -------- | 100 | 70–75 | 5–20 | NP | NP | 6.0–20 | 0.05–0.07 | 5.6–6.0 | Very low or none. |
| | | | | | | | | | |
| -------- | 100 | 100 | 95–100 | 30–50 | 11–20 | 0.6–2.0 | 0.21–0.23 | 5.1–6.0 | Moderate. |
| -------- | 100 | 100 | 95–100 | 41–50 | 20–30 | 0.6–2.0 | 0.18–0.20 | 5.1–5.5 | Moderate to high. |
| 95–100 | 90–95 | 85–90 | 55–65 | 20–35 | 11–20 | 0.2–0.6 | 0.17–0.19 | 5.6–7.8 | Low. |
| 95–100 | 90–95 | 85–90 | 55–65 | 20–30 | 11–20 | 0.2–0.6 | 0.14–0.16 | 7.9–8.4 | Low. |
| | | | | | | | | | |
| -------- | 100 | 85–90 | 55–75 | 25–40 | 11–20 | 0.6–2.0 | 0.17–0.19 | 6.1–6.5 | Moderate. |
| 95–100 | 90–100 | 90–100 | 70–80 | 35–50 | 15–25 | 0.2–0.6 | 0.15–0.17 | 5.1–6.0 | High. |
| 95–100 | 95–100 | 90–100 | 75–95 | 55–70 | 30–40 | <0.06 | 0.11–0.12 | 5.6–6.0 | High. |
| | | | | | | | | | |
| -------- | -------- | 100 | 95–100 | 41–50 | 15–30 | 0.6–2.0 | 0.20–0.22 | 5.6–6.0 | Moderate to high. |
| -------- | -------- | 100 | 95–100 | 35–45 | 15–30 | 0.6–2.0 | 0.18–0.20 | 6.1–7.3 | Moderate to high. |
| | | | | | | | | | |
| -------- | 100 | 90–95 | 70–80 | 41–55 | 11–20 | 0.6–2.0 | 0.20–0.22 | 6.1–6.5 | Moderate to high. |
| -------- | 100 | 65–90 | 60–75 | 30–40 | 11–25 | 0.6–2.0 | 0.18–0.20 | 6.6–7.3 | Moderate to high. |
| 85–95 | 80–90 | 65–90 | 30–40 | 10–30 | 2–10 | 0.6–6.0 | 0.11–0.13 | 6.6–7.3 | Low. |
| 90–95 | 85–95 | 75–90 | 50–65 | 25–40 | 11–25 | 0.2–0.6 | 0.16–0.18 | 6.6–7.3 | Low. |
| | | | | | | | | | |
| -------- | -------- | 100 | 95–100 | 45–60 | 15–25 | 0.2–0.6 | 0.21–0.23 | 5.6–6.5 | High. |
| -------- | -------- | 100 | 95–100 | 45–60 | 25–35 | 0.2–0.6 | 0.18–0.20 | 6.5–7.3 | High. |
| -------- | -------- | 100 | 95–100 | 35–45 | 15–25 | 0.6–2.0 | 0.18–0.20 | 6.6–7.3 | Moderate. |
| | | | | | | | | | |
| -------- | -------- | 100 | 95–100 | 45–60 | 15–35 | 0.2–0.6 | 0.21–0.23 | 7.9–8.4 | High. |
| | | | | | | | | | |
| -------- | -------- | 100 | 95–100 | 41–60 | 20–35 | 0.2–0.6 | 0.18–0.20 | 7.9–8.4 | High. |
| -------- | -------- | 100 | 95–100 | 30–50 | 15–30 | 0.6–2.0 | 0.18–0.20 | 7.9–8.4 | Moderate. |
| | | | | | | | | | |
| 95–100 | 95–100 | 80–95 | 55–75 | 25–40 | 11–25 | 0.6–0.2 | 0.20–0.22 | 5.6–6.5 | Moderate. |
| 90–95 | 80–90 | 65–85 | 55–65 | 25–40 | 11–20 | 0.2–0.6 | 0.17–0.19 | 5.1–6.5 | Low. |
| 90–95 | 80–90 | 65–85 | 55–65 | 25–40 | 11–20 | 0.2–0.6 | 0.15–0.17 | 6.6–8.4 | Low. |
| | | | | | | | | | |
| -------- | 100 | 100 | 95–100 | 41–50 | 15–25 | 0.6–2.0 | 0.21–0.23 | 5.6–7.3 | Moderate. |
| -------- | 100 | 100 | 95–100 | 41–50 | 20–30 | 0.6–2.0 | 0.18–0.20 | 5.6–6.0 | Moderate to high. |
| 95–100 | 90–95 | 80–90 | 55–75 | 25–35 | 11–20 | 0.2–0.6 | 0.18–0.20 | 6.6–8.4 | Low. |

TABLE 4.—*Estimates of soil properties*

| Soil series and map symbols | Depth to seasonal high water table | Depth from surface | Dominant USDA texture | Classification | |
|---|---|---|---|---|---|
| | | | | Unified | AASHTO |
| | *Ft* | *In* | | | |
| Lawler: | | | | | |
| 226 | 3–5 | 0–14 | Silt loam | OL or CL | A–6 |
| | | 14–32 | Light silty clay loam | CL | A–6 |
| | | 32–60 | Coarse sandy loam to gravelly loamy sand. | SM, SP, or SW | A–2–4 |
| 225 | 3–5 | 0–12 | Silt loam | OL or CL | A–6 |
| | | 12–24 | Light silty clay loam | CL or SC | A–6 |
| | | 24–60 | Loamy sand or gravelly sand. | SM, SP, or SW | A–2–4 |
| Lawson: 484 | 3–5 | 0–32 | Silt loam | CL or OL | A–6 or A–7–6 |
| | | 32–45 | Silt loam to loam | CL | A–6 |
| | | 45–60 | Sandy loam | SM or SC | A–4, A–2 |
| Lilah: 776C2 | >5 | 0–15 | Sandy loam | SM or SC | A–2–4 or A–4 |
| | | 15–35 | Gravelly loamy sand and loamy sand. | SM, SP, or SW | A–1–b |
| | | 35–60 | Loamy sand or sand | SW–SM | A–1–b |
| Marshan: 152 | 1–3 | 0–16 | Silty clay loam | OL, ML, MH, or OH | A–7–5 |
| | | 16–33 | Silty clay loam | CL | A–6 |
| | | 33–60 | Sandy loam and loamy sand. | SM, SP, SW, or SC | A–2–4 |
| Maxfield: 382 | 1–3 | 0–22 | Silty clay loam | MH, OH, or OL | A–7–5 |
| | | 22–30 | Silty clay loam | CL | A–7–6 |
| | | 30–70 | Loam | CL | A–6 |
| Muscatine: 119, 119B, T119 | 3–5 | 0–20 | Silty clay loam | ML, CL, or OL | A–7–6 |
| | | 20–42 | Silty clay loam | CL or CH | A–7–6 |
| | | 42–64 | Silt loam | CL | A–6 or A–7–6 |
| Nevin: 88 | 3–5 | 0–23 | Light silty clay loam | CL or OL | A–7–6 |
| | | 23–50 | Silty clay loam | CL or CH | A–7–6 |
| | | 50–60 | Loam and sand lenses | CL | A–6 |
| Ostrander: 394B, 394C, 394C2 | >5 | 0–20 | Loam | CL | A–6 |
| | | 20–36 | Heavy sandy loam | CL or SC | A–4 or A–6 |
| | | 36–60 | Loam | CL | A–6 |
| Palms: 221 | 0–3 | 0–18 | Muck | Pt | Muck |
| | | 18–27 | Silty clay loam | CL | A–7–6 |
| | | 27–63 | Heavy silt loam | CL | A–6 or A–7–6 |
| Port Byron: 620C2, 620E3 | 5 | 0–12 | Silt loam | CL | A–6 |
| | | 12–41 | Silt loam | CL | A–6 |
| | | 41–63 | Silt loam | CL or CL–ML | A–4 or A–6 |
| Readlyn: 399 | 3–5 | 0–23 | Heavy loam | CL | A–6 |
| | | 23–45 | Heavy loam | CL | A–6 |
| | | 45–60 | Loam | CL | A–6 |
| *Saude: 177, 177B, 177C, 177C2, 241B, 241C2. For Lilah parts of 241B and 241C2, see Lilah series. | >5 | 0–16 | Loam | CL | A–6 |
| | | 16–30 | Loam and light loam | CL, SC, or SC–SM | A–4 |
| | | 30–60 | Gravelly loamy sand and sand. | SM, SP, or SW | A–1–b, A–3, or A–2–4 |
| *Sawmill: 933, 933B. For Garwin part of 933B, see Garwin series. | 1–3 | 0–27 | Silty clay loam | CL, OL, OH, or CH | A–7–6 |
| | | 27–52 | Silty clay loam | CL or CH | A–7–6 |
| | | 52–63 | Silty clay loam | CL or CH | A–7–6 |

*significant in engineering*—Continued

| Percentage less than 3 inches passing sieve— No. 4 (4.7 mm) | No. 10 (2.0 mm) | No. 40 (0.42 mm) | No. 200 (0.074 mm) | Liquid limit | Plasticity index | Permeability | Available water capacity | Reaction | Shrink-swell potential |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Pct* | | *In per hr* | *In per in of soil* | *pH* | |
| 100 | 95–100 | 85–95 | 70–85 | 25–40 | 11–25 | 0.6–2.0 | 0.20–0.22 | 5.6–6.6 | Moderate. |
| 95–100 | 90–95 | 85–95 | 80–85 | 25–40 | 11–25 | 0.6–2.0 | 0.15–0.17 | 5.6–6.0 | Moderate. |
| 85–95 | 70–90 | 50–75 | 3–25 | NP | NP | 6.0–20 | 0.04–0.06 | 5.6–6.5 | None. |
| 100 | 95–100 | 85–95 | 55–75 | 25–40 | 11–25 | 0.6–2.0 | 0.18–0.20 | 5.6–6.6 | Moderate. |
| 95–100 | 90–95 | 55–75 | 45–60 | 25–40 | 11–25 | 0.6–2.0 | 0.16–0.18 | 5.6–6.0 | Moderate. |
| 85–95 | 70–90 | 50–75 | 3–25 | NP | NP | 6.0–20 | 0.04–0.06 | 5.6–6.5 | None. |
| -------- | 100 | 100 | 95–100 | 30–50 | 15–30 | 0.6–2.0 | 0.20–0.22 | 6.1–6.5 | Moderate to high. |
| -------- | 100 | 100 | 90–95 | 25–40 | 11–25 | 0.6–2.0 | 0.18–0.20 | 6.1–6.8 | Moderate. |
| 100 | 95–100 | 60–75 | 30–40 | 10–30 | 5–10 | 2.0–6.0 | 0.13–0.15 | 6.6–7.3 | Very low. |
| 95–100 | 90–95 | 60–75 | 25–40 | 15–25 | 5–10 | 2.0–6.0 | 0.08–0.10 | 5.1–7.3 | Low. |
| 70–90 | 40–60 | 20–50 | 5–20 | NP | NP | 6.0–20 | 0.05–0.07 | 5.1–6.0 | Very low or none. |
| 70–95 | 60–80 | 20–50 | 5–12 | NP | NP | >20 | 0.02–0.04 | 5.6–6.0 | None. |
| 100 | 95–100 | 80–95 | 70–80 | 41–65 | 15–30 | 0.6–2.0 | 0.20–0.22 | 6.6–7.3 | High. |
| 95–100 | 90–95 | 80–95 | 50–75 | 30–40 | 11–25 | 0.6–2.0 | 0.15–0.17 | 6.6–7.3 | Moderate. |
| 80–95 | 70–95 | 50–75 | 5–15 | NP–20 | NP–10 | 6.0–20+ | 0.02–0.04 | 6.6–7.3 | None. |
| -------- | 100 | 100 | 95–100 | 45–60 | 15–25 | 0.2–0.6 | 0.22–0.24 | 6.6–7.3 | High. |
| -------- | 100 | 100 | 95–100 | 45–55 | 25–35 | 0.2–0.6 | 0.18–0.20 | 6.6–7.3 | High. |
| 95–100 | 90–95 | 80–90 | 55–75 | 25–35 | 11–20 | 0.2–0.6 | 0.16–0.18 | 6.6–8.4 | Low. |
| -------- | -------- | 100 | 95–100 | 41–50 | 15–25 | 0.6–2.0 | 0.22–0.24 | 5.1–5.5 | Moderate. |
| -------- | -------- | 100 | 95–100 | 45–55 | 25–35 | 0.6–2.0 | 0.20–0.22 | 5.6–6.5 | Moderate to high. |
| -------- | 100 | 100 | 95–100 | 30–45 | 15–25 | 0.6–2.0 | 0.18–0.20 | 6.6–7.8 | Moderate. |
| 100 | 100 | 100 | 80–100 | 41–50 | 15–25 | 0.6–2.0 | 0.21–0.23 | 5.6–6.5 | Moderate to high. |
| 100 | 100 | 100 | 80–100 | 41–65 | 15–40 | 0.2–0.6 | 0.18–0.20 | 5.6–6.0 | High. |
| 100 | 95–100 | 75–95 | 50–65 | 20–40 | 11–20 | 0.6–2.0 | 0.10–0.12 | 5.6–6.0 | Low. |
| 100 | 95–100 | 85–95 | 55–75 | 25–40 | 10–20 | 0.6–2.0 | 0.17–0.19 | 6.1–6.5 | Moderate. |
| 80–90 | 90–95 | 60–80 | 36–55 | 20–30 | 5–15 | 2.0–6.0 | 0.13–0.15 | 5.6–6.0 | Low. |
| 90–95 | 80–90 | 65–85 | 55–65 | 25–40 | 11–25 | 0.2–0.6 | 0.15–0.17 | 6.6–8.4 | Low. |
| -------- | -------- | -------- | -------- | -------- | -------- | 2.0–6.0+ | 0.24–0.26 | 6.6–8.4 | Moderate. |
| -------- | 100 | 95–100 | 80–95 | 41–50 | 15–35 | 0.2–2.0 | 0.19–0.21 | 6.6–7.3 | Moderate to high. |
| 100 | 100 | 80–90 | 50–75 | 25–50 | 11–30 | 0.6–2.0 | 0.16–0.18 | 6.0–8.4 | Moderate. |
| -------- | 100 | 100 | 95–100 | 25–40 | 11–25 | 0.6–2.0 | 0.18–0.20 | 5.6–6.5 | Low to moderate. |
| -------- | 100 | 100 | 95–100 | 25–40 | 11–25 | 0.6–2.0 | 0.17–0.19 | 6.1–6.5 | Low to moderate. |
| -------- | 100 | 100 | 95–100 | 25–35 | 5–15 | 0.6–2.0 | 0.17–0.19 | 5.6–7.3 | Low to moderate. |
| 100 | 95–100 | 75–90 | 55–75 | 25–40 | 11–20 | 0.6–2.0 | 0.19–0.21 | 5.6–6.0 | Moderate. |
| 95–98 | 80–90 | 75–85 | 60–75 | 25–40 | 11–20 | 0.2–0.6 | 0.16–0.18 | 5.6–6.5 | Low. |
| 95–100 | 90–95 | 75–90 | 50–65 | 25–40 | 11–20 | 0.2–0.6 | 0.15–0.17 | 7.9–8.4 | Low. |
| 100 | 90–95 | 75–95 | 55–80 | 25–35 | 11–20 | 0.6–2.0 | 0.16–0.18 | 5.6–6.0 | Moderate. |
| 100 | 90–95 | 60–80 | 35–60 | 15–30 | 5–10 | 0.6–6.0 | 0.13–0.15 | 5.6–6.0 | Low. |
| 85–95 | 70–90 | 35–60 | 3–15 | NP | NP | 6.0–20+ | 0.02–0.04 | 6.1–7.3 | Very low or none. |
| -------- | 100 | 100 | 95–100 | 41–65 | 20–40 | 0.2–0.6 | 0.20–0.22 | 6.6–7.3 | High. |
| -------- | 100 | 100 | 95–100 | 41–65 | 20–40 | 0.2–0.6 | 0.18–0.20 | 6.6–7.3 | High. |
| -------- | 100 | 95–100 | 95–100 | 41–60 | 15–30 | 0.6–2.0 | 0.17–0.19 | 6.6–7.3 | Moderate to high. |

TABLE 4.—*Estimates of soil properties*

| Soil series and map symbols | Depth to seasonal high water table | Depth from surface | Dominant USDA texture | Classification | |
|---|---|---|---|---|---|
| | | | | Unified | AASHTO |
| | *Ft* | *In* | | | |
| Sparta: 41B | >10 | 0–11 | Loamy fine sand | SM | A–2–4 |
| | | 11–77 | Fine sand | SP–SM or SM | A–2–4 or A–3 |
| Sperry: 122 | 0–3 | 0–10 | Silt loam | CL | A–6 |
| | | 10–18 | Silt loam | CL | A–6 |
| | | 18–48 | Heavy silty clay loam and silty clay. | CH | A–7–6 |
| | | 48–60 | Light silty clay | CL | A–7–6 |
| Tama: 120, 120B, 120C, 120C2, T120. | >5 | 0–16 | Silty clay loam | CL | A–6, A–7–6 |
| | | 16–46 | Silty clay loam | CL | A–7–6 |
| | | 46–60 | Silt loam | CL | A–6 |
| Thorp: 404 | 1–3 | 0–10 | Heavy silt loam | CL | A–6 |
| | | 10–18 | Silt loam | CL | A–6 |
| | | 18–56 | Silty clay loam | CL | A–6 to A–7–6 |
| | | 56–60 | Sandy loam | SM or SC | A–2–4 to A–4 |
| Turlin: 96 | 3–5 | 0–33 | Loam | CL | A–6 |
| | | 33–53 | Light silty clay loam to light clay loam. | CL | A–6 |
| | | 53–63 | Loamy sand | SM | A–2–4 |
| Waukee: 178, 178B | >5 | 0–17 | Loam | CL | A–6 |
| | | 17–37 | Loam and light clay loam | CL | A–6 |
| | | 37–60 | Loamy sand | SM, SP, SM–SP | A–2–4, A–1–b, A–3 |
| Wiota: 7 | >5 | 0–18 | Silt loam or silty clay loam. | CL–ML or CL | A–6 |
| | | 18–59 | Silty clay loam | CL | A–6 or A–7–6 |
| | | 59–69 | Sandy loam | SM or SC | A–4 |
| Zook: 54 | 1–3 | 0–20 | Silty clay | OH or CH | A–7–6 |
| | | 20–60 | Silty clay and heavy silty clay loam. | CH | A–7–6 |

[1] Nonplastic.

[2] Seasonal perched water table at a depth of about 30 inches.

A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 6; the estimated classification, without group index numbers, is given in table 4 for all soils mapped in the survey area.

***Soil properties significant in engineering***

Several estimated soil properties significant in engineering are given in table 4. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 4.

*Depth to bedrock* is not given in table 4, because most soils in the survey area are deep enough over bedrock that bedrock generally does not affect their use.

*Depth to seasonal high water table* is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

*Dominant USDA texture* is described in table 4 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary at the back of this publication.

*significant in engineering*—Continued

| Percentage less than 3 inches passing sieve— | | | | Liquid limit | Plasticity index | Permeability | Available water capacity | Reaction | Shrink-swell potential |
|---|---|---|---|---|---|---|---|---|---|
| No. 4 (4.7 mm) | No. 10 (2.0 mm) | No. 40 (0.42 mm) | No. 200 (0.074 mm) | | | | | | |
| | | | | *Pct* | | *In per hr* | *In per in of soil* | *pH* | |
| -------- | 100 | 65–80 | 15–30 | NP | NP | 2.0–6.0 | 0.06–0.08 | 5.6–7.3 | Low or none. |
| -------- | 100 | 65–80 | 5–20 | NP | NP | 6.0–20 | 0.03–0.05 | 5.1–6.5 | None. |
| -------- | 100 | 100 | 95–100 | 25–40 | 11–25 | 0.6–2.0 | 0.20–0.22 | 6.1–7.3 | Moderate. |
| -------- | 100 | 100 | 95–100 | 20–30 | 11–20 | 0.2–0.6 | 0.17–0.19 | 5.1–6.0 | Low. |
| -------- | 100 | 100 | 95–100 | 50–65 | 25–45 | 0.06–0.2 | 0.17–0.19 | 4.5–6.0 | High. |
| -------- | 100 | 100 | 95–100 | 41–50 | 20–35 | 0.6–2.0 | 0.15–0.17 | 6.6–7.3 | Moderate to high. |
| -------- | 100 | 100 | 95–100 | 35–50 | 15–25 | 0.6–2.0 | 0.21–0.23 | 5.1–5.6 | Moderate. |
| -------- | 100 | 100 | 95–100 | 41–50 | 15–35 | 0.6–2.0 | 0.18–0.20 | 5.1–6.0 | Moderate to high. |
| -------- | 100 | 100 | 95–100 | 30–40 | 15–25 | 0.6–2.0 | 0.18–0.20 | 6.1–6.5 | Moderate. |
| -------- | 100 | 100 | 95–100 | 25–40 | 11–25 | 0.6–2.0 | 0.18–0.20 | 5.6–6.5 | Moderate. |
| -------- | 100 | 100 | 95–100 | 20–30 | 11–20 | 0.6–2.0 | 0.17–0.19 | 5.6–6.0 | Low. |
| -------- | 100 | 100 | 95–100 | 35–50 | 20–30 | 0.06–0.2 | 0.16–0.18 | 5.6–6.0 | Moderate to high. |
| 100 | 95–100 | 60–70 | 30–40 | 10–20 | 5–10 | 2.0–6.0 | 0.10–0.12 | 5.6–6.0 | Low. |
| 100 | 95–100 | 85–95 | 60–80 | 25–40 | 11–20 | 0.6–2.0 | 0.20–0.22 | 5.6–6.5 | Moderate. |
| 100 | 95–100 | 85–95 | 55–75 | 25–40 | 11–25 | 0.6–2.0 | 0.16–0.18 | 5.6–6.5 | Moderate. |
| 100 | 95–100 | 50–75 | 15–30 | NP | NP | 6.0–20 | 0.03–0.05 | 5.6–6.0 | None. |
| 100 | 95–100 | 80–95 | 65–80 | 25–40 | 11–25 | 0.6–2.0 | 0.16–0.18 | 5.1–6.5 | Moderate. |
| 95–100 | 95–100 | 75–85 | 55–75 | 20–40 | 11–20 | 0.6–2.0 | 0.14–0.16 | 5.1–6.0 | Moderate. |
| 85–95 | 70–95 | 35–60 | 3–15 | NP | NP | 6.0–20 + | 0.02–0.04 | 5.1–5.5 | Very low or none. |
| -------- | 100 | 100 | 85–95 | 25–40 | 11–25 | 0.6–2.0 | 0.19–0.21 | 5.6–7.3 | Moderate. |
| -------- | 100 | 100 | 85–95 | 35–45 | 15–25 | 0.6–2.0 | 0.17–0.19 | 5.6–6.0 | Moderate to high. |
| 100 | 90–100 | 85–95 | 35–50 | 20–35 | 5–10 | 2.0–6.0 | 0.11–0.13 | 5.6–6.0 | Low. |
| -------- | 100 | 100 | 95–100 | 50–65 | 25–35 | 0.2–0.6 | 0.18–0.20 | 6.1–7.3 | High. |
| -------- | 100 | 100 | 95–100 | 55–65 | 30–40 | 0.06–0.2 | 0.15–0.17 | 6.6–7.3 | High. |

[3] Seasonal high water table generally is at a depth of more than 5 feet.

*Liquid limit* and *plasticity index* indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 4, but in table 6 the data on liquid limit and plasticity index are based on tests of soil samples.

*Permeability* is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 4 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

*Available water capacity* is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

*Reaction* is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

*Shrink-swell potential* is the relative change in volume to be expected of soil material when the moisture content changes; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to mainte-

TABLE 5.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series

| Soil series and map symbols | Degree and kind of limitation for— | | | |
|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Sanitary landfill [1] | Local roads and streets |
| Bolan: 174B | Slight: sandy loam and loamy sand at a depth of 27 to 60 inches may allow effluent to travel long distances. | Severe: moderately rapid and rapid permeability in subsoil and substratum. | Severe: permeability of more than 2 inches per hour in subsoil. | Moderate to a depth of 27 inches: fair to good compaction characteristics; medium to high compressibility. Slight below a depth of 27 inches. |
| Bremer: 43 | Severe: seasonal high water table; slow permeability. | Severe: seasonal high water table. | Severe: seasonal high water table; subject to occasional flooding. | Severe: poorly drained; difficult to compact to high density; high shrink-swell potential. |
| Calco: 733 | Severe: seasonal high water table; subject to flooding; moderately slow permeability. | Severe: seasonal high water table; subject to flooding. | Severe: seasonal high water table; subject to flooding. | Severe: poorly drained; high shrink-swell potential. |
| *Clyde: 84, 391B For Floyd part of 391B, see Floyd series. | Severe: high water table; subject to concentrated runoff; water table restricts percolation. | Severe: high organic-matter content in surface layer; receives local runoff; stratified in places with coarse material. | Severe: seasonal high water table. | Severe: poorly drained; high organic-matter content; moderate to high shrink-swell potential. |
| Coland: 135 | Severe: seasonal high water table; subject to flooding; moderately slow permeability. | Severe: seasonal high water table; subject to flooding. | Severe: seasonal high water table; subject to occasional overflow. | Severe: poorly drained; subject to flooding. |
| Colo: 133, C133 | Severe: seasonal high water table; subject to flooding; moderately slow permeability. | Severe: seasonal high water table; subject to flooding. | Severe: seasonal high water table; subject to occasional overflow. | Severe: poorly drained; subject to flooding; high shrink-swell potential. |
| Dickinson: 175B, 175C | Slight: favorable percolation rate; poor filtering material may allow effluent to travel long distances. | Severe: moderately rapid permeability; subsoil too porous to hold water. | Severe: permeability of more than 2 inches per hour. | Slight |

*interpretations*

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the that appear in the first column of this table]

| Suitability as source of— | | | Soil features affecting— | | | |
|---|---|---|---|---|---|---|
| Road fill [2] | Sand and gravel | Topsoil | Pond reservoir areas | Embankments, dikes, and levees | Drainage for crops and pasture | Terraces and diversions |
| Fair to a depth of 27 inches: fair to good compaction characteristics; medium to high compressibility. Good below a depth of 27 inches. | Not suitable to a depth of 27 inches. Fair below a depth of 27 inches: too many fines in places. | Good | Rapid permeability; material too porous to hold water. | Sandy material; medium permeability where compacted; subject to piping. | Natural drainage adequate. | Highly erodible on slopes; difficult to maintain ridge and channel; subject to piping. |
| Poor: high shrink-swell potential; difficult to compact to high density; poorly drained. | Not suitable: no sand or gravel. | Fair: silty clay loam texture. | Suitable for dugout ponds in places; low permeability where compacted; nearly level; seasonal high water table at a depth of 12 to 36 inches. | Clayey material; high shrink-swell potential; poor compaction characteristics. | Poorly drained; seasonal high water table; tile functions well where properly spaced; surface drainage beneficial in places. | Terraces not needed; diversions beneficial in places if soil is subject to runoff from adjacent slopes. |
| Poor: high shrink-swell potential; poorly drained. | Not suitable: no sand or gravel. | Fair: high organic-matter content to a depth of about 36 inches; seasonal high water table; moderately fine texture. | Moderately slow permeability before compacting; high organic-matter content. | High shrink-swell potential; fair to poor stability after compacting; low shear strength. | Seasonal high water table; moderately slow permeability; subject to flooding. | Terraces not needed; features favorable for diversions. |
| Poor: high organic-matter content; poorly drained; moderate to high shrink-swell potential. | Not suitable: no sand or gravel. | Fair to good to a depth of 12 to 24 inches; high organic-matter content; high water table interferes with excavation in places. | High organic-matter content in surface layer; sand strata need blanketing with compacted material in places. | Moderate shrink-swell potential; fair to good stability after compacting. | High water table; wetness because of seepage; tile system designed to intercept laterally moving water most likely to be successful. | Generally not needed; favorable topography; terraces and tile drainage can be used in combination in places. |
| Poor: poorly drained; high organic-matter content. | Not suitable to a depth of 4 to 5 feet. Fair to good below a depth of 4 to 5 feet. | Fair to good: high organic-matter content; seasonal high water table. | Moderately slow permeability; high organic-matter content; sand strata below a depth of 60 inches in places. | Moderate to low shrink-swell potential; fair to good stability after compaction. | Moderately slow permeability; seasonal high water table; tile drainage feasible. | Generally not needed; favorable topography; little or no limitation of soil material for diversions. |
| Poor: high shrink-swell potential; poorly drained. | Not suitable: no sand or gravel. | Fair to good: high organic-matter content; seasonal high water table; slightly high in clay. | Moderately slow permeability; high organic-matter content. | High shrink-swell potential; fair to poor stability after compaction. | Moderately slow permeability; seasonal high water table; tile drainage feasible. | Generally not needed; favorable topography; little or no limitation of soil material for diversions. |
| Good: good bearing capacity and shear strength; low volume change; good workability. | Fair: poorly graded fine and medium sand; too many fines in places; no gravel. | Good to a depth of 1 to 1½ feet. Fair to poor below a depth of 1 to 1½ feet: erodible; slightly droughty. | Rapid permeability: material too porous to hold water. | Sandy material; poor resistance to piping. | Natural drainage adequate. | Highly erodible on slopes; difficult to maintain ridge and channel; subject to piping. |

TABLE 5.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for— | | | |
|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Sanitary landfill [1] | Local roads and streets |
| Dinsdale: 377B, 377C, 377C2, 377D2. | Slight: moderate permeability to a depth of 2½ feet. | Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 9 percent. Severe where slopes are more than 9 percent: moderately slow permeability in lower part of profile. | Slight | Moderate: moderate to high shrink-swell potential; fair to good compaction characteristics; subject to frost action where pockets of water-bearing sand occur. |
| Donnan: 782B | Severe: very slow permeability in subsoil; perched water table during extended wet periods; unfavorable percolation rate in places. | Moderate: slopes of 2 to 6 percent. | Moderate to severe: somewhat poorly drained; dense, clayey subsoil. | Severe: perched water table at a depth of 1 to 2 feet during extented wet periods; highly subject to frost action where pockets of water-bearing sand occur. |
| Ely: 428B | Moderate to severe: seasonal high water table; favorable percolation rate. | Moderate: moderate permeability; high organic-matter content in surface layer. | Moderate: somewhat poorly drained; receives runoff from higher soils. | Severe: fair to good compaction characteristics; seasonal high water table; subject to local flooding for short periods. |
| Floyd: 198B | Severe: seasonal high water table; favorable percolation rate. | Moderate to severe: high organic-matter content in surface layer; sand strata to a depth of 2 to 4 feet. | Moderate: somewhat poorly drained; receives runoff. | Severe: subject to seasonal wetness and seepage; highly subject to frost action where pockets of water-bearing sand occur. |
| Garwin: 118 | Severe: high water table; questionable percolation rate in places. | Moderate: high organic-matter content in surface layer; high water table; moderate permeability in substratum. | Severe: poorly drained; seasonal high water table. | Severe: poorly drained; seasonal high water table; high shrink-swell potential. |
| Harpster: 595 | Severe: seasonal high water table. | Severe: high organic-matter content in surface layer; seasonal high water table; moderate permeability. | Severe: poorly drained; seasonal high water table. | Severe: seasonal high water table; high organic-matter content in surface layer; poorly drained; high shrink-swell potential. |
| Kenyon: 83B, 83C, 83C2, 83D2. | Moderate where slopes are less than 9 percent. Severe where slopes are more than 9 percent: questionable percolation rate in places. | Moderate where slopes are 2 to 9 percent. Severe where slopes are more than 9 percent: high organic-matter content in surface layer; pockets of sand in places; moderately slow permeability. | Slight: moderately slow permeability in glacial till. | Moderate: fair to good compaction characteristics; subject to frost action where pockets of water-bearing sand occur. |

*interpretations*—Continued

| Suitability as source of— | | | Soil features affecting— | | | |
|---|---|---|---|---|---|---|
| Road fill [2] | Sand and gravel | Topsoil | Pond reservoir areas | Embankments, dikes, and levees | Drainage for crops and pasture | Terraces and diversions |
| Fair to a depth of 2 to 3 feet: high volume change. Good below a depth of 3 feet: fair to good bearing capacity; easy to compact to high density. | Not suitable: no sand or gravel. | Good to a depth of 1 to 1½ feet: generally high organic-matter content. Fair below a depth of 1 to 1½ feet. | Moderate to moderately slow permeability; pockets of sand in places. | Moderate to high shrink-swell potential; fair to good stability after compaction; medium to high compressibility. | Natural drainage adequate. | All features favorable; cuts should be minimal below a depth of about 3 feet in order not to expose lower fertility, higher density glacial till. |
| Fair to a depth of 1 to 2 feet. Poor below a depth of 1 to 2 feet: high volume change; poor workability; poor bearing capacity. | Not suitable: no sand or gravel. | Fair to a depth of 1 to 1½ feet: low organic-matter content. Poor below a depth of 2 feet: too clayey. | Very slow permeability in subsoil; pockets and lenses of sand in places. | Moderate to high shrink-swell potential; fair stability after compaction. | Very slow permeability in subsoil; subject to seasonal seepage and wetness. | Low fertility and high density in subsoil; subject to seasonal wetness and seepage. |
| Poor: moderate or high expansion potential; poor bearing capacity; difficult to compact to high density. | Not suitable: no sand or gravel. | Good: high organic-matter content in thick surface layer. | Coarse-textured material below a depth of 4 feet in places; moderate permeability; difficult to compact. | Moderate to high shrink-swell potential; fair to good stability after compaction. | Subject to wetness because of seepage in places; interceptor tile needed. | Features favorable; properly placed diversions protect against overflow and siltation. |
| Poor to a depth of 2 feet: high organic-matter content; poor bearing capacity. Fair below a depth of about 2 feet: good bearing capacity. | Not suitable: no sand or gravel. | Good to a depth of 1 to 1½ feet: high organic-matter content in surface layer; seasonal high water table. | Pockets and strata of sand in places; reservoir bottom needs blanketing with compacted material in places. | Moderate to high shrink-swell potential; fair to poor compaction characteristics and stability after compaction. | Subject to seasonal wetness because of laterally moving water; drainage that intercepts laterally moving water is most likely to be successful. | Wetness hinders construction in places; terraces tend to increase wetness; terraces and tile in combination are most likely to be successful. |
| Poor: high shrink-swell potential; poor bearing capacity; difficult to compact to high density. | Not suitable: no sand or gravel. | Fair: moderately fine texture; high organic-matter content; seasonal high water table. | Uniform material; moderately slow permeability; seasonal high water table. | Moderate to high shrink-swell potential; fair to poor compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well. | Not needed because of topography. |
| Poor: seasonal high water table; high organic-matter content to a depth of about 1½ feet. | Not suitable: no sand or gravel. | Poor: high content of calcium carbonates; seasonal high water table. | Nearly level; seasonal high water table. | Moderate to high shrink-swell potential; fair to poor compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well. | Not needed because of topography. |
| Good below a depth of 1½ to 2 feet: low compressibility; fair to good bearing capacity; easy to compact to high density. | Not suitable: no sand or gravel. | Good to a depth of 1 to 1½ feet: high organic-matter content. Fair below a depth of 1 to 1½ feet: low fertility. | Low permeability where compacted strata and pockets of sand in places; difficult to find suitable sites. | Fair to good compaction characteristics and stability after compaction. | Moderately slow permeability; seepage on hillsides in places; tile generally not needed. | Terraces and tile drainage in combination generally are most successful; low fertility in subsoil; concentration of small stones at a depth of 1½ to 2 feet. |

TABLE 5.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for— | | | |
|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Sanitary landfill [1] | Local roads and streets |
| Klinger: 184, 184B | Moderate: seasonal high water table; favorable percolation rate. | Moderate: high organic-matter content in surface layer; strata of sand in places; slow permeability in substratum where compacted; seasonal high water table. | Moderate: somewhat poorly drained; seasonal water table at a depth of 3 to 5 feet. | Moderate to severe: fair to good compaction characteristics below a depth of 2½ to 3 feet; moderate to high shrink-swell potential; seasonal high water table at a depth of 3 to 5 feet. |
| Lawler: | | | | |
| 226 | Moderate: seasonal high water table; rapid permeability in substratum; poor filtering material below a depth of 40 inches; favorable percolation rate; hazard of contamination of ground water. | Severe: substratum too porous to hold water. | Severe: rapid permeability in the sandy substratum. | Moderate: seasonal high water table at a depth of 2 to 4 feet. |
| 225 | Moderate: rapid permeability in substratum; seasonal high water table; poor filtering material below a depth of 32 inches. | Severe: substratum too porous to hold water. | Severe: rapid permeability in the sandy substratum. | Moderate: somewhat poorly drained; seasonal water table at a depth of 2 to 4 feet. |
| Lawson: 484 | Severe: seasonal high water table; subject to flooding; favorable percolation rate. | Severe: subject to flooding and fluctuating water table; coarse strata in places below a depth of 5 feet. | Severe: somewhat poorly drained; seasonal high water table; sandy substratum in places below a depth of 60 inches; subject to flooding. | Moderate: somewhat poorly drained; seasonal high water table; moderate to high shrink-swell potential. |
| Lilah: 776C2 | Slight: pollution of water supply is a severe hazard in places. | Severe on all slopes: rapid permeability in substratum; too porous to hold water; severe hazard of contamination. | Severe: very rapid permeability in substratum. | Slight |
| Marshan: 152 | Severe: high water table; water table restricts percolation; subject to concentrated runoff. | Severe: substratum too porous to hold water; hazard of contamination of ground water. | Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet; rapid permeability in sandy substratum. | Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet. |

*interpretations*—Continued

| Suitability as source of— | | | Soil features affecting— | | | |
|---|---|---|---|---|---|---|
| Road fill [2] | Sand and gravel | Topsoil | Pond reservoir areas | Embankments, dikes, and levees | Drainage for crops and pasture | Terraces and diversions |
| Poor to a depth of 2 to 3 feet: fair bearing capacity; poor shear strength; high organic-matter content in surface layer. Fair below a depth of 2 to 3 feet: good bearing capacity; good shear strength. | Not suitable: no sand or gravel. | Good: high organic-matter content in surface layer. | Difficult to find suitable sites; strata of sand below a depth of 2 to 3 feet in places; reservoir area needs to be compacted in places to prevent seepage. | Moderate to high shrink-swell potential; fair to good compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well; tile needed in places. | Generally not needed because of topography; if needed, soil features are favorable; terraces and tile drainage in combination generally are successful. |
| Fair to poor to a depth of about 32 inches: high organic-matter content. Good below a depth of 32 inches. | Good below a depth of about 32 inches for sand: generally low in gravel. | Good to a depth of about 3 feet. Poor below a depth of about 3 feet: high organic-matter content in surface layer. | Nearly level; moderate permeability; porous substratum at a depth of 32 to 40 inches. | Moderate to low shrink-swell potential; good to poor compaction characteristics and stability after compaction in the substratum. | Seasonal high water table; moderate permeability; water-bearing sand restricts installation in places. | Not applicable because of unfavorable topography; soil features favorable for diversions. |
| Poor to a depth of about 24 to 30 inches: high organic-matter content. Good below a depth of 24 to 30 inches. | Good below a depth of about 24 to 30 inches for sand: generally low in gravel. | Good to a depth of about 2 feet. Poor below a depth of about 2 feet: high organic-matter content in surface layer. | Nearly level; moderate permeability; porous substratum at a depth of 24 to 30 inches. | Sandy substratum; fair to poor resistance to piping; poor stability after compaction. | Seasonal high water table; moderate permeability; water-bearing sand restricts installation in places. | Not applicable because of topography; soil properties favorable for diversion terraces. |
| Poor: high organic-matter content; low bearing capacity; high compressibility; seasonal high water table. | Poor to a depth of 5 feet: sand below a depth of 5 feet; too many fines in places. | Good: high organic-matter content in thick surface layer; subject to flooding. | Moderate permeability; subject to flooding; substratum is sandy in places below a depth of 60 inches. | Fair to good compaction characteristics and stability after compaction in subsoil. | Seasonal high water table; tile functions well; protection from flooding needed in places. | Soil features favorable; properly placed diversions help direct local runoff and reduce flooding and wetness. |
| Very good: well-graded sand and gravel; very low to no compressibility; little or no volume change when wet. | Good: well-graded sand and gravel in places below a depth of 1 to 1½ feet. | Fair in upper part. Very poor below: low organic-matter content. | Shallow to very rapidly permeable in sand and gravel substratum; too porous to hold water. | Sandy subsoil and substratum; poor resistance to piping; medium to high permeability where compacted. | Natural drainage adequate. | Slopes generally very short; slopes very irregular in some places; shallow to sand and gravel; highly erodible; difficult to maintain ridge and channel. |
| Very poor to a depth of 3 feet: high organic-matter content. Good below a depth of 3 feet: good bearing capacity; good shear strength; low volume change. | Good below a depth of 3 feet: well-graded sand and gravel; low in gravel; high water table interferes with excavation in places. | Good to a depth of 1 to 1½ feet. Fair between depths of 1½ and 3 feet. Poor below a depth of 3 feet. | Substratum too porous to hold water; fluctuating water table; dugout ponds feasible. | Fair to good compaction characteristics and stability after compaction in subsoil; poor resistance to piping and high permeability in substratum where compacted. | Seasonal high water table; tile drainage feasible; water-bearing fine sand restricts installation in places. | Generally not needed because of topography. |

TABLE 5.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for— | | | |
|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Sanitary landfill [1] | Local roads and streets |
| Maxfield: 382 | Severe: high water table; questionable percolation rate in places. | Moderate: high organic-matter content in surface layer; seasonal high water table. | Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet. | Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet; high shrink-swell potential. |
| Muscatine: 119, 119B, T119 | Moderate: seasonal high water table; favorable percolation rate. | Moderate: moderate permeability; difficult to find suitable sites; high organic-matter content in surface layer. | Severe: somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet. | Severe: high organic-matter content; fair to poor compaction characteristics; seasonal high water table at a depth of 3 to 5 feet. |
| Nevin: 88 | Severe: seasonal high water table; moderately slow permeability. | Moderate: moderately slow permeability; high organic-matter content; sandy strata occur in places below a depth of 4 feet. | Severe: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate to high shrink-swell potential; rapid to very rapid permeability in places below a depth of 60 inches. | Severe: CL material; plasticity index generally more than 15; somewhat poorly drained. |
| Ostrander: 394B, 394C, 394C2. | Slight where slopes are less than 5 percent. Moderate where slopes are 5 to 9 percent. Severe where slopes are more than 9 percent: favorable percolation rate. | Severe: moderately rapid permeability in sandy substratum. | Slight: moderately slow permeability in glacial till below a depth of 3 to 4 feet. | Moderate: subject to frost action where pockets of water-bearing sand occur. |
| Palms: 221 | Severe: frequent high water table; subject to ponding. | Severe: high organic-matter content; variable permeability in strata below muck. | Severe: very poorly drained; seasonal high water table at a depth of 0 to 3 feet; muck to a depth of 28 inches. | Severe: very poorly drained; seasonal high water table at a depth of 0 to 3 feet; highly subject to frost heave; very high organic-matter content. |
| Port Byron: 620C2, 620E3 | Slight where slopes are less than 5 percent. Moderate where slopes are 5 to 9 percent. Severe where slopes are more than 9 percent: moderate permeability; favorable percolation rate. | Moderate where slopes are less than 9 percent. Severe where slopes are more than 9 percent: semipervious even where compacted. | Slight where slopes are less than 15 percent. Moderate where slopes are more than 15 percent: loess underlain by glacial till. | Severe: poor bearing capacity; fair to poor compaction characteristics. |

*interpretations*—Continued

| Suitability as source of— | | | Soil features affecting— | | | |
|---|---|---|---|---|---|---|
| Road fill [2] | Sand and gravel | Topsoil | Pond reservoir areas | Embankments, dikes, and levees | Drainage for crops and pasture | Terraces and diversions |
| Poor to a depth of about 3 feet. Fair below a depth of about 3 feet: high shrink-swell potential; poor bearing capacity; difficult to compact. | Not suitable: no sand or gravel. | Fair: moderately fine texture; high water table; high organic-matter content in thick surface layer. | Difficult to find suitable sites; moderately slow permeability; strata of sand occur in places below a depth of 3 feet. | High shrink-swell potential; fair to good compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well. | Generally not needed because of topography. |
| Poor: fair bearing capacity; poor shear strength; moderate to high shrink-swell potential; high organic-matter content in surface layer. | Not suitable: no sand or gravel. | Good: high organic-matter content in thick surface layer. | Difficult to find suitable sites; reservoir areas need to be compacted in places to prevent seepage. | Moderate to high shrink-swell potential; fair to good compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well; tile not needed in places. | Generally not needed because of topography; if needed, no soil limitations. |
| Not suitable: poor bearing capacity; poor shear strength; high shrink-swell potential; high elasticity; difficult to compact. | Not suitable: no sand or gravel. | Good | Difficult to find suitable sites; low permeability where compacted. | Moderate to high shrink-swell potential; fair to good compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well; tile generally not needed. | Terraces not needed; diversions beneficial in places in preventing runoff overflow from adjacent slopes. |
| Good below a depth of 1½ to 2 feet: low compressibility; fair to good bearing capacity; easy to compact to high density. | Not suitable: no sand or gravel. | Good | Low permeability where compacted; pockets and strata of sand in many places; reservoir areas need to be scarified and compacted in places. | Fair to good compaction characteristics and stability after compaction. | Not needed: seepage in places in early spring. | Subsoil low in fertility; terraces and tile drainage in combination generally are most successful. |
| Very poor: very high organic-matter content in muck; frequent high water table; subject to ponding and wetness. | Not suitable: no sand or gravel. | Good when mixed with mineral soil; underlying material fair to poor. | Frequent high water table; depressional areas; suitable for dug-out ponds in places. | Organic material unsuited for embankments. | Variable but generally moderate or moderately slow permeability; deep cuts needed in places for outlets. | Not needed: depressional soil. |
| Fair to poor: medium to high compressibility; difficult to compact to high density; poor bearing capacity; high organic-matter content. | Not suitable: no sand or gravel. | Good | Moderate permeability in subsoil; subject to seepage; bottoms of reservoirs need to be compacted in places; uniform material. | Fair to good compaction characteristics and stability after compaction. | Natural drainage adequate. | All soil features favorable. |

TABLE 5.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for— | | | |
|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Sanitary landfill [1] | Local roads and streets |
| Readlyn: 399 | Moderate to severe: seasonal high water table; questionable percolation rate in places; moderately slow permeability. | Slight where slopes are less than 2 percent. Moderate where slopes are 2 to 5 percent: high organic-matter content in surface layer; pockets of sand in places. | Moderate: somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; moderately slow permeability in glacial till. | Moderate to severe: somewhat poorly drained; medium to low shear strength; fair to good compaction characteristics; subject to frost action where pockets of sand occur. |
| *Saude: 177, 177B, 177C, 177C2, 241B, 241C2. For Lilah parts of 241B and 241C2, see Lilah series. | Slight where slopes are less than 5 percent. Moderate where slopes are 5 to 9 percent: favorable percolation rate; moderate hazard of stream contamination. | Severe: sand and gravel at a depth of about 2 feet; too porous to hold water; severe hazard of contamination. | Severe: very rapid permeability. | Slight |
| *Sawmill: 933, 933B. For Garwin part of 933B, see Garwin series. | Severe: seasonal high water table; unfavorable percolation rate in places; subject to flooding. | Severe: subject to flooding; seasonal high water table. | Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet. | Severe: poorly drained; fair to poor compaction characteristics; moderate to high shrink-swell potential. |
| Sparta: 41B | Moderate where slopes are less than 9 percent. Severe where slopes are more than 9 percent: poor filtering material; severe hazard of contamination. | Severe: material too porous to hold water; high rate of seepage. | Severe: very rapid permeability. | Slight |
| Sperry: 122 | Severe: high water table; slow permeability; unfavorable percolation rate. | Moderate: slow permeability; high organic-matter content in surface layer; difficult to find suitable sites. | Severe: very poorly drained; seasonal high water table at a depth of 0 to 3 feet. | Severe: very poorly drained; fair to poor compaction characteristics; moderate to high shrink-swell potential. |
| Tama: 120, 120B, 120C, 120C2, T120. | Slight where slopes are less than 5 percent. Moderate where slopes are 5 to 9 percent. Severe where slopes are more than 9 percent: favorable percolation rate; poor filtering material below a depth of 5 feet in T120 causes contamination of ground water in places. | Moderate where slopes are 2 to 9 percent. Severe where slopes are more than 9 percent: moderate permeability. Severe on T120: sandy material below a depth of 5 feet. | Slight: loess underlain by glacial till at a depth of 5 to 15 feet. Severe on T120: sandy material below a depth of 5 feet. | Severe: medium to low shear strength; fair to good compaction characteristics; moderate to high shrink-swell potential. |

*interpretations*—Continued

| Suitability as source of— | | | Soil features affecting— | | | |
|---|---|---|---|---|---|---|
| Road fill [2] | Sand and gravel | Topsoil | Pond reservoir areas | Embankments, dikes, and levees | Drainage for crops and pasture | Terraces and diversions |
| Good below a depth of 1½ to 2 feet: low compressibility; fair to good bearing capacity; fair to good compaction characteristics. | Not suitable: no sand or gravel. | Good to a depth of 1 to 1½ feet: high organic-matter content. Fair below a depth of 1½ feet: clayey; low fertility. | Moderately slow permeability; strata of sand in places; difficult to find suitable sites. | Fair to good compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well where properly installed; not all areas need tile drainage. | Terraces generally not needed; terraces increase infiltration and the need for drainage in places; terraces and tile drainage in combination generally are most successful. |
| Good below a depth of about 2 feet: low volume change; good workability; good bearing capacity; good shear strength. | Good below a depth of about 30 inches: well-graded sand that has gravel in places. | Good to a depth of 1 to 1½ feet; coarse below a depth of 30 inches. | Sand and gravel at a depth of about 30 inches; too porous to hold water. | Poor compaction characteristics and stability after compaction in lower part of subsoil and in substratum. | Natural drainage adequate. | Slopes generally short and irregular; coarse below a depth of 2 feet; cuts should be minimal. |
| Very poor: high shrink-swell potential; poor bearing capacity; poor shear strength. | Not suitable: no sand or gravel. | Fair: moderately fine texture; high organic-matter content; seasonal high water table. | Moderately slow permeability before compaction; high organic-matter content. | Fair to good compaction characteristics and stability after compaction. | Seasonal high water table; tile functions well. | Not needed because of topography. |
| Good: low volume change; good workability where soil is more than 15 percent fines; lacks stability under wheel loads when dry; erodible. | Good: poorly graded fine and medium sand. | Poor: very low water-holding capacity. | Rapid permeability; material too porous to hold water. | Fair to poor compaction characteristics; poor stability after compaction; fair to poor resistance to piping. | Natural drainage excessive. | Highly erodible; unstable on slopes; difficult to maintain ridge and channel; subject to piping. |
| Very poor: high shrink-swell potential; poor bearing capacity; difficult to compact. | Not suitable: no sand or gravel. | Fair in surface layer. Poor below a depth of about 1 to 1½ feet: high water table; subsoil high in clay. | Depressional topography; very slow permeability; suited to dug-out ponds in places. | Fair to poor compaction characteristics and stability after compaction. | High water table; slow permeability; tile does not drain all areas; surface drainage needed to remove ponded water. | Not needed because of topography. |
| Fair to poor: fair bearing capacity; moderate to high shrink-swell potential; loss of bearing capacity with increase in moisture. Good on T120 below a depth of 5 feet. | Not suitable: no sand or gravel. T120 has sandy material below a depth of 5 feet that has too many fines in places; little or no gravel. | Good to a depth of 1 to 1½ feet: generally thick, dark surface layer. Fair below surface layer: somewhat clayey. | Moderate permeability; bottoms of reservoirs need to be scarified and compacted in places. Rapid permeability in T120 below a depth of 5 feet. | Fair to good compaction characteristics and stability after compaction. | Natural drainage generally adequate. | Well suited: subsoil generally responds well to good management practices; not needed on T120. |

TABLE 5.—*Engineering*

| Soil series and map symbols | Degree and kind of limitation for— | | | |
|---|---|---|---|---|
| | Septic tank absorption fields | Sewage lagoons | Sanitary landfill [1] | Local roads and streets |
| Thorp: 404 | Severe: seasonal high water table; slow permeability. | Moderate: seasonal high water table; slow permeability. | Severe: poorly drained; seasonal high water table at a depth of 2 to 4 feet. | Severe: poorly drained; moderate to high shrink-swell potential. |
| Turlin: 96 | Severe: subject to flooding; seasonal high water table; flooding damages filter field in places. | Severe: subject to flooding; moderate permeability; coarse in places below a depth of 4 feet. | Severe: poorly drained; seasonal high water table at a depth of 2 to 5 feet. | Moderate: somewhat poorly drained; subject to occasional flooding. |
| Waukee: 178, 178B | Slight where slopes are less than 5 percent. Moderate where slopes are 5 to 9 percent: favorable percolation rate; moderate hazard of ground water contamination. | Severe: sand and gravel below a depth of 3 feet; too porous to hold water. | Severe: very rapid permeability in the substratum. | Moderate: moderate shrink-swell potential. |
| Wiota: 7 | Slight to moderate: moderate permeability. | Moderate: generally moderate permeability in places below a depth of 5 feet. | Severe: very rapid permeability in places below a depth of 60 inches. | Moderate to severe: good to poor compaction characteristics; moderate to high shrink-swell potential. |
| Zook: 54 | Severe: high water table; subject to flooding; unfavorable percolation rate. | Severe: high water table; subject to flooding; high organic-matter content; slow permeability. | Severe: poorly drained; seasonal high water table at a depth of 1 to 3 feet; subject to ponding and overflow. | Severe: poorly drained; high shrink-swell potential. |

[1] Onsite study is needed of the deep underlying strata, the water table, and the hazards of aquifer pollution and drainage into ground water in landfill deeper than 5 or 6 feet.

nance of structures built in, on, or of material having this rating.

### *Engineering interpretations*

The interpretations in table 5 are based on the estimated engineering properties of soils shown in table 4, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Grundy County. In table 5, ratings are used to summarize limitations or suitability of the soils for all listed purposes other than for pond reservoir areas; embankments, dikes, and levees; drainage for crops and pasture; and terraces and diversions. For these particular uses, table 5 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means soil properties are

*interpretations*—Continued

| Suitability as source of— | | | Soil features affecting— | | | |
|---|---|---|---|---|---|---|
| Road fill[2] | Sand and gravel | Topsoil | Pond reservoir areas | Embankments, dikes, and levees | Drainage for crops and pasture | Terraces and diversions |
| Poor: fair to poor bearing capacity; fair to poor shear strength; poor compaction characteristics; moderate or high shrink-swell potential. | Poor: sand has too many fines in places below a depth of 5 feet. | Good in surface layer. Fair below. | Difficult to compact; seasonal high water table; slow permeability; suitable for dugout ponds in places. | Fair to good compaction characteristics and stability after compaction. | Seasonal high water table; tile drainage difficult in places; surface needed. | Terraces not needed; diversions beneficial to prevent runoff overflow from adjacent slopes. |
| Fair to poor: high organic-matter content in surface layer; fair to poor bearing capacity; fair to poor shear strength; medium to high compressibility. | Fair to poor below a depth of 5 feet: sand has too many fines in places. | Good: high organic-matter content. | Moderate permeability; subject to flooding; coarse strata in places below a depth of 4 feet. | Fair to good compaction characteristics and stability after compaction. | Moderate permeability; seasonal high water table; subject to flooding; dikes and tile drainage feasible; not all areas need tile. | Generally not needed; no soil limitations. |
| Fair in upper part. Good below a depth of 3 feet: high organic-matter content in surface layer; good bearing capacity and shear strength in substratum; low volume. | Good below a depth of 3 feet: poorly graded sand and gravel; low in gravel. | Good to a depth of 1 to 1½ feet: high organic-matter content. Fair between depths of 1½ and 3 feet. Poor below a depth of 3 feet. | Moderate permeability in upper part; very rapid permeability in substratum; sand and gravel below a depth of 3 feet. | Fair to good compaction characteristics and stability after compaction. | Natural drainage adequate. | Slopes generally short and irregular; cuts should be minimal; sand and gravel at a depth of 3 feet. |
| Poor to fair in lower strata: fair bearing capacity; moderate to high shrink-swell potential. | Fair to poor: sandy material has too many fines in places below a depth of 5 to 6 feet. | Good ---------- | Generally not suitable; too porous to hold water in places; difficult to find suitable sites. | Good to poor compaction characteristics and stability after compaction. | Not needed: well drained. | Terraces not needed; diversions beneficial in preventing runoff overflow. |
| Very poor: high water table; high shrink-swell potential; poor compaction; poor bearing capacity. | Not suitable: no sand or gravel. | Poor: too high in clay. | Suitable for dugout ponds in places; seasonal high water table; subject to flooding; slow permeability. | High shrink-swell potential; fair to poor compaction characteristics and stability after compaction. | Tile drains work only if closely spaced; surface drains needed to remove water in places. | Not needed because of topography. |

[2] Specific values should not be assigned to estimates of bearing capacity given in this column.

generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special designs. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties are so unfavorable for a particular use that overcoming the limitation is most difficult and costly and commonly not practical for the rated use.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 5.

TABLE 6.—*Engineering*

[Tests performed by the Iowa State Highway Commission in accordance with standard procedures

| Soil name and location | Parent material | Iowa report No. AAD1 | Depth | Moisture-density [1] | |
|---|---|---|---|---|---|
| | | | | Maximum dry density | Optimum moisture |
| | | | *In* | *Lb per cu ft* | *Pct* |
| Dinsdale silty clay loam:<br>437 feet E and 639 feet S of the NW corner of NE¼ sec. 20, T. 88 N., R. 15 W. (Modal) | Wisconsin loess over Iowan till. | 1980<br>1981<br>1982<br>1983 | 0–6<br>16–21<br>37–44<br>48–58 | 100<br>103<br>116<br>123 | 19<br>20<br>13<br>11 |
| Muscatine silty clay loam:<br>130 feet S and 126 feet W of the NE corner of NW¼SW¼NE¼ sec. 20, T. 87 N., R. 17 W. (Modal) | Wisconsin loess. | 1126<br>1127<br>1128 | 0–7<br>23–30<br>53–60 | 90<br>98<br>108 | 25<br>21<br>17 |

[1] Based on AASHTO Designation T 99–57, Method A (*1*).

[2] Mechanical analysis according to AASHTO Designation: T 88–57 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method

*Septic tank absorption fields* are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

*Sewage lagoons* are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified soil classification, and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

*Sanitary landfill* is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 5 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

*Local roads and streets*, as rated in table 5, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly of asphalt or concrete. These roads are graded to shed water, have ordinary provisions for drainage, and are built mainly from soil at hand. Most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material and the shrink-swell potential indicate traffic supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and the amount of cut and fill needed to reach an even grade.

*Road fill* is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material from borrow areas.

*test data*

of the American Association of State Highway and Transportation Officials (AASHTO) (*1*)]

| Mechanical analysis [2] | | | | | | | | | Liquid limit | Plasticity index | Classification | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Percentage passing sieve— | | | | | Percentage smaller than— | | | | | | | |
| ⅜ in. | No. 4 (4.7 mm) | No. 10 (2.0 mm) | No. 40 (0.42 mm) | No. 200 (0.074 mm) | 0.05 mm | 0.005 mm | 0.002 mm | 0.001 mm | | | AASHTO [3] | Unified [4] |
| | | | | | | | | | *Pct* | | | |
| -------- | -------- | 100 | 99 | 94 | 85 | 35 | 27 | 20 | 29 | 16 | A-6(10) | CL |
| -------- | -------- | 100 | 99 | 93 | 87 | 40 | 34 | 30 | 46 | 25 | A-7-6(15) | CL |
| 100 | 99 | 99 | 91 | 63 | 56 | 31 | 27 | 23 | 34 | 20 | A-6(10) | CL |
| -------- | 100 | 98 | 88 | 64 | 54 | 28 | 22 | 18 | 27 | 14 | A-6(7) | CL |
| -------- | -------- | -------- | 100 | 98 | 93 | 40 | 30 | 23 | 49 | 21 | A-7-6(14) | ML-CL |
| -------- | -------- | -------- | -------- | 99 | 93 | 45 | 39 | 35 | 50 | 28 | A-7-6(17) | CL |
| -------- | -------- | 100 | 98 | 98 | 89 | 31 | 25 | 21 | 36 | 17 | A-6(11) | CL |

and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[3] Based on AASHTO Designation M 145-49 (*1*).

[4] Based on the Unified soil classification system (*16*).

Engineers and others, however, should not apply specific values to the estimates of bearing capacity given in table 5.

*Sand and gravel* are used in great quantities in many kinds of construction. The ratings in table 5 provide guidance in looking for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not account for thickness of overburden, location of the water table, or other factors that affect mining of the materials, and they do not indicate quality of the deposit.

*Topsoil* is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

*Pond reservoir areas* hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

*Embankments, dikes, and levees* require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among factors that are unfavorable.

*Drainage for crops and pasture* is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

*Terraces and diversions* are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

### *Test data*

Table 6 contains engineering test data for some of the major soil series in Grundy County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or *moisture-density*) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Liquid limit and plastic limit tests measure the effect of water on the consistence of soil material, as has been explained for table 4.

### *Nonfarm use of the soils*

This section is mainly for builders of residential and industrial structures who plan to use the soil in systems for sewage disposal. It can also be used by landowners, planners, developers, and zoning officials. In table 5 the soils are rated for use in septic tank absorption fields and sewage lagoons. The degree of limitations in table 5 has been explained in the section "Engineering interpretations."

*Septic tank absorption fields.*—The characteristics that affect the limitations for septic tank absorption fields are soil permeability, percolation rate, ground water level, flood hazard, natural drainage, landscape position, slope, and depth to bedrock and coarse-textured sand and gravel.

The rate at which effluent moves through a soil depends partly on the texture of the subsoil and underlying material. Water moves at a faster rate through coarse-textured, sandy and gravelly soils than through fine-textured, clayey soils. For an effective septic tank absorption field, the permeability of the soil should be moderate to rapid, and the rate of percolation should be at least 1 inch per hour. A percolation test should be made before installing a septic tank (*2, 17*).

If ground water rises to the level of the subsurface tile in the filter field, the soil is so saturated that it will not take the effluent from the septic tank. The effluent may rise to the surface of the ground, giving off an ill-smelling odor and endangering health. The ground-water table should be at least 4 feet below the surface during the wettest periods for maximum efficiency (*2*).

Generally, well-drained soils are satisfactory for these disposal systems and poorly drained soils are not.

A disposal system for septic tanks should not be on a flood plain or near a stream that is likely to flood. An occasional flooding over the filter field impairs its efficiency, and frequent floods soon destroy its effectiveness. In many areas, local regulations require that the filter field be located 25 to 50 feet away from a stream, lake, open ditch, or other watercourse in which unfiltered and contaminated effluent might enter and spread.

A clay layer or other impervious stratum should be at a depth of more than 4 feet below the bottom of the trench in the filter field so that there is enough soil to filter and purify the effluent. Even more depth is needed if the domestic water supply comes from wells. A depth of more than 4 feet is needed if the underlying material is sand and gravel. A disposal system works very well in a sandy soil, but effluent contaminates the water in places where the supply of domestic water comes from a shallow source.

If other characteristics of a soil are favorable for the functioning of filter fields, slopes of as much as 9 percent are satisfactory. The filter beds are easier to construct and maintain in level areas or in gently sloping areas than they are in steeper areas, where the effluent may follow the natural drainage lines through the soil or seep out at the surface before it is properly filtered. Tile lines for the system should be placed on the contour to assist in filtering the effluent.

Dinsdale and Tama soils have characteristics that are favorable for septic tank filter fields. They are moderately well drained to well drained and moderate to moderately slow in permeability, and the water table is more than 72 inches deep. Since slope is an important factor, these soils increase in degree of limitation from slight to moderate or severe as slope increases. The moderately well-drained Kenyon soils have a moderate limitation on slopes of less than 9 percent that increases to severe on slopes of more than 9 percent. These soils have an unfavorable percolation rate in places.

The somewhat poorly drained soils, such as Klinger and Muscatine soils, have moderate limitations because of a seasonal high water table and moderate to moderately slow permeability. Floyd and Readlyn soils, which are also somewhat poorly drained, have moderate to severe limitations on all slopes. These soils have a seasonal high water table, and the Readlyn soils have an unfavorable percolation rate in places. Lawler soils, which are also somewhat poorly drained, have moderate limitations but have a substratum of sand and gravel. The danger of contamination of the ground water is greater for these soils because of the underlying coarse-textured materials. Clyde, Colo, Garwin, Marshan, Maxfield, and Sawmill soils occur in depressions or drainageways and are poorly drained. These soils have severe to very severe limitations.

Ely, Lawson, and Turlin soils are subject to periodic overflow. Their limitations for use as filter fields are moderate to very severe, depending on the frequency of flooding or runoff from higher elevations. The mucks have very severe limitations because of high organic-matter content and a high water table.

Some of the sandy soils, such as Dickinson, Lilah, Saude, and Sparta soils, have slight or moderate limitations where slopes are less than 9 percent and severe limitations where slopes are greater than 9 percent. However, there is a severe hazard of contaminating the ground water supply, because the sandy or gravelly material allows the effluent to travel long distances.

*Sewage lagoons.*—Many communities are using sewage lagoons as a method for disposing of sewage without polluting streams. The soil properties considered are permeability, depth to bedrock, slope, texture, and organic-matter content.

The moderately well drained to well drained soils, such as Dinsdale, Kenyon, and Tama soils, have favorable soil characteristics and only slight limitations where slopes are less than 2 percent. The degree of limitation increases as slope increases.

Floyd, Klinger, Muscatine, and Readlyn soils have slight to moderate limitations. They have a seasonal high water table and high organic-matter content and are somewhat poorly drained. The Lawler soils, which are also somewhat poorly drained, have severe limitations because they have a substratum of sand and gravel. This material is too porous to hold liquids.

The poorly drained soils, such as Clyde, Coland, Colo, Garwin, Marshan, Maxfield, and Sawmill soils, have moderate to severe limitations. These soils receive runoff or are subject to overflow. Marshan soils have a substratum of sand and gravel that is too porous to hold liquids.

Ely, Lawson, Nevin, and Turlin soils have moderate to very severe limitations. All these soils are subject to runoff from higher elevations or to frequent flooding. The soil material in loamy alluvial land is so variable that the material used in lagoons would be too pervious to hold liquids.

The sandy soils, such as Dickinson and Sparta soils, have severe limitations. The texture of these soils is too coarse and permeability is too rapid for them to hold any liquids.

*Foundations for buildings with basements.*—It is important to know the soil and slope before constructing any type of residential or industrial building, particularly where basements are to be constructed. Soil characteristics that should be considered are shear strength, shrink-swell potential, compressibility, consolidation characteristics, susceptibility to liquefaction and piping, soil texture and permeability, depth to bedrock, depth to water table (seasonal or permanent), and susceptibility to sliding.

Other characteristics to be considered are drainage, flood hazard, landscape position, and slope.

On soils that have a seasonal high water table, subsurface drainage is needed to make the soils suitable as sites for buildings. If the water table is close to the surface during most of the year, the construction of basements is especially difficult. Both surface and subsurface drainage should be considered. A soil that has a permanently high water table requires a different kind of drainage than a soil that has a seasonal high water table. Soils in rolling areas require still another kind of drainage. Soils that are periodically wet or frequently flooded generally are not satisfactory as sites for buildings if basements are to be constructed. Soils that have a water table at a greater depth are more suitable. Depressional areas are also not favorable because of the large amount of fill needed to improve drainage.

Landscape positions and slopes are also important. Convex slopes are more desirable than concave slopes or drainageways. Some slope is desirable, but runoff from higher places may require that the excess water be diverted away from the buildings. In steeper areas, measures to stabilize banks and buildings may be needed.

Depth to bedrock in Grundy County is such that it is not a problem in the construction of residential or industrial buildings, particularly where basements are to be constructed.

# *Formation and Classification of the Soils*

This section tells how the factors of soil formation have affected soils in Grundy County. It also explains the system of soil classification currently used and places each soil series in the classes of that system.

## Factors of Soil Formation

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (a) the physical and mineralogical composition of the parent material, (b) the climate under which the soil material has accumulated and existed since accumulation, (c) the plant and animal life on and in the soil, (d) the relief, or lay of the land, and (e) the length of time the forces of soil formation have acted on the soil material (*3*).

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the formation of distinct horizons.

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

### *Parent material and geology*

The accumulation of parent material is the first step in the formation of a soil. Most soils in Grundy County formed in material that was transported from the site of the parent rock and redeposited at a new location through the action of wind, glacial ice, water, and gravity.

The principal parent materials in Grundy County are loess, glacial drift, alluvium, and eolian, or wind-deposited, sand.

*Loess* is silty material deposited by wind that covers about 75 percent of the county. In 56 percent of the county, dominantly in the southwestern part, it is more than 40 inches thick. It extends to a depth of 20 to 40 inches over glacial drift in the remaining 19 percent. It consists mostly of silt and some clay. It does not contain coarse sand or gravel, because those materials are too large to be moved by wind, but it does contain a small amount of very fine sand. These eolian deposits are 14,000 to 22,000 years old (*9*).

In Grundy County, Tama, Muscatine, Garwin, Harpster, and Sperry soils formed in loess that is more than 40 inches thick (fig. 17). A moderately steep paha is in German Township, in the northwest part of the county (*11*). Port Byron soils formed in the loess that makes up this paha. Bolan, Dinsdale, Klinger, and Maxfield soils formed in loess that is 20 to 40 inches thick (fig. 18). Eolian sand is below the loess in Bolan soils, and glacial till is below the loess in Dinsdale, Klinger, and Maxfield soils. These soils are among the most productive in the county.

*Glacial drift* is rock material transported by glacier ice, glacial ice deposits, and deposits of dominantly glacial origin formed in the sea or in bodies of glacial melt water. It includes glacial till, which is unsorted sediment that ranges in size from boulders to clay (*10*). Glacial drift occurs in about 15 percent of the county. It is uniformly covered with loamy material that is about 1 to 2 feet thick. On the lower concave slopes and in waterways the thickness of the overburden is as much as 40 inches. A stone line or pebble

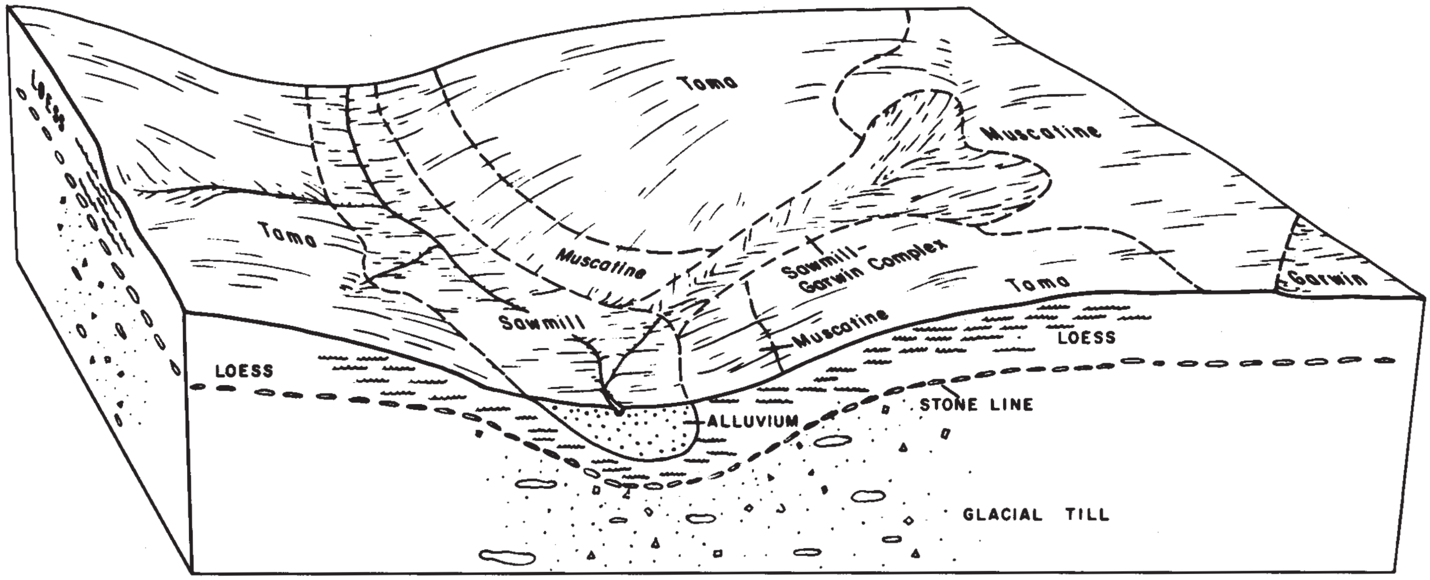


*Figure 17.*—Relationship between slope and parent material in Muscatine, Tama, and Garwin soils.

band commonly separates the friable, loamy overburden from the more dense, firm loam and clay loam glacial till. Remnants of a silty clay paleosol derived from glacial till occur throughout the drift area, typically at an elevation of 1,000 to 1,050 feet. Pockets of coarse-textured material also occur within the glacial till.

The first glacial advance over Grundy County was the Nebraskan Glaciation, which occurred some 750,000 years ago (*4*). It was followed by the Aftonian interglacial period. The Kansan Glaciation is thought to have started about 500,000 years ago.

Intensive geomorphic, stratigraphic work shows that the landscape is a multilevel sequence of erosion surfaces and that many levels are cut into Kansan and Nebraskan till (*9*). The Iowan surface is multilevel and is arranged in a series of steps from major drainageways toward bordering divides. It is marked by a stone line where it cuts Kansan and Nebraskan till. The stone line occurs on all levels of the stepped surfaces where they occur, and it passes under the alluvium along drainageways.

Clyde, Donnan, Floyd, Kenyon, Ostrander, and Readlyn soils formed in glacial material. Clyde and Floyd soils are in lower areas and in drainageways, and their loamy overburden is thicker than that of other upland soils that formed in glacial drift (fig. 19). Kenyon and Readlyn soils have firm clay loam or loam

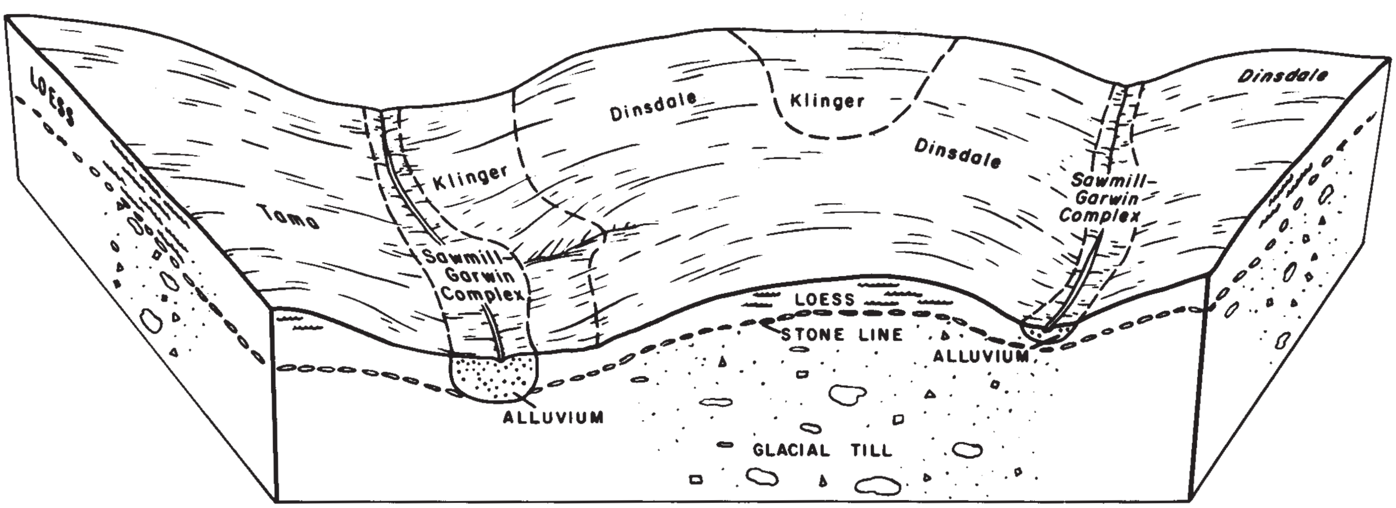


*Figure 18.*—Relationship between slope and parent material in Dinsdale, Tama, and Klinger soils.

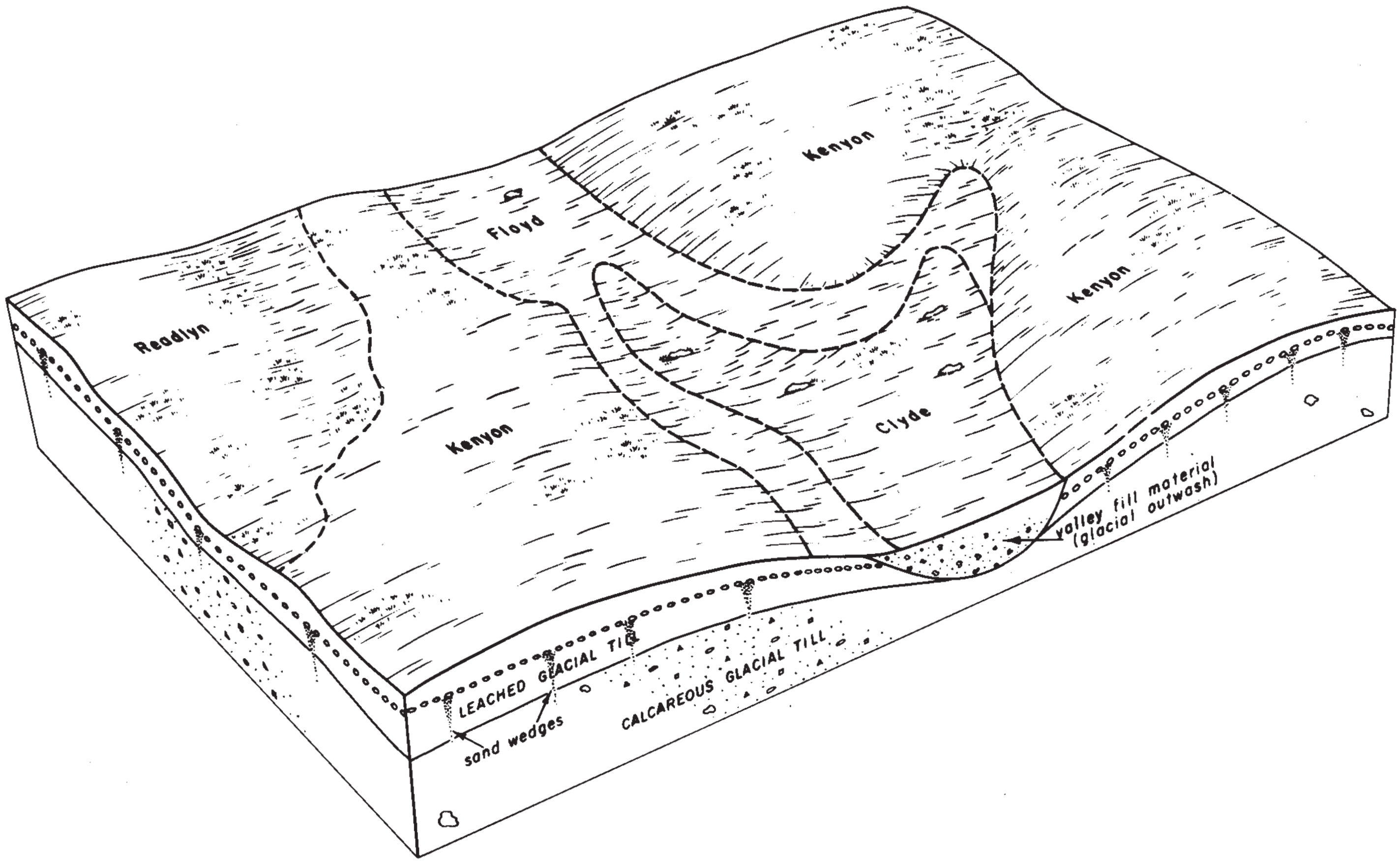


*Figure 19.*—**Relationship between slope and parent material in Readlyn, Kenyon, Clyde, and Floyd soils.**

glacial till in the lower part of the B2 horizon. Ostrander soils formed in friable, loamy sediment and friable glacial till to a depth of 30 to 56 inches over firm glacial till. Donnan soils formed in a silty clay paleosol derived from glacial till.

Boulders that are 3 to 15 feet in diameter are on the surface in some areas of glacial drift. Boulders and stones that are 6 to 30 inches in diameter are concentrated in many upland drainageways in areas of Clyde and Floyd soils.

*Alluvium* is material that is deposited by water on flood plains along streams. About 10 percent of the soils in Grundy County formed in alluvium. Much of the alluvium washed from adjoining loess-covered uplands and is high in silt. Bremer, Calco, Colo, Sawmill, and Zook soils on first bottoms and Ely, Lawson, Nevin, and Wiota soils on second bottoms formed in silty alluvium (fig. 20).

Some alluvium washed from adjoining areas that have a loamy overburden of glacial drift. This alluvium is loam or silty clay loam that is high in sand. Many soils in these areas have a substratum of sand or gravel. Coland and Turlin soils on first bottoms and Lawler, Marshan, Saude, Thorp, and Waukee soils on second bottoms and stream benches formed in this alluvium (fig. 21).

A few small areas of outwash are on gently sloping to strongly sloping uplands. These deposits extend to a depth of as much as 30 feet. They consist of gravelly loamy material underlain by well-oxidized sand. Lilah and Saude soils formed in this material.

*Eolian sand* is wind-deposited and is not extensive in Grundy County. Areas occur along some valleys of major streams, particularly in the glacial drift area. Eolian sand consists mainly of very fine and fine quartz particles that are highly resistant to weathering. It has not been altered appreciably since it was deposited. Dickinson and Sparta soils formed mostly in eolian sand.

*Organic deposits* are the parent material of organic soils or muck. Organic soils are in small, wet areas in the county where poor drainage has retarded the decay of plant remains that have accumulated over a period of time. The thickness of organic material is about 10 to 60 inches.

Most of the muck soils in Grundy County are in upland drainageways. They are associated with upland soils that have a substratum of sand or layers of sand in the subsoil. Permeability is rapid in these sandy layers. Water moves laterally to lower areas through these sandy layers, and provides a continuous supply of excess water to areas where muck is formed.

### Climate

According to available evidence, the soils of Grundy County have been forming under the influence of a

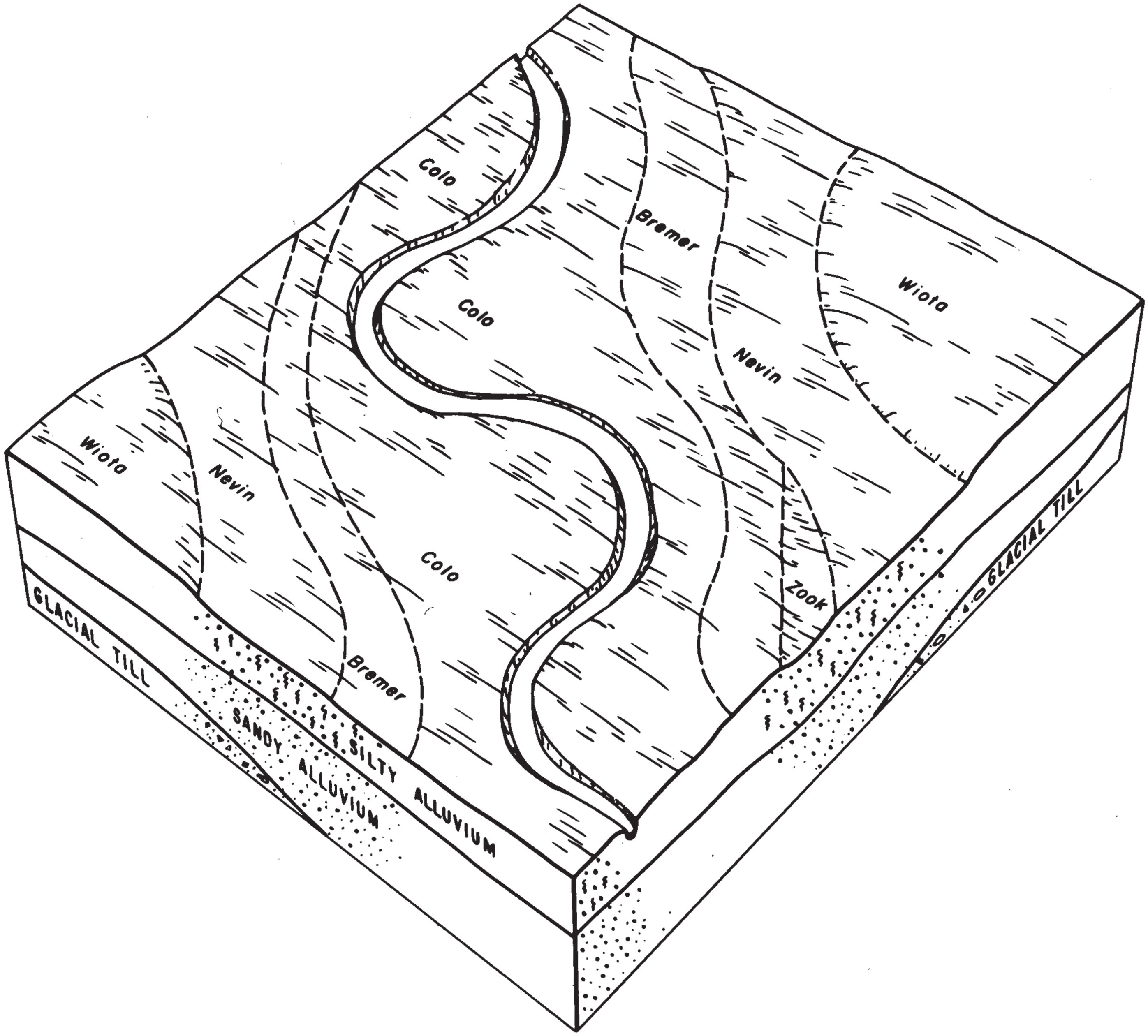


*Figure 20.*—**Relationship between slope and parent material in Bremer, Colo, Wiota, and Nevin soils.**

midcontinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to the growth of forest vegetation (*7*). The morphology of most of the soils in the county indicates that the climate in which the soils formed is similar to the present one. At present the climate is fairly uniform throughout the county, but it is marked by wide seasonal extremes in temperature. Precipitation is distributed throughout the year.

The rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by climate. Temperature, rainfall, relative humidity, and length of the frost-free period are important in determining the vegetation.

The influence of the general climate of the region is somewhat modified by the local conditions in or near the developing soil. For example, low-lying, poorly drained soils are wetter and colder than most soils around them. These contrasts account for some differences in soils within the same general climatic region.

***Plant and animal life***

Plant life and animal life are important factors in

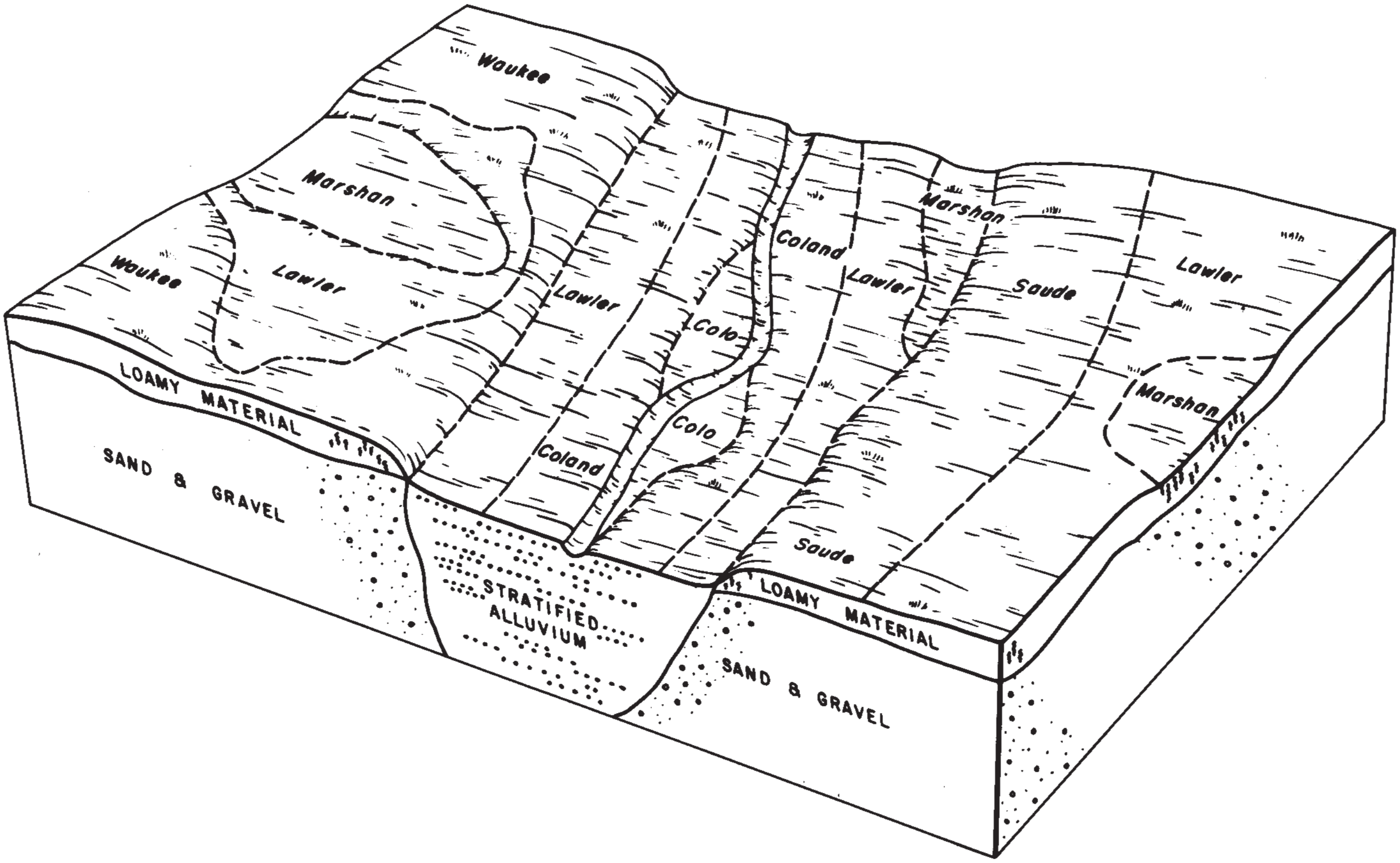


***Figure 21.*—Relationship between slope and parent material in Lawler, Marshan, Colo, Coland, and Waukee soils.**

soil formation. Plant life is especially significant, because soil formation really begins with the coming of vegetation. As plants grow and die, their remains add organic matter to the upper layers of the soil. The native grasses have myriad fibrous roots that penetrate the soil to a depth of 10 to 20 inches; thus, large amounts of organic matter accumulate in the surface layer. Trees commonly feed on nutrients deep in the subsoil. Consequently, there is little accumulation of organic matter in the surface layer other than that gained from fallen leaves and trees. Much of the organic matter from leaves and trees remains on the surface or is lost through decomposition.

In Grundy County most soils formed under prairie vegetation, but a few soils formed in small areas along major streams. These areas have a prairie-forest type of vegetation. The soils formed under the prairie-forest vegetation are included with the soils formed under prairie vegetation in Grundy County, because their extent is small.

Dinsdale, Kenyon, Muscatine, Tama, and Waukee soils are typical soils that formed under prairie vegetation in Grundy County. Clyde, Coland, and Colo soils are representative of soils that formed under prairie grasses and water-tolerant plants.

Organic-matter content is high in soils that formed under prairie vegetation. As a result, they have a thick, dark-colored surface layer.

Activities of burrowing animals and insects have some effect in loosening and aerating the upper few feet of soils. In some sloping areas cultivation followed by erosion has removed much of the dark-colored surface layer.

### *Relief*

Relief is an important cause of differences among soils. Indirectly it influences soil formation through its effect on drainage. In Grundy County relief ranges from level to strongly sloping. Many nearly level areas are frequently flooded and have a high or seasonal high water table. On steeper slopes much of the rainfall is lost as runoff.

In general, the soils in Grundy County that are affected by a high or seasonal high water table have a dominantly olive-gray subsoil. They include Clyde, Coland, Colo, Marshan, and Sawmill soils. Dinsdale, Kenyon, Ostrander, and Tama soils have a yellowish-brown subsoil and a water table that is below the subsoil. Floyd, Muscatine, Readlyn, and Lawler soils formed where natural drainage is intermediate. They have a mottled, grayish-brown subsoil. Soils that formed under prairie conditions and that have a high water table generally have a higher organic-matter content in the surface layer than those that have good natural drainage.

Aspect, as well as slope, affects soil formation. Southfacing slopes generally are warmer and drier than north-facing slopes, and consequently they support a different kind and amount of vegetation.

The influence of porous, rapidly permeable parent material may override the influence of relief. Dickinson soils, for example, are somewhat excessively drained because they are rapidly permeable, but they are moderately sloping.

Garwin, Muscatine, and Tama soils formed in the same kind of parent material and under similar vegetation, but they differ because of differences in topographic position. Muscatine soils are on nearly level ridges and concave foot slopes. Tama soils are on long, convex ridges and gentle or moderate, convex side slopes. Relief influences the drainage of these soils.

Ely and Sawmill soils are on foot slopes and in narrow, upland waterways. They have properties related to soils upslope, from which they receive sediment.

#### *Time*

Time is necessary for the various processes of soil formation. The necessary amount of time ranges from a few days for the formation of soils in fresh alluvial deposits, such as Colo soils, channeled, to thousands of years for the paleosol that makes up the subsoil of Donnan soils. In general, if other factors are favorable, the texture of the subsoil becomes finer and a greater amount of soluble material is leached as soils continue to weather. Exceptions to this are soils that formed in quartz sand, such as Sparta soils, or in other materials that are resistant to weathering. Such soils change only slightly over a long period of time.

Where organic material, such as trees, has been buried by later deposition through the action of ice, water, or wind, the age of a landscape can be determined by a process known as radiocarbon dating (*8*).

The loess that covers much of Grundy County is about 14,000 to 20,000 years old. Dinsdale, Tama, and Muscatine soils formed in this material. The maximum age for these soils on stable summits is 14,000 years (*8*). Recent studies by Ruhe and others (*9*) show that the Iowan erosion surface formed during the period of loess deposition. Radiocarbon dating shows this to be between 14,000 to 20,000 years ago. The Iowan surface beneath the loess possibly is as young as 14,000 years; this dates the close of the major period of loess deposition in Iowa. The surface might also be younger than the loess. The Iowan surface, where it is covered by loam sediment, is younger than 14,000 years (*9*). It is this erosional surface of loam sediment that is the parent material of Kenyon, Ostrander, and Readlyn soils. Floyd soils are younger because they are below these higher-lying soils.

Radiocarbon dating shows that some surfaces in Grundy County are as young as 2,000 to 6,000 years (*9*). This perhaps accounts for the weakly developed profile of Floyd and Clyde soils.

Time is needed for soil formation, but the age of parent material does not necessarily reflect the true age of the soil profile.

#### *Man's influence on the soil*

Important changes take place in a soil when it is drained and cultivated. Some of these changes have little effect on soil productivity; others have drastic effect. Changes caused by erosion generally are the most apparent. On many of the cultivated soils in the county, particularly those on the steeper slopes, part or all of the original surface layer has been lost through sheet erosion. Even in fields that are not eroded, the compaction of the soil by heavy farm machinery reduces the thickness of the surface layer.

Man has done much to increase the productivity of soils and to reclaim areas not suited to crops. For example, tile drainage has been installed in many areas and has lowered the water table so that these areas can be cropped. Through the use of commercial fertilizers, man has been able to counteract deficiencies in plant nutrients and to make soils more productive than virgin soils. Most of the soils in Grundy County have not been seriously affected by erosion, because much of the county has low relief, and past rotations have included a fairly high percentage of grass.

Man is able to improve the soil through good management or reduce soil fertility and production through improper land use.

## Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

In classification soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and used in managing farms and fields, in developing rural areas, in engineering work, and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as counties and continents.

The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (*12, 14*).[5] In table 7, the soil series of Grundy County are placed in some categories of the current system.

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are the soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate among these soil orders

[5] See also the unpublished working document "Selected Chapters from the Unedited Text of the Soil Taxonomy," available in the SCS State Office, Des Moines, Iowa.

TABLE 7.—*Classification of soil series*

| Series | Family | Subgroup | Order |
|---|---|---|---|
| Bolan [1] | Coarse-loamy, mixed, mesic | Typic Hapludolls | Mollisols. |
| Bremer [1] | Fine, montmorillonitic, mesic | Typic Argiaquolls | Mollisols. |
| Calco | Fine-silty, mixed, mesic | Cumulic Haplaquolls | Mollisols. |
| Clyde | Fine-loamy, mixed, mesic | Typic Haplaquolls | Mollisols. |
| Coland | Fine-loamy, mixed, mesic | Cumulic Haplaquolls | Mollisols. |
| Colo | Fine-silty, mixed, mesic | Cumulic Haplaquolls | Mollisols. |
| Dickinson | Coarse-loamy, mixed, mesic | Typic Hapludolls | Mollisols. |
| Dinsdale | Fine-silty, mixed, mesic | Typic Argiudolls | Mollisols. |
| Donnan [1] | Fine-loamy over clayey, mixed, mesic | Aquollic Hapludalfs | Alfisols. |
| Ely | Fine-silty, mixed, mesic | Cumulic Hapludolls | Mollisols. |
| Floyd | Fine-loamy, mixed, mesic | Aquic Hapludolls | Mollisols. |
| Garwin | Fine-silty, mixed, mesic | Typic Haplaquolls | Mollisols. |
| Harpster [1] | Fine-silty, mixed, mesic | Typic Calciaquolls | Mollisols. |
| Kenyon | Fine-loamy, mixed, mesic | Typic Hapludolls | Mollisols. |
| Klinger | Fine-silty, mixed, mesic | Aquic Hapludolls | Mollisols. |
| Lawler | Fine-loamy over sandy or sandy-skeletal, mixed, mesic. | Aquic Hapludolls | Mollisols. |
| Lawson | Fine-silty, mixed, mesic | Cumulic Hapludolls | Mollisols. |
| Lilah [1] | Sandy, mixed, mesic | Psammentic Hapludalfs | Alfisols. |
| Marshan | Fine-loamy over sandy or sandy-skeletal, mixed, mesic. | Typic Hapluquolls | Mollisols. |
| Maxfield | Fine-silty, mixed, mesic | Typic Haplaquolls | Mollisols. |
| Muscatine | Fine-silty, mixed, mesic | Aquic Hapludolls | Mollisols. |
| Nevin | Fine-silty, mixed, mesic | Aquic Argiudolls | Mollisols. |
| Ostrander | Fine-loamy, mixed, mesic | Typic Hapludolls | Mollisols. |
| Palms | Loamy, mixed, euic, mesic | Terric Medisaprists | Histosols. |
| Port Byron [1] | Fine-silty, mixed, mesic | Typic Hapludolls | Mollisols. |
| Readlyn | Fine-loamy, mixed, mesic | Aquic Hapludolls | Mollisols. |
| Saude | Coarse-loamy over sandy or sandy-skeletal, mesic, mixed. | Typic Hapludolls | Mollisols. |
| Sawmill | Fine-silty, mixed, mesic | Cumulic Haplaquolls | Mollisols. |
| Sparta | Sandy, mixed, mesic | Entic Hapludolls | Mollisols. |
| Sperry [1] | Fine, montmorillonitic, mesic | Typic Argialbolls | Mollisols. |
| Tama | Fine-silty, mixed, mesic | Typic Argiudolls | Mollisols. |
| Thorp [1] | Fine-silty, mixed, mesic | Argiaquic Argialbolls | Mollisols. |
| Turlin | Fine-loamy, mixed, mesic | Cumulic Hapludolls | Mollisols. |
| Waukee | Fine-loamy over sandy or sandy-skeletal, mixed, mesic. | Typic Hapludolls | Mollisols. |
| Wiota [1] | Fine-silty, mixed, mesic | Typic Argiudolls | Mollisols. |
| Zook | Fine, montmorillonitic, mesic | Cumulic Haplaquolls | Mollisols. |

[1] These soils are taxadjuncts to the series. The way in which they differ from the classified series is given in the description of the soil series.

are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Table 7 shows the three soil orders in Grundy County: Histosols, Mollisols, and Alfisols.

Histosols are soils that are dominantly organic. They are mostly soils that are commonly called bogs or peats and mucks. The organic materials that constitute Histosols are more than 12 to 18 percent organic carbon by weight, depending on clay content of the mineral fraction and kinds of materials, and well over half organic matter, by volume.

Mollisols formed under grass and have a thick, dark-colored surface horizon containing colloids dominated by bivalent cations. The soil material in these soils has now been mixed by shrinking and swelling.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike Mollisols, they lack a thick, dark-colored surface layer that contains colloids dominated by bivalent cations, but the base status of the lower horizons is not extremely low.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of the characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP: Suborders are divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 7, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the great group.

FAMILY: Families are established within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES: The series consists of a group of soils that formed in a particular kind of parent material and have genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

## *Additional Information About the County*

This section describes the physiography, drainage, and water supply; climate; natural resources, transportation, and markets; farming and agricultural services; and the population trends and educational facilities of Grundy County.

### Physiography, Drainage, and Water Supply

Grundy County is located on the divide between the Iowa and Cedar rivers. Most of the area drains to the east into the Cedar River. Except for the area in the southwestern part of the county, known as Palermo Flats, areas are gently sloping to moderately sloping. A system of drainageways and streams is well established. Black Hawk Creek drains about 50 percent of the county in the central and eastern part, Wolf Creek drains about 15 percent in the southern part, and Beaver Creek drains about 30 percent along the northern side. The remaining 5 percent, along the western edge of the county, is in the Iowa River watershed. This area is drained by small creeks and drainageways, the most prominent of which is Davis Creek in the southwestern part of the county.

The water supply is considered more than adequate to meet the present and projected needs of the farm and urban communities in the foreseeable future.

### Climate [6]

Grundy County is located northeast of the State's geographic center. Climatic data recorded at Grundy Center are representative of the climate in the rest of the county, although there are local variations in minimum temperatures on calm, clear mornings.

Approximately 70 percent of the yearly precipitation falls during the period of April through September. About 10 percent of the annual precipitation falls as snow, mainly from December through March.

Table 8 shows temperature and precipitation data for the county. On the average, about 180 days per year have a trace or more of rain; 97 days have 0.01 inch or more; 60 days have 0.10 inch or more; and 20 days have 0.50 inch or more. The latter value is associated with probable soil erosion, because heavy showers occur mainly during the cropping season.

The probability of heavy rainfall during 24-hour periods, which can result in flooding, is as follows: 4.0 inches once in 5 years, 4.7 inches once in 25 years, and 6.6 inches once in 100 years.

[6] By PAUL J. WAITE, climatologist for Iowa and Director, Iowa Weather Service.

TABLE 8.—*Temperature and precipitation*

| Month | Temperature | | | | Precipitation | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Average daily maximum | Average daily minimum | Average maximum | Average minimum | Average total | One year in 10 will have— Less than— | One year in 10 will have— More than— | Average number days with snow cover 1 inch or more | Average depth of snow on days with snow cover |
| | *°F* | *°F* | *°F* | *°F* | *Inches* | *Inches* | *Inches* | | *Inches* |
| January | 27 | 10 | 46 | −19 | 1.3 | 0.2 | 2.5 | 21 | 5 |
| February | 32 | 13 | 49 | −12 | 1.0 | .1 | 2.5 | 16 | 4 |
| March | 43 | 23 | 66 | 0 | 2.1 | .9 | 3.9 | 13 | 5 |
| April | 60 | 36 | 82 | 21 | 2.6 | 1.2 | 4.6 | (1) | 2 |
| May | 72 | 48 | 87 | 30 | 4.0 | 1.4 | 6.1 | 0 | 0 |
| June | 80 | 58 | 92 | 43 | 5.1 | 2.2 | 8.6 | 0 | 0 |
| July | 86 | 62 | 93 | 48 | 3.7 | 1.1 | 6.8 | 0 | 0 |
| August | 83 | 60 | 92 | 45 | 3.5 | .9 | 6.9 | 0 | 0 |
| September | 76 | 51 | 89 | 33 | 3.6 | .7 | 5.5 | 0 | 0 |
| October | 65 | 40 | 82 | 22 | 2.2 | .2 | 4.3 | 0 | 0 |
| November | 46 | 26 | 67 | 6 | 1.9 | .2 | 2.7 | 3 | 3 |
| December | 33 | 15 | 52 | −11 | 1.1 | .3 | 2.0 | 12 | 3 |
| Year | 59 | 37 | 95 | −21 | 32.1 | 25.6 | 41.5 | 65 | 4 |

[1] Less than one-half day.

The first 1-inch snowfall generally occurs late in November, but it has occurred as early as late in September. The ground is usually covered with snow to a depth of 1 inch or more on about 65 days per season.

Ideally, during the crop-planting season, the topsoil is slightly dry but the subsoil has ample moisture. However, variations from the optimum are frequent. Without ample subsoil moisture at the beginning of the crop season, rainfall rarely is sufficient for optimum crop growth. Rapidly growing and maturing corn requires nearly 1 inch of moisture or precipitation per week for best growth and development. The chances of receiving at least the 1-inch amount during each week are about one in three. Chances are best early in June and diminish by late in August.

Temperatures at Grundy Center have ranged from a high of 108° F on August 18, 1936, to a low of -34° on February 13, 1905. During half the winters temperatures drop as low as about -20° or colder, and in half the summers maximum temperatures equal or exceed 95°.

Probabilities of occurrence of the last freezing temperatures in spring and the first in fall are given in table 9.

Grundy County averages 13 days per year on which temperatures are equal to or higher than 90° and 159 days per year on which temperatures are at or below the freezing level. The average length of the growing season is 158 days.

## Natural Resources, Transportation, and Markets

The soils of Grundy County are the most valuable natural resource in the county. There a few sources of sand and gravel along Black Hawk Creek and in the area of the Saude-Lilah complex. There is one source of limestone in the northwestern part of the county.

State Highway 14 runs north and south through the center of the county and intersects State Highway 175, which runs east and west through the center of the county. State Highway 57 connects with State Highway 14 in the north-central part of the county and runs easterly to Waterloo. U.S. Route 20 runs along the north edge of the county in the northeast and northwest corners. State Highway 214 connects with State Highway 175 in the west-central part of the county and runs north to Wellsburg. State Highway 185 extends from State Highway 14 near the south edge of the county easterly to the town of Conrad. The proposed Interstate 520 will cross the northcentral part of the county from west to east. All farmsteads in the county are located on all-weather roads, many of which have asphalt pavement.

Rail service is provided to each town in the county.

There is one small airport, just west of Grundy Center, which has a turf runway that accommodates small private airplanes in good weather. The nearest regularly scheduled air service is at the Waterloo Airport in Waterloo. It is about 10 miles east of the northeast corner of the county or about 29 miles north and east of Grundy Center, which is the county seat.

There are hog-buying stations in the county, and there is a packing plant in Waterloo. Several local locker plants process most of the beef consumed in the county. The majority of the beef is shipped to markets outside the county or sold to representatives of various packing firms located outside the county.

Surplus feed grain and soybeans are marketed at local elevators and shipped out of the county. Seed crops, mainly corn and soybeans, are grown under contract with seed companies in the county or in adjacent counties.

A cannery at Reinbeck processes sweet corn and asparagus grown under contract. An alfalfa-processing plant near Conrad provides a cash market for alfalfa.

## Farming and Agricultural Services

Approximately 96 percent of the county is farmed (6). The number of farms is decreasing, but the average size of farms is increasing. The total area in farms remains relatively constant.

Corn and soybeans are the main crops. Hay and oats are the only other significant crops, but there are a few areas of grain sorghum, silage, asparagus, and various seed crops, in addition to corn and soybeans, that are grown for seed. Approximately 10 percent of the county is in pasture.

A number of well-distributed businesses, both private and cooperative, provide services to agriculture in the county. They include 13 grain dealers who both

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data from Grundy Center]

| Probability | Data for given probability and temperature | | | | |
|---|---|---|---|---|---|
| | 16° F or lower | 20° F or lower | 24° F or lower | 28° F or lower | 32° F or lower |
| Spring: | | | | | |
| 1 year in 10 later than | April 5 | April 15 | April 29 | May 9 | May 18 |
| 2 years in 10 later than | March 30 | April 9 | April 24 | May 4 | May 13 |
| 5 years in 10 later than | March 20 | March 29 | April 13 | April 24 | May 3 |
| Fall: | | | | | |
| 1 year in 10 earlier than | October 29 | October 19 | October 8 | October 4 | September 23 |
| 2 years in 10 earlier than | November 3 | October 24 | October 14 | October 9 | September 28 |
| 5 years in 10 earlier than | November 14 | November 4 | October 25 | October 20 | October 8 |

buy and sell grain, 12 farm machinery dealers, 19 fertilizer dealers, 5 livestock markets that deal principally in buying and marketing hogs and feeder pigs, 27 feed dealers, 1 alfalfa processing plant, 2 seed corn processing plants, 2 plants that process and sell soybean and oat seed, and 2 commercial feedlots that feed out cattle under contract. There is one hatchery in the county that provides poults for turkey farmers and chicks for chicken farmers.

### Population Trends and Educational Facilities

The total population of Grundy County remained relatively constant from 1960 to 1970 (6), and it is projected that population will increase by less than 1,000 in the next 20 years. The rural population of the county has been declining steadily, and there has been a corresponding increase in the nonfarm population.

There are 5 school districts within the county that have elementary, junior-high, and senior-high school facilities. Six school districts within Grundy County have educational facilities in neighboring counties. There are two private elementary schools, one each in Shiloh and German Townships, in the northwestern part of the county. Marshalltown Community College, a junior college, is located in Marshalltown, about 11 miles south of Grundy County. Ellsworth Junior College, in Iowa Falls, is about 15 miles west of the northwest corner of the county. Hawkeye Tech, an area technical school that services Grundy County, is located in Waterloo, about 10 miles east of the county. The University of Northern Iowa at Cedar Falls is located about 5 miles east of the northeast corner of the county. Three high schools in Grundy County have vocational agricultural departments that provide special courses for adult education to farmers.

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## *Glossary*

**Alluvium.** Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

**Available water capacity** (also termed 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 capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

**Bench terrace.** A shelflike embankment of earth that has a level or nearly level top and a steep or nearly vertical downhill face, constructed along the contour of sloping land or across the slope to control runoff and erosion. The downhill face of the bench may be made of rocks or masonry, or it may be planted to vegetation.

**Bottom, first.** The normal flood plain of a stream; land along the stream subject to overflow.

**Bottom, second.** An old alluvial plain, generally flat, that borders a stream but is seldom flooded.

**Clay.** As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

**Complex, soil.** A mapping unit consisting of different kinds of soils that occur in such small individual areas or in such an intricate pattern that they cannot be shown separately on a publishable soil map.

**Concretions.** Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

**Consistence, soil.** The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

*Loose.*—Noncoherent when dry or moist; does not hold together in a mass.

*Friable.*—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

*Firm.*—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

*Plastic.*—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

*Sticky.*—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

*Hard.*—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

*Soft.*—When dry, breaks into powder or individual grains under very slight pressure.

*Cemented.*—Hard and brittle; little affected by moistening.

**Diversion, or diversion terrace.** A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

**Field moisture capacity.** The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

**Flood plain.** Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

**Fragipan.** A loamy, brittle, subsurface horizon that is very low in organic-matter content and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur below the B horizon, 15 to 40 inches below the surface.

**Gleyed soil.** A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

*O horizon.*—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

*A horizon.*—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

*C horizon.*—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that in which the overlying horizons formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

*R layer.*—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

**Interfluves.** The land between adjacent streams flowing in the same direction.

**Leaching.** The removal of soluble materials from soils or other material by percolating water.

**Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state. In engineering, a high liquid limit indicates that the soil has a high content of clay and low capacity for supporting loads.

**Parent material.** Disintegrated and partly weathered rock in which soil has formed.

**Pedisediment.** A sediment that covers a pediment rather thinly. A pediment is an erosion surface that lies at the foot of a receded slope, is underlain by rocks or sediment of the upland, is barren or mantled with alluvium, and displays a longitudinal profile, normally concave upward.

**Permeability.** The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid, and very rapid.*

**pH value.** A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

**Profile, soil.** A vertical section of the soil through all its horizons and extending into the parent material.

**Reaction, soil.** The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

| | *pH* | | *pH* |
|---|---|---|---|
| Extremely acid | Below 4.5 | Mildly alkaline | 7.4 to 7.8 |
| Very strongly acid | 4.5 to 5.0 | Moderately alkaline | 7.9 to 8.4 |
| Strongly acid | 5.1 to 5.5 | Strongly alkaline | 8.5 to 9.0 |
| Medium acid | 5.6 to 6.0 | Very strongly alkaline | 9.1 and higher |
| Slightly acid | 6.1 to 6.5 | | |
| Neutral | 6.6 to 73. | | |

**Sand.** Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

**Silt.** Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

**Site index.** A numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at an arbitrarily chosen age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.

**Soil.** A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Solum.** The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

**Stone line.** A concentration of coarse rock fragments in soils that generally represents an old weathering surface. In a cross section, the line may be one stone or more thick. The line generally overlies material that weathered in place, and it is ordinarily overlain by sediment of variable thickness.

**Structure, soil.** The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structures 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 grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Substratum.** Technically, the part of the soil below the solum.

**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 it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

**Terrace** (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

**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."

**Water table.** The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

**Well-graded soil.** A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

GUIDE TO MAPPING UNITS

For a complete description of a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. A technical description of a representative profile is given under each soil series. In referring to a capability unit, read the introduction to the section it is in for general information about its management. Other information is given in tables as follows:

Acreage and extent, table 1, page 8.
Predicted yields, table 2, page 48.
Wildlife interpretations, table 3, page 50.
Engineering uses of the soils, tables 4, 5, and 6, pages 52 through 71.

| Map symbol | Mapping unit | Page | Capability unit | |
|---|---|---|---|---|
| | | | Symbol | Page |
| 7 | Wiota silt loam, 0 to 2 percent slopes | 37 | I-1 | 39 |
| 41B | Sparta loamy fine sand, 2 to 5 percent slopes | 32 | IVs-1 | 46 |
| 43 | Bremer silty clay loam, 0 to 2 percent slopes | 9 | IIw-3 | 41 |
| 54 | Zook silty clay loam, 0 to 1 percent slopes | 37 | IIw-3 | 41 |
| 83B | Kenyon loam, 2 to 5 percent slopes | 19 | IIe-1 | 40 |
| 83C | Kenyon loam, 5 to 9 percent slopes | 19 | IIIe-1 | 42 |
| 83C2 | Kenyon loam, 5 to 9 percent slopes, moderately eroded | 19 | IIIe-1 | 42 |
| 83D2 | Kenyon loam, 9 to 14 percent slopes, moderately eroded | 19 | IIIe-2 | 44 |
| 84 | Clyde silty clay loam, 0 to 3 percent slopes | 10 | IIw-1 | 41 |
| 88 | Nevin silty clay loam, 0 to 2 percent slopes | 26 | I-1 | 39 |
| 96 | Turlin loam, 0 to 2 percent slopes | 35 | I-1 | 39 |
| 118 | Garwin silty clay loam, 0 to 2 percent slopes | 17 | IIw-1 | 41 |
| 119 | Muscatine silty clay loam, 0 to 2 percent slopes | 25 | I-1 | 39 |
| 119B | Muscatine silty clay loam, 2 to 5 percent slopes | 25 | IIe-5 | 41 |
| T119 | Muscatine silty clay loam, benches, 0 to 2 percent slopes | 25 | I-1 | 39 |
| 120 | Tama silty clay loam, 0 to 2 percent slopes | 33 | I-1 | 39 |
| 120B | Tama silty clay loam, 2 to 5 percent slopes | 33 | IIe-1 | 40 |
| 120C | Tama silty clay loam, 5 to 9 percent slopes | 33 | IIIe-1 | 42 |
| 120C2 | Tama silty clay loam, 5 to 9 percent slopes, moderately eroded | 34 | IIIe-1 | 42 |
| T120 | Tama silty clay loam, benches, 0 to 2 percent slopes | 34 | I-1 | 39 |
| 122 | Sperry silt loam, 0 to 1 percent slopes | 33 | IIIw-2 | 45 |
| 133 | Colo silty clay loam, 0 to 2 percent slopes | 12 | IIw-1 | 41 |
| C133 | Colo silty clay loam, channeled, 0 to 2 percent slopes | 12 | Vw-1 | 46 |
| 135 | Coland silty clay loam, 0 to 2 percent slopes | 11 | IIw-1 | 41 |
| 152 | Marshan silty clay loam, deep, 0 to 2 percent slopes | 23 | IIw-5 | 42 |
| 174B | Bolan loam, 2 to 5 percent slopes | 8 | IIe-2 | 40 |
| 175B | Dickinson fine sandy loam, 2 to 5 percent slopes | 13 | IIIe-3 | 44 |
| 175C | Dickinson fine sandy loam, 5 to 9 percent slopes | 13 | IIIe-3 | 44 |
| 177 | Saude loam, 0 to 2 percent slopes | 30 | IIs-1 | 42 |
| 177B | Saude loam, 2 to 5 percent slopes | 30 | IIe-3 | 40 |
| 177C | Saude loam, 5 to 9 percent slopes | 30 | IIIe-3 | 44 |
| 177C2 | Saude loam, 5 to 9 percent slopes, moderately eroded | 30 | IIIe-3 | 44 |
| 178 | Waukee loam, 0 to 2 percent slopes | 36 | I-2 | 39 |
| 178B | Waukee loam, 2 to 5 percent slopes | 36 | IIe-2 | 40 |
| 184 | Klinger silty clay loam, 0 to 2 percent slopes | 20 | I-1 | 39 |
| 184B | Klinger silty clay loam, 2 to 5 percent slopes | 20 | IIe-5 | 41 |
| 198B | Floyd loam, 1 to 4 percent slopes | 16 | IIw-2 | 41 |
| 221 | Palms muck, 1 to 3 percent slopes | 28 | IIIw-1 | 45 |
| 225 | Lawler silt loam, moderately deep, 0 to 2 percent slopes | 21 | IIs-1 | 43 |
| 226 | Lawler silt loam, deep, 0 to 2 percent slopes | 21 | I-2 | 39 |
| 241B | Saude-Lilah complex, 2 to 5 percent slopes | 30 | IVe-1 | 45 |
| 241C2 | Saude-Lilah complex, 5 to 14 percent slopes, moderately eroded | 30 | VIs-1 | 46 |
| 377B | Dinsdale silty clay loam, 2 to 5 percent slopes | 14 | IIe-1 | 40 |
| 377C | Dinsdale silty clay loam, 5 to 9 percent slopes | 14 | IIIe-1 | 42 |
| 377C2 | Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded | 14 | IIIe-1 | 42 |

| Map symbol | Mapping unit | Page | Capability unit Symbol | Capability unit Page |
|---|---|---|---|---|
| 377D2 | Dinsdale silty clay loam, 9 to 14 percent slopes, moderately eroded | 14 | IIIe-2 | 44 |
| 382 | Maxfield silty clay loam, 0 to 2 percent slopes | 24 | IIw-1 | 41 |
| 391B | Clyde-Floyd complex, 1 to 4 percent slopes | 11 | IIw-2 | 41 |
| 394B | Ostrander loam, 2 to 5 percent slopes | 27 | IIe-2 | 40 |
| 394C | Ostrander loam, 5 to 9 percent slopes | 27 | IIIe-3 | 44 |
| 394C2 | Ostrander loam, 5 to 9 percent slopes, moderately eroded | 27 | IIIe-3 | 44 |
| 399 | Readlyn loam, 0 to 2 percent slopes | 29 | I-1 | 39 |
| 404 | Thorp silt loam, 0 to 2 percent slopes | 35 | IIIw-2 | 45 |
| 428B | Ely silty clay loam, 2 to 5 percent slopes | 16 | IIe-5 | 41 |
| 484 | Lawson silt loam, 0 to 2 percent slopes | 22 | I-1 | 39 |
| 595 | Harpster silty clay loam, 0 to 2 percent slopes | 18 | IIw-4 | 41 |
| 620C2 | Port Byron silt loam, 5 to 9 percent slopes, moderately eroded | 28 | IIIe-1 | 42 |
| 620E3 | Port Byron silt loam, 9 to 18 percent slopes, severely eroded | 28 | VIe-1 | 46 |
| 733 | Calco silty clay loam, 0 to 2 percent slopes | 10 | IIw-4 | 41 |
| 776C2 | Lilah sandy loam, 3 to 9 percent slopes, moderately eroded | 23 | IVs-2 | 46 |
| 782B | Donnan loam, 2 to 6 percent slopes | 15 | IIe-4 | 41 |
| 933 | Sawmill silty clay loam, 0 to 2 percent slopes | 31 | IIw-1 | 41 |
| 933B | Sawmill-Garwin silty clay loams, 1 to 4 percent slopes | 31 | IIw-2 | 41 |

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