SOIL SURVEY OF

Mitchell County, Iowa

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

Major fieldwork for this soil survey was done in the period 1967 to 1970. Soil names and descriptions were approved in 1971. 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; 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 Mitchell County Soil Conservation District. Funds appropriated by Mitchell County were used to defray part of the cost of this survey.

Either enlarged or reduced copies of the printed soil map can be made by commercial photographers, or they can be purchased on individual order, from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

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 appraising the suitability of tracts of land for farming, industry, or recreation.

Locating Soils

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

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. 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. It shows the page where each soil is described and also 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 information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. 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 with a moderate limitation can be colored yellow, and those with 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 the interpretive groupings.

Engineers and builders can find, under "Use of the Soils for Engineering" tables that give engineering descriptions of the soils in the county and that name 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 Mitchell 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 "General Nature of the County," which gives additional information about the county.

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SOIL SURVEY OF MITCHELL COUNTY, IOWA

BY KERMIT D. VOY AND JOHN D. HIGHLAND, SOIL CONSERVATION SERVICE
FIELDWORK BY KERMIT D. VOY, MELVIN D. BROWN, DARWIN D. HOEFT, LYLE F. JACKSON, AND KENNETH K. KITTLESON

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION

MITCHELL COUNTY is in the northeast corner of north-central Iowa (fig. 1). It has an area of 298,816 acres. Osage, the county seat, is in the south-central part of the county about 125 miles northeast of Des Moines, the Sate capital.

Mitchell County is rural. The main crops are corn, soybeans, oats, hay, and pasture. Except for soybeans, most of the crops produced are fed to livestock. Beef cattle, hogs, and dairying are the principal sources of income.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Mitchell 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.

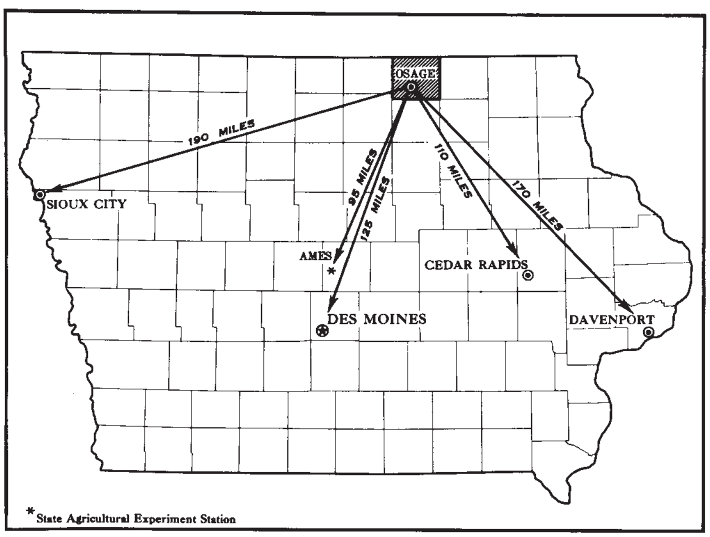

Figure 1.—Location of Mitchell County in Iowa.

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. Ansgar and Riceville, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some 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, Kenyon loam, 2 to 5 percent slopes, is one of several phases within the Kenyon 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 at 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 management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientist has a problem of delineating areas where different kinds of soil are so intricately mixed and so small in size that it is not practical to show them separately on the map. Therefore, he shows this mixture of soils as one mapping unit and calls it a soil complex. Ordinarily a soil complex is named for the major soil series in it, for example, Clyde-Floyd complex.

Also, there are areas to be shown that are so frequently flooded or worked by water that they cannot be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Marsh or Alluvial land, channeled, and are called land types rather than soils.

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 and plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or a high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current 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 Mitchell 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 farming or other 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 management. The seven soil associations in Mitchell County are described in the following paragraphs.

1. Dinsdale-Klinger-Maxfield association

Nearly level to gently sloping, well-drained to poorly drained soils formed in loess and underlying loam glacial till; on uplands

The topography of this association is mainly broad, upland flats and gently sloping areas. A drainage network has been developed over much of the area. Nearly all of this association is cultivated. Only a small acreage is in permanent pasture. This association makes up about 35 percent of Mitchell County.

Dinsdale soils make up about 25 percent of this association; Klinger soils, about 23 percent; Maxfield soils, about 20 percent; and minor soils, the remaining 32 percent. These soils formed in about 20 to 40 inches of loess and in the underlying glacial till. Shallow basins, or sinkholes, are in many places where limestone bedrock is at a depth of 10 to 25 feet. Water is ponded in a few of these sinkholes, but crops are grown on most of them. Crop damage is slight, because the water generally drains down into the soil soon after precipitation. In a few areas, uncrossable, deep sinkholes have been used as drainage outlets. This type of sinkhole has small vertical channels to bedrock, through which surface water can be channelled very rapidly underground (fig. 2).

The poorly drained and somewhat poorly drained soils in the association are mainly in the upper part of the watershed, where the underlying glacial till is generally thickest over bedrock. Many soils at lower elevations are drained by fractured bedrock that is close to the surface. Tile outlets for some of the wet soils at higher elevations should be installed in the lower lying, well-drained soils. In a few areas, however, bedrock is so close to the surface that it impedes tile installation.

The Dinsdale soils are well drained and moderately well drained. They have a thick surface layer of dark-colored light silty clay loam. The subsoil is yellowish-brown silty clay loam. The underlying material is yellowish-brown loam. The nearly level soils are on broad upland flats, and

Figure 2.—**Limestone sinkhole in road ditch in the Dinsdale-Klinger-Maxfield soil association.**

the gently sloping soils are on ridgetops and side slopes (fig. 3).

The Klinger soils are nearly level and somewhat poorly drained. They have a thick surface layer of black silty clay loam. The subsoil is loam that is dark grayish brown in the upper part and olive brown in the lower part. These soils are on upland flats, ridges, and the lower parts of side slopes (fig. 4).

The Maxfield soils are nearly level and poorly drained. They have a thick surface layer of black silty clay loam. The subsoil is olive silty clay loam in the upper part and mottled loam in the lower part. These soils are on upland flats and in waterways.

The Ansgar, Franklin, and Waubeek soils are the most extensive of the minor soils in this association and the Bassett, Clyde, Coland, Kenyon, and Turlin soils are less extensive. Ansgar soils are similar to Maxfield soils, but the dark-colored surface layer is thinner and surface drainage is generally somewhat poorer. Franklin soils are similar to Klinger soils in position on the landscape, but the surface layer is thinner than in the Klinger soils and not so dark colored. Waubeek soils are similar to Dinsdale soils in position on the landscape, but they have a thinner dark-colored surface layer than Dinsdale soils. The Bassett and Kenyon soils are similar to Dinsdale soils in position on the landscape. The Clyde, Coland, and Turlin soils are in drainageways or narrow stream valleys.

***Figure 3.*—Nearly level Dinsdale soils recently planted to corn.**

This association is well suited to row crops. Nearly all of it is cultivated. The principal management needs are to improve drainage and the general level of fertility and to control erosion. In some areas, special care is needed to prevent water on the surface or in tile drains from running down through sinkholes aand polluting underground water supplies.

2. *Tama-Downs association*

Nearly level to strongly sloping, well-drained soils formed in thick loess; on uplands

The topography of this association is mainly long, gentle slopes, a few broad upland flats that are broken in places by stronger side slopes and ridge crests. Some of this association, particularly along the Cedar River, has steeper topography and narrow drainageways. Much of the area has a well-developed drainage system. Nearly all of this association is in cultivation, and a few areas are in woods and pasture. This association makes up about 5 percent of Mitchell County.

Tama soils make up about 40 percent of this association (fig. 5); Downs soils, about 14 percent; and minor soils, the remaining 46 percent. The soils in this association formed in 3½ to 7 feet of loess. In a few places glacial till is at a depth of 20 to 40 inches. In a few areas along Spring Creek, limestone bedrock is near the surface. A few shallow and deep sinkholes are in the area west of U.S. Highway 218.

The poorly drained and somewhat poorly drained soils in some areas are mainly in the upper part of the watershed, where the loess and underlying glacial till are generally thickest over bedrock. Many soils at lower elevations are drained by fractured bedrock that is closer to the surface.

The Tama soils are well drained. They have a thick surface layer of dark-colored light silty clay loam or heavy silt loam. The subsoil is brown silty clay loam. The nearly level soils are on broad plains, the gently sloping soils are on ridgetops and side slopes, and the moderately sloping soils are on a few short, moderately eroded side slopes.

The Downs soils are well drained. They have a surface layer of moderately dark colored silt loam. The subsoil is brown and yellowish-brown silty clay loam and silt loam. The gently sloping to moderately sloping soils are on ridge crests, and the gently sloping to strongly sloping soils are on side slopes.

The most extensive minor soils are the thick, loess Atterberry, Fayette, Garwin, and Muscatine soils on uplands. The Atterberry soils are nearly level and somewhat poorly drained. They have a moderately dark colored surface layer and are generally on ridges or in waterways. The Fayette soils are gently sloping to sloping and are well drained. They have a thin surface layer of light-colored silt loam and a subsoil of brown and yellowish-brown silty clay loam and silt loam. They are on ridge crests and side slopes. The Garwin soils are poorly drained. They have a thick surface layer of black silty clay loam and a subsoil of olive-gray silty clay loam and silt loam. They are in upland waterways or low concave positions (fig. 6). The Muscatine soils are somewhat poorly drained and nearly level. They have a thick surface layer of black silty clay loam and a dark grayish-brown subsoil. They generally are on the lower parts of side slopes and in shallow drainageways. A few areas are on ridge crests.

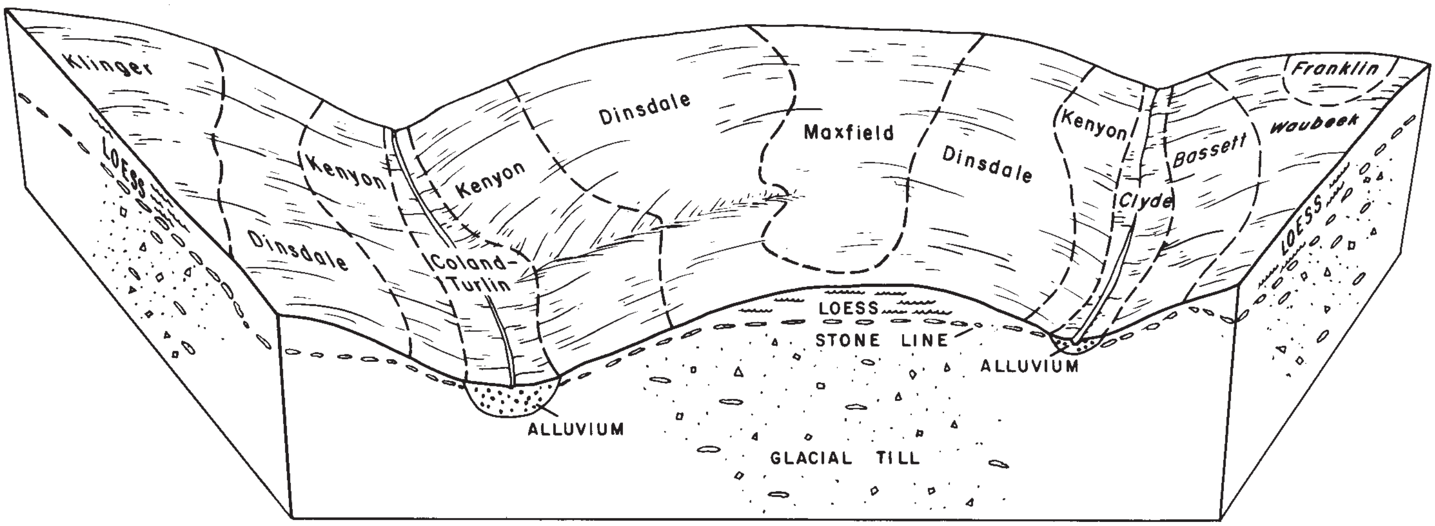

Figure 4.—**Relationship of soils in association 1 to topography and the underlying material.**

Figure 5.—**Nearly level to gently sloping area of Tama soils being prepared for a corn crop.**

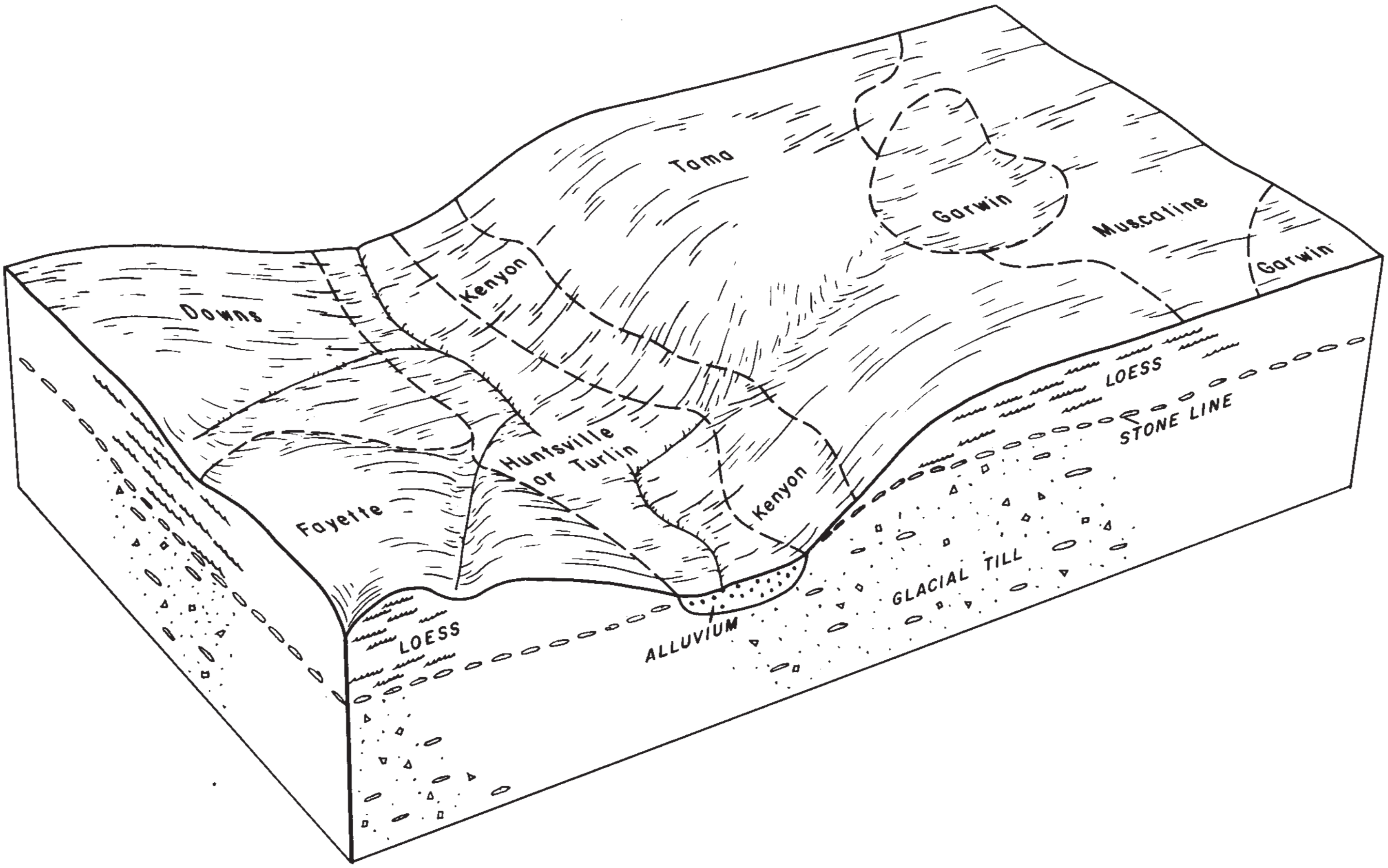

Figure 6.—**Diagram showing the topography, soil, and underlying materials in soil association 2.**

The Dinsdale, Huntsville, Kenyon, Turlin, Waubeek, Waucoma, and Winneshiek soils are the less extensive of the minor soils. The Huntsville and Turlin soils are dark-colored alluvial soils in upland drainageways and on narrow flood plains. The Dinsdale and Waubeek soils are underlain by glacial till at a depth of about 2 to 3 feet. The Waucoma and Winneshiek soils are underlain by limestone at a depth of about 2 to 4 feet. The Kenyon soils have loamy material, about 2 feet thick, over glacial till.

This association is well suited to row crops. Nearly all of it is cultivated. A few upland areas are wooded. The principal management needs are to control erosion, improve drainage, and maintain fertility. A few areas west of U.S. Highway 218 require special care to prevent surface water from running down through sinkholes and polluting underground water supplies.

3. Ashdale-Atkinson-Winneshiek association

Nearly level to strongly sloping, well-drained soils formed in loess and loamy material underlain by limestone; on uplands

The topography of this association is mainly broad, upland flats, gently sloping ridgetops, and moderately sloping to steep side slopes. Along the Cedar River the slopes break sharply and there are numerous limestone escarpments. Although the escarpments commonly are a severe barrier to the construction of roads, use of farm machinery, and movement of livestock, they generally cover less land surface than indicated by their appearance. This association makes up about 11 percent of Mitchell County.

Ashdale soils make up about 19 percent of this association; Atkinson soils, about 14 percent; Winneshiek soils, about 11 percent; and minor soils, the remaining 56 percent. These soils formed in loess and loamy material overlying limestone bedrock. In most areas the bedrock is at a depth of 24 to 60 inches, but in some areas it is shallower, and in other areas it is deeper.

The Ashdale soils have a thick surface layer of dark-colored silt loam. The subsoil is brown silty clay loam in the upper part and yellowish-brown loamy material in the lower part. The nearly level soils are on broad flats, and the gently sloping soils are on ridge crests and side slopes.

The Atkinson soils have a thick surface layer of dark-colored loam. The subsoil is brown and yellowish-brown loamy material. Limestone is at a depth of about 48 inches. The nearly level soils are on broad flats, and the gently sloping soils are on ridge crests and side slopes.

The Winneshiek soils have a moderately dark colored surface layer. The subsoil is brown and yellowish-brown loamy material. Limestone bedrock is at a depth of 20 to 30 inches. The gently sloping to moderately sloping soils are on ridgetops, and the gently sloping to moderately steep soils are on side slopes.

The Waucoma and Sogn soils are the most extensive of the minor soils in this association. The Waucoma soils have a surface layer of moderately dark colored loamy material and a subsoil of brown and yellowish-brown loamy material. These gently sloping to moderately sloping soils are on ridge crests and side slopes. The Sogn soils are less than 15 inches thick over bedrock. They have a surface layer of dark-colored loamy material. The moderately sloping and moderately steep Sogn soils are on ridge crests, and the moderately sloping to steep soils are on side slopes and escarpments (fig. 7). Bedrock commonly crops out, particularly in the steeper areas.

The Atkinson, Dubuque, Nasset, moderately deep Rockton, Roseville, Terril, Turlin, and Whalan soils are the less extensive of the minor soils. All but the Turlin and Terril soils are gently sloping and moderately sloping, well-drained soils on ridge crests and side slopes and are underlain by limestone bedrock. The Turlin soils are nearly level, somewhat poorly drained soils on bottom lands along rivers and narrow streams. The Terril soils are nearly level to gently sloping, moderately well drained soils in waterways and narrow valleys and on foot slopes on uplands.

This association is used for cultivated crops, except where the soils are too shallow over bedrock, where slopes are too steep, or where cultivatable areas are too small to farm economically. These nonarable areas are generally left in timber or permanent pasture. The principal management needs are to control erosion and improve the general level of fertility. A major concern is the limited soil depth for plant root development (fig. 8).

4. Dickinson-Ostrander-Schley association

Nearly level to gently sloping, somewhat excessively drained to somewhat poorly drained soils formed in loamy material overlying sand, or in loamy material and underlying loam glacial till; on uplands

The topography of this association is mainly nearly level to gently sloping mounds and ridges. Nearly all of the area is cultivated. This association makes up about 2 percent of Mitchell County.

Dickinson soils make up about 40 percent of this association; Ostrander soils, about 15 percent; Schley soils, about 10 percent; and minor soils, the remaining 35 percent. The Dickinson soils formed in wind-deposited sand dunes and ridges. The Ostrander and Schley soils formed in loamy material and the underlying glacial till or till-derived sediment. Water tends to move more rapidly in the loamy material than it does in the underlying glacial till, and it accumulates at this contact and then moves downslope. In places water appears at the surface part way down the slope, causing a seepy spot.

The Dickinson soils are nearly level to gently sloping and somewhat excessively drained. They have a thick surface layer of very dark brown fine sandy loam. The subsoil is brown fine sandy loam that grades to yellowish-brown sand with depth. These soils are on dunes or ridges, some of which are as much as a mile or more in length.

Figure 7.—**Uncultivated area of steep Sogn soils on an escarpment. Nearly level Ashdale soils are above the Sogn soils.**

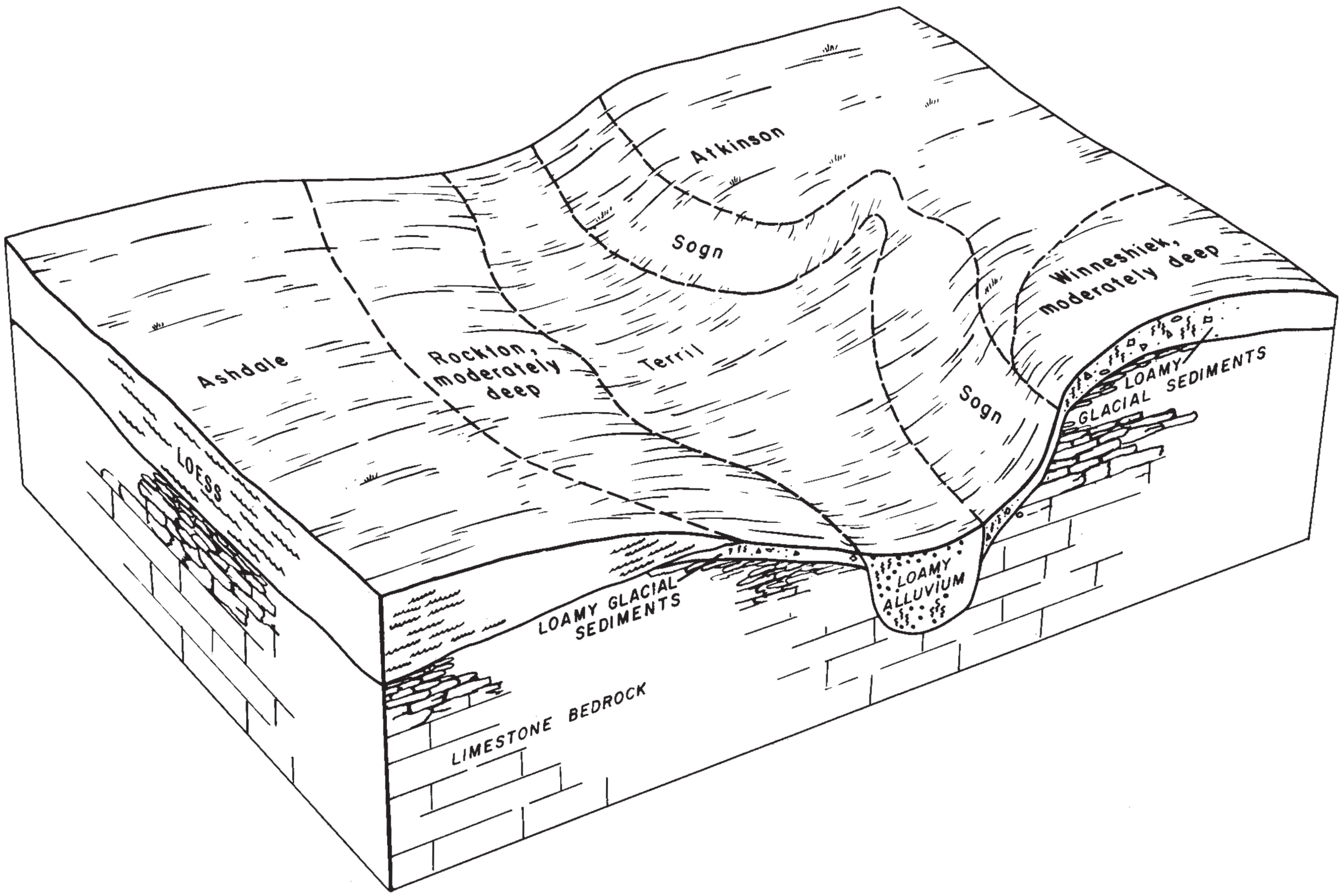

Figure 8.—**Relationship of soils in association 3 to topography and the underlying material.**

The Ostrander soils are nearly level and gently sloping and are well drained. They have a thick, dark-colored surface layer. The subsoil is brown and yellowish brown. These soils are on ridge crests and side slopes.

The Schley soils are nearly level and somewhat poorly drained. They have a moderately dark colored loamy surface layer and a grayish-brown subsurface layer. The subsoil is mottled, grayish-brown and strong-brown, loamy material. These soils are in shallow drainageways.

Minor soils in this association are the Floyd, Kenyon, Oran, Donnan, Bassett, and Lamont soils, and a few other soils. The nearly level to gently sloping Floyd soils are in shallow waterways and on lower parts of side slopes. The nearly level to gently sloping Oran, Donnan, and Bassett soils are on ridges. The nearly level to gently sloping sandy Lamont soils are on dunes and ridges like the Dickinson soils.

The association is well suited to row crops. Most of it is cultivated. A few undrained wet soils and a few sandy soils are left in permanent pasture. The principal management needs are to control soil blowing on the Dickinson and Lamont soils, improve drainage on the wet soils, control water erosion on the sloping soils, and generally improve fertility.

Blowing sand cuts off young growing crops and damages stands in this association. Fieldwork that leaves much of the crop residue on the surface decreases the hazard of soil blowing and erosion. The wetness of the Floyd and Schley soils is caused, at least in part, by hillside seepage. In seepy places, intercepter tile is needed.

5. *Wapsie-Alluvial land-Marshan association*

Nearly level to moderately sloping, excessively drained to poorly drained soils formed in alluvial sediments; on stream bottoms and benches

The topography of this association is mainly nearly level, but some areas are gently sloping or moderately sloping. A few areas are narrow bench escarpments. Most of the soils on the benches and some on the bottom lands are cultivated. Many of the bottom-land soils that are along the major streams and flooded frequently are in permanent pasture commonly interspersed with wooded areas. This association makes up about 11 percent of Mitchell County.

Wapsie soils make up 20 percent of this association; Alluvial land, about 15 percent; Marshan soils, about 13 percent; and the minor soils, the remaining 52 percent. The bottom-land soils and the soils of the benches form two distinct associations, but separating them is impractical because they are closely associated and the stream valleys are generally narrow. Much of the bottom land is subject to flooding, but the soils on benches are generally

Figure 9.—**Bayou containing water in an area of Alluvial land that is partially dissected by old stream channel of the Little Cedar River.**

free from flooding, except for some low areas. The soils of this association range from poorly drained to excessively drained (fig. 9).

The Wapsie soils are well drained and are on stream benches. They have a moderately dark surface layer. The subsoil is brown and yellowish brown and is loamy. Below a depth of 24 to 36 inches is sand and some gravel. The nearly level soils are on broad flats, the gently sloping soils are on ridges, and the moderately sloping soils are on escarpments. These soils are generally at a somewhat higher elevation than the associated Hayfield and Marshan soils (fig. 10).

Alluvial land is poorly drained to excessively drained. It is on flood plains along most of the major streams. It varies in texture and other characteristics. Some areas are used for crops, but most areas are highly dissected by old stream channels and are in permanent pasture or woods.

The Marshan soils are nearly level, poorly drained soils on stream benches. They have a thick surface layer of black and very dark gray clay loam. The subsoil is dark grayish brown and olive and is loamy. Sand and gravel are below a depth of 24 to 40 inches.

Coland, Hayfield, Lawler, Saude, Turlin, Waukee, and a few other minor soils are in this association. The Coland and Turlin soils have a thick black surface layer and are on bottom lands. Coland soils are poorly drained, and Turlin soils are somewhat poorly drained. Coland and Turlin soils commonly occur together in an intricate pattern. Many areas of these soils are dissected by old stream channels and are frequently flooded.

Lawler, Hayfield, Saude, and Waukee soils are on the stream benches. They generally have a deep, dark-colored surface layer, but Hayfield soils are moderately dark colored. Lawler and Hayfield soils are somewhat poorly drained. Sand and gravel are below a depth of 24 to 40 inches. Saude and Waukee soils are well drained and have sand and gravel at a depth of 20 to 40 inches.

Most of the soils on benches are well suited to row crops. Most are cultivated. Some areas are in permanent pasture or are wooded. The principal management needs are to improve drainage of the wet soils, to control erosion on the sloping soils, and generally to improve fertility. A major concern is a somewhat limited available water capacity and droughtiness in some of the soils. The principal manage-

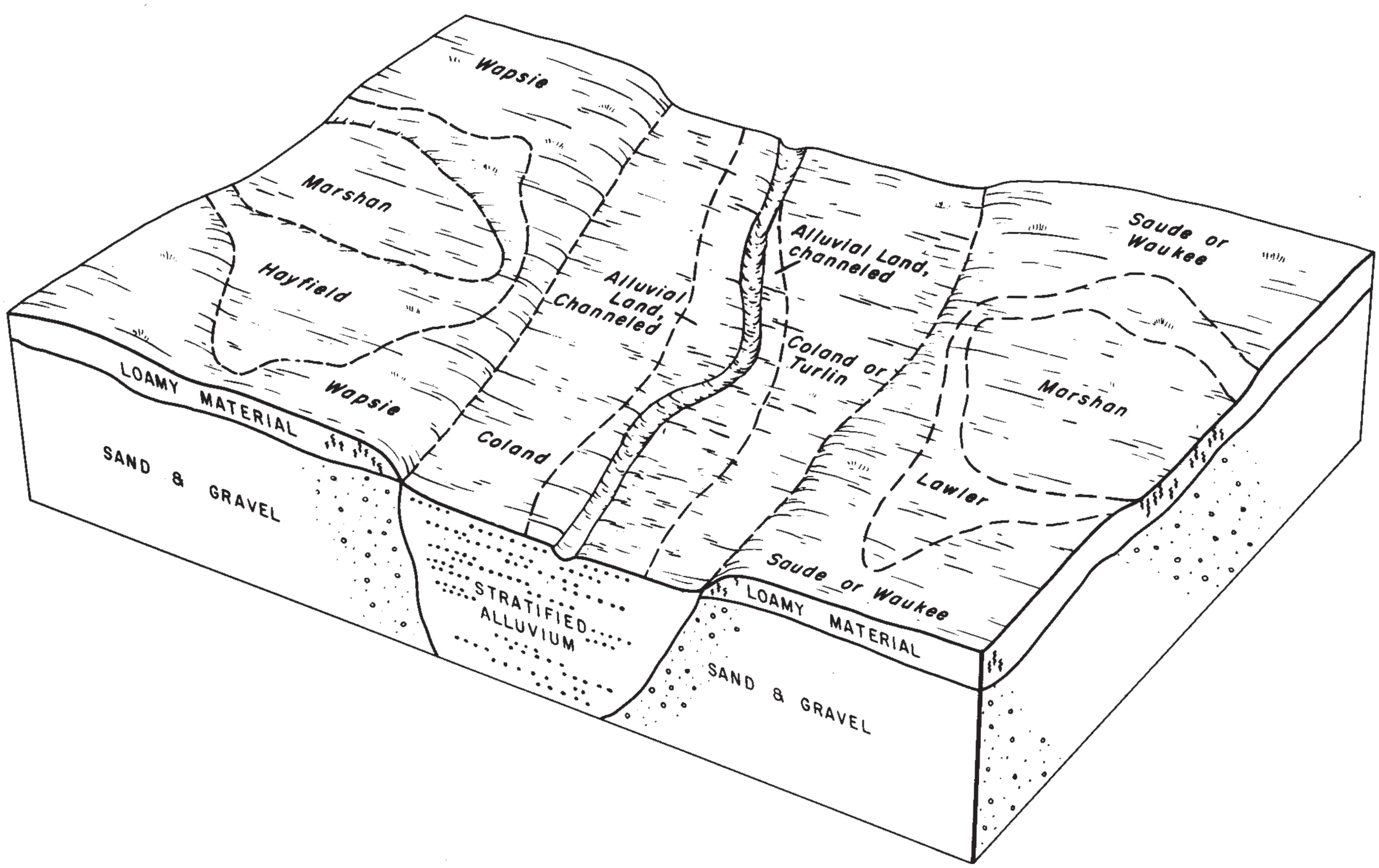

Figure 10.—**Diagram showing topography, soils, and underlying material in soil association 5.**

ment needs of the soils of the bottom lands are to prevent flooding and improve drainage. Water is frequently impounded in low swales. Some areas that are not cut up by stream channels and are not flooded too frequently are suited to cultivated crops.

6. Clyde-Floyd-Kenyon association

Nearly level to moderately sloping, moderately well drained to poorly drained soils formed in loamy material and underlying loam glacial till; on uplands

The topography of this association is mainly broad upland flats and gently sloping areas that have a poorly developed to fairly well developed drainage network and long, gently sloping, slightly rounded hills that have a well-developed drainage network. Most areas are cultivated, but some of the wet, undrained areas are in permanent pasture. In some undrained areas large granite boulders are a conspicuous feature of the landscape. This association makes up about 28 percent of Mitchell County.

Clyde soils make up about 20 percent of the association; Floyd soils, about 12 percent; Kenyon soils, about 8 percent; and minor soils; the remaining 60 percent (fig. 11). These formed in loamy material and the underlying glacial till. There is an appreciable difference between the rate at which water moves through the loamy material and the rate at which it moves through the less permeable glacial till. Most of the precipitation is readily absorbed by the loamy material. In periods of high precipitation, excess water is perched just above the till in places. Thus, a large part of the slope is seasonally wet, and tillage is difficult. Tile systems designed to intercept water are generally successful in draining these areas.

The Clyde soils are poorly drained. They have a thick surface layer of black silty clay loam. The subsoil is grayish, mottled, and stratified loamy material that grades to mottled gray and strong-brown loam with increasing depth. These nearly level to gently sloping soils are in drainageways and low concave positions. They are adjacent to many of the intermittent streams. Some of the Clyde soils are in undrained permanent pasture and sloughs. Many of these areas contain stones and boulders that interfere with cultivation and tile installation (fig. 12).

The Floyd soils are somewhat poorly drained. They have a thick, black, loamy surface layer. The subsoil is dark grayish brown and yellowish brown and is stratified. It grades to yellowish-brown, firm loam with depth. Floyd soils are nearly level to gently sloping and are on low, convex ridges and the slightly convex to concave lower parts of side slopes and coves.

The Kenyon soils are moderately well drained. They have a thick, black and very dark brown loamy surface layer. The subsoil is yellowish-brown loam. The gently

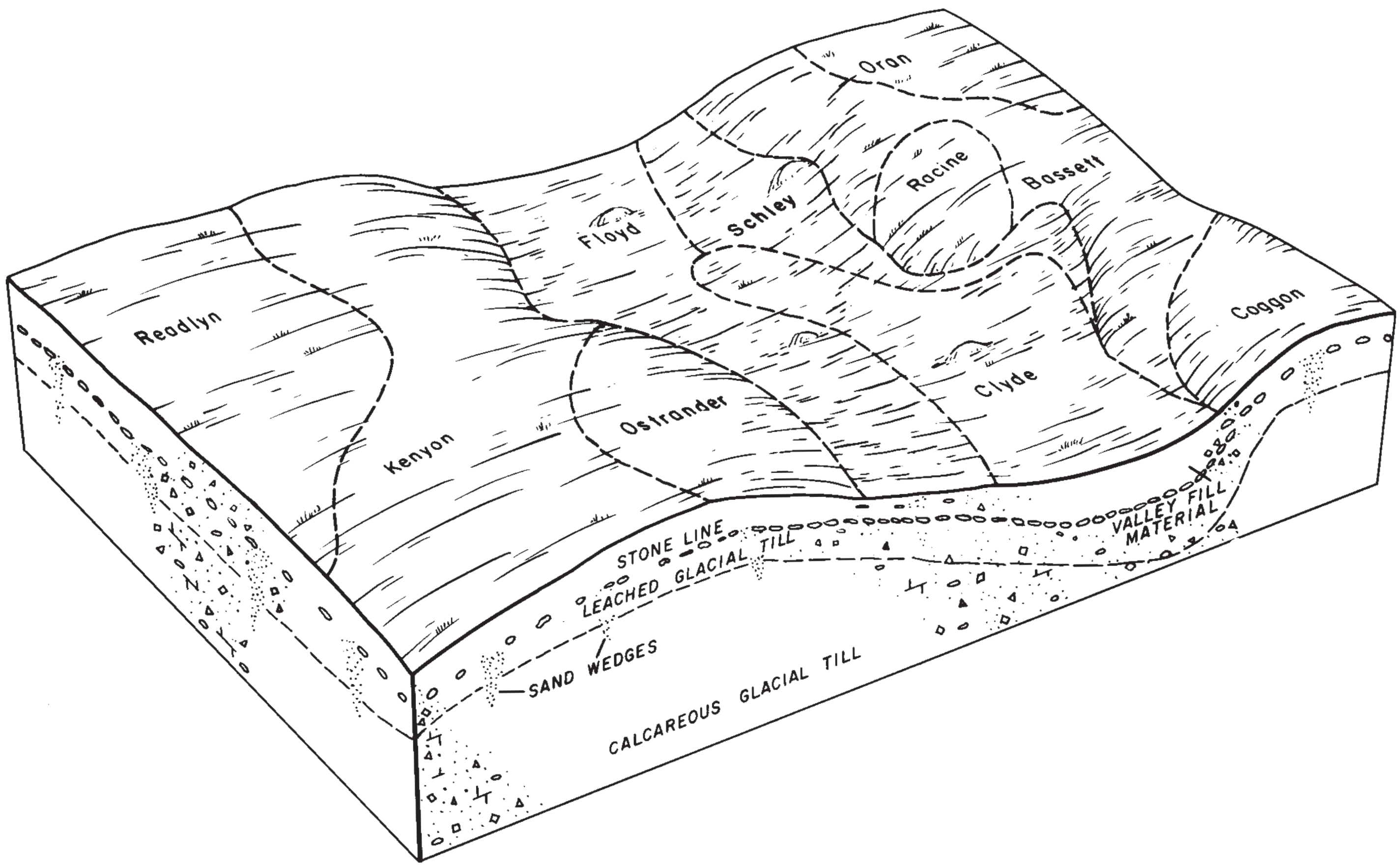

***Figure 11.*—Diagram showing topography, soils, and underlying materials in soil association 6.**

sloping soils are on ridgetops, and the gently sloping to moderately sloping soils are on side slopes.

The minor soils in this soil association are Bassett, Coggon, Donnan, Oran, Ostrander, Racine, Readlyn, Schley, and Tripoli soils. The Oran, Readlyn, and Schley soils are somewhat poorly drained, and the Tripoli soils are poorly drained. These soils benefit from tile drainage in most years (fig. 13). The gently sloping Bassett, Coggon, Ostrander, and Racine soils commonly are on long, convex ridges and are subject to erosion. The gently sloping Donnan soils are on short, convex ridges and the nearly level soils are on divides. They have a fine-textured, very slowly permeable subsoil and are seasonally wet and seepy.

This association is well suited to row crops. Most of it is cultivated. Some undrained areas are in permanent pasture. The principal management needs are to improve drainage, control erosion, and generally improve fertility. The wetness of the Clyde, Floyd, and Schley soils is caused, at least in part, by hillside seepage. In seeped places, interceptor tile laid upslope from the wet spots is needed for drainage. Providing adequate drainage and controlling erosion are difficult because they conflict to some extent. The long upland slopes are well suited to contour cultivation and terracing, but these practices slow down the movement of surface water and let more of it soak into the soil. The extra water entering the soil on the upper slopes seeps out in places on the lower parts of slopes and complicates drainage, especially in wet years. A combination of tile drainage and terracing is beneficial.

7. *Protivin-Clyde-Lourdes association*

Nearly level to moderately sloping, moderately well drained to poorly drained soils formed in loamy material and underlying clay loam or loam glacial till; on uplands

The topography of this association is mainly long, gentle slopes and slightly rounded hills. The drainage network is well developed. Some soils on short side slopes are moderately sloping. Most areas are cultivated, but some wet areas are in permanent pasture. This association occupies about 8 percent of Mitchell County.

Protivin soils make up about 20 percent of the association; Clyde soils, about 20 percent; Lourdes soils, about 11 percent; and minor soils, the remaining 49 percent (fig. 14). Most of the soils in this association, except for Clyde soils, formed in 13 to 24 inches of loamy material over very firm clay loam glacial till. A pebble band, or concentration of small stones, separates this loamy material from the glacial till. There is an appreciable difference between the rate at which water moves through the loamy material and the rate at which it moves through the till. Water tends to accumulate at the contact between the loamy material and the glacial till, and then moves downward along

Figure 12.—**Clyde silty clay loam. Stones and boulders occur in some areas of Clyde soils. Undrained areas are generally in permanent pasture.**

the contact. Seepy spots appear part way down the slope, and in places a large part of the slope is wet. The soils range from moderately well drained to poorly drained. Drainage can be improved with properly installed tile lines in most areas.

The Protivin soils are nearly level to gently sloping and somewhat poorly drained. They have a thick, black, loamy surface layer. The subsoil is mottled gray to strong-brown, very firm clay loam. These soils are on lower parts of side slopes below Cresco, Lourdes, and other soils and on broad ridge crests.

The Clyde soils are nearly level and poorly drained. They have a thick surface layer of black silty clay loam. The subsoil is grayish, mottled, and stratified and grades to mottled, gray and strong-brown loam with increasing depth. These soils are in drainageways and sloughs. Some are in undrained permanent pasture. Many areas contain stones and boulders that interfere with cultivation and tile installation.

The Lourdes soils are gently sloping to moderately sloping and are moderately well drained. They have a thin, dark loamy surface layer. The subsoil is strong-brown, gray, and yellowish-brown, very firm clay loam. These soils are on ridgetops and side slopes.

The most extensive minor soils are the Cresco, Floyd, and Riceville soils. Riceville soils are in similar positions on the landscape to those of Protivin soils. They are similar to Protivin soils, but the surface layer is thinner and not so dark colored. Cresco soils have a thicker, darker colored surface layer than the Lourdes soils and occupy similar positions on the landscape. Floyd soils are somewhat poorly drained. They have a thick, black, loamy surface layer and a stratified loamy subsoil. Among the other minor soils are the Bassett, Jameston, Kenyon, and Ostrander soils.

This association is well suited to moderately well suited to row crops. Most of it is cultivated. A few areas are in permanent pasture. Principal management needs are to improve fertility and drainage and to control erosion. Providing adequate drainage and controlling erosion are difficult because they conflict to some extent. The long upland slopes are well suited to contour cultivation and terracing, but these practices slow down the movement of surface water and let more of it soak into the soil. The extra water that enters the soil on the upper slopes seeps out in places on the lower slopes and complicates drainage, especially in wet years. A combination of tile drainage and terracing is beneficial.

Figure 13.—**Tile on area of Oran soils. Tripoli and Clyde soils are in the background.**

Descriptions of the Soils

This section describes the soil series and mapping units of Mitchell County. The acreage and proportionate extent of each mapping unit are given in table 1.

The procedure is first to describe the soil series and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the soil series to which it belongs. As mentioned in the section "How the Survey Was Made," not all mapping units are members of a soil series. Marsh and Alluvial land, channeled, for example, are miscellaneous land types that do not belong to a soil series. They are listed, nevertheless, in alphabetic order along with the soil series.

In comparing a mapping unit with a soil series, many prefer to read the short description in paragraph form. It precedes the technical description that identifies layers by A, B, and C horizons and depth ranges. The technical profile descriptions are mainly for soil scientists and others who want detailed information about soils. Unless otherwise indicated, the colors given in the descriptions are those of a moist soil. Some of the terms used to describe the soils are defined in the Glossary at the back of this soil survey, and more detailed information about terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*8*).[1]

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

[1] Italic numbers in parentheses refer to Literature cited, p. 123.

Alluvial Land

Alluvial land, channeled (C315) is mainly on the flood plain of the Cedar and Wapsipinicon Rivers. Most areas are cut by many old stream channels that generally fill with water during floods. Slopes are 0 to 2 percent.

Alluvial land has a wide range of texture. In most places it is stratified and is silty, loamy, or sandy. It is also commonly of silty clay texture, and in many places the surface layer is sandy and light colored. Even if the texture is fairly uniform, areas are too small and intermingled to be mapped separately.

The available water capacity is variable, but in many places it is low. Permeability and drainage also vary. The content of organic matter ranges from moderate to high. Flooding is frequent, and many areas are kept wet by recurring floods or by water standing in low places after floods.

Alluvial land is suited to permanent pasture or woodland. Some areas are cleared and used for permanent pasture; others are in brush willow and other scrub trees. Capability unit Vw-1.

Ansgar Series

The Ansgar series consists of nearly level, poorly drained soils on uplands. These soils are on flats and at the heads and along the upper parts of shallow drainageways. They formed in 24 to 40 inches of loess and the underlying glacial till. A layer of pebbles typically forms the contact line between the loess and the till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is black silt loam about 8 inches thick. The subsurface layer is grayish-brown, friable silt loam about 4 inches thick. The subsoil extends to a depth of about 72 inches. In the upper part it is grayish-brown and gray, friable silty clay loam; in the middle part it is mottled olive-gray and strong-brown, firm heavy loam; and in the lower part it is mottled gray, grayish-brown, yellowish-brown, and light brownish-gray, firm till of sandy clay loam texture.

The available water capacity is high. Permeability is moderate in the loess and moderately slow in the till. The content of available nitrogen is low. The subsoil is low in available potassium and low to very low in available phosphorus. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid.

Ansgar soils are suited to intensive use for row crops if they are adequately drained and properly managed.

Representative profile of Ansgar silt loam, in a cultivated field 400 feet east and 75 feet south of the northwest corner of the SW1/4 sec. 28, T. 99 N., R. 17 W.

Ap—0 to 8 inches, black (10YR 2/1) heavy silt loam; weak, fine, subangular blocky structure; friable; medium acid; abrupt boundary.

A2—8 to 12 inches, grayish-brown (2.5Y 5/2) silt loam; discontinuous dark-gray (10YR 4/1) coatings on peds; many, very fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, platy structure parting to moderate, very fine and fine, granular; friable; medium acid; abrupt boundary.

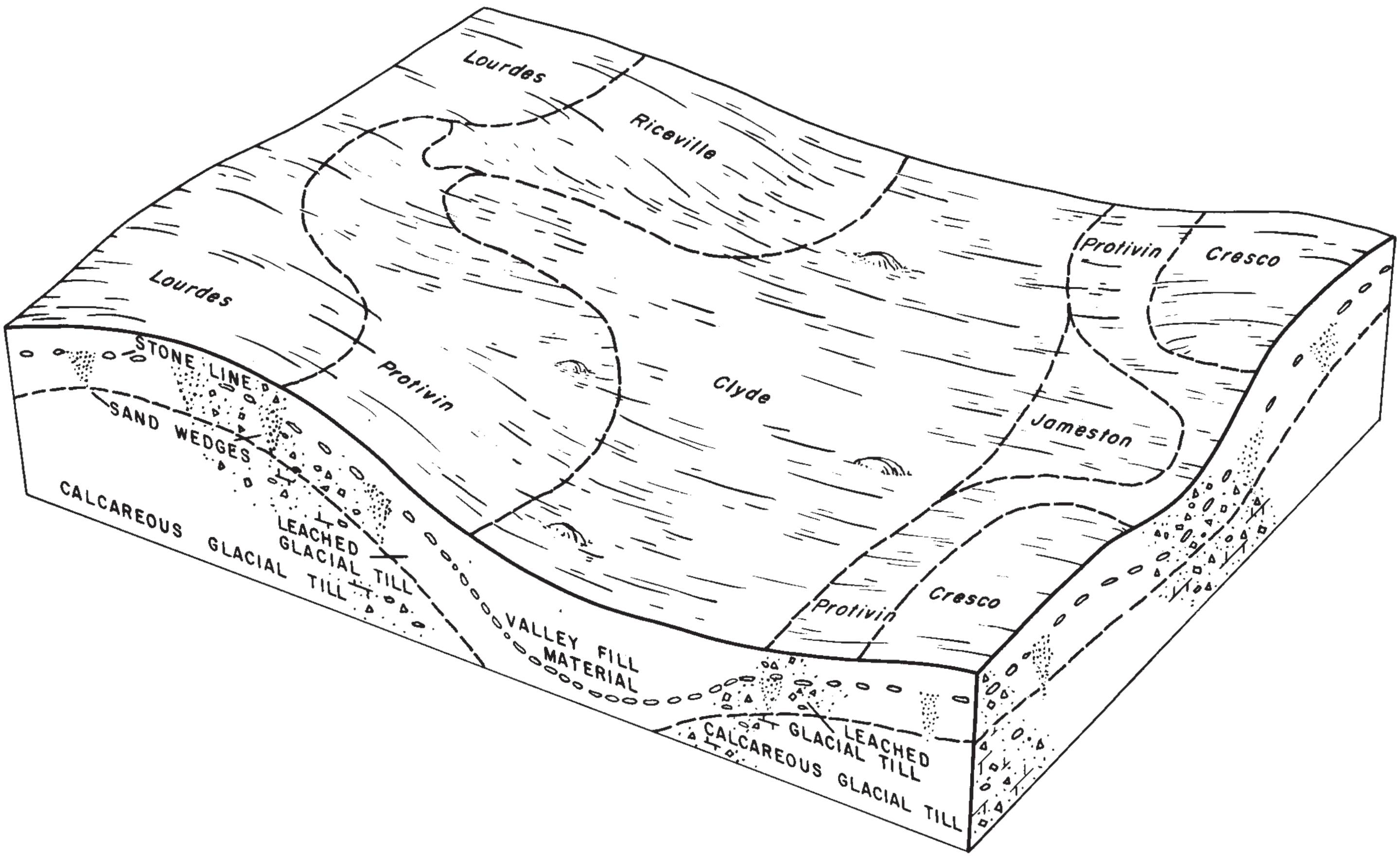

Figure 14.—**Diagram showing topography, soils, and underlying material in soil association 7.**

B1g—12 to 18 inches, grayish-brown (2.5Y 5/2) silty clay loam; many, fine, distinct, yellowish-brown (10YR 5/6) mottles and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, very fine, subangular blocky structure; friable; medium acid; clear boundary.

B21g—18 to 28 inches, gray (10YR 5/1) silty clay loam; many, fine and medium, prominent yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles and few, fine, prominent, yellowish-red (5YR 5/6) mottles; moderate, fine, subangular blocky structure; friable; medium acid; clear boundary.

IIB22g—28 to 36 inches, mottled olive-gray (5Y 5/2) and strong-brown (7.5YR 5/6) heavy loam; gray (10YR 6/1) coatings on peds; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; few pebbles, few black (5YR 2/1) oxide concretions; medium acid; clear boundary.

IIB23tg—36 to 47 inches, mottled gray (10YR 6/1) and grayish-brown (2.5Y 5/2) sandy clay loam; common, medium, distinct, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; firm; common, thin, patchy, dark-gray (10YR 4/1) and very dark gray (10YR 3/1) clay films on faces of peds and prisms; few small pebbles; medium acid; clear boundary.

IIB3t—47 to 72 inches, mottled yellowish-brown (10YR 5/6) and light brownish-gray (2.5Y 6/2) sandy clay loam; common, fine, distinct, strong-brown (7.5YR 4/4) mottles; weak, medium, prismatic structure; firm; few large root channels lined with dark-gray (10YR 4/1) clay films; few small pebbles; slightly acid.

The solum generally ranges from 4 to 6 feet in thickness. The A1 or Ap horizon is black (10YR 2/1) or very dark gray (10YR 3/1). The A2 horizon is 4 to 8 inches thick and distinctly mottled. It ranges from dark gray (10YR 4/1) to grayish brown (2.5Y 5/2).

The B horizon ranges from medium acid to strongly acid in the most acid part. The part of the B horizon that formed in loess ranges from 10YR to 5Y in hue, from 4 to 5 in value, and from 1 to 2 in chroma. It ranges from light to medium silty clay loam in texture, and in places has thin horizons that are more than 35 percent clay. The loess is generally 26 to 36 inches thick, but it ranges from 20 to 40 inches. The IIB2 horizon formed in glacial drift. It ranges from 10YR to 5Y in hue and from 5 to 6 in value and has mottles of 10YR and 7.5YR that are high in chroma. It is generally heavy loam or sandy clay loam, but it is light clay loam in places.

Ansgar soils are closely associated with Franklin, Klinger, Maxfield, and Dinsdale soils. They have a thinner A horizon and a grayer B horizon than Klinger and Dinsdale soils and are not so well drained as those soils. They have a grayer B horizon and are more poorly drained than Franklin soils. They have a thinner A horizon than Maxfield soils.

Ansgar silt loam, 0 to 2 percent slopes (760).—This soil is mainly on broad upland divides. Some areas are at the heads of broad shallow drainageways. Slopes are typically less than 1 percent. In areas where fractured limestone bedrock is at a depth of 15 to 25 feet, this soil is in shallow sinkholes, or basins, that in places impound water for short periods. Most areas are about 5 to 50 acres in size, but a few are much larger.

If drained and properly managed, this soil is well suited

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

Soil	Area	Extent
	Acres	*Percent*
Alluvial land, channeled	4, 520	1. 5
Ansgar silt loam, 0 to 2 percent slopes	5, 405	1. 8
Ashdale silt loam, 0 to 2 percent slopes	3, 975	1. 3
Ashdale silt loam, 2 to 5 percent slopes	2, 280	. 8
Atkinson loam, 0 to 2 percent slopes	2, 350	. 8
Atkinson loam, 2 to 5 percent slopes	2, 220	. 7
Atterberry silt loam, 0 to 2 percent slopes	615	. 2
Bassett loam, 0 to 2 percent slopes	820	. 3
Bassett loam, 2 to 5 percent slopes	5, 610	1. 9
Bassett loam, 5 to 9 percent slopes	470	. 1
Bassett loam, 5 to 9 percent slopes, moderately eroded	335	. 1
Bixby loam, 0 to 2 percent slopes	270	. 1
Bixby loam, 2 to 5 percent slopes	405	. 1
Burkhardt sandy loam, 0 to 3 percent slopes	160	. 1
Burkhardt sandy loam, 3 to 9 percent slopes	360	. 1
Calco silty clay loam, 0 to 2 percent slopes	290	. 1
Canisteo silty clay loam, 0 to 2 percent slopes	380	. 1
Clyde silty clay loam, 0 to 3 percent slopes	21, 320	7. 1
Clyde-Floyd complex, 1 to 4 percent slopes	5, 030	1. 7
Coggon loam, 2 to 5 percent slopes	730	. 2
Coland silty clay loam, 0 to 2 percent slopes	1, 255	. 4
Coland-Turlin complex, 0 to 2 percent slopes	3, 000	1. 0
Coland-Turlin complex, channeled, 0 to 2 percent slopes	1, 480	. 5
Cresco loam, 2 to 5 percent slopes	1, 520	. 5
Cresco loam, 5 to 9 percent slopes	370	. 1
Dickinson fine sandy loam, 0 to 2 percent slopes	465	. 2
Dickinson fine sandy loam, 2 to 5 percent slopes	1, 385	. 4
Dickinson-Ostrander complex, 0 to 2 percent slopes	515	. 2
Dickinson-Ostrander complex, 2 to 5 percent slopes	1, 690	. 6
Dinsdale silty clay loam, 0 to 2 percent slopes	16, 500	5. 5
Dinsdale silty clay loam, 2 to 5 percent slopes	10, 185	3. 4
Donnan silt loam, 0 to 2 percent slopes	1, 995	. 7
Donnan silt loam, 2 to 5 percent slopes	880	. 3
Downs silt loam, 2 to 5 percent slopes	1, 570	. 5
Downs silt loam, 5 to 9 percent slopes, moderately eroded	410	. 1
Downs silt loam, 9 to 14 percent slopes, moderately eroded	225	. 1
Dubuque silt loam, moderately deep, 2 to 5 percent slopes	255	. 1
Dubuque silt loam, moderately deep, 5 to 9 percent slopes	195	. 1
Fayette silt loam, 2 to 5 percent slopes	200	. 1
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	315	. 1
Flagler sandy loam, 0 to 2 percent slopes	110	[1]
Flagler sandy loam, 2 to 5 percent slopes	400	. 1
Floyd loam, 1 to 4 percent slopes	10, 605	3. 5
Franklin silt loam, 1 to 3 percent slopes	12, 830	4. 3
Garwin silty clay loam, 0 to 2 percent slopes	1, 040	. 4
Hanlon sandy loam, 0 to 2 percent slopes	345	. 1
Hayfield loam, deep, 0 to 2 percent slopes	805	. 3
Hayfield loam, moderately deep, 0 to 2 percent slopes	2, 040	. 7
Huntsville silt loam, 0 to 2 percent slopes	415	. 1
Huntsville silt loam, 2 to 5 percent slopes	400	. 1
Jameston silty clay loam, 0 to 2 percent slopes	350	. 1
Kensett silt loam, 0 to 2 percent slopes	335	. 1
Kenyon loam, 0 to 2 percent slopes	1, 740	. 6
Kenyon loam, 2 to 5 percent slopes	5, 230	1. 8
Kenyon loam, 5 to 9 percent slopes	595	. 2
Kenyon loam, 5 to 9 percent slopes, moderately eroded	285	. 1
Klinger silty clay loam, 0 to 2 percent slopes	24, 436	8. 2
Lamont fine sandy loam, 0 to 2 percent slopes	600	0. 2
Lamont fine sandy loam, 2 to 5 percent slopes	710	. 2
Lamont fine sandy loam, 5 to 9 percent slopes	220	. 1
Lamont-Renova complex, 2 to 5 percent slopes	385	. 1
Lawler loam, deep, 0 to 2 percent slopes	2, 725	. 9
Lawler loam, moderately deep, 0 to 2 percent slopes	1, 035	. 4
Lilah sandy loam, 0 to 3 percent slopes	210	. 1
Lilah sandy loam, 3 to 9 percent slopes	805	. 3
Lourdes loam, 2 to 5 percent slopes	1, 830	. 6
Lourdes loam, 5 to 9 percent slopes	530	. 2
Lourdes loam, 5 to 9 percent slopes, moderately eroded	445	. 1
Marsh	185	. 1
Marshan clay loam, deep, 0 to 2 percent slopes	3, 465	1. 2
Marshan clay loam, moderately deep, 0 to 2 percent slopes	710	. 2
Maxfield silty clay loam, 0 to 2 percent slopes	20, 930	7. 0
Muck, moderately deep	445	. 1
Muscatine silty clay loam, 0 to 2 percent slopes	1, 610	. 5
Nasset silt loam, 0 to 2 percent slopes	200	. 1
Nasset silt loam, 2 to 5 percent slopes	835	. 3
Oran loam, 0 to 2 percent slopes	7, 660	2. 6
Oran loam, 2 to 5 percent slopes	3, 470	1. 2
Ostrander loam, 0 to 2 percent slopes	3, 580	1. 2
Ostrander loam, 2 to 5 percent slopes	3, 010	1. 0
Pinicon loam, 1 to 4 percent slopes	1, 580	. 6
Protivin loam, 1 to 4 percent slopes	4, 910	1. 6
Racine silt loam, 0 to 2 percent slopes	1, 550	. 5
Racine silt loam, 2 to 5 percent slopes	3, 400	1. 1
Racine silt loam, 5 to 9 percent slopes	700	. 3
Readlyn loam, 0 to 2 percent slopes	2, 530	. 8
Readlyn loam, 2 to 5 percent slopes	2, 355	. 8
Renova loam, 2 to 5 percent slopes	580	. 2
Riceville silt loam, 1 to 4 percent slopes	2, 880	1. 0
Rockton loam, moderately deep, 2 to 5 percent slopes	1, 515	. 5
Rockton loam, moderately deep, 5 to 9 percent slopes	725	. 2
Rockton silt loam, moderately deep, 2 to 5 percent slopes	775	. 3
Roseville silt loam, 2 to 5 percent slopes	480	. 2
Sattre silt loam, 0 to 2 percent slopes	380	. 1
Saude loam, 0 to 2 percent slopes	1, 655	. 6
Saude loam, 2 to 5 percent slopes	1, 375	. 5
Schley silt loam, 1 to 4 percent slopes	11, 670	3. 9
Sogn loam, 2 to 5 percent slopes	160	. 1
Sogn loam, 5 to 14 percent slopes	645	. 2
Sogn loam, 14 to 40 percent slopes	1, 135	. 4
Tama silty clay loam, 0 to 2 percent slopes	2, 130	. 7
Tama silty clay loam, 2 to 5 percent slopes	3, 225	1. 1
Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	495	. 2
Terril loam, 0 to 2 percent slopes	500	. 2
Terril loam, 2 to 5 percent slopes	780	. 3
Tripoli silty clay loam, 0 to 2 percent slopes	3, 310	1. 1
Turlin silt loam, 0 to 2 percent slopes	1, 260	. 4
Wapsie loam, 0 to 2 percent slopes	2, 780	. 9
Wapsie loam, 2 to 5 percent slopes	3, 370	1. 1
Wapsie loam, 5 to 9 percent slopes	640	. 2
Waubeek silt loam, 0 to 2 percent slopes	2, 110	. 7
Waubeek silt loam, 2 to 5 percent slopes	4, 895	1. 6
Waucoma silt loam, 0 to 2 percent slopes	1, 555	. 5
Waucoma silt loam, 2 to 5 percent slopes	2, 770	. 9
Waukee silt loam, 0 to 2 percent slopes	2, 705	. 9
Waukee silt loam, 2 to 5 percent slopes	530	. 2
Whalan loam, deep, 2 to 5 percent slopes	575	. 2

See footnote at end of table.

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Whalan loam, deep, 5 to 9 percent slopes	425	0.1	Winneshiek loam, moderately deep, 9 to 14 percent slopes	245	0.1
Winneshiek loam, moderately deep, 0 to 2 percent slopes	300	.1	Quarries and gravel pits	350	.1
Winneshiek loam, moderately deep, 2 to 5 percent slopes	1,815	.6	Water	110	(1)
Winneshiek loam, moderately deep, 5 to 9 percent slopes	1,430	.5	Total	298,816	100.0

[1] Less than 0.05 percent.

to intensive use for row crops. It has a moderate content of organic matter. It is generally in good tilth, but it puddles if worked when wet. The major limitation to farming is wetness. Tile drainage is needed for optimum production. Good tile outlets are difficult to obtain in a few areas because the slope is low. Capability unit IIw-1.

Ashdale Series

The Ashdale series consists of nearly level and gently sloping, well-drained soils on uplands. These soils are on ridge crests and side slopes. They formed in 24 and 36 inches of loess and the underlying loamy sediment. Limestone bedrock is at a depth fo 40 to 60 inches. A thin layer of clayey limestone residuum generally is on the surface of the underlying limestone bedrock. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark brown silt loam about 14 inches thick. The subsoil is about 34 inches thick. The upper part is dark-brown and brown, friable heavy silt loam and light silty clay loam; the lower part is friable and firm heavy loam and clay loam overlying a thin, firm layer of dark yellowish-brown clay. Below the subsoil is shattered limestone bedrock.

The available water capacity is medium to high. Permeability is moderate in most of the profile, and it is very slow in the clayey residuum. The content of organic matter is high. The content of available nitrogen is low to medium. The subsoil is low to medium in available potassium and low in available phosphorus. Unless these soils are limed, the upper layers generally are medium acid.

Ashdale soils are well suited to row crops and are generally associated with large areas of other well-suited and well-drained soils. Gently sloping soils are subject to slight erosion if cultivated.

Representative profile of Ashdale silt loam, 0 to 2 percent slopes, in a cultivated field, 315 feet east and 20 feet north of the southwest corner of the NW¼ sec. 16, T. 98 N., R. 18 W.

Ap—0 to 7 inches, black (10YR 2/1) heavy silt loam; cloddy, breaking to very fine subangular blocky structure; friable; medium acid; abrupt boundary.

A12—7 to 14 inches, very dark brown (10YR 2/2) heavy silt loam; black (10YR 2/1) coatings on peds; moderate, very fine and fine, granular structure; friable; medium acid; clear boundary.

B1—14 to 20 inches, dark-brown (10YR 3/3) heavy silt loam; nearly continuous very dark brown (10YR 2/2) coatings on peds; moderate, fine and very fine, subangular blocky structure; friable; medium acids; clear boundary.

B21t—20 to 29 inches, brown (10YR 4/3) light silty clay loam; discontinuous very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) coatings on peds; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; friable; few grainy coatings; few dark-brown (10YR 3/3) clay films on peds and in root channels; medium acid; clear boundary.

IIB22t—29 to 33 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, medium, prismatic structure breaking to weak, medium, subangular blocky; friable; medium acid; clear boundary.

IIB23t—33 to 40 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) clay loam; moderate, very fine and fine, subangular blocky structure; firm; nearly continuous clay films on peds; medium acid; clear boundary.

IIIB31—40 to 42 inches, dark yellowish-brown (10YR 4/4) clay; weak, angular blocky structure; firm; some limestone fragments; moderately alkaline; slight effervescence; abrupt boundary.

IIIB32—42 to 48 inches, mottled yellowish-brown (10YR 5/6) and yellow (10YR 7/8) light sandy loam; very weak, coarse, subangular blocky structure; very friable; 50 percent limestone fragments; moderately alkaline; slight effervescence; abrupt boundary.

IIIR—48 inches, shattered limestone bedrock.

The solum is generally 44 to 54 inches thick, but it ranges from 44 to 60 inches. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). The A3 horizon, if present, ranges from very dark brown (10YR 2/2) to dark brown (10YR 4/3). The loess ranges from 24 to 36 inches in thickness.

The upper part of the IIB2 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4). It is typically heavy loam, but ranges to light clay loam and heavy sandy loam. The IIIB horizon just above the shattered bedrock is generally clay or silty clay limestone residuum 2 to 6 inches thick.

In some places a loamy horizon that contains many rock fragments is between the residuum and the limestone. The shattered upper part of the bedrock ranges from 2 to 5 feet in thickness, and 5 to 15 percent of it is generally loamy materials in crevices and thin layers of clayey material on the slabs of bedrock.

Ashdale soils are slightly higher in content of sand in the lower part of the B horizon than is defined in the range for the series. This difference, however, does not greatly alter the usefulness and behavior of these soils.

Ashdale soils are associated with Atkinson, Nasset, Kensett, Dinsdale, and Rockton soils and formed in similar material. They have a lower sand content and higher silt content in the A horizon and upper part of the B horizon than Atkinson soils. They have a thicker A1 horizon than Nasset soils. They have a browner B horizon and are better drained than Kensett soils. They are deeper over the underlying bedrock than Rockton soils. They are underlain by limestone bedrock, but Dinsdale soils are underlain by glacial till.

Ashdale silt loam, 0 to 2 percent slopes (804).—This soil is on high uplands. It generally is just above gently sloping Ashdale, Atkinson, or Rockton soils and adjacent to Dinsdale and Kensett soils. Most areas range from 4 to 80 acres in size, and some are larger.

This soil has the profile described as representative of the series. In a few spots bedrock is at a depth of less than 40 inches, and in a few other spots it is at a depth of more than 60 inches.

This soil is well suited to cultivated crops and generally is associated with large areas of other well-suited, well-drained soils. Capability unit I–2.

Ashdale silt loam, 2 to 5 percent slopes (804B).—This soil is on long, convex side slopes and ridge crests. It generally is associated with Atkinson, Dinsdale, and nearly level Ashdale soils and with Rockton silt loam. Huntsville soils generally occupy nearby drainageways.

This soil has a profile similar to that described as representative of the series, but the dark colored surface layer generally is not so thick. In a few spots bedrock is at a depth of less than 40 inches, and in a few other spots it is at a depth of more than 60 inches.

This soil is well suited to cultivated crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Atkinson Series

The Atkinson series consists of nearly level and gently sloping well-drained soils on uplands. These soils are on ridge crests and side slopes. They formed in loamy material overlying limestone bedrock at a depth of 40 to 60 inches. A thin layer of clayey limestone residuum overlies the limestone bedrock. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark brown, and dark-brown loam about 20 inches thick. The subsoil is about 28 inches thick. The upper part is dark yellowish-brown, friable loam; the middle part is yellowish-brown, friable loam; and the lower part is brown, very firm clay. Below the subsoil is shattered limestone bedrock that contains some loamy soil material. It is underlain by massive bedrock.

Available water capacity is medium to high. Permeability is moderate in the loamy upper part but very slow in the clayey residuum. The content of organic matter is high. The content of available nitrogen is low to medium. The subsoil is low to medium in available potassium and low in available phosphorus. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Atkinson soils are well suited to row crops and are generally associated with large areas of other well-suited, well-drained soils. Gently sloping soils are subject to slight erosion if cultivated.

Representative profile of Atkinson loam, 0 to 2 percent slopes, in a cultivated field, 570 feet east and 35 feet north of the southwest corner of the NE¼ sec. 3, T. 97 N., R. 17 W.

Ap—0 to 8 inches, black (10YR 2/1) loam; moderate, very fine and fine, granular structure; friable; neutral; clear boundary.

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

A3—14 to 20 inches, dark-brown (10YR 3/3) heavy loam; nearly continuous very dark brown (10YR 2/2) coatings on peds; moderate, very fine and fine, granular structure; friable; medium acid; clear boundary.

B1—20 to 30 inches, dark yellowish-brown (10YR 4/4) heavy loam; discontinuous brown (10YR 4/3) coatings on peds; moderate, fine, subangular blocky structure; friable; pebble band in upper part of horizon; few stones, 2 millimeters in diameter; strongly acid; clear boundary.

B21t—30 to 43 inches, yellowish-brown (10YR 5/6) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few, thin, discontinuous clay films on faces of prisms and peds; strongly acid; clear boundary.

IIB22t—43 to 48 inches, brown (7.5YR 4/2) clay; strong, fine, angular blocky structure; very firm; slightly acid; abrupt boundary.

IIR—48 inches, shattered limestone bedrock; 10 percent is crevices filled with loamy material; discontinuous thin layer of clayey material on limestone slabs.

The solum is generally 44 to 54 inches thick, but ranges from 40 to 60 inches. It is underlain by limestone bedrock. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) and from silt loam that has a high content of sand to loam. The A3 horizon ranges from very dark brown (10YR 2/2) to dark brown (10YR 4/3).

The part of the B horizon formed in loamy material ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) and from heavy sandy loam to loam or light clay loam. The residuum just above the shattered bedrock is generally clay or silty clay 2 to 6 inches thick.

The shattered upper part of the bedrock ranges from 2 to 5 feet in thickness and generally is 5 to 15 percent loamy materials in crevices and thin layers of clayey material on slabs of bedrock.

Atkinson soils are associated with Ashdale, Kensett, Rockton, Roseville, Waucoma, Sogn, Whalan, and Winneshiek soils and formed in similar materials. They are deeper over bedrock than Rockton, Kensett, Sogn, Whalan, and Winneshiek soils. They have a thicker A1 horizon than Waucoma, Roseville, Winneshiek, and Whalan soils. They are higher in sand and lower in silt in the A horizon and upper part of the B horizon than Ashdale soils. These soils have a browner B horizon and are better drained than Kensett soils.

Atkinson loam, 0 to 2 percent slopes (813).—This soil is on high uplands. It is generally just above gently sloping Atkinson or Rockton soils and adjacent to Ostrander soils. Huntsville and Terril soils are in the drainageways. Most areas are 4 to 80 acres in size, but some are larger.

This soil has the profile described as representative of the series. In a few areas bedrock is at a depth of less than 40 inches, and in a few other areas it is at a depth of more than 60 inches.

This soil is well suited to cultivated crops. It is generally associated with large areas of other well-suited, well-drained soils. Capability unit I–2.

Atkinson loam, 2 to 5 percent slopes (813B).—This soil is on long, convex side slopes and ridge crests. It is generally associated with Ostrander and Rockton soils, nearly level Atkinson soils, and other well-drained soils underlain by limestone bedrock. Huntsville and Terril soils are in many of the drainageways. Most areas are 4 to 30 acres in size.

This soil has a profile similar to that described as representative of the series, but the dark-colored A horizon is not so thick. In a few spots bedrock is at a depth of less than 40 inches.

This soil is well suited to cultivated crops, and it generally is associated with large areas of other well-suited soils. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Atterberry Series

The Atterberry series consists of nearly level, somewhat poorly drained soils on uplands. These soils are on convex ridges and in lower concave positions. They formed in 4 to 8 feet of loess deposits over glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is black silt loam about 8 inches thick. The subsurface layer, about 3 inches thick, is dark grayish-brown, friable silt loam. The subsoil is about 34 inches thick. The upper part is dark grayish-brown and grayish-brown, friable silty clay loam. The lower part of the subsoil and the substratum are mottled olive-gray and gray, friable silt loam.

Available water capacity is high, and permeability is moderate. The content of organic matter is moderate. The content of available nitrogen is low. The subsoil is low in available phosphorus and very low in available potassium. Unless these soils are limed, the upper layers are medium acid.

These soils are well suited to intensive use for row crops. Artificial drainage is beneficial in some areas.

Representative profile of Atterberry silt loam, 0 to 2 percent slopes, in a cultivated field 690 feet west and 70 feet north of the southeast corner of sec. 3, T. 97 N., R. 16 W.

Ap—0 to 8 inches, black (10YR 2/1) silt loam; weak, fine, granular structure; friable; slightly acid; abrupt boundary.

A2—8 to 11 inches, dark grayish-brown (10YR 4/2) heavy silt loam; few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; weak, medium, platy structure; friable; few gray grainy ped coatings when dry; strongly acid; clear boundary.

B21—11 to 18 inches, dark grayish-brown (10YR 4/2) medium silty clay loam; common, fine, faint, dark yellowish-brown (10YR 4/4) mottles; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; few grainy ped coatings when dry; strongly acid; gradual boundary.

B22t—18 to 26 inches, grayish-brown (2.5Y 5/2) medium silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; few, thin, discontinuous, brown (10YR 4/3) clay films; strongly acid; gradual boundary.

B31t—26 to 33 inches, grayish-brown (2.5Y 5/2) light silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles and few, fine, faint, light olive-brown (2.5Y 5/4) mottles; weak, medium, prismatic structure parting to medium subangular blocky; friable; few, thin, discontinuous, brown (10YR 4/3) clay films; few dark oxide concretions; strongly acid; gradual boundary.

B32t—33 to 45 inches, mottled olive-gray (5Y 5/2) and gray (5Y 6/1) silt loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles and few, fine, prominent, dark-brown (7.5YR 4/4) mottles; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; friable; common very dark brown (10YR 2/2) and very dark gray (10YR 3/1) clay films in root channels and on prisms; medium acid; gradual boundary.

C—45 to 60 inches, mottled olive-gray (5Y 5/2) and gray (5Y 6/1) silt loam; many, medium, prominent, strong-brown (7.5YR 5/6) mottles; massive; friable; common very dark brown (10YR 2/2) and very dark gray (10YR 3/1) and few, thick, black (10YR 2/1) clay films lining root channels; slightly acid to mildly alkaline.

The solum is generally about 4 feet thick but ranges from 42 to 60 inches. The A1 or Ap horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) and 6 to 10 inches thick. The A2 horizon ranges from 3 to 8 inches in thickness. It is medium acid to strongly acid.

The B horizon is 30 to 40 inches thick. It ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (2.5Y 5/2) in the upper part to gray (5Y 6/1) and olive gray (5Y 6/2) in the lower part. The B2t horizon is silty clay loam, and it is 30 to 35 percent clay. The B horizon is medium acid to strongly acid.

Atterberry soils have a larger percentage of colors that have a chroma of 2 or less in all horizons between the Ap horizon and a depth of 30 inches than is defined in the range for the Atterberry series. This difference, however, does not greatly alter the usefulness and behavior of these soils.

Atterberry soils are associated with Downs, Franklin, Garwin, Muscatine, and Tama soils. They are not so well drained as Downs and Tama soils and have a grayer B horizon. They are better drained and have a browner B horizon than Garwin soils. They have a thinner A horizon than Muscatine and Tama soils. They formed in loess deposits 4 to 8 feet thick, but Franklin soils formed in 24 to 40 inches of loess and the underlying glacial till.

Atterberry silt loam, 0 to 2 percent slopes (291).—This soil is on convex ridge crests and lower concave positions on uplands. Most areas are 5 to 50 acres in size.

This soil is well suited to intensive use for row crops. Artificial drainage is beneficial in some areas in years of high precipitation. Capability unit I–3.

Bassett Series

The Bassett series consists of nearly level to moderately sloping, moderately well drained soils on uplands. The nearly level to gently sloping soils are on long ridge crests, and the gently sloping to moderately sloping soils are on side slopes. These soils formed in 13 to 22 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones forms the contact line between the loamy overburden and the glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 8 inches thick. The subsurface layer, about 4 inches thick, is brown, friable loam. The subsoil extends to a depth of about 60 inches. It is yellowish-brown, friable loam in the upper part; yellowish-brown, firm loam in the middle part; and mottled light brownish-gray, brownish-yellow, and strong-brown, firm light sandy clay loam in the lower part.

Available water capacity is high. The rate at which water moves through the friable, loamy overburden differs considerably from the rate at which it moves through the underlying glacial till. Permeability is moderate in the loamy overburden and moderately slow in the glacial till. Water moves more rapidly in the overburden and accumulates at the till contact, which produces wet, seepy spots in some years. The content of organic matter is moderate. The content of available nitrogen is low. The subsoil is low to very low in available phosphorus and potassium. Unless these soils are limed, the upper layers are acid.

Bassett soils are well suited to row crops if properly managed. The sloping areas of these soils are subject to erosion if cultivated.

Representative profile of Bassett loam, 2 to 5 percent slopes, in a cultivated field 600 feet north and 265 feet east of the southwest corner of sec. 20, T. 100 N., R. 15 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; weak, fine and very fine, granular structure; friable; neutral; abrupt boundary.

A2—8 to 12 inches, brown (10YR 4/3) loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium, platy structure parting to weak, fine and very fine, granular; friable; few, patchy, light brownish-gray (10YR 6/2) grainy coatings when dry; medium acid; clear boundary.

B1—12 to 18 inches, yellowish-brown (10YR 5/4) heavy loam; brown (10YR 4/3) coatings on peds; very fine subangular blocky structure; friable; few, patchy, light brownish-gray (10YR 6/2) coatings when dry; strongly acid; clear boundary.

IIB21—18 to 24 inches, yellowish-brown (10YR 5/6) loam; few, fine, faint, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to moderate, very fine and fine, subangular blocky; friable; few pebbles, ½ to 1 inch in diameter throughout; strongly acid; clear boundary.

IIB22t—24 to 39 inches, yellowish-brown (10YR 5/6) loam; nearly continuous light brownish-gray (2.5Y 6/2 and 10YR 6/2) coatings on prisms; few, fine, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to very fine and fine subangular blocky; firm; dark grayish-brown (10YR 4/2) thin clay films lining root channels; few, fine, black (5YR 2/1) oxide concentrations; strongly acid; clear boundary.

IIB31t—39 to 46 inches, mottled, light brownish-gray (2.5Y 6/2) and brownish-yellow (10YR 6/8) light sandy clay loam; light brownish-gray (2.5Y 6/2) coatings on prisms; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; firm; few dark grayish-brown (10YR 4/2) clay films; thin, discontinuous, white (10YR 8/1) grainy coatings on prisms and peds when dry; few yellowish-red (5YR 5/8) oxide concentrations ¼ inch in diameter; few concentrations of a dark oxide; strongly acid; clear boundary.

IIB32t—46 to 60 inches, strong-brown (7.5YR 5/6) light sandy clay loam; common, medium, distinct, light grayish-brown (2.5Y 6/2) mottles; weak, coarse, prismatic structure; common clay-lined and filled pores; firm; medium acid.

The solum is generally 3½ to 5 feet thick. The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1) or very dark brown (10 YR 2/2) and is 6 to 9 inches thick. It ranges from loam to silt loam that has a high content of sand. The A2 horizon is commonly brown (10YR 4/3 or 5/3) and ranges from loam to silt loam that has a high content of sand. In some eroded areas the A2 horizon is wholly incorporated in the Ap horizon.

The upper part of the B horizon has a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 3 to 6. It lacks distinct mottling but has faint, fine mottles of high chroma in some places. In some places mottles in the lower part of the B2 horizon and the B3 horizon have chroma of 2 or less. The B horizon is generally heavy loam or sandy clay loam, but ranges to light clay loam. It is strongly acid to very strongly acid in the most acid part.

Bassett soils are associated with Coggon, Kenyon, Lourdes, and Oran soils and formed in similar materials. They are also associated with Clyde, Floyd, Racine, Schley, and Waucoma soils. They have a browner B horizon than Oran and Schley soils and are better drained. They contain less clay and are not so firm in the B horizon as Lourdes soils. They have a thicker A1 horizon than Coggon soils. In contrast with Clyde, Floyd, and Kenyon soils, they have an A2 horizon and a thinner A1 horizon. They have a browner B horizon and are better drained than Clyde and Floyd soils. In contrast with Racine soils, they have a firmer B horizon that has low-chroma mottles, and they are not so well drained. They are not underlain by limestone bedrock as are Waucoma soils.

Bassett loam, 0 to 2 percent slopes (171).—In most places this soil is on high upland ridge crests or upland flats. It is associated with Oran, Schley, Waucoma, and other upland glacial soils. Most areas of this soil are 3 to 8 acres in size.

This soil has a profile similar to that described as representative of the series, but in places it has a few gray mottles shallower in the profile. Most of the Bassett soils in Iowa, unlike this one, have slopes of more than 2 percent. This soil, however, is underlain by limestone bedrock at a depth of 10 to 15 feet, which tends to lower the regional water table. Thus, this soil, although it is nearly level, is well drained.

Included with this soil in mapping were a few small areas that are less well drained and require some artificial drainage.

This soil is well suited to intensive use for row crops. Capability unit I–2.

Bassett loam, 2 to 5 percent slopes (171B).—This soil is on long, convex ridges and side slopes. In most places it is upslope from Clyde, Floyd, and Schley soils and is on landscapes adjoining Kenyon, Oran, and Racine soils. Some areas are associated with soils that are underlain by limestone. Most areas are 4 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas of Oran soils that are not so well drained and a few small areas of Kenyon soils that have a darker and thicker surface layer.

This soil is well suited to row crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Bassett loam, 5 to 9 percent slopes (171C).—This soil is on convex ridges and side slopes on uplands. In most places it is upslope from Clyde, Floyd, or Schley soils and downslope from gently sloping Bassett soils. Most areas are 4 to 10 acres in size.

This soil has a profile similar to that described as representative of the series, but is generally somewhat shallower over glacial till. In some places are small eroded spots where the surface layer is lighter in color and lower in organic matter.

This soil is suited to row crops. It is subject to moderate erosion if cultivated. Capability unit IIIe–1.

Bassett loam, 5 to 9 percent slopes, moderately eroded (171C2).—This soil has short, convex slopes. It is generally below areas of gently sloping Bassett soils and above Clyde, Floyd, or Schley soils. Most areas are 3 to 8 acres in size.

This soil has a profile similar to that described as representative of the series, but it generally is somewhat shallower over glacial till and the surface layer is very dark brown to yellowish brown.

This soil is suited to row crops. It is subject to moderate erosion if cultivated. Capability unit IIIe–1.

Bixby Series

The Bixby series consists of nearly level to gently sloping, well-drained soils on uplands and stream benches.

These soils formed in 24 to 36 inches of loamy material and the underlying sand and gravel. The native vegetation was trees.

In a representative profile the surface layer is very dark brown loam about 4 inches thick. The subsurface layer, about 7 inches thick, is dark grayish-brown, friable light loam. The subsoil is about 30 inches thick. It is brown and dark yellowish-brown, friable loam and sandy clay loam in the upper part and yellowish-brown, very friable loamy sand in the lower part. The substratum is yellowish-brown, very friable loamy sand.

Available water capacity is low. Permeability is moderate in the loamy surface layer and upper part of the subsoil and rapid to very rapid in the sandy lower part of the subsoil and substratum. On uplands the soils are 6 to 10 feet deep over glacial till. Content of available nitrogen is very low to low. The subsoil is very low to low in phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are medium acid to strongly acid.

Bixby soils are suited to row crops, but they are slightly droughty in years of average rainfall. Gently sloping areas are subject to erosion if cultivated.

Representative profile of Bixby loam, 0 to 2 percent slopes, in a wooded area 130 feet south and 180 feet west of the northeast corner of the SE¼ sec. 15, T. 97 N., R. 17 W.

A1—0 to 4 inches, very dark brown (10YR 2/2) loam; moderate, very fine and fine, granular structure; friable; slightly acid; clear boundary.

A2—4 to 11 inches, dark grayish-brown (10YR 4/2) light loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, thin, platy structure; friable; light brownish-gray (10YR 6/2) grainy coatings when dry; slightly acid; clear boundary.

B21t—11 to 19 inches, brown (10YR 4/3) loam; moderate, fine and medium, subangular blocky structure; friable; few, thin, patchy, dark-brown (10YR 3/3) clay films on faces of peds; few, discontinuous, light brownish-gray (10YR 6/2) grainy coatings; slightly acid; clear boundary.

B22t—19 to 27 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; weak, medium and coarse, subangular blocky structure; friable; common, patchy, dark-brown (10YR 3/3) clay films; common fine pebbles; medium acid; abrupt boundary.

IIB31t—27 to 41 inches, yellowish-brown (10YR 5/6) loamy sand; very weak, coarse, subangular blocky structure; very friable; few, thick, dark yellowish-brown (10YR 3/4) clay films; few, thick, dark yellowish-brown clay-enriched bands; fine gravel; medium acid; clear boundary.

IIC1—41 to 60 inches, yellowish-brown (10YR 5/6) loamy sand; slightly cemented; single grained; very friable; few, thin, clay-enriched bands, ½ inch in diameter; medium acid.

The solum is generally 3½ to 5 feet thick. Depth of loamy materials over sandy material ranges from 24 to 36 inches. The Ap horizon, if present, is generally dark grayish brown (10YR 4/2). The A horizon ranges from loam to silt loam and has a high content of sand.

The B2 horizon ranges from brown (10YR 4/3 and 7.5YR 4/4) to yellowish brown (10YR 5/6) and from loam or sandy clay loam to sandy loam. The B3 horizon is gravelly loamy sand or sand and contains some gravel. The B horizon ranges from medium acid to very strongly acid in the most acid part.

The C horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) and from loamy sand that contains some gravel to gravelly sand.

Bixby soils formed in about the same kind of material as Hayfield, Lilah, Lamont, Sattre, Saude, and Wapsie soils. They have a thinner A horizon than Hayfield, Sattre, Saude, and Wapsie soils. They contain less sand in the A horizon and upper part of the B horizon than Lamont and Lilah soils.

Bixby loam, 0 to 2 percent slopes (265).—This soil is on stream benches. It is generally associated with Hayfield, Lamont, Lilah, Saude, and Wapsie soils. Most areas are 4 to 20 acres in size. This soil has the profile described as representative of the series.

This soil is suited to row crops, but it is slightly droughty, even in years of average rainfall. Capability unit IIs–1.

Bixby loam, 2 to 5 percent slopes (265B).—This soil is on the larger stream benches and uplands. It is associated with Hayfield, Lilah, and Wapsie soils on the stream benches and with Renova soils on uplands. Most areas are 4 to 10 acres in size.

This soil is suited to row crops, but it is somewhat droughty, even in years of average rainfall. It is subject to slight erosion if cultivated. Capability unit IIe–4.

Burkhardt Series

The Burkhardt series consists of nearly level to moderately sloping, excessively drained soils. These soils are on stream benches, in upland outwash areas, and on escarpments that are identified on the soil map by an escarpment symbol. They formed in 10 to 20 inches of sandy loam that contains a few pebbles and the underlying gravelly and sandy materials.

In a representative profile the surface layer is very dark brown and very dark grayish-brown sandy loam about 11 inches thick. The subsoil is about 14 inches thick. It is brown, very friable sandy loam that has some pebbles in the upper part and dark yellowish-brown, very friable loamy sand that has some pebbles in the lower part. The substratum is yellowish-brown and light yellowish-brown gravelly sand and coarse sand.

Available water capacity is very low, and permeability is rapid to very rapid. The content of available nitrogen is low. The subsoil is low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Burkhardt soils are poorly suited to row crops. They are droughty and are subject to soil blowing where crop or residue cover is limited. Sloping areas are subject to water erosion if cultivated.

Representative profile of Burkhardt sandy loam, 3 to 9 percent slopes, in a meadow field 365 feet south and 80 feet east of the northwest corner of the SW¼NW¼ sec. 14, T. 97 N., R. 17 W.

A1—0 to 7 inches, very dark brown (10YR 2/2) heavy sandy loam; weak, fine, granular structure; very friable; few fine pebbles; slightly acid; clear boundary.

A3—7 to 11 inches, very dark grayish-brown (10YR 3/2) heavy sandy loam; weak, fine, subangular blocky structure; very friable; some gravel; medium acid; clear boundary.

B2—11 to 17 inches, brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) coatings on peds; very weak, medium, subangular blocky structure; very friable; some gravel; medium acid; gradual boundary.

B3—17 to 25 inches, dark yellowish-brown (10YR 4/4) loamy sand; brown (10YR 4/3) coatings on peds; very weak, medium, subangular blocky structure; very friable; some gravel; strongly acid; clear boundary.

C1—25 to 33 inches, yellowish-brown (10YR 5/6) gravelly sand; single grained; loose; medium acid; clear boundary.

C2—33 to 60 inches, light yellowish-brown (10YR 6/4) coarse sand; single grained; loose; some fine gravel; slightly acid; clear boundary.

The solum is generally 20 to 25 inches thick but ranges to 30 inches. The Ap or A1 horizon is very dark brown (10YR 2/2) and is 7 to 12 inches thick. It generally is sandy loam but ranges to light loam and sandy loam that contains gravel. The B1 horizon, if present, is generally dark-brown (10YR 4/3) sandy loam. The B2 horizon ranges from dark brown (10YR 4/3) to dark yellowish brown (10YR 4/4) and brown (7.5YR 4/4) and is free of grayish mottles. It ranges from light to heavy sandy loam that is 5 to 15 percent gravel.

The C horizon ranges from gravelly sand to coarse sand. The amount of gravel is variable. In most places the greatest concentration of gravel-size material is at a depth of less than 50 inches. Depth to calcareous material is more than 50 inches.

Burkhardt soils are associated with Flagler, Lilah, Saude, and Wapsie soils and formed in similar materials. They are not so deep to loamy sand or sand as Flagler, Saude, and Wapsie soils. They have a lower content of clay and a higher content of sand in the A horizon and upper part of the B horizon than Saude and Wapsie soils. They generally have a thicker A1 horizon than Lilah and Wapsie soils.

Burkhardt sandy loam, 0 to 3 percent slopes (285).—This soil is mainly on stream benches and uplands. It is associated with Flagler, Lilah, Saude, Wapsie, and a few other soils. Most areas are 3 to 10 acres in size. This soil has a profile similar to that described as representative of the series, but the surface layer is somewhat thicker.

Included with this soil in mapping were a few areas that have less gravel and a few other areas that have a thinner, dark-colored surface layer.

This soil is poorly suited to row crops because it is excessively drained and droughty. It is subject to slight soil blowing if cultivated. Small areas generally are cropped along with adjacent areas. Many larger areas are in pasture. Capability unit IVs–1.

Burkhardt sandy loam, 3 to 9 percent slopes (285C).—This soil is on narrow bench escarpments and uplands. Most areas are 3 to 8 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few areas that have less gravel than typical and a few other areas that have a higher concentration of gravel on the surface.

This soil is poorly suited to row crops because it is excessively drained and droughty. Small areas are commonly cropped along with adjacent soils. Water erosion and soil blowing are hazards in cultivated areas. Capability unit IVs–2.

Calco Series

The Calco series consists of nearly level, poorly drained, calcareous soils. These soils are on bottom lands and in low upland drainageways. They formed in medium-textured and moderately fine textured alluvial deposits. The native vegetation was prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black silty clay loam about 36 inches thick. The subsoil is about 9 inches thick. It is dark-gray, friable light clay loam in the upper part and yellowish-brown, friable loam in the lower part. The substratum is yellowish-brown, friable sandy loam.

Available water capacity is high, and permeability is moderately slow. Content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. The surface layer is moderately alkaline to mildly alkaline.

The Calco soils that are seldom flooded are suited to row crops if they are adequately fertilized. The frequently flooded soils are better suited to pasture.

Representative profile of Calco silty clay loam, 0 to 2 percent slopes, in a bluegrass pasture 55 feet east and 55 feet south of the northwest corner of sec. 16, T. 98 N., R. 18 W.

A11—0 to 10 inches, black (N 2/0) light slity clay loam high in content of sand; weak, moderate, granular structure; friable; moderately alkaline; strongly effervescent; gradual boundary.

A12—10 to 20 inches, black (10YR 2/1) light silty clay loam high in content of sand; moderate, fine, granular structure; friable; mildly alkaline; slightly effervescent; gradual boundary.

A13—20 to 36 inches, black (10YR 2/1) medium silty clay loam high in content of sand; friable; moderate, fine, granular structure; mildly alkaline; slightly effervescent; gradual boundary.

B1g—36 to 40 inches, dark-gray (5Y 4/1) light clay loam; nearly continuous very dark gray (5Y 3/1) coatings on peds; common, medium, olive-brown (2.5Y 4/4) mottles; weak, fine and medium, subangular blocky structure; friable; mildly alkaline; slightly effervescent; gradual boundary.

B2—40 to 45 inches, yellowish-brown (10YR 5/6) loam; many, medium, gray (5Y 6/1) mottles; weak, medium, subangular blocky structure; friable; few pebbles; mildly alkaline; gradual boundary.

C—45 to 55 inches, yellowish-brown (10YR 5/6) sandy loam; common, medium, light olive-gray (5Y 6/2) mottles; friable; massive; few pebbles; neutral.

The solum is generally 36 to 48 inches thick. The A1 horizon is black (N 2/0 or 10YR 2/1) or very dark gray (10YR 3/1) and is 24 to 36 inches thick. It ranges from light silty clay loam that has a high content of sand to heavy loam, and it is slightly calcareous to moderately calcareous.

The C horizon, below a depth of about 40 inches, ranges from heavy loam to loamy sand.

Many of these soils contain more sand than is typical for the series, but this difference does not greatly alter the usefulness and behavior of the soils.

Calco soils are in the same drainage class as Coland, Clyde, Maxfield, and Marshan soils and formed in similar materials. They are calcareous and have more lime in the A horizon than those soils.

Calco silty clay loam, 0 to 2 percent slopes (733).—This soil is on flood plains and in low upland drainageways. It is associated with Coland and Marshan soils on flood plains and with Clyde and Maxfield soils in the upland drainageways. Most areas are 10 to 80 acres in size.

Included with this soil in mapping were a few areas that have a surface layer lower in content of sand than typical and a few other areas that have a somewhat thinner surface layer. Also included were some areas where glacial till is at a depth of 3 to 4 feet.

This soil is well suited to row crops if it is adequately drained and not too frequently flooded. The outlets are difficult to obtain in places. This Calco soil generally has different fertilizer needs than the associated soils. It does not need lime, and it benefits from larger applications of phosphorus and potassium. Capability unit IIw-4.

Canisteo Series

The Canisteo series consists of nearly level, poorly drained, alkaline soils. These soils are in upland drainageways. They formed in a moderately fine textured silty mantle and underlying glacial till or till-derived sediment. The native vegetation was prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black and very dark gray, calcareous silty clay loam about 17 inches thick. The subsoil is about 18 inches thick. It is olive-gray, friable light silty clay loam in the upper part and olive-gray, friable loam in the lower part. The substratum is mottled grayish-brown and yellowish-brown, friable loam.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. The surface layer is moderately alkaline to mildly alkaline.

Canisteo soils are well suited to intensive use for row crops if drained and adequately fertilized.

Representative profile of Canisteo silty clay loam, 0 to 2 percent slopes, in a cultivated field 1,120 feet west and 270 feet south of the northeast corner of sec. 24, T. 98 N., R. 18 W.

Ap—0 to 8 inches, black (N 2/0) silty clay loam; weak, fine, granular structure; friable; moderately alkaline; strongly effervescent; abrupt boundary.

A12—8 to 13 inches, black (N 2/0) silty clay loam; weak, fine, granular structure; friable; mildly alkaline; slightly effervescent; gradual boundary.

A3—13 to 17 inches, very dark gray (10YR 3/1) silty clay loam; weak, fine, granular structure; friable; mildly alkaline; slightly effervescent; gradual boundary.

B21g—17 to 26 inches, olive-gray (5Y 5/2) light silty clay loam; weak, fine, subangular blocky structure; friable; mildly alkaline; slightly effervescent; clear boundary.

IIB22g—26 to 35 inches, olive-gray (5Y 5/2) loam; common, medium, olive-brown (2.5Y 4/4) mottles; weak, fine, subangular blocky structure; friable; mildly alkaline; clear boundary.

IICg—35 to 50 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) loam; massive; friable; mildly alkaline.

The solum is generally 35 to 40 inches thick. The A1 horizon is black (N 2/0 or 10YR 2/1) or very dark gray (10YR 3/1) and is 12 to 15 inches thick. It ranges from moderately alkaline to mildly alkaline.

The B2g horizon is generally loam, but it ranges to light sandy clay loam that has thin strata of sandy loam.

Canisteo soils are associated with Maxfield and Klinger soils and formed in similar material. They have a moderately alkaline to mildly alkaline A horizon, like Calco soils, but unlike Maxfield and Klinger soils. They have a thinner A horizon than Calco soils.

Canisteo silty clay loam, 0 to 2 percent slopes (507).—The soil is in low upland drainageways. It is associated with Maxfield and Klinger soils. Most areas are 5 to 40 acres in size. Included in mapping were a few areas that have less sand in the subsoil.

This soil is well suited to intensive use for row crops if drained and properly fertilized. It generally has different fertilizer needs than the associated soils. It does not need lime, and it benefits from larger applications of phosphorus and potassium. Capability unit IIw-1.

Clyde Series

The Clyde series consists of nearly level to gently sloping, poorly drained soils. These soils are in drainageways and lower concave positions on uplands. They formed in 20 to 40 inches of moderately fine textured material and the underlying friable glacial till or glacial drift. In some places a layer of pebbles and stones forms the contact line between the glacial till and the overlying material. The native vegetation was grasses and sedges.

In a representative profile the surface layer is black and very dark gray silty clay loam about 21 inches thick. The subsoil is about 35 inches thick. It is mottled dark-gray and olive-gray, friable clay loam in the upper part; mottled strong-brown and dark grayish-brown, very friable sandy loam in the middle part; and mottled gray and strong-brown, firm loam in the lower part. The substratum is mottled gray and strong-brown, firm loam.

Available water capacity is high. Permeability is moderate, but the rate of water movement through the soil varies, depending on the differing textures. The content of available nitrogen is medium to low. The subsoil is low to very low in available phosphorus and potassium. The content of organic matter is very high. In most places these soils are neutral. Wetness is caused, at least in part, by hillside seepage from Floyd and Kenyon soils, which are commonly upslope.

These soils are well suited to intensive use for row crops if drained. Undrained areas are in pasture or are idle.

Representative profile of Clyde silty clay loam, 0 to 3 percent slopes, in a pasture 1,005 feet north and 155 feet east of the southwest corner of the SE¼ sec. 10, T. 100 N., R. 15 W.

A11—0 to 8 inches, black (N 2/0) silty clay loam; moderate, fine and very fine, granular structure; friable; neutral; gradual boundary.

A12—8 to 17 inches, black (N 2/0) silty clay loam high in content of sand; moderate, fine and very fine, granular structure; friable; few fine concentrations of yellowish-red (5YR 5/8) oxide; neutral; clear boundary.

A3—17 to 21 inches, very dark gray (5Y 3/1) silty clay loam high in content of sand; black (10YR 2/1) coatings on peds; moderate, very fine and fine, granular structure; friable; few fine concentrations of yellowish-red (5YR 5/8) oxide; neutral; gradual boundary.

B1—21 to 32 inches, mottled, dark-gray (5Y 4/1) and olive-gray (5Y 4/2) clay loam; weak, medium, prismatic structure parting to weak, very fine, subangular blocky; friable; common fine concentrations of yellowish-red (5YR 5/8) oxide; black (N 2/0) organic fills in root channels and on prisms; neutral; clear boundary.

B2—32 to 37 inches, olive-gray (5Y 5/2) loam; many, medium, prominent, strong-brown mottles and concentrations of oxide; weak, medium, prismatic structure parting to weak, fine and medium, subangular blocky; friable; discontinuous dark grayish-brown (2.5Y 4/2) coatings on prisms; neutral; clear boundary.

B31—37 to 42 inches, mottled, strong-brown (7.5YR 5/6) and dark grayish-brown (2.5Y 5/2) coarse sandy loam; weak, coarse, prismatic structure parting to very weak, coarse, subangular blocky; very friable; few concentrations of dark oxide, 10 to 15 millimeters in diameter; common pebbles, 10 to 15 millimeters in diameter; neutral; clear boundary.

B32—42 to 49 inches, strong-brown (7.5YR 5/6 and 7.5YR

5/8) sandy loam high in content of medium and coarse sand; common, medium, prominent, grayish-brown (2.5Y 5/2) mottles; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; very friable; few pebbles, as much as 15 to 20 millimeters in diameter; neutral; clear boundary.

IIB33—49 to 56 inches, mottled, gray (5Y 6/1) and strong-brown (7.5YR 5/6) loam; weak, medium, prismatic structure; firm; neutral; clear boundary.

IIC—56 to 68 inches, mottled, gray (N 5/0) and strong-brown (7.5YR 5/6) loam; massive; firm; neutral.

The solum in generally 3½ to 5 feet thick. The A1 horizon ranges from black (N 2/0 or 10YR 2/1) to very dark gray (10YR 3/1) and from 16 to 24 inches in thickness. The A horizon is dominantly silty clay loam that has a high content of sand, but it ranges to clay loam.

The B1 and B2 horizons range from dark gray (5Y 4/1) to grayish brown (2.5Y 5/2). The IIB3 horizon is generally mottled with gray (5Y 6/1) to grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/8) to olive brown (2.5Y 4/4). The IIB3 horizon ranges from loam to sandy loam and has discontinuous layers of loamy sand. Depth to unstratified firm loam till ranges from 36 to 80 inches. These soils are generally neutral throughout and are no more than slightly acid in the most acid part. Depth to carbonates ranges from 60 to 75 inches.

Clyde soils are closely associated with Floyd, Jameston, and Marshan soils, and they are in the same drainage class as Tripoli and Maxfield soils. They are more poorly drained and have a grayer B horizon than Floyd soils. They differ from Tripoli and Jameston soils in having a stratified and more friable B horizon. They are underlain by glacial till, whereas Marshan soils are underlain by thick beds of sand and gravel. They contain more sand in the A horizon and upper part of the B horizon than Maxfield soils.

Clyde silty clay loam, 0 to 3 percent slopes (84).—This soil is in drainageways and lower concave positions in the uplands. The drainageways are almost level across the bottom, and most of them have so little slope that water flows through them very slowly. Areas are large but narrow, and some extend across two or more farms.

Included with this soil in mapping were some areas that have stones or boulders on the surface. Also included were a few small seepy muck areas, generally identified with a spot symbol on the soil map. In these areas, the subsoil is bluish gray. Where this soil is associated with very firm till soils, such as the Jameston soils, the material below a depth of 40 to 70 inches is clay loam in some places.

This soil is well suited to intensive use for row crops if drained and properly managed. Areas that are drained are generally in row crops, and undrained areas are in pasture. The major limitation is wetness. Artificial drainage is needed. Because wetness is, at least in part, caused by sidehill seepage, a drainage system that intercepts laterally moving water is the most successful. Large granite boulders are common in many areas and have to be removed before this soil can be used for crops. Capability unit IIw-1.

Clyde-Floyd complex, 1 to 4 percent slopes (391B).—The soils of this complex are dark colored and poorly drained and somewhat poorly drained. About 60 percent of this complex is Clyde soil and 40 percent is Floyd soil.

This complex is in small, upland drainageways in association with better drained and more sloping glacial till soils. In most places Clyde soil is in the center of the drainageway, and Floyd soil is in a band bordering or fingering into the drainageway. Areas range from about 4 to 15 acres in size and generally are narrow and long. They commonly extend over more than one farm.

The soils in this complex are well suited to row crops if drained. They generally have good tilth, but puddle if worked when wet. The major limitation to the use of these soils is wetness. Artificial drainage is needed. Because wetness is caused, at least in part, by sidehill seepage, a drainage system that intercepts laterally moving water is the most successful. Large granite boulders are common and have to be removed before the areas can be used for crops. Capability unit IIw-1.

Coggon Series

The Coggon series consists of gently sloping, moderately well drained soils on uplands. These soils are on long ridge crests and convex side slopes. They formed in 13 to 22 inches of loamy material and the underlying glacial till. In most places a layer of pebbles forms the contact line between the loamy overburden and the glacial till. The native vegetation was trees.

In a representative profile the surface layer is dark grayish-brown loam about 7 inches thick. The subsurface layer, about 4 inches thick, is dark-brown, friable loam. The subsoil extends to a depth of about 65 inches. It is dark yellowish-brown, friable loam in the upper part; yellowish-brown, firm loam in the middle part; and mottled yellowish-brown and gray, firm loam in the lower part. The substratum is yellowish-brown, firm loam that is prominently mottled with gray.

Available water capacity is high. The rate at which water moves through the loamy overburden differs considerably from the rate at which it moves through the glacial till. Permeability is moderate in the loamy overburden and moderately slow in the underlying glacial till. Water moves more rapidly in the overburden and accumulates at the till contact, where it produces wet, seepy spots in some years. The content of available nitrogen is very low to low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are generally acid.

Coggon soils are suited to row crops, but they are subject to erosion.

Representative profile of Coggon loam, 2 to 5 percent slopes, in a cultivated field 685 feet north and 235 feet west of the southeast corner of the NW¼NE¼ sec. 25, T. 99 N., R. 16 W.

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak, very fine, granular structure; friable; few, fine, soft, dark-brown (7.5YR 4/4) oxide concentrations; neutral; clear boundary.

A2—7 to 11 inches, dark-brown (10YR 4/3) loam; brown (10YR 5/3) coatings on peds; moderate, thin, platy structure; friable; few dark oxide concentrations; medium acid; clear boundary.

B1—11 to 16 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 5/3) coatings on peds; light-gray (10YR 7/2) grainy coatings when dry; moderate, fine, subangular blocky structure; friable; strongly acid; abrupt boundary.

IIB21—16 to 25 inches, yellowish-brown (10YR 5/6) heavy loam; discontinuous light-gray (10YR 7/2) grainy coatings when dry; few, fine, dark-brown (7.5YR 4/4) oxide concentrations; moderate, fine and medium, subangular blocky structure; firm; strongly acid; clear boundary.

IIB22t—25 to 33 inches, yellowish-brown (10YR 5/6) heavy loam; nearly continuous brown (10YR 5/3) coatings on peds; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; moderate, fine, prismatic structure parting to moderate, medium, subangular blocky; firm; patchy dark yellowish-brown (10YR 3/4) clay films and clay-filled pores and channels; common dark oxide concentrations; medium acid; gradual boundary.

IIB23t—33 to 50 inches, yellowish-brown (10YR 5/6) loam; common, medium, distinct, grayish-brown (2.5Y 5/2) mottles and few, medium, prominent, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; firm; common clay-filled pores and root channels; few dark oxide concentrations; medium acid; gradual boundary.

IIB3t—50 to 65 inches, mottled yellowish-brown (10YR 5/6) and gray (5Y 5/1) heavy loam; weak, coarse, prismatic structure; firm; many, very dark, clay-filled root channels; common dark oxide concentrations; medium acid; gradual boundary.

IIC—65 to 80 inches, yellowish-brown (10YR 5/6) loam; many, medium, prominent, gray (5Y 5/1) mottles; massive; firm; few, dark, clay-filled root channels; slightly acid.

The solum is generally about 40 to 65 inches thick, but it ranges to 70 inches. The A1 horizon in uncultivated areas ranges from very dark gray (10YR 3/1) to black (10YR 2/1) and is 1 to 4 inches thick. The A2 horizon generally is dark brown (10YR 4/3) or brown (10YR 5/3) and is 4 to 10 inches thick. In some cultivated areas the A2 horizon is incorporated wholly in the Ap horizon. The A horizon is typically loam but ranges to gritty silt loam.

The B horizon ranges from brown to yellowish brown or strong brown. Depth to grayish-brown and gray mottles is 20 to 34 inches. The B2, B3, and C horizons are typically loam, but they range to light clay loam and sandy clay loam. The B2 horizon ranges from medium acid to very strongly acid. Depth to carbonates ranges from 50 to 90 inches.

Coggon soils are closely associated with Bassett, Oran, Pinicon, Renova, and Schley soils. They have a lighter colored A horizon than Bassett, Oran, and Schley soils. They are not so poorly drained as Oran, Pinicon, and Schley soils and have a browner B horizon. They have gray mottles in the lower part of the B horizon and are not so well drained as Renova soils.

Coggon loam, 2 to 5 percent slopes (302B).—This soil is on long, convex ridges and side slopes. It is associated with Bassett, Pinicon, Oran, Renova, and Schley soils. Most areas are 5 to 15 acres in size.

Some areas of this soil are wooded and have a very dark gray to black surface layer 1 to 4 inches thick. In cultivated areas, the plow layer is dark grayish brown.

Most of the acreage is cultivated. The soil is suited to row crops if properly managed. It is low in content of organic matter, and it is subject to slight erosion if cultivated. Capability unit IIe-1.

Coland Series

The Coland series consists of nearly level, poorly drained soils on bottom lands. These soils are on flood plains of rivers and narrow intermittent streams throughout the county. They formed in moderately fine textured alluvial deposits. The native vegetation was prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black, friable silty clay loam that is high in content of sand and about 32 inches thick. The next layer is black clay loam about 8 inches thick. The substratum is stratified with material that ranges from clay loam to loamy sand and is black, very dark gray, and gray.

Available water capacity is high, and permeability is moderately slow. The content of available nitrogen is low to medium. The subsoil is medium in available phosphorus and potassium. The content of organic matter is high. These soils are slightly acid to neutral.

Areas of Coland soils that are not frequently flooded are well suited to intensive use for row crops. The frequently flooded areas are better suited to permanent pasture or woodland.

Representative profile of Coland silty clay loam, 0 to 2 percent slopes, in a bluegrass pasture 505 feet east and 50 feet south of the northwest corner of the NE¼ sec. 31, T. 99 N., R. 15 W.

Ap—0 to 8 inches, black (N 2/0) light silty clay loam high in content of sand; moderate, very fine, granular structure; friable; slightly acid; gradual boundary.

A12—8 to 16 inches, black (N 2/0) silty clay loam high in content of sand; moderate, very fine and fine, granular structure; friable; slightly acid; gradual boundary.

A13—16 to 32 inches, black (N 2/0) silty clay loam high in content of sand; moderate, very fine, subangular blocky structure; firm; slightly acid; clear boundary.

AC—32 to 40 inches, black (5Y 2/1) medium clay loam grading to light clay loam; few, medium, dark reddish-brown (5YR 3/3) mottles; moderate, fine, prismatic structure parting to weak, medium, subangular blocky; firm; slightly acid; clear boundary.

IIC1g—40 to 44 inches, gray (5Y 5/1) sandy loam; moderate, fine, prismatic structure; friable; slightly acid; clear boundary.

IIC2—44 to 52 inches, black (N 2/0) and very dark gray (10YR 3/1) light clay loam; few, fine, yellowish-brown (10YR 5/6) oxide concentrations and mottles; weak, medium, prismatic structure parting to weak, very fine, subangular blocky; firm; dark-brown (10YR 3/3) coatings on prisms; slightly acid; clear boundary.

IIC3—52 to 60 inches, gray (5Y 5/1) loamy sand; single grained; loose; slightly acid.

The solum is generally 36 to 42 inches thick. The A horizon is black (N 2/0 or 10YR 2/1) or very dark gray (10YR 3/1) and extends to a depth of 36 inches or more. It ranges from silty clay loam to light clay loam. Clay content ranges from 27 to 35 percent.

The C1 horizon ranges from black (N 2/0) to gray (5Y 5/1) and from loam or clay loam to sandy loam. The C horizon, below a depth of about 50 inches, is generally stratified loamy sand, sandy loam, or loam that has some gravel. Reaction is slightly acid or neutral, and depth to carbonates is generally more than 60 inches.

Coland soils are closely associated with Hanlon and Turlin soils and Alluvial land. They generally contain more clay, are more poorly drained, and are grayer in the lower part of the A horizon and in the C horizon than Alluvial land. They have a thicker A horizon, are more poorly drained, and have grayer lower horizons than Turlin soils. They are more poorly drained, are grayer in the lower part of the A and in the C horizon, and contain more clay and less sand than Hanlon soils.

Coland silty clay loam, 0 to 2 percent slopes (135).—This soil is on flood plains. It generally is adjacent to Hanlon and Turlin soils or the Coland-Turlin complex. Most areas are 5 to 40 acres in size, but a few are much larger. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas of Hanlon sandy loams that contain more sand and a few areas of Turlin soils that have a thinner surface layer.

This soil is generally well suited to intensive use for row crops if properly drained and protected from flooding. Adequate tile outlets are difficult to obtain in some areas. Flooding is the major limitation. Areas that are frequently flooded are used mainly for pasture. Capability unit IIw–4.

Coland-Turlin complex, 0 to 2 percent slopes (235).—This complex consists of Coland silty clay loam intermingled with Turlin silt loam. It is on flood plains. Turlin soils generally are at slightly higher elevations than Coland soils. Most areas are 5 to 40 acres in size.

Included with these soils in mapping were common areas of Hanlon sandy loam. Also included were a few areas of Alluvial land that are variable in texture and drainage.

The soils in this complex are generally well suited to intensive use for row crops if they are properly drained and protected from flooding. Wetness caused by flooding is the major limitation. Frequently flooded areas are generally used for pasture. Capability unit IIw–4.

Coland-Turlin complex, channeled, 0 to 2 percent slopes (C235).—This complex consists of Coland silty clay loam intermingled with Turlin silt loam. These areas are characterized by meandering channels and swales. Coland soils generally make up 50 to 70 percent of the complex. Most areas are 10 to 40 acres in size.

Included with these soils in mapping were a few small areas of recent stream deposits that range from light-colored sand to moderately dark colored sandy loam.

The soils in this complex are poorly suited to row crops. Floods are frequent, and water stands in some of the deeper swales all year. Some areas could be cultivated if the swales were filled, but flooding would still be a hazard. Capability unit Vw–1.

Cresco Series

The Cresco series consists of gently sloping and moderately sloping, moderately well drained soils on uplands. These soils are on ridge crests and side slopes. They formed in 14 to 22 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones forms the contact line between the loamy overburden and the underlying glacial till. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark brown, friable heavy loam about 13 inches thick. The subsoil is about 30 inches thick. The upper 5 inches is brown, friable heavy loam; the next 5 inches is yellowish-brown, firm clay loam; and the lower 20 inches is mottled, strong-brown and gray, very firm clay loam. The substratum is mottled strong-brown and gray, very firm clay loam.

Available water capacity is high. The rate at which water moves through the friable, loamy overburden differs considerably from the rate at which it moves through the firm, underlying glacial till. Permeability is moderate in the loamy overburden and slow in the glacial till. Water moves more rapidly through the overburden and accumulates at the contact with the till, which produces a temporarily high water table, particularly early in spring. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are medium acid to very strongly acid.

Cresco soils are suited to row crops, but they are subject to erosion if cultivated.

Representative profile of Cresco loam, 2 to 5 percent slopes, in a cultivated field 10 feet south and 15 feet east of the northwest corner of the NE¼ sec. 34, T. 98 N., R. 15 W.

Ap—0 to 8 inches, black (10YR 2/1) heavy loam; weak, fine, granular structure; friable; neutral; clear boundary.

A12—8 to 13 inches, very dark brown (10YR 2/2) heavy loam; moderate, fine, granular structure; friable; slightly acid; clear boundary.

B1—13 to 18 inches, brown (10YR 4/3) heavy loam; very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, subangular blocky structure; friable; strongly acid; clear boundary.

IIB21—18 to 23 inches, yellowish-brown (10YR 5/4) light clay loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; brown (10YR 5/3) coatings on peds; moderate, fine, subangular blocky structure; firm; pebble band in upper part of horizon; strongly acid; clear boundary.

IIB22t—23 to 34 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 5/1) medium clay loam; discontinuous gray (5Y 5/1) coatings on prisms and nearly continuous gray (5Y 5/1) coatings on peds; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; very firm; few, fine, black and dark reddish-brown oxide concentrations; few roots penetrating peds; few, thin, dark-gray (10YR 4/1) clay films on faces of prisms; strongly acid; clear boundary.

IIB3t—34 to 43 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 5/1) medium clay loam; continuous gray (5Y 5/1) coatings on peds and prisms; moderate, medium, prismatic structure parting to weak, coarse, subangular blocky; very firm; few, dark-gray (10YR 4/1), clay-lined root channels and films on ped exteriors; neutral; clear boundary.

IIC—43 to 60 inches, mottled strong-brown (7.5YR 5/6) and gray (5Y 5/1) clay loam; massive, some vertical cleavage; very firm; moderately alkaline; strongly effervescent.

The solum is generally 3½ to 4½ feet thick. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). It is loam, silt loam that has a high content of sand, or light clay loam that has a high content of sand.

The IIB21 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4). Depth to grayish mottles is 20 to 34 inches. The IIB2 horizon ranges from light clay loam to medium clay loam that is about 28 to 35 percent clay. Consistence is firm or very firm. Depth to carbonates is generally 42 to 56 inches, but it is as shallow as 36 inches in places. Vertical wedges of sandy loam or sand commonly are in the glacial till.

Cresco soils are associated with Protivin, Clyde, Floyd, Jameston, Kenyon, Lourdes, or Riceville soils and formed in similar material. They have a browner B horizon and are better drained than Protivin, Riceville, Jameston, Floyd, and Clyde soils. They lack the mottles that are common in the upper part of the B horizon in Protivin soils. They have a firmer IIB horizon that contains more clay than Kenyon, Clyde, and Floyd soils. They have a thicker A horizon than Lourdes and Riceville soils.

Cresco loam, 2 to 5 percent slopes (783B).—In most places this soil is on long, convex ridges and side slopes above Floyd, Protivin, or Riceville soils, and in many places it is adjacent to Lourdes and Kenyon soils. Most areas are 5 to 50 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few areas that are not so well drained and a few other small areas where the surface layer is not so thick and where the content of organic matter is lower.

This soil is well suited to row crops. It is subject to erosion if cultivated. Capability unit IIe–2.

Cresco loam, 5 to 9 percent slopes (783C).—In most places this soil is on short, convex side slopes below areas of gently sloping Cresco soils and above Clyde, Floyd, and Protivin soils. Most areas are about 3 to 10 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick. Depth to the very firm clay loam till generally is somewhat shallower.

Included with this soil in mapping were a few, small, eroded spots where the surface layer is dark brown or brown and where the content of organic matter is lower. In these eroded areas the till is at a depth of 10 to 14 inches.

This soil is suited to row crops, but it is subject to moderate erosion if cultivated. Erosion decreases the depth to the very firm clay loam till, the properties of which are much less favorable for crop production and cultivation than those of the surface layer. Capability unit IIIe–2.

Dickinson Series

The Dickinson series consists of nearly level to gently sloping, somewhat excessively drained soils. These soils are on uplands. They formed in 24 to 34 inches of fine sandy loam and loamy sand over sand and loamy sand. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown, very dark grayish-brown, and dark-brown fine sandy loam about 18 inches thick. The subsoil is about 18 inches thick. It is brown, very friable fine sandy loam in the upper part and yellowish-brown, very friable loamy sand in the lower part. The substratum is yellowish-brown, loose sand.

Available water capacity is low. Permeability is moderately rapid to rapid. The content of available nitrogen is low. The subsoil is low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Dickinson soils are well suited to cultivated crops, but productivity depends on timeliness of rainfall. Unless protected by a cover crop or crop residue, these soils are subject to soil blowing. Sloping areas are subject to water erosion if cultivated.

Representative profile of Dickinson fine sandy loam, 2 to 5 percent slopes, in a cultivated field 435 feet north and 180 feet east of the southwest corner of sec. 23, T. 100 N., R. 17 W.

Ap—0 to 9 inches, very dark brown (10YR 2/2) fine sandy loam; very weak, fine, granular structure; neutral; abrupt boundary.

A12—9 to 14 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; nearly continuous very dark brown (10YR 2/2) coatings on peds; weak, very fine and fine, subangular blocky structure; very friable; neutral; gradual boundary.

A3—14 to 18 inches, dark-brown (10YR 3/3) fine sandy loam; nearly continuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, subangular blocky structure; very friable; medium acid; gradual boundary.

B1—18 to 24 inches, brown (10YR 4/3) heavy fine sandy loam; nearly continuous dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; very friable; medium acid; gradual boundary.

B2—24 to 30 inches, brown (10YR 4/3) fine sandy loam; nearly continuous dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; very friable; medium acid; gradual boundary.

B3—30 to 36 inches, yellowish-brown (10YR 5/4) loamy sand; very weak, coarse, prismatic structure; very friable; strongly acid; gradual boundary.

C—36 to 55 inches, yellowish-brown (10YR 5/4) sand; some very weak vertical cleavage; loose; medium acid.

The solum is generally 36 inches thick, but it ranges from 30 to 50 inches. The Ap or A1 horizon is generally very dark brown (10YR 2/2), but it ranges to very dark grayish brown (10YR 3/2). The horizon is 10 to 20 inches thick.

The B horizon ranges from dark brown (10YR 3/3) to yellowish brown (10YR 5/6). It is loamy sand or sand below a depth of 20 to 34 inches.

The C horizon ranges from yellowish brown (10YR 5/4) to light yellowish brown (10YR 6/4) or strong brown (7.5YR 5/8). It ranges from loamy sand to sand.

Dickinson soils formed in about the same kind of material as Lamont and Flagler soils. They have a thicker A1 horizon than Lamont soils. They lack the coarse sand and gravel of Flagler soils.

Dickinson fine sandy loam, 0 to 2 percent slopes (175).—This soil is on uplands. Most areas are 3 to 25 acres in size, but some are much larger. This soil has a profile similar to that described as representative of the series, but the dark-colored surface layer is slightly thicker.

Included with this soil in mapping were a few small areas that have glacial till at a depth of 20 to 40 inches. A few other small spots have a loam or loamy sand surface layer.

This soil is well suited to row crops, but productivity depends on the timeliness of rainfall. The soil is somewhat excessively drained and is droughty in some years. It is subject to slight soil blowing if cultivated. Capability unit IIIs–1.

Dickinson fine sandy loam, 2 to 5 percent slopes (175B).—This soil is in convex areas on uplands. Most areas are 3 to 25 acres in size but some are much larger. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas that have glacial till at a depth of 20 to 40 inches. A few other small areas have a loam or loamy sand surface layer. In small, moderately eroded areas the surface layer is dark brown to brown. Also included were a few areas of moderately sloping Dickinson soils. These are subject to moderate erosion if cultivated.

This soil is well suited to row crops, but productivity depends on the timeliness of rainfall. The soil is somewhat excessively drained and is droughty in some years. It is subject to slight water erosion and soil blowing if cultivated. Capability unit IIIe–4.

Dickinson-Ostrander complex, 0 to 2 percent slopes (575).—This complex consists of low mounds and ridges of Dickinson fine sandy loam closely associated with areas of Ostrander loam. Dickinson soils commonly make up about 60 percent of the complex, but the range is from 30 to 70 percent. Most areas are 5 to 35 acres in size.

Dickinson soils contain more sand than Ostrander soils and are droughty. Ostrander soils have high available water capacity.

Included with these soils in mapping were small areas of Kenyon soils and spots of wet soils. A few small areas have a loamy sand surface layer.

The soils in this complex are well suited to cultivated crops, but productivity varies, particularly in dry periods.

Dickinson soils are subject to slight soil blowing if cultivated. Capability unit IIs-1.

Dickinson-Ostrander complex, 2 to 5 percent slopes (575B).—This complex occurs as ridges of Dickinson fine sandy loam closely associated with Ostrander loam. The Dickinson soils commonly occupy about 60 percent of the complex, but the range is from 30 to 70 percent. Most areas are 5 to 50 acres in size, but a few are much larger.

Dickinson soils contain more sand than Ostrander soils, and they are droughty. Ostrander soils have high available water capacity.

Included with these soils in mapping were a few small areas of Kenyon soils and spots of wet soils. A few small areas have a loamy sand surface layer.

The soils in this complex are well suited to cultivated crops, but productivity varies, particularly in dry periods. Dickinson soils are subject to slight soil blowing if cultivated, and both Dickinson and Ostrander soils are subject to slight water erosion. Capability unit IIe-4.

Dinsdale Series

The Dinsdale series consists of nearly level to gently sloping, well drained and moderately well drained soils on uplands. These soils are on large upland flats, ridge crests, and side slopes. They formed in 24 to 40 inches of loess and the underlying glacial till or till-derived material. In many places a layer of pebbles is at or near the contact line between the loess and the underlying glacial material. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark grayish brown, and dark-brown silty clay loam about 19 inches thick. The subsoil extends to a depth of about 60 inches. It is dark yellowish-brown, friable light silty clay loam in the upper part; yellowish-brown and brown, friable loam in the middle part; and yellowish-brown, firm loam in the lower part.

Available water capacity is high. Permeability is moderate in the part of the soil that formed in loess and moderately slow in the part that formed in till. The content of available nitrogen is low to medium. The subsoil is low in available phosphorus and very low in available potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Dinsdale soils are well suited to row crops and are generally associated with large areas of other well-suited soils. Gently sloping soils are subject to slight erosion if cultivated.

Representative profile of Dinsdale silty clay loam, 0 to 2 percent slopes, in a cultivated field 90 feet west and 155 feet south of the northeast corner of the SE$\frac{1}{4}$ sec. 10, T. 99 N., R. 17 W.

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; weak, medium, subangular blocky structure; friable; abundant roots; neutral; clear boundary.

A12—7 to 14 inches, very dark brown (10YR 2/2) light silty clay loam; weak, medium, subangular blocky structure parting to moderate, fine, granular; friable; few roots; medium acid; gradual boundary.

A3—14 to 19 inches, dark-brown (10YR 3/3) and dark yellowish-brown (10YR 3/4) light silty clay loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B2—19 to 27 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; weak, medium, subangular blocky structure; friable; strongly acid; clear boundary.

IIB31—27 to 34 inches, yellowish-brown (10YR 5/4) light loam; weak, coarse, subangular blocky structure; friable; pebble band in upper part of horizon; strongly acid; clear boundary.

IIB32—34 to 45 inches, brown (10YR 5/3) loam; thick, light-gray (10YR 7/2), grainy coatings on prisms when dry; few, fine, yellowish-brown (10 YR 5/6) and strong-brown (7.5YR 5/6) mottles; weak, coarse, prismatic structure; friable; strongly acid; gradual boundary.

IIB33t—45 to 60 inches, yellowish-brown (10YR 5/4 and 5/6) loam; few, fine, strong-brown (7.5YR 5/8) mottles; moderate, medium, prismatic structure; firm; discontinuous, light-gray (10YR 7/1), grainy coatings on prisms; few patchy clay films on root channels; medium acid.

The solum is generally 4 to 5 feet thick but ranges from 3½ to 5½ feet. The loess is generally at a depth of 24 to 32 inches, but ranges from 20 to 40 inches. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) heavy silt loam or light silty clay loam. The A3 and B horizons are generally light silty clay loam but range to heavy silt loam.

The B horizon formed in loess and ranges from brown (10YR 4/3) to dark yellowish brown (10YR 4/4). The sand content of the A and B horizons ranges from 3 to 10 percent but is higher near the loess-till contact. A transitional horizon is between the loess and the till in many places. Many prisms and ped exteriors in the lower part of the solum have a grainy appearance when dry. The texture of the underlying till or till-derived material is typically loam, but ranges to sandy clay loam and, in some places, to light clay loam. In places discontinuous lenses of sandy loam to sand 1 to 8 inches thick are between the loess and the till.

Dinsdale soils are associated with Waubeek, Franklin, Ashdale, Atkinson, Klinger, Maxfield, Rockton, Ostrander, Dickinson, and Tama soils and formed in similar materials. They have a browner B horizon and are better drained than Klinger, Franklin, and Maxfield soils. They are not underlain by limestone bedrock as are Ashdale, Rockton, and Atkinson soils. They have a higher content of silt and contain less sand in the A horizon and upper part of the B horizon than Ostrander soils. They contain less sand throughout than Dickinson soils. They have a thicker A1 horizon than Waubeek and Franklin soils and lack an A2 horizon. They formed in 24 to 40 inches of loess and the underlying glacial material, but Tama soils formed in more than 40 inches of loess.

Dinsdale silty clay loam, 0 to 2 percent slopes (377).—This soil is on flats and convex ridges on uplands. In many places it is just above the nearly level Klinger, Franklin, and Maxfield soils or adjacent to Dickinson, Ostrander, and Waubeek soils. In other areas it is associated with such soils as Ashdale, Atkinson, and Rockton soils that are 20 to 60 inches deep over limestone bedrock. In these areas, the waterways commonly contain Huntsville soils. In some areas the more poorly drained soils are upslope where depth to bedrock is greater. Most areas of this soil are 10 to 50 acres in size, and some areas are several hundred acres in size.

Most of the Dinsdale soils in Iowa have slopes of more than 2 percent, but this soil is underlain by limestone bedrock at a depth of 10 to 15 feet and thus has a lower water table. Consequently, this soil is well drained even though it is nearly level. It has the profile described as representative of the series.

Included with this soil in mapping were a few small areas that have bedrock at a depth of 40 to 60 inches and also a few small areas not so well drained.

This soil is well suited to cultivated crops. It generally is associated with large areas of other soils well suited to cultivation. Capability unit I–2.

Dinsdale silty clay loam, 2 to 5 percent slopes (377B).—This soil is on long, convex side slopes and ridge crests, generally just above Franklin, Klinger, and Maxfield soils and adjacent to Waubeek soils. It is associated in some areas with soils underlain by limestone bedrock. Huntsville soils are generally in the waterways in these areas. In a number of areas this soil is adjacent to Dickinson and Ostrander soils.

This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick.

Included with this soil in mapping were a few small areas that have limestone at a depth of 30 to 60 inches, a few areas that have glacial materials at a depth of less than 20 inches, and a few areas not so well drained as typical. In small, moderately eroded areas the surface layer is dark brown to brown and is lower in content of organic matter.

This soil is well suited to cultivated crops, and it generally is associated with large areas of other soils well suited to cultivation. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Donnan Series

The Donnan series consists of nearly level and gently sloping, moderately well drained to somewhat poorly drained soils on uplands. These soils are on upland flats, ridge crests, and side slopes. They formed in 20 to 40 inches of dominantly loamy materials and the underlying very firm, clayey, grayish, weathered glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 8 inches thick. The subsurface layer, about 4 inches thick, is brown, friable silt loam. The subsoil extends to a depth of about 60 inches. It is light olive-brown and grayish-brown, friable light silty clay loam in the upper part; dark-gray, very firm silty clay in the middle part; and dark grayish-brown, very firm silty clay in the lower part.

Available water capacity is high. Permeability is moderate in the upper part of this soil that formed in loamy materials and very slow in the lower part that formed in the very firm, clayey till. Water moves more rapidly in the loamy upper part and accumulates at the contact with the clayey glacial till, which produces a seasonal perched water table. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper horizons are medium acid to strongly acid.

Donnan soils are suited to row crops, but wetness is a limitation in years of above normal rainfall. Providing adequate drainage is difficult because of the very slowly permeable subsoil.

Representative profile of Donnan silt loam, 0 to 2 percent slopes, in a cultivated field 750 feet east and 50 feet south of the northwest corner of sec. 6, T. 98 N., R. 16 W.

Ap—0 to 8 inches, very dark grayish-brown (10YR 2/2) heavy silt loam; weak, fine, granular structure; friable; slightly acid; abrupt boundary.

A2—8 to 12 inches, brown (10YR 4/3) heavy silt loam; weak, medium, platy structure; friable; very strongly acid; clear boundary.

B1—12 to 19 inches, light olive-brown (2.5Y 5/4) light silty clay loam; nearly continuous grayish-brown (2.5Y 5/2) coatings on peds; fine, prominent, strong-brown (7.5YR 5/6) mottles; weak, very fine and fine, subangular blocky structure; friable; strongly acid; clear boundary.

B21—19 to 24 inches, grayish-brown (2.5Y 5/2) light silty clay loam; many, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; strongly acid; abrupt boundary.

IIB22—24 to 29 inches, dark-gray (10YR 4/1) silty clay high in content of sand; moderate, medium, prismatic structure breaking to very fine angular blocky; very firm; few roots between ped surfaces; thick, grainy, white (10YR 8/1) coatings on prism exteriors when dry; strongly acid; clear boundary.

IIB23t—29 to 38 inches, dark-gray (10YR 4/1) silty clay; common, fine, distinct, dark yellowish-brown (10YR 5/6) mottles; strong, fine, angular blocky structure; very firm; few roots between peds; few, thick, discontinuous clay films; medium acid; clear boundary.

IIB3t—38 to 60 inches, dark grayish-brown (10YR 4/2) silty clay; many medium, prominent, strong-brown (7.5YR 5/6) mottles; moderate, fine, angular and subangular blocky structure; thin continuous clay films; very firm; neutral.

Depth to the fine textured, very firm layer ranges from 20 to 40 inches. The overlying mantle is dominantly silt loam and silt loam that has a high content of sand. A thin sandy horizon commonly is between the overlying mantle and the underlying, fine-textured material. The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to black (10YR 2/1) and very dark gray (10YR 3/1). The A2 horizon is dominantly brown (10YR 4/3), but ranges to dark grayish brown (10YR 4/2).

The IIB horizon ranges from dark gray (10YR 4/1) to grayish brown (10YR 5/3) and olive brown (2.5Y 4/4) that is mottled. It is generally silty clay but ranges to heavy clay loam and clay. The IIB horizon ranges from 20 to 60 inches in thickness.

Donnan soils are generally associated with Clyde, Dinsdale, Franklin, Klinger, Maxfield, Schley, and Waubeek soils. They have a finer textured, firmer IIB horizon than any of those soils. They have a thinner A horizon than Clyde, Dinsdale, Klinger, and Maxfield soils. They have a grayer B horizon than Dinsdale and Waubeek soils and are not so well drained. They have a browner B horizon than Clyde and Maxfield soils and are better drained.

Donnan silt loam, 0 to 2 percent slopes (782).—In most places this soil is on broad ridges or high upland flats and is associated with Franklin, Dinsdale, Clyde, Klinger, Maxfield, and Schley soils. Most areas are 4 to 30 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas where the subsoil is not so fine textured and is more permeable.

This soil is suited to row crops. In years of above normal rainfall, wetness is a limitation. Because of the very slowly permeable subsoil, tile does not drain all areas successfully. Capability unit IIw–3.

Donnan silt loam, 2 to 5 percent slopes (782B).—In most areas this soil is on long, convex ridges. In other areas it is on side slopes. It is associated with Clyde, Dinsdale, Klinger, Franklin, Maxfield, Schley, and Waubeek soils. Most areas are 3 to 15 acres in size. This soil has a profile similar to that described as representative of the series, but the clayey part of the subsoil is generally not so thick.

Included with this soil in mapping were a few small areas where the subsoil is not so fine textured and is more permeable. Also included were a few other small areas that have the clayey part of the subsoil at a depth of 10 to 20 inches.

This soil is suited to row crops. It is subject to slight erosion if cultivated. Because of the very slowly permeable subsoil, wetness and seepage are limitations in years of above-normal rainfall. Capability unit IIe–2.

Downs Series

The Downs series consists of gently sloping to strongly sloping, well-drained, silty soils on uplands. These soils are on ridges and side slopes. They formed in loess deposits, 3½ to 7 feet thick, overlying glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown silt loam about 9 inches thick. The subsoil is about 39 inches thick. It is brown, friable silty clay loam in the upper part and yellowish-brown, friable heavy silt loam in the lower part. The substratum is mottled yellowish-brown and grayish-brown, friable silt loam.

Available water capacity is high. Permeability is moderate. The content of available nitrogen is low. The subsoil is low to medium in available phosphorus and very low in available potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Downs soils are well suited to row crops, but they are subject to erosion if cultivated.

Representative profile of Downs silt loam, 2 to 5 percent slopes, in a cultivated field 25 feet south and 40 feet east of the northwest corner of SW¼ sec. 2, T. 97 N., R. 16 W.

Ap—0 to 9 inches, very dark brown (10YR 2/2) silt loam; moderate, fine and very fine, granular structure; friable; few mixings of dark brown (10YR 4/3); neutral; abrupt boundary.

B1—9 to 13 inches, brown (10YR 4/3) silty clay loam; moderate, very fine, subangular blocky structure; friable; few very dark grayish-brown (10YR 3/2) worm casts; slightly acid; clear boundary.

B21—13 to 23 inches, brown (10YR 4/3) silty clay loam; moderate, very fine, subangular blocky structure; friable; medium acid; clear boundary.

B22t—23 to 40 inches, yellowish-brown (10YR 5/6) heavy silt loam; weak, fine, prismatic structure parting to weak, fine and medium, subangular blocky; friable; few, dark, patchy clay films in root channels and on ped exteriors in lower part of horizon; strongly acid; gradual boundary.

B3t—40 to 48 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; friable; few, dark, patchy clay films in root channels; discontinuous grainy coatings when dry; strongly acid; gradual boundary.

C—48 to 68 inches, mottled yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) silt loam; weak, medium, prismatic structure; friable; discontinuous grainy coatings when dry; slightly acid.

The solum is generally 4 to 5 feet thick but ranges from 3½ to 5½ feet. The most acid part of the solum is medium acid to strongly acid. The content of sand is less than 10 percent to a depth of 40 inches. The Ap or A1 horizon ranges from black (10YR 2/1) to very dark grayish brown and is 6 to 9 inches thick. The A2 horizon, if present, is generally dark grayish-brown (10YR 4/2) silt loam. In many cultivated areas it is incorporated in the Ap horizon.

The B horizon is commonly brown (10YR 4/3) in the upper part and grades to a value of 4 or 5 and chroma of 4 to 6 with increasing depth. The B horizon is free of low-chroma mottles to a depth of 30 inches or more. The finest part of the B2 horizon ranges from light to medium silty clay loam that is 27 to 35 percent clay.

Downs, Atterberry, Fayette, Tama, and Waubeek soils all formed in similar material. Downs soils have a thicker A1 horizon or a lighter colored Ap horizon than Fayette soils and a thinner A1 horizon than Tama soils. They formed entirely in loess, but Waubeek soils formed in loess and the underlying glacial till. They are better drained and have a browner B horizon than Atterberry soils.

Downs silt loam, 2 to 5 percent slopes (162B).—This soil is on convex ridges and side slopes. It is associated with Atterberry, Fayette, Tama, and other Downs soils. Most areas are 5 to 75 acres in size, and a few areas are much larger. This soil has the profile described as representative of the series.

This soil is well suited to row crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Downs silt loam, 5 to 9 percent slopes, moderately eroded (162C2).—This soil is on the crests of divides and side slopes. It is associated with Fayette and other Downs soils. Most areas are 5 to 30 acres in size. This soil has a profile similar to that described as representative of the series, but it has a thinner dark-colored surface layer that is lower in organic matter.

Included with this soil in mapping were some areas that are slightly higher in content of sand and a few areas that are severely eroded and lower in content of organic matter and available potassium.

This soil is subject to moderate erosion if cultivated. It generally had good tilth, but it puddles and becomes cloddy if worked when wet. Capability unit IIIe–1.

Downs silt loam, 9 to 14 percent slopes, moderately eroded (162D2).—In most places this soil is on side slopes below less sloping Downs soils.

This soil has a profile similar to that described as representative of the series, but it has a thinner, dark-colored surface layer and contains slightly more clay. In some severely eroded spots the surface layer is very low in content of organic matter and contains slightly more clay.

This soil is suited to row crops if erosion is controlled. The soil is subject to severe erosion if cultivated. It generally has good tilth but becomes cloddy if worked when wet. Capability unit IIIe–1.

Dubuque Series

The Dubuque series consists of gently sloping to moderately sloping, well-drained soils on uplands. These soils are on long ridges and side slopes. They formed in about 20 to 30 inches of loess and a thin layer of clayey limestone residuum overlying limestone bedrock. The native vegetation was trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 6 inches thick. The subsurface layer, about 7 inches thick, is grayish-brown, friable silt loam. The subsoil is about 15 inches thick. The upper part of the subsoil is dark yellowish-brown, friable silty clay loam. The lower part is brown, very firm clay. Below the subsoil is shattered limestone bedrock overlying massive bedrock.

Available water capacity is medium to low. Permeability is moderate in the upper part but very slow in the clayey residuum. The subsoil is medium in available phosphorus and very low in available potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are medium acid.

Dubuque soils are suited to row crops. Erosion control is needed in cultivated areas, because any erosion further limits the rooting zone and moisture supply. These soils are droughty in years of normal or below-normal rainfall.

Representative profile of Dubuque silt loam, moderately deep, 2 to 5 percent slopes, in a meadow 1,030 feet east and 40 feet south of the northwest corner of the SE¼ sec. 8, T. 98 N., R. 17 W.

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate, very fine, granular structure; friable; medium acid; clear boundary.

A2—6 to 13 inches, grayish-brown (10YR 5/2) silt loam, pale brown (10YR 6/3) dry; moderate, thin, platy structure; friable; light-gray (10YR 7/2) grainy coats dry; medium acid; clear boundary.

B1—13 to 18 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; moderate, very fine, subangular blocky structure; friable; brown (10YR 4/3) coatings on peds, light-gray (10YR 7/2) grainy coatings dry; medium acid; clear boundary.

B21t—18 to 24 inches, dark yellowish-brown (10YR 4/4) silty clay loam; moderate, fine, subangular and angular blocky structure; few, patchy, dark-brown (10YR 3/3) clay films on faces of peds; firm; medium acid; clear boundary.

IIB22t—24 to 28 inches, brown (7.5YR 4/4) clay; moderate and strong, fine, subangular and angular blocky structure; very firm; discontinuous dark reddish-brown (5YR 3/2) coatings on peds; slightly acid; abrupt boundary.

IIR—28 inches, shattered limestone bedrock.

The solum is generally 24 to 30 inches thick but ranges from 20 to 40 inches. In uncultivated areas the A1 horizon is very dark gray (10YR 3/1) and is less than 4 inches thick.

The IIB2 horizon just above the shattered bedrock is clay or silty clay 2 to 6 inches thick. The shattered upper part of the bedrock ranges from 2 to 5 feet in thickness. About 5 to 15 percent of the volume consists of loamy materials in crevices and a thin layer of clay residuum on the slabs of limestone.

Dubuque soils are associated with Ashdale, Roseville, Sogn, Whalan, and Winneshiek soils and formed in similar materials. Dubuque soils are shallower over bedrock than Ashdale soils and have a thinner A horizon or a lighter colored Ap horizon. They contain more silt and less sand than Roseville, Whalan, and Winneshiek soils. Dubuque soils are deeper over bedrock than Sogn soils.

Dubuque silt loam, moderately deep, 2 to 5 percent slopes (183B).—In most places this soil is on long, convex side slopes and ridge crests above more sloping Dubuque, Sogn, or Winneshiek soils. Most areas are 4 to 15 acres in size.

This soil has the profile described as representative of the series. In a few spots bedrock is near the surface or exposed. In a few other spots it is at a depth of more than 40 inches.

This soil is suited to row crops, but the limited root zone causes it to be droughty in years of normal or below normal rainfall. The soil is subject to slight erosion if cultivated. Capability unit IIe–4.

Dubuque silt loam, moderately deep, 5 to 9 percent slopes (183C).—This soil is on ridge crests and side slopes. It is generally downslope from the less sloping Dubuque soils and above the more sloping Sogn and Winneshiek soils. Most areas are 4 to 15 acres in size.

This soil has a profile similar to that described as representative of the series, but it is somewhat lighter in color and shallower over bedrock. In some eroded spots the surface layer is brown. Limestone bedrock is at a depth of 20 to 34 inches in most places, but is near the surface or exposed in a few spots.

This soil is suited to row crops, but the limited root zone causes it to be droughty in years of normal or below normal rainfall. It is subject to moderate erosion if cultivated. Erosion decreases the already limited root zone. Capability unit IIIe–3.

Fayette Series

The Fayette series consists of gently sloping to sloping, well-drained, silty soils on uplands. These soils are on ridge crests and side slopes. They formed in loess deposits 3½ to 6 feet thick. The native vegetation was trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 4 inches thick. The subsurface layer, about 5 inches thick, is dark grayish-brown, friable silt loam. The subsoil extends to a depth of about 60 inches. The upper 24 inches is brown, friable heavy silt loam and light silty clay loam. The lower part is yellowish-brown, friable silt loam.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is low. The subsoil is high in available phosphorus and very low in available potassium. The content of organic matter is low. Unless these soils are limed, the upper layers generally are medium acid to strongly acid.

Fayette soils are well suited to row crops. The hazard of erosion is moderate or severe if the sloping soils are cultivated. A suitable cropping system and other soil-conserving measures are needed.

Representative profile of Fayette silt loam, 2 to 5 percent slopes, in bluegrass, 165 feet south and 15 feet west of the northwest corner of the Mitchell Cemetery, SW¼ SW¼ sec. 9, T. 98 N., R. 17 W.

A1—0 to 4 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine, granular structure; friable; many roots; neutral; clear boundary.

A2—4 to 9 inches, dark grayish-brown (10YR 4/2) silt loam; slightly darker coating on peds; weak, medium, platy structure parting to weak, fine, granular; slightly acid; clear boundary.

B1t—9 to 14 inches, brown (10YR 4/3) heavy silt loam; moderate, very fine and fine, subangular blocky structure; few, thin, patchy clay films on faces of peds; medium acid; gradual boundary.

B21t—14 to 19 inches, brown (10YR 4/3) light silty clay loam; moderate, very fine and fine, subangular blocky structure; friable; few patchy clay films on faces of peds; thin, light-gray (10YR 7/1), grainy coatings when dry; strongly acid; clear boundary.

B22t—19 to 24 inches, brown (10YR 5/3) heavy silt loam; moderate, fine, subangular blocky structure; friable; few, thin, patchy clay films on faces of peds; strongly acid; clear boundary.

B23t—24 to 28 inches, yellowish-brown (10YR 5/4) heavy silt loam; moderate, medium, prismatic structure parting to strong and moderate, subangular and angular blocky; thick discontinuous clay films on faces of prisms; strongly acid; clear boundary.

B24t—28 to 36 inches, yellowish-brown (10 YR 5/4) heavy silt loam; brown (10YR 4/3) coating on peds; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; common thick clay films on faces of peds; strongly acid; clear boundary.

B31t—36 to 46 inches, yellowish-brown (10YR 5/4) silt loam high in content of sand; nearly continuous brown (10YR 4/3) coatings on peds; moderate, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; common thick clay films on faces of prisms; medium acid; abrupt boundary.

B32t—46 to 60 inches, yellowish-brown (10YR 5/4) stratified medium and light silt loam high in content of sand; weak, coarse, prismatic structure; common patchy clay films on faces of prisms; medium acid.

The solum is generally about 45 to 60 inches thick but ranges from 40 to 65 inches. The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in uncultivated areas and is 3 to 5 inches thick. If cultivated, the plow layer is very dark grayish brown (10YR 3/2) to brown (10YR 4/3). The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) and is 3 to 6 inches thick. It is silt loam. In places the A2 horizon is wholly incorporated in the plow layer.

The B2 horizon ranges from dark brown (10YR 4/3) or brown (10YR 5/3) to yellowish brown (10YR 5/6) and is free of low-chroma mottles to a depth of 3 feet or more. The B2 horizon ranges from heavy silt loam to light silty clay loam. The B3 horizon is 10 to 35 percent sand, much of it very fine and fine. The B horizon ranges from medium acid to very strongly acid in the most acid part.

Fayette soils formed in about the same kind of material as Dubuque, Downs, and Tama soils. They have a thinner A1 horizon than Downs and Tama soils. They are not moderately deep over the limestone bedrock as are Dubuque soils.

Fayette silt loam, 2 to 5 percent slopes (163B).—This soil is on convex ridges and side slopes. It is associated with more sloping Fayette soils and with Downs soils. Most areas are 5 to 25 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas in which the subsoil is slightly higher in content of sand.

This soil is well suited to row crops if properly managed. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Fayette silt loam, 5 to 9 percent slopes, moderately eroded (163C2).—This soil is on the crests of divides and on side slopes. It is associated with other Fayette soils and with Downs soils. Most areas are about 5 to 25 acres in size.

This soil has a profile similar to that described as representative of the series, but it is eroded and lower in content of organic matter. In most places all of the subsurface layer is incorporated in the plow layer.

Included with this soil in mapping were uneroded wooded areas where the surface layer is darker colored. Also included were a few areas that have more sand in the subsoil and a few places where a fine sandy subsoil is at a depth of about 30 inches.

This soil is suited to row crops if it is properly managed and erosion is controlled. It is subject to moderate to severe erosion if cultivated. Capability unit IIIe–1.

Flagler Series

The Flagler series consists of nearly level to gently sloping, somewhat excessively drained soils on stream benches and uplands. These soils formed in 24 to 36 inches of sandy loam material and the underlying gravelly sand. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown sandy loam about 20 inches thick. The subsoil is about 20 inches thick. It is brown, very friable sandy loam in the upper part and brown, loose gravelly loamy sand in the lower part. The substratum is brown, loose gravelly sand.

Available water capacity is low. Permeability is moderately rapid in the upper part and very rapid in the underlying coarse-textured material. The content of available nitrogen is low. The subsoil is very low to low in available phosphorus and low in available potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid.

Flagler soils are suited to cultivated crops, but productivity depends on the timeliness of rainfall. Where crop or residue cover is limited, they are subject to soil blowing. Sloping areas are subject to water erosion if cultivated.

Representative profile of Flagler sandy loam, 2 to 5 percent slopes, in a cultivated field 555 feet north and 435 feet east of the southwest corner of SE¼ sec. 23, T. 99 N., R. 18 W.

Ap—0 to 9 inches, black (10YR 2/1) sandy loam; weak, fine, granular structure; very friable; slightly acid; clear boundary.

A12—9 to 16 inches, black (10YR 2/1) heavy fine sandy loam; moderate, fine and very fine, granular structure; very friable; medium acid; clear boundary.

A3—16 to 20 inches, very dark grayish-brown (10YR 3/2) sandy loam; nearly continuous very dark brown (10YR 2/2) coatings on peds; moderate, very fine and fine, subangular blocky structure; very friable; few fine pebbles; medium acid; clear boundary.

B21—20 to 26 inches, brown (10YR 4/3) sandy loam; nearly continuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium, platy structure parting to weak, fine, subangular blocky; very friable; size of sand grains and amount of gravel increase with depth; medium acid; clear boundary.

B22—26 to 32 inches, brown (10YR 4/3) sandy loam; nearly continuous dark yellowish-brown (10YR 3/4) coatings on peds; weak, medium, prismatic structure parting to fine and very fine subangular blocky; very friable; high content of medium and coarse sand; common fine pebbles; medium acid; clear boundary.

IIB3t—32 to 40 inches, brown (10YR 4/3) gravelly loamy sand; single grained; loose to very weakly cemented; 20 to 30 percent gravel; few pebbles, as much as 1 inch in diameter; thin clay films surround sand grains and pebbles; few clay bridges between sand grains; medium acid; clear boundary.

IIC1—40 to 48 inches, brown (10YR 4/3 to 5/3) gravelly sand; single grained; loose; 20 to 30 percent gravel; thin clay films on sand grains and pebbles; few clay bridges between sand grains; medium acid.

The solum ranges from 36 to 50 inches in thickness. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). The A horizon is 10 to 20 inches thick. A few pebbles are in the A horizon in places.

The B horizon ranges from dark brown (10YR 3/3) to brown (10YR 4/3) or dark yellowish brown (10YR 4/4). It generally contains some gravel. The IIB horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). The amount of gravel varies, but generally ranges from 15 to 30 percent.

The C horizon ranges from yellowish brown (10YR 5/4) to light yellowish brown (10YR 6/4) or strong brown (7.5YR 5/8) and from gravelly sand to sand. The content of gravel is highly variable.

Flagler soils are associated with Burkhardt, Dickinson, Lamont, and Lilah soils and formed in similar materials. They contain more gravel in the solum and C horizon than Dickinson and Lamont soils. They have less clay and more sand in the A horizon and upper part of the B horizon than Saude soils. They are deeper over loamy sand or sand than Burkhardt and Lilah soils. They have a thicker A1 horizon than Lamont and Lilah soils.

Flagler sandy loam, 0 to 2 percent slopes (284).—This soil is on ridges on uplands and stream benches. Areas are 3 to 10 acres in size. Included in mapping were a few small areas that have a gravelly sand surface layer and are more droughty.

This soil is suited to row crops, but productivity depends on the timeliness of rainfall. This soil is somewhat excessively drained, and moisture limits crop production in many years. It is subject to soil blowing if cultivated. Crop residue left on the surface helps control soil blowing and conserve water and soil. Capability unit IIIs–1.

Flagler sandy loam, 2 to 5 percent slopes (284B).—This soil is on ridges and side slopes on stream benches and uplands. Most areas are 3 to 10 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas that have a gravelly sand surface layer. Also included were a few other areas on uplands that have glacial till within a depth of 30 to 50 inches.

This soil is suited to row crops, but productivity depends on the timeliness of rainfall. The soil is somewhat excessively drained, and moisture limits crop production in many years. It is subject to slight soil blowing and water erosion if cultivated. Leaving crop residue on the surface helps control soil blowing and water erosion and conserve water. Capability unit IIIe–4.

Floyd Series

The Floyd series consists of somewhat poorly drained soils on uplands. These soils occupy slightly convex to concave downslope and cove positions and have slopes of 1 to 4 percent. They formed in 30 to 45 inches of loamy material and the underlying firm loam glacial till. The loamy material is stratified in the lower part. In some places a layer of pebbles forms the contact line between the loamy overburden and the stratified sediment or is on the surface of the glacial till. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown heavy loam about 20 inches thick. The subsoil is about 26 inches thick. It is dark grayish-brown, friable loam in the upper part; yellowish-brown, very friable sandy loam in the middle part; and yellowish-brown, firm heavy loam in the lower part. The substratum is yellowish-brown, firm heavy loam.

Available water capacity is high. Permeability is moderate to moderately rapid in the upper part and moderately slow in the lower part. The content of available nitrogen is medium to low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. In most places these soils are slightly acid to neutral, and generally do not require additional lime. Wetness is caused, at least in part, by hillside seepage from Kenyon and other soils that are commonly upslope.

Floyd soils are well suited to intensive use for row crops. The major limitation is wetness, and tile drainage is needed for maximum production.

Representative profile of Floyd loam, 1 to 4 percent slopes, in a cultivated field 300 feet east and 70 feet south of the northwest corner of the NE¼NE¼ sec. 1, T. 99 N., R. 16 W.

Ap—0 to 11 inches, black (10YR 2/1) heavy loam; moderate, fine, granular structure; friable; slightly acid; clear boundary.

A12—11 to 16 inches, black (10YR 2/1) heavy loam; weak, fine, granular structure; friable; few very dark grayish-brown (10YR 3/2) mixings; slightly acid; clear boundary.

A3—16 to 20 inches, very dark grayish-brown (2.5Y 3/2) heavy loam; weak, fine, subangular blocky structure; friable; slightly acid; clear boundary.

B1—20 to 25 inches, dark grayish-brown (2.5Y 4/2) heavy loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; neutral; abrupt boundary.

B2—25 to 32 inches, yellowish-brown (10YR 5/4) sandy loam; weak, medium, subangular blocky structure; very friable; ped exteriors slightly darker than interiors; neutral; abrupt boundary.

IIB3—32 to 46 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; moderate, medium, prismatic structure parting to weak, fine and medium, subangular blocky; firm; nearly continuous grayish-brown (2.5Y 5/2) coatings on peds; few, fine, black oxide concentrations; pebble band in upper part of horizon; neutral; clear boundary.

IIC—46 to 60 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, olive-gray (5Y 5/2) mottles; few, medium, strong-brown (7.5YR 5/6) and reddish-brown (5YR 4/4) oxide concentrations; massive; firm; slightly alkaline in upper part; strongly effervescent at depth of 50 inches.

The solum is generally 3½ to 5 feet thick. The A1 horizon ranges from 12 to 18 inches in thickness. The A3 horizon is generally very dark grayish brown (2.5Y 3/2) but ranges to very dark gray (10YR 3/1). The A horizon is generally heavy loam but ranges to silt loam high in content of sand, light silty clay loam high in content of sand, and light clay loam.

The upper part of the B horizon has a color value of 4, chroma of 2 to 4, and hue of 2.5Y, or chroma of 2 and hue of 10YR. Mottles are of higher chroma in places. Depth to firm loam till ranges from 30 to 45 inches. The B horizon ranges from light sandy loam to light sandy clay loam and loam that has horizontal lenses of loamy sand or sand.

Floyd soils are in the same drainage class as Lawler, Klinger, Readlyn, and Schley soils and are closely associated with Clyde soils. They have a thicker A1 horizon than Schley soils. They have a browner B horizon than Clyde soils and are better drained. They lack the coarse textured C horizon of Lawler soils. They are more stratified than Readlyn soils and are not so acid. They contain more sand in the upper part of the solum than Klinger soils.

Floyd loam, 1 to 4 percent slopes (198B).—This soil is in drainageways and on lower parts of side slopes on uplands. Areas commonly range from about 3 to 100 acres in size. They are generally narrow, and many areas extend over more than one farm.

Included with this soil in mapping, near the Cresco, Protivin, and Riceville soils, were a few areas where very firm clay loam till is at a depth of more than 40 inches.

This soil is well suited to intensive use for row crops if drained and properly managed. The major limitation is wetness, but in some areas some soil is lost through erosion. Because wetness is caused, at least in part, by sidehill seepage, a drainage system that intercepts laterally moving water is the most successful. Capability unit IIw–2.

Franklin Series

The Franklin series consists of somewhat poorly drained soils on uplands. These soils are on upland flats, ridges, and side slopes. Slopes are 1 to 3 percent. They formed in 20 to 40 inches of loess and the underlying till or till-derived material. In many places a layer of pebbles is at or near the contact line between the loess and the underlying glacial materials. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is black silt loam about 7 inches thick. The subsurface layer, about 6 inches thick, is dark grayish-brown, friable silt loam. The subsoil extends to a depth of about 60 inches. It is brown and dark grayish-brown, friable silty clay loam in the upper part; dark grayish-brown and yellowish-brown, friable and firm heavy loam in the middle part; and mottled yellowish-brown, dark yellowish-brown, and grayish-brown, firm heavy loam in the lower part.

Available water capacity is high. Permeability is moderate in the upper part that formed in loess and moderately slow in the lower part that formed in till. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid or strongly acid.

Franklin soils are well suited to cultivated crops and are generally associated with large areas of other well-suited soils. Artificial drainage is beneficial in some areas.

Representative profile of Franklin silt loam, 1 to 3 percent slopes, in an open wooded pasture, 1,090 feet north and 1,215 feet east of the southwest corner of the NE¼ sec. 15, T. 97 N., R. 16 W.

A1—0 to 7 inches, black (10YR 2/1) heavy silt loam; moderate, fine, subangular blocky structure; friable; strongly acid; clear boundary.

A2—7 to 13 inches, dark grayish-brown (10YR 4/2) silt loam; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, medium, platy structure parting to weak and moderate, very fine, subangular blocky; friable; some mixing of black (10YR 2/1) from above horizon; medium acid; clear boundary.

B1—13 to 19 inches, brown (10YR 4/3) light silty clay loam; some slightly darker coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21—19 to 27 inches, dark grayish-brown (10YR 4/2) light silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/4) mottles; moderate, fine, subangular blocky structure; friable; few, fine, dark oxide concentrations; strongly acid; gradual boundary.

IIB22t—27 to 31 inches, mottled dark grayish-brown (10YR 4/2) and dark yellowish-brown (10YR 4/4) heavy loam; common, fine, faint, grayish-brown (10YR 5/2) mottles; grayish-brown (10YR 5/2) coatings on prisms and peds; weak and moderate, fine, subangular blocky structure; friable; few dark grayish-brown (10YR 4/2) clay films in root channels; pebble band in horizon; strongly acid; gradual boundary.

IIB31t—31 to 43 inches, yellowish-brown (10YR 5/6) heavy loam; moderate, fine, prismatic structure parting to weak and moderate, fine, subangular blocky; firm; few, fine, dark oxide concentrations; discontinuous dark-gray (10YR 4/1) clay films in root channels; strongly acid; gradual boundary.

IIB32t—43 to 60 inches, mottled yellowish-brown (10YR 5/6), dark yellowish-brown (10YR 4/4), and grayish-brown (10YR 5/2) heavy loam; weak, fine, prismatic structure parting to very weak, medium and coarse, subangular blocky; firm; discontinuous dark-gray (10YR 4/1) clay films lining root channels and pores; many, fine, very dark gray (10YR 3/1) oxide concentrations; slightly acid.

The solum is generally 4½ to 5 feet thick but ranges from 4 to 6 feet. The loess is generally 24 to 32 inches deep but ranges from 20 to 40 inches. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A2 horizon ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (10YR 5/2).

The B horizon formed in loess. It ranges from dark grayish brown (10YR or 2.5Y 4/2) to brown (10YR 4/3) or olive brown (2.5Y 4/4) and has a few mottles. It is light to medium silty clay loam. The sand content of the A and B horizons ranges from 3 to 10 percent but is higher near the till contact. The prism and ped exteriors of the till, when dry, have a gray to grayish-brown, grainy appearance. The till or till-derived material is typically loam but ranges to sandy clay loam and, in some places, to light clay loam. In places discontinuous lenses of sandy loam to sand, 1 to 8 inches thick, are between the loess and the till.

Franklin soils are associated with Dinsdale, Atterberry, Klinger, Maxfield, Oran, and Waubeek soils and formed in similar materials. They have a grayer B horizon than Dinsdale and Waubeek soils and are not so well drained. They have a browner B horizon and are better drained than Maxfield soils. They have a thinner A1 horizon than Dinsdale, Klinger, and Maxfield soils, and they also have an A2 horizon. They formed in 20 to 40 inches of loess overlying glacial materials, but Atterberry soils formed in loess deposits more than 40 inches deep. Franklin soils have less sand and more silt in the A horizon than Oran soils and are deeper over the underlying till.

Franklin silt loam, 1 to 3 percent slopes (761).—This soil is on flats, convex ridges, and side slopes on uplands. It is generally on large flats; in other areas it is just above Maxfield soils and just downslope from gently sloping Dinsdale and Waubeek soils. Areas are generally 5 to 80 acres in size, but some are much larger.

Included with this soil in mapping were a few small areas that are poorly drained. Also included were a few other areas that have a lighter colored surface layer and a few areas that contain shallow sinkholes, some of which retain water for short periods after rains.

This soil is well suited to intensive use for row crops and is generally associated with large areas of other well suited soils. Capability unit I–3.

Garwin Series

The Garwin series consists of nearly level, poorly drained soils on uplands. These soils are in drainageways and low concave positions. They formed in loess deposits, 4 to 8 feet thick, overlying glacial till. The native vegetation was mixed grasses and sedges.

In a representative profile the surface layer is black, very dark gray, and dark olive-gray silty clay loam about 18 inches thick. The subsoil is about 16 inches thick. It is olive-gray and grayish-brown, friable light silty clay loam in the upper part and olive-gray, friable heavy silt loam in the lower part. The substratum is olive-gray, friable silt loam.

Available water capacity is high. Permeability is moderately slow in the upper part and moderate in the lower part. The content of available nitrogen is medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. These soils center on neutral but range from slightly acid to slightly alkaline. They do not generally need additional lime.

Garwin soils are naturally poorly drained, but if artificial drainage is adequate they are well suited to intensive use for row crops.

Representative profile of Garwin silty clay loam, 0 to 2 percent slopes, in a cultivated field 90 feet north and 90 feet west of the southeast corner of sec. 3, T. 97 N., R. 16 W.

Ap—0 to 10 inches, black (10YR 2/1) light silty clay loam; very weak, medium, subangular blocky structure; friable; few roots; neutral; gradual boundary.

A12—10 to 14 inches, very dark gray (10YR 3/1) heavy silty clay loam; weak, medium, subangular blocky structure; friable; neutral; clear boundary.

A3—14 to 18 inches, dark olive-gray (5Y 3/2) medium silty clay loam; very dark gray (10YR 3/1) coatings on peds; weak, fine, subangular blocky structure; friable; few black oxide concentrations; slightly alkaline; clear boundary.

B2g—18 to 23 inches, olive-gray (5Y 4/2) and grayish-brown (2.5Y 5/2) light silty clay loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, granular structure; friable; few dark oxide concentrations; slightly alkaline; clear boundary.

B3g—23 to 34 inches, olive-gray (5Y 5/2) heavy silt loam; common, distinct, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; few dark oxide concentrations; neutral; gradual boundary.

Cg—34 to 48 inches, olive-gray (5Y 5/2) silt loam; common, fine, distinct, light olive-brown (2.5Y 5/6) and yellowish-brown (10YR 5/6) mottles; massive; friable; few dark oxide concentrations; mildly alkaline.

The solum is generally 32 to 48 inches thick. The A horizon ranges from 16 to 22 inches in thickness. The A1 horizon is black (N 2/0 to 10YR 2/1) and very dark gray (10YR 3/1) in the lower part. The A3 horizon ranges from very dark gray (10YR 3/1) to dark olive gray (5Y 3/2).

If present, the B1 horizon is dark grayish-brown (2.5Y 4/2) medium silty clay loam that has high-chroma mottles of 10YR or redder, or it is olive gray (5Y 4/2).

These soils have a lower content of clay in the B horizon than is defined in the range for the series, but this difference does not greatly alter the usefulness and behavior of these soils.

Garwin soils formed in about the same kind of material as Atterberry, Muscatine, and Tama soils and are closely associated with Maxfield soils. They are more poorly drained and have a grayer B horizon than Atterberry, Muscatine, and Tama soils. They have a thicker A1 horizon than Atterberry soils and they have less sand in the lower part of the B horizon than Maxfield soils.

Garwin silty clay loam, 0 to 2 percent slopes (118).—This soil is in drainageways and low concave positions on uplands. It is associated with Maxfield, Muscatine, and Tama soils. Most areas are 10 to 50 acres in size.

This soil is suited to intensive use for row crops if adequately drained. Most areas are in row crops. The major limitation is wetness. Capability unit IIw–1.

Hanlon Series

The Hanlon series consists of nearly level, moderately well drained soils on bottom lands. These soils are on flood plains of rivers and smaller streams. They formed in moderately coarse textured alluvial sediment.

In a representative profile the surface layer is black and very dark brown fine sandy loam about 50 inches thick. The subsoil is about 19 inches thick. It is very dark grayish-brown, friable heavy sandy loam. The substratum is dark grayish-brown, friable loam.

Available water capacity is medium, and permeability is moderately rapid. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate to high. The upper layers are generally slightly acid or neutral.

Hanlon soils are suited to intensive use for row crops. They are somewhat droughty during extended dry periods. Some areas are subject to flooding.

Representative profile of Hanlon sandy loam, 0 to 2 percent slopes, in a pasture 325 feet east and 100 feet north of the southwest corner of SE¼ sec. 23, T. 99 N., R. 18 W.

A11—0 to 7 inches, black (10YR 2/1) sandy loam; weak, very fine, subangular blocky structure breaking to fine granular; very friable; slightly acid; clear boundary.

A12—7 to 27 inches, black (10YR 2/1) heavy fine sandy loam; very weak, fine and medium, subangular blocky structure; very friable; neutral; clear boundary.

A13—27 to 40 inches, black (10YR 2/1) light fine sandy loam; very weak, medium to coarse, subangular blocky structure; very friable; neutral; clear boundary.

A3—40 to 50 inches, very dark brown (10YR 2/2) light fine sandy loam grading to medium sandy loam with depth; very weak, medium and coarse, subangular blocky structure; very friable; neutral; gradual boundary.

B—50 to 69 inches, very dark grayish-brown (10YR 3/2) heavy sandy loam; very dark brown (10YR 2/2) coatings on peds; very weak, medium and coarse, subangular blocky structure; friable; clay bridges between sand grains; neutral; abrupt boundary.

C—69 to 80 inches, dark grayish-brown (10YR 4/2) light loam; very weak, coarse, prismatic structure; friable; mildly alkaline; slight effervescence.

The solum is generally 4 to 6 feet thick and slightly acid or neutral, but it ranges to medium acid. The A horizon generally is about 45 inches thick, but ranges from 36 to 54 inches. The A horizon is generally black (10YR 2/1) or very dark brown (10YR 2/2). In some profiles it is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) in the lower part.

The B horizon commonly has a hue of 10YR, value of 3 or 2, and chroma of 2 or 3.

The C horizon is commonly sandy loam but ranges from loam to sand.

Hanlon soils are closely associated with Coland and Turlin soils. They have less clay and more sand in the A and B horizons than Coland or Turlin soils. They are better drained than Coland soils.

Hanlon sandy loam, 0 to 2 percent slopes (536).—This soil is on natural levees and bottom lands. It is generally adjacent to Coland and Turlin soils. In most places it is at a somewhat higher elevation than the associated soils. Areas generally range from 5 to 25 acres in size.

This soil is well suited to intensive use for row crops. It is somewhat droughty during extended dry periods. Some areas are subject to flooding, but generally flooding is of short duration. Capability unit IIs–2.

Hayfield Series

The Hayfield series consists of nearly level, somewhat poorly drained soils on stream benches. These soils formed in 24 to 40 inches of medium-textured alluvial deposits overlying thick layers of coarse-textured material. The native vegetation was prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 7 inches thick. The subsurface layer, about 4 inches thick, is dark grayish-brown and brown, friable loam. The subsoil is about 18 inches thick. It is brown, friable loam in the upper part; strong-brown, friable light sandy clay loam in the middle part; and strong-brown, very friable fine gravelly loamy sand in the lower part. Grayish mottles are throughout the subsoil. The substratum is mottled strong-brown and grayish-brown, loose fine gravelly sand grading with depth to loose, light yellowish-brown sand.

Available water capacity is low to medium. Permeability is moderate in the medium-textured material and rapid to very rapid in the coarse-textured underlying material. The content of available nitrogen is low. The subsoil is low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are medium acid to very strongly acid.

Hayfield soils are well suited to row crops. The moderately deep soils are slightly droughty in years of normal to below-normal rainfall.

Representative profile of Hayfield loam, moderately deep, 0 to 2 percent slopes, in a cultivated field 130 feet east and 60 feet north of the southwest corner of SE¼ sec. 7, T. 98 N., R. 15 W.

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; common roots; neutral; abrupt boundary.

A2—7 to 11 inches, dark grayish-brown (10YR 4/2) and brown (10YR 4/3) loam; friable; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, thin, platy structure; clear boundary.

B1—11 to 20 inches, brown (10YR 5/3) loam; common, fine, faint, grayish-brown (10YR 5/2) mottles and few, distinct, strong-brown (7.5YR 5/6 mottles; weak, fine, subangular blocky structure; friable; few dark reddish-brown (5YR 3/3) oxide concentrations; very strongly acid; clear boundary.

B2—20 to 24 inches, strong-brown (7.5YR 4/4) light sandy clay loam; many, fine, distinct, grayish-brown (10YR 5/2) mottles and few, fine, distinct, strong-brown 7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; very strongly acid; clear boundary.

IIB3t—24 to 29 inches, strong-brown (7.5YR 5/6) fine gravelly loamy sand; common, medium, prominent, grayish-brown (10YR 5/2) mottles; weak, medium, subangular blocky structure; very friable; clay bridging between sand grains; very strongly acid.

IIC1—29 to 37 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown 2.5Y 5/2) fine gravelly sand; few, fine, faint, brown (7.5YR 4/4) mottles; single grained; loose; few, medium, yellowish-red (5YR 4/6) oxide concentrations; very strongly acid; gradual boundary.

IIC2—37 to 50 inches, light yellowish-brown (10YR 6/4) sand; single grained; loose; few fine pebbles; medium acid.

The solum is generally 24 to 40 inches thick. It generally extends into the upper part of the underlying sand and gravel. Depth to contrasting textures ranges from 24 to 40 inches. The A horizon is generally loam but ranges to silt loam that has a high content of sand. The Ap or A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2).

The part of the B horizon formed in medium-textured material ranges from loam to light sandy clay loam and light clay loam. It is commonly underlain by a thin zone of sandy loam at a depth of more than 24 to 36 inches. The IIB3 horizon or the upper part of the IIC horizon typically ranges from loamy coarse sand to gravelly sand and includes thin layers of sandy loam.

Hayfield soils are associated with Lawler, Marshan, Sattre, Saude, and Wapsie soils and formed in similar materials. They have a thinner A1 horizon than Lawler, Marshan, and Saude soils. They have a browner B horizon and are better drained than Marshan soils. They have a grayer B horizon than Sattre and Wapsie soils and are not so well drained.

Hayfield loam, deep, 0 to 2 percent slopes (726).—This soil is on stream benches. Most areas are 4 to 40 acres in size. This soil has a profile similar to that described as representative of the series, but the underlying sand and gravel are at a depth of 32 to 40 inches.

Included with this soil in mapping were a few small areas in which the sand and gravel are at a depth of more than 40 inches or less than 32 inches.

This soil is well suited to cultivated crops. It is somewhat poorly drained and benefits from tile drainage in wet seasons. Tile placement is difficult in some places because of loose, unstable sand. Capability unit I–3.

Hayfield loam, moderately deep, 0 to 2 percent slopes (725).—This soil is on stream benches. Most areas are 4 to 30 acres in size, but a few are much larger. This soil has the profile described as representative of the series, but sand and gravel are 24 to 32 inches below the surface.

Included with this soil in mapping were a few areas where the surface layer is sandy loam and some where the sand and gravel are at a depth of less than 20 inches.

This soil is suited to cultivated crops. During extended dry periods, it is somewhat droughty. It is somewhat poorly drained and benefits from tile drainage during wet seasons. Tile placement is difficult in some places because the sand is loose and unstable. Capability unit IIs–1.

Huntsville Series

The Huntsville series consists of nearly level to gently sloping, well-drained soils. These soils are in upland waterways and narrow valleys and on foot slopes adjacent to steep areas. They formed in silty alluvial sediment of medium texture.

In a representative profile the surface layer is black and very dark brown silt loam about 32 inches thick. The subsoil extends to a depth of about 60 inches. It is dark-brown and brown, friable silt loam.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is medium to low. The subsoil is medium in available phosphorus and very low in available potassium. The content of organic matter is high. Unless these soils are limed, the upper horizons are generally medium acid.

Huntsville soils are subject to flooding of short duration. They are well suited to row crops, but in some years crops are damaged by flooding and siltation.

Representative profile of Huntsville silt loam, 2 to 5 percent slopes, in a cultivated field 175 feet east and 160 feet north of the southwest corner of sec. 30, T. 98 N., R. 16 W.

Ap—0 to 9 inches, black (10YR 2/1) heavy silt loam; weak, very fine, subangular blocky structure; friable; neutral; abrupt boundary.

A12—9 to 24 inches, weakly stratified, very dark brown (10YR 2/2) heavy silt loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; black (10YR 2/1) coatings on peds; weak, thick, platy structure that breaks to weak, fine, granular; friable; thin discontinuous strata of brown (10YR 5/3); medium acid; gradual boundary.

A13—24 to 32 inches, very dark brown (10YR 2/2) heavy silt loam; black (10YR 2/1) coatings on peds; moderate, very fine and fine, granular structure; friable; medium acid; gradual boundary.

B1—32 to 38 inches, dark-brown (10YR 3/3 and 4/3) heavy silt loam; nearly continuous very dark grayish-brown

(10YR 3/2) coatings on peds; weak, fine, granular structure; friable; strongly acid; clear boundary.

B2—38 to 45 inches, brown (10YR 4/3) heavy silt loam; patchy very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) coatings on peds; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; strongly acid; gradual boundary.

B3—45 to 60 inches, brown (10YR 4/3) silt loam; few, patchy, dark-brown (10YR 3/3) coatings on peds; weak, coarse, prismatic structure; friable; medium acid.

The solum is generally 3½ to 5 feet thick. The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) and is 24 to 36 inches thick. The Ap or A12 horizon ranges from neutral to slightly acid. The A12 and A13 horizons range from slightly acid to medium acid.

The B horizon ranges from medium acid to strongly acid. These soils are more acid in the B horizon than is defined in the range for the series, but the difference does not greatly alter the usefulness and behavior of these soils.

Huntsville soils formed in about the same kind of material as Turlin, Coland, Spillville, and Terril soils. They are closely associated with Tama soils but have a thicker A horizon. They contain less sand and more silt than Spillville, Terril, and Turlin soils. They are better drained and contain less sand than Coland soils.

Huntsville silt loam, 0 to 2 percent slopes (98).—Most of this soil is in waterways associated with nearly level to gently sloping, well-drained soils. In a few places it is in narrow upland valleys that have steep sides. Most areas of this soil range from 3 to 15 acres in size. This soil has a profile similar to the one described as representative of the series, but the dark-colored surface layer is thicker.

This soil is well suited to intensive use for row crops. There are no major management problems, but some areas are subject to flooding of short duration. Capability unit I–1.

Huntsville silt loam, 2 to 5 percent slopes (98B).—Most areas of this soil are on the sides of narrow upland valleys and are associated with well-drained soils. Some of the associated soils have a limestone substratum. Most areas range from 3 to 15 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few areas where limestone bedrock is at a depth of 30 to 40 inches.

This soil is well suited to row crops. It is subject to slight sheet and gully erosion if runoff water concentrates. Some areas are subject to runoff from adjacent areas at higher elevations, and in some years crops are damaged by short-duration flooding and siltation. Contouring and terracing the areas above help to control erosion and reduce local runoff and siltation. Capability unit IIe–5.

Jameston Series

The Jameston series consists of nearly level, poorly drained soils on uplands. These soils are at the heads of drainageways and along the upper parts of some of them. Areas are slightly concave. These soils formed in about 24 to 30 inches of loamy material and the underlying very firm clay loam glacial till. In most places a layer of pebbles and stones forms the contact line between the overburden and the glacial till. The native vegetation was mixed prairie grasses and sedges.

In a representative profile the surface layer is black and very dark gray silty clay loam about 18 inches thick. The subsoil is about 32 inches thick. It is olive-gray, friable silty clay loam and olive, firm light clay loam in the upper part and mottled gray, yellowish-brown, and strong-brown, very firm clay loam in the lower part. The substratum is mottled strong-brown and gray, very firm clay loam.

Available water capacity is high. Permeability is slow. The content of available nitrogen is medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. These soils are typically neutral but range from mildly alkaline to slightly acid. Wetness is caused, at least in part, by hillside seepage from Cresco and Protivin soils that are commonly upslope.

If artificial drainage is adequate, these soils are suited to row crops. Undrained soils are generally in pasture. Placement and spacing of tile are very important because the subsoil is slowly permeable.

Representative profile of Jameston silty clay loam, 0 to 2 percent slopes, in a cultivated field 100 feet south and 45 feet east of the northwest corner of sec. 9, T. 98 N., R. 15 W.

A1—0 to 8 inches, black (N 2/0) silty clay loam; moderate, very fine, granular structure; friable; neutral; abrupt boundary.

A12—8 to 13 inches, black (N 2/0) silty clay loam; moderate, very fine and fine, granular structure; friable; neutral; clear boundary.

A3—13 to 18 inches, very dark gray (10YR 3/1) silty clay loam; few, fine, distinct, light olive-brown (2.5Y 5/4) mottles; moderate, very fine and fine, granular structure; friable; few, very fine, yellowish-red (5YR 4/8) oxide concentrations; neutral; clear boundary.

B1g—18 to 22 inches, olive-gray (5Y 4/2) silty clay loam; nearly continuous very dark gray (10YR 3/1) coatings on peds; moderate, very fine, subangular blocky structure; friable; few, fine, distinct, yellowish-red (5YR 4/6) oxide concentrations; neutral; clear boundary.

IIB21—22 to 28 inches, olive (5Y 4/4 and 5/4) light clay loam; discontinuous very dark grayish-brown (2.5Y 3/2) coatings on peds; moderate, very fine, subangular blocky structure; firm; few, very fine, red (2.5YR 4/6) and yellowish-red (5YR 4/6) oxide concentrations; slightly acid; clear boundary.

IIB22—28 to 32 inches, mottled gray (5Y 5/1) and yellowish-brown (10YR 5/6) clay loam; weak, fine and medium, subangular blocky structure; very firm; pebble band in upper part of horizon; neutral; clear boundary.

IIB22t—32 to 36 inches, mottled gray (5Y 5/1) and strong-brown (7.5YR 5/6) clay loam; nearly continuous gray (5Y 6/1) coatings on prisms; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; very firm; few yellowish-red (5YR 4/8) oxide concentrations, 5 millimeters in diameter; few very dark gray (10YR 3/1) and dark-gray (10YR 4/1) clay films in channels; neutral; gradual boundary.

IIB3t—36 to 50 inches, strong-brown (7.5YR 5/6) clay loam; nearly continuous gray (5Y 5/1) coatings on prisms; many, medium and coarse, distinct, gray (5Y 5/1) mottles; moderate, medium, prismatic structure; very firm; few, dark-gray (N 4/0), clay-lined root channels; few yellowish-red (5YR 4/8) oxide concentrations, 5 millimeters in diameter; neutral; abrupt boundary.

C—50 to 60 inches, strong-brown (7.5YR 5/6) clay loam; many, medium and coarse, prominent, gray (5Y 5/1) mottles; massive; very firm; moderately alkaline; strong effervescence.

The solum is generally 3½ to 5 feet thick. The A1 horizon is black (N 2/0 to 10YR 2/1). An A3 horizon is generally present and is very dark gray (10YR 3/1 or 5Y 3/1). The A horizon ranges from 15 to 22 inches in thickness. It is generally light or medium silty clay loam but ranges to light and medium clay loam.

The B1 horizon ranges from dark gray (10YR 4/1) to dark grayish brown (2.5Y 4/2) and olive gray (5Y 4/2). This horizon has mottles of high and low chroma. It is generally light to medium silty clay loam but ranges to clay loam. The B2 horizon ranges from dark grayish brown (2.5Y 4/2) to light olive brown (2.5Y 5/4) mottled in hues of 7.5YR, 10YR, and 2.5, values of 4 and 5, and chroma of 2 to 8. The upper part of the B2 horizon ranges from light to medium clay loam that is firm to very firm in consistence.

Jameston soils formed in about the same kind of material as Protivin and Riceville soils, and they are in the same drainage class as Clyde, Maxfield, and Tripoli soils. They are more poorly drained than Protivin and Riceville soils. They have more sand in the upper part of the B horizon than Maxfield soils. They have more clay and are firmer in the lower part of the B horizon than Maxfield, Clyde, and Tripoli soils. They lack the stratified B horizon of Clyde soils.

Jameston silty clay loam, 0 to 2 percent slopes (797).—This soil is in drainageways on uplands. It is associated with Cresco, Lourdes, Protivin, and Riceville soils upslope and Clyde soils downslope. Most areas are 5 to 25 acres in size.

This soil is suited to intensive use for row crops if properly drained and managed. Undrained areas are better suited to pasture. Because wetness is caused, at least in part, by hillside seepage from Cresco and Protivin soils and other associated soils, a drainage system that is designed to intercept laterally moving water is most successful. Permeability of the subsoil is slow, so proper depth and spacing of tile are very important. Large granite boulders common in some areas have to be removed before these areas can be used for crops. The major limitation is wetness. Capability unit IIw–1.

Kensett Series

The Kensett series consists of nearly level, somewhat poorly drained soils. These soils are on stream benches and uplands of low relief. They formed in 24 to 40 inches of loamy material overlying limestone bedrock.

In a representative profile the surface layer is black and very dark brown heavy silt loam about 18 inches thick. The subsoil is about 18 inches thick. It is dark grayish-brown and olive-brown, friable light clay loam in the upper part and yellowish-brown, friable sandy loam in the lower part. The substratum is shattered limestone bedrock.

Available water capacity is low to medium. Permeability is moderate. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally slightly acid to medium acid.

Kensett soils are suited to intensive use for row crops, but in years of above-average rainfall, productivity decreases in places. Tile drains are difficult to install because the soils are only moderately deep over limestone bedrock.

Representative profile of Kensett silt loam, 0 to 2 percent slopes, in a cultivated field 1,100 feet south and 45 feet east of the northwest corner of sec. 6, T. 98 N., R. 18 W.

Ap—0 to 7 inches, black (10YR 2/1) heavy silt loam high in content of sand; weak, very fine and fine, granular structure; friable; neutral; abrupt boundary.

A12—7 to 13 inches, black (10YR 2/1) heavy silt loam high in content of sand; moderate, fine, granular structure; friable; slightly acid; gradual boundary.

A13—13 to 18 inches, very dark brown (10YR 2/2) heavy silt loam high in content of sand; continuous black (10YR 2/1) coatings on peds; moderate, very fine, granular structure; friable; slightly acid; gradual boundary.

B1—18 to 23 inches, dark grayish-brown (2.5YR 4/2) light clay loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, very fine, subangular blocky structure; friable; slightly acid; clear boundary.

B2—23 to 28 inches, olive-brown (2.5YR 4/4) light clay loam; nearly continuous dark grayish-brown (2.5YR 4/2) coatings on peds; moderate, fine and medium, subangular blocky structure; friable; slightly acid; clear boundary.

B3—28 to 36 inches, yellowish-brown (10YR 5/6) sandy loam; few, fine, red (2.5YR 4/6) mottles; weak, medium and coarse, subangular blocky structure; friable; few dark oxide concentrations; slightly acid; abrupt boundary.

R—36 inches, shattered limestone bedrock.

The thickness of the solum, which is the same as the depth to limestone bedrock, is generally 28 to 36 inches, but it ranges from 24 to 40 inches. Unless limed, the A horizon ranges from slightly acid to medium acid. The A and B1 horizons are generally silt loam that has a high content of sand, or light clay loam that has a low content of sand. The range in texture is from silt loam to light silty clay loam and heavy loam.

The B2 horizon is generally somewhat stratified. It ranges from sandy loam to heavy loam and sandy clay loam.

Kensett soils formed in about the same kind of material as Ashdale, Atkinson, and Rockton soils, and they are associated with Clyde, Calco, and Coland soils. They have a greater B horizon than Ashdale, Atkinson, and Rockton soils and are not so well drained. They are not so deep over bedrock as Ashdale and Atkinson soils. They have a browner B horizon than the associated Marshan, Coland, and Calco soils and are not so poorly drained. In contrast with Marshan, Coland, and Calco soils, they are underlain by limestone bedrock at a depth of 24 to 40 inches.

Kensett silt loam, 0 to 2 percent slopes (188).—This soil is on stream benches and uplands. It is downslope from Ashdale, Atkinson, and Rockton soils that are underlain by limestone bedrock. It is upslope from Calco, Coland, and Marshan soils that are poorly drained alluvial soils. Most areas are 5 to 20 acres in size.

This soil is suited to intensive use for row crops. The major limitation is wetness in years of higher than normal rainfall. Tile drains are difficult to install because of the underlying bedrock. In years of low precipitation, productivity is decreased in places because of droughtiness. Capability unit IIw–3.

Kenyon Series

The Kenyon series consists of nearly level to moderately sloping, moderately well drained soils on uplands. The nearly level to gently sloping soils are on upland ridge crests, and the gently sloping to moderately sloping soils are on side slopes. All formed in 14 to 22 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones is between the loamy overburden and the glacial till. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown loam about 17 inches thick. The subsoil extends to a depth of about 60 inches. It is brown, friable loam in the upper part; yellowish-brown, firm loam in the middle part; and mottled, strong-brown and gray, firm loam in the lower part.

Available water capacity is high. The rate at which water moves through the friable loamy overburden differs considerably from the rate at which it moves through the firm glacial till. Permeability is moderate in the loamy overburden and moderately slow in the glacial till. Water moves more rapidly in the overburden and accumulates at the till contact, which produces wet seepy spots in some years. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Kenyon soils are well suited to row crops. Sloping areas are subject to erosion if cultivated.

Representative profile of Kenyon loam, 2 to 5 percent slopes, in a cultivated field 1,125 feet south and 220 feet east of the northwest corner of SW¼ sec. 23, T. 100 N., R. 15 W.

Ap—0 to 8 inches, black (10YR 2/1) loam; weak, very fine and fine, granular structure; friable; neutral; abrupt boundary.

A12—8 to 12 inches, very dark brown (10YR 2/2) loam; moderate, very fine and fine, granular structure; friable; neutral; clear boundary.

A3—12 to 17 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate, very fine and fine, granular structure; friable; slightly acid; clear boundary.

B1—17 to 21 inches, brown (10YR 4/3) loam; nearly continuous very dark grayish-brown (10YR 3/2) coatings on peds; moderate, very fine, subangular blocky structure; friable; medium acid; abrupt boundary.

IIB21—21 to 27 inches, yellowish-brown (10YR 5/4) loam; nearly continuous brown (10YR 4/3) coatings on peds; weak and moderate, very fine, subangular blocky structure; firm; band of pebbles ¼ inch to 1½ inches in diameter in upper part of horizon; strongly acid; clear boundary.

IIB22—27 to 34 inches, yellowish-brown (10YR 5/6) loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; firm; nearly continuous brown (10YR 5/3) coatings on prisms; medium acid; clear boundary.

IIB23—34 to 42 inches, yellowish-brown (10YR 5/6) loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium and coarse, prismatic structure parting to weak, coarse, subangular blocky; firm; neutral; gradual boundary.

IB3—42 to 60 inches, mottled strong-brown (7.5YR 5/6) and light brownish-gray (2.5Y 6/2) loam; weak, medium, prismatic structure; firm; neutral.

The solum is generally 4 to 5 feet thick. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). The A horizon and upper part of the B horizon range from loam to silt loam that has a high content of sand.

The IIB2 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) and has some grayish mottles below a depth of 20 to 34 inches. It is generally heavy loam but ranges from medium loam or sandy clay loam to light clay loam. The B horizon ranges from medium acid to very strongly acid. The soils are typically leached of carbonates to a depth of 45 to 80 inches.

Kenyon soils are commonly associated with Bassett, Clyde, Cresco, Floyd, Oran, Ostrander, Readlyn, Schley, and Tripoli soils. They have a browner B horizon and are better drained than Clyde, Floyd, Oran, Readlyn, Schley, and Tripoli soils. They have a B horizon that is firmer in the lower part than that of Ostrander soils, and they are not so well drained. They have a thicker A horizon than Bassett soils. They have less clay in the IIB horizon than Cresco soils.

Kenyon loam, 0 to 2 percent slopes (83).—In most places this soil is on high upland flats or ridge crests. It is associated with Floyd, Oran, Ostrander, Readlyn, and Schley soils. Areas are generally 5 to 40 acres in size, but some are much larger. In this soil, limestone bedrock is only 10 to 15 feet from the surface in places. This soil has a profile similar to that described as representative of the series, but gray mottles are nearer the surface.

Included with this soil in mapping were a few small areas that are not so well drained and a few small areas where the surface layer is not so deep.

This soil is well suited to intensive use for row crops and is generally associated with other well-suited soils. Capability unit I–2.

Kenyon loam, 2 to 5 percent slopes (83B).—In most places this soil is on long, convex ridges and side slopes. It is above the more poorly drained Clyde, Floyd, Readlyn, and Schley soils. Most areas are 5 to 60 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas that were not so well drained. Also included were small sandy spots that are droughty and small eroded spots where the surface layer is dark brown and lower in content of organic matter.

This soil is well suited to row crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Kenyon loam, 5 to 9 percent slopes (83C).—This soil is on short, convex side slopes. It is generally below gently sloping Kenyon and Readlyn soils. Clyde, Floyd, and Schley soils are commonly downslope. Areas are 5 to 15 acres in size.

This soil has a profile similar to that described as representative of the series, but the dark-colored surface layer is not so thick. In eroded spots the surface layer is dark brown and lower in content of organic matter. The underlying glacial till is generally nearer the surface than in the less sloping Kenyon soils.

This soil is well suited to row crops. It is subject to moderate erosion if cultivated. Capability unit IIIe–1.

Kenyon loam, 5 to 9 percent slopes, moderately eroded (83C2).—This soil is on short, convex side slopes. It is generally below gently sloping Kenyon and Readlyn soils and above Clyde and Floyd soils. Areas are generally 3 to 10 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is very dark grayish brown or dark brown and is not so thick. The underlying glacial till is generally nearer the surface than in the less eroded Kenyon soils.

This soil is suited to row crops. It is subject to moderate erosion if cultivated. Capability unit IIIe–1.

Klinger Series

The Klinger series consists of nearly level, somewhat poorly drained soils on uplands. These soils are on flats and at the heads of waterways. They formed in 20 to 40 inches of loess and the underlying till or till-derived material. In many places a layer of pebbles is at or near the contact line between the loess and the underlying glacial materials. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown, friable silty clay loam about 18 inches thick. The subsoil is about 27 inches thick. It is dark grayish-brown, friable silty clay loam in the upper part; olive-brown, friable loam in the middle part; and mottled olive-brown, yellowish-brown, and grayish-brown, firm loam in the lower part. The substratum is brownish, firm loam.

Available water capacity is high. Permeability is moderate in the loess and moderately slow in the underlying till. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid.

Klinger soils are well suited to cultivated crops and are generally associated with large areas of other well-suited soils. Artificial drainage is beneficial in some areas.

Representative profile of Klinger silty clay loam, 0 to 2 percent slopes, in a cultivated field 1,500 feet south and 80 feet east of northwest corner of sec. 36, T. 99 N., R. 17 W.

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

A12—7 to 13 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; medium acid; gradual boundary.

A3—13 to 18 inches, very dark grayish-brown (2.5Y 3/2) medium silty clay loam; slightly darker coatings on peds; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; medium acid; gradual boundary.

B21—18 to 27 inches, dark grayish-brown (2.5Y 4/2) medium silty clay loam; common, fine, distinct, light olive-brown (2.5Y 5/4) mottles and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak and moderate, fine, subangular blocky structure; friable; slightly acid; abrupt boundary.

IIB22t—27 to 31 inches, olive-brown (2.5Y 4/4) loam; dark grayish-brown (2.5Y 4/2) coatings on peds; common, fine, distinct, yellowish-brown (10YR 5/6) and dark grayish-brown (2.5Y 4/2) mottles; weak, medium, prismatic structure parting to weak and moderate, fine, subangular blocky; friable; few, thin, discontinuous clay films; slightly acid; gradual boundary.

IIB31t—31 to 37 inches, mottled light olive-brown (2.5Y 5/4) and yellowish-brown (10YR 5/6) loam; dark grayish-brown (10YR 4/2) coatings on peds; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; firm; root channels lined with dark grayish-brown (2.5Y 4/2) clay films; neutral; gradual boundary.

IIB32—37 to 45 inches, mottled yellowish-brown (10YR 5/6) and light olive-brown (2.5Y 5/2) loam; few, fine, distinct, yellowish-red (5YR 4/6) mottles; dark grayish-brown (2.5Y 4/2) coatings on peds; very weak, coarse, prismatic structure parting to very weak, coarse, subangular blocky; firm; few, fine, very dark gray (10YR 3/1), soft oxide concentrations; mildly alkaline; clear boundary.

IIC—45 to 52 inches, mottled light olive-brown (2.5Y 5/6), pale-brown (10YR 6/3), and yellowish-brown (10YR 5/8) loam; few, fine, distinct, yellowish-red (5 YR 4/8) mottles; massive; firm; few, fine, very dark gray (10YR 3/1), soft oxide concentrations; moderately alkaline; strongly effervescent.

The solum is generally 3½ to 4 feet thick but ranges from 3 to 5 feet. The loess is generally 24 to 32 inches thick but ranges from 20 to 40 inches. The A3 horizon ranges from very dark grayish brown (2.5Y 3/2) to very dark gray (10YR 3/1). The B1 horizon, if present, is dominantly dark grayish-brown (2.5Y or 10YR 4/2) medium or light silty clay loam. The A3 horizon and that part of the B horizon formed in loess range from medium to light silty clay loam. The part of the B horizon formed in loess ranges from dark grayish brown (10YR or 2.5Y 4/2) to light olive brown (2.5Y 5/4) and has a few mottles. The content of sand in the A and B horizons ranges from 3 to 10 percent, but it is higher near the loess-till contact. The IIB horizon is generally loam but ranges to sandy clay loam and, in some places, to light clay loam. In places discontinuous lenses of sandy loam to sand, 1 to 8 inches thick, are between the loess and the till.

Klinger soils are associated with Dinsdale, Franklin, Maxfield, and Waubeek soils. They have a grayer B horizon than Dinsdale and Waubeek soils and are not so well drained. They have a thicker combined Ap and A1 horizon than Franklin and Waubeek soils and lack an A2 horizon. They have a browner B horizon than Maxfield soils and are better drained.

Klinger silty clay loam, 0 to 2 percent slopes (184).—This soil is on uplands, on flats, and at the heads of waterways. It is generally above Maxfield soils and downslope from gently sloping or nearly level Dinsdale, Franklin, or Waubeek soils. Areas are generally 5 to 80 acres in size.

Included with this soil in mapping were a few small areas near drainageways that are poorly drained and a few small areas where the surface layer is somewhat thinner, lighter colored, and lower in content of organic matter. Also included were a few areas of Klinger soil in which shallow sinkholes retain water for short periods. These areas benefit from surface drainage.

This soil is well suited to intensive use for row crops. It is generally associated with large areas of other well-suited soils. Capability unit I–3.

Lamont Series

The Lamont series consists of nearly level to moderately sloping, well-drained soils. These soils are on uplands and stream benches. They formed in 20 to 40 inches of sandy loam over loamy sand or sand. The native vegetation was trees.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam about 5 inches thick. The subsurface layer, about 9 inches thick, is brown, very friable fine sandy loam. The subsoil, about 17 inches thick, is dark yellowish-brown, friable fine sandy loam. The substratum is yellowish-brown sand.

Available water capacity is low. Permeability is moderately rapid in the upper part and very rapid in the sandy substratum. The content of available nitrogen is very low to low. The subsoil is medium in available phosphorus and very low in available potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are generally medium acid or strongly acid.

Lamont soils are suited to cultivated crops, but they are somewhat droughty. Moisture limits crop production in most years. These soils are subject to soil blowing, and sloping areas are subject to water erosion if cultivated.

Representative profile of Lamont fine sandy loam, 0 to 2 percent slopes, in a cultivated field 910 feet north and 545 feet east of the southwest corner of SE¼ sec. 2, T. 99 N., R. 15 W.

Ap—0 to 5 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, light brownish gray (10YR 6/2) dry;

moderate, fine and very fine, granular structure; friable; medium acid; abrupt boundary.

A2—5 to 14 inches, brown (10YR 4/3) fine sandy loam, very pale brown (10YR 7/3) dry; weak, medium, platy structure; very friable; medium acid; clear boundary.

B1—14 to 20 inches, dark yellowish-brown (10YR 4/4) fine sandy loam; weak, fine, subangular blocky structure; friable; very pale brown (10YR 7/3) grainy coatings when dry; medium acid; clear boundary.

B2t—20 to 31 inches, dark yellowish-brown (10YR 4/4) fine sandy loam; weak, medium, subangular blocky structure; thin, discontinuous, dark yellowish-brown (10YR 3/4) clay films on faces of peds; medium acid; clear boundary.

C1—31 to 44 inches, yellowish-brown (10YR 5/6) sand that has lenses of brown (7.5YR 4/4) loamy fine sand 1/2 inch thick, at depths of 31, 36, and 43 inches; massive; very friable; medium acid; clear boundary.

C2—44 to 72 inches, yellowish-brown (10YR 5/4) fine sand that has lenses of brown (7.5YR 4/4) loamy fine sand, 1/2 inch thick at depths of 49, 55, and 69 inches; single grained; loose; medium acid.

The solum is generally 2½ to 4 feet thick. In uncultivated areas, the A1 horizon is very dark gray (10YR 3/1) to dark gray (10YR 4/1) and is 2 to 5 inches thick.

The B horizon is generally fine sandy loam but it ranges to light sandy loam or heavy sandy loam. It ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) or strong brown (7.5YR 5/6).

The C horizon is dominantly yellowish brown (10YR 5/6) or strong brown (7.5YR 5/6), but sand grains of grayer color are evident.

Lamont soils are associated with Bixby, Dickinson, Flagler, Hayfield, Lilah, and Wapsie soils and formed in similar materials. They have a thinner A1 horizon than Dickinson and Flagler soils. They have a higher sand content in the A horizon and upper part of the B horizon than Bixby, Hayfield, and Wapsie soils. They are better drained and have a browner B horizon than Hayfield soils. In contrast with Burkhardt and Lilah soils, they do not have gravel in the B and C horizons.

Lamont fine sandy loam, 0 to 2 percent slopes (110).—This soil is on low, convex ridges on uplands and on benches. It is associated with many different soils on uplands. It typically is adjacent to the Bixby, Flagler, Lilah, and Wapsie soils and is at slightly higher elevations than Hayfield soils on benches. Areas are generally 3 to 15 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas that are somewhat darker than typical and spots that are somewhat wet. The sand is slightly coarser on the benches than on uplands. Some areas, commonly along the Wapsipinicon River, have gravel below a depth of 30 inches.

This soil is suited to row crops, but it is droughty. Moisture limits crop production in many years. Soil blowing is a hazard in cultivated areas. Leaving crop residue on the surface helps control soil blowing and conserves water and soil. Capability unit IIIs–1.

Lamont fine sandy loam, 2 to 5 percent slopes (110B).—This soil is on ridges and side slopes on uplands and on high benches. It is associated with many different soils on uplands. On the benches it is typically adjacent to Bixby, Flagler, Lilah, and Wapsie soils and just above Hayfield soils. Areas are generally 3 to 15 acres in size.

Included with this soil in mapping were a few small areas of exposed gravel, a few spots that have a loamy sand or sand surface layer, and on uplands, a few spots where glacial till is at a depth of 30 to 40 inches. On benches, the sand is somewhat coarser than is typical. In some areas a few pebbles are at a depth of 30 inches.

This soil is suitable to row crops, but it is droughty. Moisture limits crop production. The soil is subject to slight soil blowing and water erosion if cultivated. Leaving crop residue on the surface helps controls soil blowing and water erosion and conserves water. Capability unit IIIe–4.

Lamont fine sandy loam, 5 to 9 percent slopes (110C).—This soil is on ridges and side slopes on uplands. It is associated with many soils. Areas are generally 3 to 8 acres in size. This soil has a profile similar to that described as representative of the series, but the depth to sand is less.

Included with this soil in mapping were a few small areas in which glacial till is at a depth of about 20 to 40 inches, a few small areas where the surface layer is loamy sand, and a few small areas where gravel is at or near the surface.

This soil is suitable for row crops. It is subject to soil blowing and water erosion if cultivated. It is droughty, and moisture limits crop production in most years. Leaving crop residue on the surface helps control soil blowing and water erosion and conserves water for crop use. Capability unit IIIe–4.

Lamont-Renova complex, 2 to 5 percent slopes (610B).—This complex consists of ridges of gently sloping Lamont soils closely associated with gently sloping Renova soils. Lamont soils commonly make up about 60 percent of the complex, but the range is from 30 to 70 percent. Most areas are 5 to 15 acres in size. The Lamont soils contain more sand than the Renova soils and are droughty. The Renova soils have high available water capacity.

Included with this complex in mapping were a few small areas of Racine and Coggon soils, a few small areas of wet soils, and a few small areas where the surface layer is loamy sand.

The soils in this complex are well suited to cultivated crops, but productivity is variable, particularly in dry periods. Lamont soils are subject to slight soil blowing if cultivated, and Lamont and Renova soils are subject to slight water erosion. Capability unit IIe–4.

Lawler Series

The Lawler series consists of nearly level, somewhat poorly drained soils. These soils are on stream benches. They formed in 24 to 40 inches of medium-textured alluvial deposits overlying thick layers of coarse-textured material. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown heavy loam about 16 inches thick. The subsoil is about 24 inches thick. It is dark grayish-brown, friable light clay loam in the upper part; mottled dark grayish-brown and light olive-brown, friable sandy clay loam in the middle part; and dark yellowish-brown, very friable gravelly loamy sand in the lower part. The substratum is mottled yellowish-brown and grayish-brown, loose gravelly sand.

Available water capacity is medium. Permeability is moderate in the medium-textured material and rapid to very rapid in the coarse-textured substratum. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are slightly acid to medium acid.

Lawler soils are well suited to row crops. These moderately deep soils are slightly droughty in years of normal to below-normal rainfall.

Representative profile of Lawler loam, moderately deep, 0 to 2 percent slopes, in a cultivated field 50 feet west and 30 feet north of the center of sec. 9, T. 97 N., R. 17 W.

Ap—0 to 8 inches, black (10YR 2/1) heavy loam; cloddy, breaking to very fine and fine granular structure; friable; neutral; clear boundary.

A12—8 to 13 inches, very dark brown (10YR 2/2) heavy loam; black (10YR 2/1) coatings on peds; weak, very fine and fine, granular structure; friable; few pebbles; medium acid; clear boundary.

A3–13 to 16 inches, very dark grayish-brown (10YR 3/2) heavy loam; discontinuous very dark gray (10YR 3/1) coatings on peds; moderate, fine and very fine, granular structure; friable; few, grainy, light-gray (10YR 6/1) coatings when dry; medium acid; gradual boundary.

B21—16 to 26 inches, dark grayish-brown (10YR 4/2) light clay loam; moderate, very fine, subangular blocky structure; friable; few brown (7.5YR 4/4) and yellowish-brown (10YR 5/6) oxide concentrations; few, patchy, light brownish-gray (10YR 6/2) grainy coatings when dry; medium acid; clear boundary.

B22—26 to 30 inches, mottled dark grayish-brown (2.5YR 4/2) and light olive-brown (2.5YR 5/6) sandy clay loam; weak, medium, subangular blocky structure; friable; few, fine, brown (7.5YR 4/4) oxide concentrations; few stones, 2 millimeters in diameter; medium acid; clear boundary.

IIB3t—30 to 40 inches, dark yellowish-brown (10YR 4/4) gravelly loamy sand; common grayish-brown (10YR 5/2) mottles; coarse, very weak, subangular blocky structure; very friable; clay bridging between sand grains; few, fine, dark-brown (7.5YR 4/4) oxide concentrations; medium acid.

IIC1—40 to 60 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (10YR 5/2) gravelly sand; single grained; loose; few, fine, dark-brown (7.5YR 4/4) oxide concentrations; slightly acid.

The solum is generally 24 to 40 inches thick. In some areas it extends into the upper part of the underlying sand and gravel. The A horizon is generally loam but ranges to light silty clay loam that has a high content of sand.

The B2 horizon generally ranges from loam to sandy clay loam and light clay loam. It is commonly underlain by a thin zone of sandy loam below a depth of 24 to 36 inches. The IIB3 horizon or the upper part of the IIC horizon generally ranges from loamy coarse sand to gravelly sand and has thin layers of sandy loam.

Lawler soils are associated with Hayfield, Marshan, Saude, Turlin, and Waukee soils and formed in similar materials. They have a thicker A1 horizon than Hayfield soils. They are not so well drained as Saude and Waukee soils and have a grayer B horizon. They are not so poorly drained as Marshan soils and have a browner B horizon. They have a thinner A horizon than Turlin soils.

Lawler loam, deep, 0 to 2 percent slopes (226).—This soil is on stream benches. Most areas are 4 to 30 acres in size, but a few are larger. This soil has a profile similar to that described as representative of the series, but sand and gravel are at a depth of 32 to 40 inches.

Included with this soil in mapping were a few small areas in which the coarse materials are somewhat deeper or shallower.

This soil is well suited to cultivated crops. It is somewhat poorly drained and benefits from tile drainage in wet seasons. Tile placement is difficult in some places because of loose, unstable sand. Capability unit I–3.

Lawler loam, moderately deep, 0 to 2 percent slopes (225).—This soil is on stream benches. Most areas are 4 to 30 acres in size, but a few are larger. This soil has the profile described as representative of the series, but sand and gravel are at a depth of 24 to 32 inches.

This soil is well suited to cultivated crops. During extended dry periods it is somewhat droughty. It is somewhat poorly drained and benefits from tile drainage in wet seasons. Tile placement is difficult in some places because the sand is loose and unstable. Capability unit IIs–1.

Lilah Series

The Lilah series consists of nearly level to moderately sloping, excessively drained soils. These soils are on stream benches and upland outwash areas. They formed in 10 to 20 inches of sandy loam that contains a few pebbles overlying gravelly and sandy materials.

In a representative profile the surface layer is dark grayish-brown sandy loam about 7 inches thick. The subsoil is about 26 inches thick. It is brown, very friable sandy loam in the upper part; yellowish-brown, light sandy loam in the middle part; and strong-brown, finely gravelly loamy sand in the lower part. The substratum is light yellowish-brown, finely gravelly loamy sand.

Available water capacity is low to very low. Permeability is moderately rapid in the upper part and rapid to very rapid in the lower part. The content of available nitrogen is very low, and the subsoil is very low in available phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are strongly acid.

Lilah soils are poorly suited to grow crops. They are very droughty, and sloping areas erode easily if cultivated.

Representative profile of Lilah sandy loam, 3 to 9 percent slopes, in a cultivated field 125 feet east and 355 feet north of the southwest corner of SE¼NW¼ sec. 20, T. 100 N., R. 16 W.

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) sandy loam; slightly darker coatings on peds; weak, fine, granular structure; very friable; slightly acid; abrupt boundary.

B1—7 to 12 inches, brown (10YR 4/3) sandy loam; weak and moderate, fine, subangular blocky structure; very friable; few fine pebbles throughout; slightly acid; clear boundary.

B2t—12 to 20 inches, yellowish-brown (10YR 5/4) light sandy loam; very weak, coarse, subangular blocky structure; very friable; 5 percent fine pebbles; few, very thin, dark-brown (7.5YR 4/4), discontinuous clay films on faces of peds; slightly acid; clear boundary.

IIB3t—20 to 33 inches, strong-brown (7.5YR 5/6) finely gravelly loamy sand; very weak, coarse, subangular blocky structure; very friable; weakly cemented when dry; 70 percent fine gravel; clay bridging between many sand grains; strongly acid; clear boundary.

IIC—33 to 60 inches, light yellowish-brown (10YR 6/4) finely gravelly loamy sand; single grained; very friable; slightly cemented when dry; 40 percent fine gravel; clay bridging between some sand grains; very strongly acid.

The solum is generally 30 to 42 inches thick. The A1 or Ap horizon is generally dark grayish brown (10YR 4/2) or very dark grayish brown (10YR 3/2) and is 3 to 9 inches thick. It is generally sandy loam but ranges to light loam and gravelly sandy loam. The A2 horizon, if present, is generally brown (10YR 4/3 or 5/3) sandy loam.

The B1 horizon is generally brown (10YR 4/3 or 5/3) sandy loam that has some pebbles, but it ranges to light loam or gravelly sandy loam. The B2t and B3t horizons range from brown (10YR 5/3) to yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6). The B2t horizon is generally gravelly sandy loam but ranges to gravelly loamy sand and light loam. If the texture is sandy loam or light loam, it does not extend beyond 20 inches in depth.

The Lilah and Burkhardt soils formed in similar materials. Lilah soils are associated with Bixby and Wapsie soils. They have a thinner A1 horizon than Burkhardt soils and have an A2 horizon. They have more sand and are shallower over gravelly materials than Bixby and Wapsie soils.

Lilah sandy loam, 0 to 3 percent slopes (776).—Most areas of this soil are on stream benches. A few areas are on uplands. Most areas are 2 to 10 acres in size, and a few are much larger.

Included with this soil in mapping were a few small areas of Wapsie soils that contain less sand in the surface layer and subsoil. Also included were spots where gravelly material is at the surface.

This soil is poorly suited to row crops. It is excessively drained and very droughty. Soil blowing is a slight hazard in cultivated areas. Generally, small areas are cropped along with the adjacent soil, and larger areas are in pasture. A few areas are wooded. Capability unit IVs–1.

Lilah sandy loam, 3 to 9 percent slopes (776C).—This soil is on uplands and narrow bench escarpments. Most areas are 2 to 10 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas that have heavier textured glacial till within a few feet of the surface and a few eroded areas that have gravelly material on the surface.

This soil is poorly suited to row crops. It erodes easily if cultivated. Small areas are commonly cropped along with the adjacent soils. Larger areas are commonly used for pasture. A few areas are wooded. Capability unit IVs–2.

Lourdes Series

The Lourdes series consists of gently sloping to moderately sloping, moderately well drained soils on uplands. The gently sloping soils are on long, convex ridge crests and the gently sloping to moderately sloping soils are on side slopes. All formed in 13 to 22 inches of loamy material and the underlying very firm clay loam glacial till. In most places a layer of pebbles and stones forms the contact line between the overburden and the glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 8 inches thick. The subsurface layer, about 4 inches thick, is brown, friable loam. The subsoil is about 36 inches thick. The upper part, about 6 inches thick, is yellowish-brown, friable loam. Below this, the subsoil is strong-brown and yellowish-brown, very firm clay loam that has continuous gray coatings on peds. The substratum is yellowish-brown, very firm clay loam.

Available water capacity is high. The rate at which water moves through the loamy overburden differs considerably from the rate at which it moves through the glacial till. Permeability is moderate in the loamy overburden, generally 1½ to 2 feet thick, and slow in the till. Water moves more rapidly in the overburden, and then tends to accumulate at the till contact, which causes a seasonal perched water table and sidehill seepage in wet years. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

These soils are generally suited to row crops if properly managed. During extended wet periods, cultivation is delayed in places. Most areas of this soil are subject to erosion if cultivated.

Representative profile of Lourdes loam, 2 to 5 percent slopes, in a cultivated field 365 feet north and 75 feet east of the southwest corner of NE¼ sec. 1, T. 98 N., R. 16 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; medium acid.

A2—8 to 12 inches, brown (10YR 4/3) loam; patchy very dark grayish-brown (10YR 3/2) coatings on plates; modrate, medium, platy structure; friable; strongly acid; clear boundary.

B1—12 to 18 inches, yellowish-brown (10YR 5/4) heavy loam; common, fine, yellowish-brown (10YR 5/6 and 5/8) mottles; brown (10YR 4/3) coatings on peds; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; light-gray (10YR 7/1) grainy coatings when dry; pebble band, 1 to 4 inches in diameter, in lower part of horizon; strongly acid; clear boundary.

IIB21t—18 to 24 inches, strong-brown (7.5YR 5/6) clay loam; common, fine, distinct, gray (5Y 5/1) mottles; continuous gray (5Y 5/1) coatings on peds; moderate, medium, prismatic structure parting to strong, fine, subangular blocky; very firm; few very dark gray (10YR 3/1) clay films on faces of peds; many clay-lined and filled root channels; few reddish-brown (5YR 4/4) and black (10YR 2/1) oxide concentrations; very strongly acid; gradual boundary.

IIB22t—24 to 31 inches, yellowish-brown (10YR 5/6) clay loam; nearly continuous gray (5Y 5/1) coatings on peds; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very firm; few very dark gray (10YR 3/1) clay films and clay-filled pores; few yellowish-red (7.5YR 6/8) oxide concentrations; very strongly acid; clear boundary.

IIB3t—31 to 48 inches, yellowish-brown (10YR 5/6) clay loam; discontinuous gray (5Y 5/1) coatings on prisms; weak, coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; very firm; many clay-filled root channels of very dark gray (10YR 3/1); few, small, reddish-yellow (7.5YR 6/8) and dark yellowish-brown (10YR 4/8) oxide concentrations; neutral; clear boundary.

IIC—48 to 60 inches, yellowish-brown (10YR 5/6) light clay loam; many, medium, gray (5Y 5/1) mottles; massive; very firm; few root channels filled with very dark gray (10YR 3/1) clay; few yellowish-red (5YR 5/8) oxide concentrations; many, fine, soft, white (10YR 8/1) lime concentrations; moderately alkaline; slight effervescence.

The solum is generally about 48 inches thick but ranges from 40 to 60 inches. In uncultivated areas the A1 horizon is black (10YR 2/1). The Ap horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A horizon ranges from silt loam that has a high content of sand to loam. The A2 horizon is commonly incorporated in the plow layer.

The B1 horizon ranges from brown (10YR 4/3) to yellowish-brown (10YR 5/6) loam. The IIB2 horizon ranges from yellowish brown (10YR 5/6) to strong brown (7.5YR 5/6) and has discontinuous to continuous gray (10YR 6/1) coatings on ped and prism exteriors. The IIB2 horizon is generally very firm, medium clay but ranges to light clay loam.

The C horizon is mottled strong-brown (7.5YR 5/6) or yellowish-brown (10YR 5/6) and gray (10YR 6/1), very firm clay loam that is calcareous.

Lourdes soils formed in about the same kind of material as Bassett, Cresco, Protivin, and Riceville soils. They are better drained and have a browner B horizon than Protivin and Riceville soils. They have a thinner A1 horizon than Cresco and Protivin soils. Lourdes soils contain more clay and have a firmer B horizon than Bassett soils.

Lourdes loam, 2 to 5 percent slopes (781B).—This soil is on long, convex ridges and side slopes. In most places it is upslope from Protivin, Riceville, and Schley soils. It is commonly associated with Cresco soils and other Lourdes soils. Most areas range from about 5 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas where the surface layer is brown or dark brown and is lower in content of organic matter. A few small areas of the more poorly drained Riceville soils were also included.

This soil is generally suited to row crops. It is subject to slight erosion if cultivated. Because of the slowly permeable subsoil, wetness and seepage are limitations in wet seasons. Capability unit IIe–2.

Lourdes loam, 5 to 9 percent slopes (781C).—This soil is on short, convex side slopes. It is below gently sloping Lourdes soils and above Riceville and Schley soils. Most areas are about 3 to 10 acres in size. This soil has a profile similar to that described as representative of the series, but the loamy overburden is not so thick.

Included with this soil in mapping were a few moderately eroded areas where the plow layer is dark grayish-brown to brown loam. These eroded soils are lower in content of organic matter, and the slowly permeable till is at a shallower depth.

This soil is suited to row crops if properly managed. It is subject to moderate erosion if cultivated. Because of the slowly permeable subsoil, wetness and seepage are limitations in wet seasons. Capability unit IIIe–2.

Lourdes loam, 5 to 9 percent slopes, moderately eroded (781C2).—This soil is on short convex side slopes. It is mainly below gently sloping Lourdes soils and generally above Clyde, Protivin, and Riceville soils. Most areas are about 3 to 10 acres in size.

This soil has a profile similar to that described as representative of the series, but it is somewhat shallower over glacial till than the less eroded Lourdes soil and the surface layer is brown and very dark brown to yellowish brown.

This soil is suited to row crops if erosion is controlled. It is subject to moderate erosion if cultivated. Because the subsoil is slowly permeable, wetness and seepage are limitations in wet seasons. Capability unit IIIe–2.

Marsh

Marsh (354) is a miscellaneous land type that is on first bottoms and very low terraces in flat or depressional areas. The water table is at or near the surface. Areas of Marsh are interspersed with ponds, intermittent ponds, and shallow lakes. They remain wet all year. The natural vegetation is mainly cattails, rushes, sedges, and other water-tolerant plants. Capability unit VIIw–1.

Marshan Series

The Marshan series consists of nearly level, poorly drained soils. These soils are on stream benches. They formed in 24 to 40 inches of loamy alluvial deposits and the underlying thick layers of sandy materials. The native vegetation was prairie grasses, sedges, and other water-tolerant plants.

In a representative profile the surface layer is black and very dark grayish-brown clay loam about 21 inches thick. The subsoil is about 13 inches thick. It is olive-gray and gray, friable loam in the upper part and light olive-brown, very friable loamy sand in the lower part. The substratum is light yellowish-brown and pale-olive sand.

Available water capacity is medium to low. Permeability is moderate in the loamy upper part and rapid to very rapid in the sandy lower part. The water table is seasonally high. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. In most places these soils are neutral and do not require lime.

Marshan soils are well suited to row crops if properly drained. Undrained areas are generally in pasture. Tile placement is difficult in some areas because loose, unstable sand is at a depth of about 3 feet.

Representative profile of Marshan clay loam, moderately deep, 0 to 2 percent slopes, in a cultivated field 700 feet west and 65 feet north of the southeast corner of NE¼ sec. 9, T. 97 N., R. 17 W.

Ap—0 to 9 inches, black (N 2/0) clay loam; weak, very fine and fine, granular structure; friable; neutral; abrupt boundary.

A12—9 to 15 inches, black (10YR 2/1) light clay loam; weak, fine and very fine, granular structure; friable; few worm casts and mixings of olive gray (5Y 5/2); neutral; gradual boundary.

A3—15 to 21 inches, very dark grayish-brown (2.5Y 3/2) light clay loam; common, fine, distinct, olive-gray (5Y 5/2) and olive (5Y 5/4) mottles; slightly darker coatings on peds; moderate, fine and very fine, granular structure; friable; few, very fine, red (2.5YR 4/6) oxide concentrations; neutral; clear boundary.

B21g—21 to 24 inches, olive-gray (5Y 4/2) heavy loam; few, fine, faint, patchy, olive (5Y 4/3) and light olive-brown (2.5Y 5/4) mottles; weak, fine, subangular blocky structure; friable; few, fine, prominent, strong-brown (7.5YR 5/6) oxide concentrations; neutral; clear boundary.

B22g—24 to 27 inches, olive (5Y 5/3) loam; weak, fine, subangular blocky structure; friable; few very dark gray (10YR 3/1 and 5Y 3/1) channel fills; few, patchy, olive-gray (5YR 4/2) coatings on peds; few, fine, strong-brown (7.5YR 5/5) oxide concentrations; mildly alkaline; abrupt boundary.

IIB31—27 to 34 inches, light olive-brown (2.5Y 5/6) loamy sand; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; very friable; few pebbles ½ inch in diameter; sandy loam krotovinas of very dark grayish brown (10YR 3/2); mildly alkaline; abrupt boundary.

IIC1—34 to 39 inches, light yellowish-brown (2.5Y 6/4) sand; very weak, medium and coarse, prismatic structure; very friable; mildly alkaline; abrupt boundary.

IIC2—39 to 80 inches, pale-olive (5Y 6/3) sand; single grained; loose; few fine pebbles; mildly alkaline.

The solum is generally 30 to 40 inches thick. The A1 horizon is black (N 2/0 to 10YR 2/1). The A3 horizon, if present, is generally very dark gray (10YR 3/1 to 5Y 3/1) or very dark grayish brown (2.5Y 3/2) and has olive-gray (5Y 5/2) mottles. The A horizon is dominantly clay loam but ranges from heavy loam to silty clay loam.

The upper part of the B horizon ranges from dark gray

(10YR 4/1 or 5Y 4/1) to dark grayish brown (2.5Y 4/2) or olive gray (5Y 5/2) and from loam to silty clay loam that has a high content of sand. The IIB horizon ranges from heavy sandy loam to sand.

The IIC horizon ranges from gravelly loamy sand to sand and has some gravel.

Marshan soils formed in about the same kind of material as Hayfield and Lawler soils and are in the same drainage class as Clyde and Coland soils. They are more poorly drained and have a grayer B horizon than Hayfield and Lawler soils. They are underlain by thick beds of sand or gravelly sand, but Clyde soils are underlain by glacial till. They have a thinner A horizon than Coland soils.

Marshan clay loam, deep, 0 to 2 percent slopes (152).—This soil is on stream benches. It is associated with many of the bench soils, such as Lawler and Hayfield. The Calco, Coland, and Turlin soils are commonly on the adjoining bottom lands. Most areas are 4 to 20 acres in size, and a few are much larger. This soil has a profile similar to that described as representative of the series, but the sandy materials are generally at a depth of 36 to 40 inches.

Included with this soil in mapping were a few depressions that are seasonally ponded and are difficult to drain.

This soil is well suited to intensive use for row crops if drained and properly managed. It generally has good tilth, but it puddles if worked when wet. Tile placement is difficult where loose, unstable sand is at a depth of about 3 feet. Capability unit IIw–1.

Marshan clay loam, moderately deep, 0 to 2 percent slopes (151).—This soil is on stream benches and in valleys. It is associated with many of the bench soils, such as Hayfield and Lawler. Coland and Turlin soils are commonly on the adjoining bottom lands. Most areas are 4 to 20 acres in size. This soil has the profile described as representative of the series.

This soil is well suited to intensive use for row crops if drained and properly managed. It generally has good tilth, but it puddles if worked when wet. Tile placement is difficult where loose, unstable sand is at a depth of 2½ to 3 feet. Capability unit IIw–1.

Maxfield Series

The Maxfield series consists of nearly level, poorly drained silty soils on uplands. These soils are on flats and in shallow drainageways. They formed in 24 to 40 inches of loess and the underlying glacial till. In most places, a layer of pebbles forms the contact line between the loess and the glacial till. The native vegetation was grasses and water-tolerant plants.

In a representative profile the surface layer is black and very dark grayish-brown silty clay loam about 19 inches thick. The subsoil is about 33 inches thick. It is olive-gray light silty clay loam in the upper part and yellowish-brown, firm heavy loam in the lower part. The substratum is yellowish-brown, firm loam.

Available water capacity is high. Permeability is moderate in the loess and moderately slow in the till. The content of available nitrogen is medium. The subsoil is very low in available phosphorus and potassium. In most places these soils are neutral and do not require lime.

Maxfield soils are well suited to intensive use for row crops, and most areas are used for that purpose. Artificial drainage is beneficial in most years.

Representative profile of Maxfield silty clay loam, 0 to 2 percent slopes, in a cultivated field 390 feet west and 105 feet south of the northeast corner of SE¼ sec. 8, T. 98 N., R. 16 W.

Ap—0 to 8 inches, black (N 2/0) silty clay loam; weak, very fine and fine, granular structure; firm; neutral; abrupt boundary.

A12—8 to 15 inches, black (10YR 2/1) heavy silty clay loam; very weak, fine, granular and very fine subangular blocky structure; firm; few, very fine, yellowish-red (5YR 4/6) and red (2.5YR 4/6), soft oxide concentrations; neutral; clear boundary.

A3—15 to 19 inches, very dark grayish-brown (2.5Y 3/2) heavy silty clay loam; discontinuous very dark gray (10YR 3/1) coatings on peds; moderate, very fine and fine, granular structure; friable; few strong-brown (7.5YR 5/6), yellowish-red (5YR 4/6), and dark reddish-brown (5YR 3/2) oxide concentrations; neutral; clear boundary.

B21g—19 to 26 inches, olive-gray (5Y 5/2) light silty clay loam; common, fine, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; weak, fine, subangular blocky structure; friable; few dark-gray (10YR 4/1) clay films on faces of peds and in root channels; few dark reddish-brown (5YR 3/2) oxide concentrations; neutral; clear boundary.

B22g—26 to 29 inches, olive-gray (5Y 5/2) heavy silt loam; many, fine, yellowish-brown (10YR 5/6) mottles; weak, very fine, subangular blocky structure; friable; few yellowish-red (5YR 4/6) oxide concentrations; neutral; abrupt boundary.

IIB31—29 to 32 inches, mottled strong-brown (7.5YR 5/6) and light brownish-gray (10YR 6/2) sandy loam; very weak, medium, subangular blocky structure; very friable; few dark oxide concentrations; few pebbles, more than 2 millimeters in diameter; neutral; clear boundary.

IIB32—32 to 52 inches, yellowish-brown (10YR 5/6) heavy loam; common, medium, gray (5Y 5/1) and grayish-brown (2.5Y 5/2) mottles; moderate, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; firm; discontinuous gray (5Y 5/1) coatings on prisms; common dark reddish-brown (5YR 3/2) oxide concentrations; few dark-gray (10YR 4/1) clay films in root channels; few pebbles more than 2 millimeters in diameter; neutral; abrupt boundary.

IIC—52 to 60 inches, yellowish-brown (10YR 5/6) loam; weak, coarse, prismatic structure; firm; few pebbles, more than 2 millimeters in diameter; mildly alkaline; slight effervescence.

The solum is generally 42 to 54 inches thick. The A1 horizon is black (N 2/0 to 10YR 2/1). An A3 horizon is generally present and is very dark gray (10YR 3/1 or 5Y 3/1) to very dark grayish brown (2.5Y 3/2). The A horizon ranges from 16 to 22 inches in thickness. It is generally medium silty clay loam, but is light silty clay loam and heavy silty clay loam in places.

The B1 horizon, if present, ranges from dark gray (10YR 4/1) to dark grayish brown (2.5Y 4/2) and olive gray (5Y 4/2) and has mottles of high and low chroma. It is light to medium silty clay loam. The B2 horizon ranges from olive gray (5Y 5/2) to dark grayish brown (2.5Y 4/2) and has mottles of high and low chroma. The IIB2 and IIB3 horizons are generally heavy loam, but the range includes sandy clay loam and light clay loam thinly stratified with sandy loam.

Maxfield soils formed in about the same kind of material as Klinger, Dinsdale, and Franklin soils. They are in the same drainage class as Garwin, Clyde, and Tripoli series. They are more poorly drained and have a grayer B horizon than associated Dinsdale, Franklin, and Klinger soils. They formed in thinner deposits of loess over glacial till than Garwin soils. They are deeper over glacial till and have less sand in the A horizon and upper part of the B horizon than Tripoli soils. They have less sand in the A horizon than Clyde soils and are not so stratified in the lower part of the solum.

Maxfield silty clay loam, 0 to 2 percent slopes (382).—This soil is on flats and in shallow drainageways on uplands. It is associated with Dinsdale, Clyde, Franklin, Klinger, and Tripoli soils. Most areas are 5 to 40 acres in size.

This soil is well suited to intensive use for row crops. Drainage is beneficial in most years. The soil generally has good tilth, but it puddles if worked when wet. Capability unit IIw–1.

Muck

Muck consists of nearly level to gently sloping, very poorly drained, organic soils. It is 18 to 52 inches thick over stratified glacial till or alluvial sediment. It is mostly on concave side slopes, in drainageways, and on low benches, but in a few areas it occurs as large mounds. In many areas the substratum contains lenses of sandy material. Slopes are mostly 1 to 3 percent, but range from depressional to 5 percent. The native vegetation was sedges, grasses, and other water-tolerant plants.

In a representative profile the surface layer is black muck about 34 inches thick. The substratum is black to dark-gray, firm light clay loam and loam in the upper part and gray and olive-gray, firm silty clay loam to a depth of about 60 inches.

Available water capacity is high to very high. Permeability varies and ranges from moderately rapid in the organic part to moderately slow in the mineral part. The content of available nitrogen is high. The subsoil is low in available phosphorus and very low in available potassium. The content of organic matter is very high. Muck is slightly acid to neutral.

The surface of Muck soils is hummocky unless it has been leveled. Drainage is difficult. Tile or ditches generally must be very near the underground springs or seeps, and tile must be spaced much closer than in mineral soils if the area is to be successfully drained. The springs and seep area are commonly difficult to locate. Tile upslope from the Muck can generally be expected to intercept seep water and add to the chances of successful drainage of the area. Muck that is not drained has a water table at the surface or within a depth of 36 inches, depending on the season. If drained, Muck settles, and the total thickness of the organic layer decreases. Unless drained, Muck is poorly suited to row crops. It is more difficult to drain than the closely associated Clyde and Marshan soils.

Representative profile of Muck, moderately deep, in a permanent pasture 2,345 feet north and 825 feet west of the southeast corner of sec. 10, T. 100 N., R. 16 W.

Oa1—0 to 4 inches, black (N 2/0) muck; massive; very friable; many roots that do not disintegrate when rubbed; weak, medium, subangular blocky structure; few small stones, 2 millimeters in diameter; neutral; clear boundary.

Oa2—4 to 24 inches, black (N 2/0) muck; common roots that do not disintegrate when rubbed; weak, coarse, subangular blocky structure; common, dark reddish-brown (2.5YR 3/4), fine fibers that disintegrate when rubbed; neutral; clear boundary.

Oa3—24 to 34 inches, black (N 2/0) muck; common, dark-brown (7.5YR 3/2), fine and coarse fibers that disintegrate when rubbed; massive; neutral; clear boundary.

IIC1—34 to 38 inches, black (10YR 2/1) light clay loam grading to very dark gray (10YR 3/1) with depth; very weak, coarse, subangular blocky structure; firm; neutral; clear boundary.

IIC2g—38 to 42 inches, dark gray (5Y 4/1) loam; common mixings of very dark gray (5Y 3/1) loam; massive; firm; few krotovinas filled with black (N 2/0) muck; neutral; clear boundary.

IIC3g—42 to 60 inches, gray (5Y 5/1) and olive-gray (5Y 4/2) silty clay loam; few mixings of very dark gray (10YR 3/1) silty clay loam; massive; firm; few krotovinas of black (N 2/0) muck; mildly alkaline.

The upper organic surface layer contains a higher percentage of roots and fibers if the muck has not been cultivated. Color ranges from black (N 2/0) to very dark brown (10YR 2/2). Lenses of mucky silt loam are within the range of the lower organic horizons. The underlying mineral layers are generally somewhat stratified and within a few feet range from silty clay loam to loam, sandy loam, or sand. On uplands firm glacial till is below a depth of 50 to 90 inches.

Muck is generally closely associated with Clyde and Marshan soils. It differs from those soils principally in having thick organic layers and poorer drainage.

Muck, moderately deep (221).—This soil has black and very dark brown organic layers 18 to 52 inches thick. It is in seeps on lower hillsides, in broad upland drainageways, in level or depressed areas on stream benches, and in a few places on mounds. Muck is hummocky unless it has been leveled. On the lower hillside seeps and mounds, the areas are generally 2 to 5 acres in size, but on the benches they are as much as 30 acres. Areas in waterways range from 2 to 10 acres in size.

Included with this soil in mapping were a few areas where the muck is only about 10 to 15 inches thick and a few other areas, particularly on the mounds and benches, where it is as much as 6 feet thick.

This soil is too wet for commonly grown cultivated crops unless drained. If properly drained, it is suited to cultivated crops. Capability unit IIIw–1.

Muscatine Series

The Muscatine series consists of nearly level, somewhat poorly drained soils on uplands. These soils occupy lower, concave positions and convex ridges. They formed in loess deposits, 4 to 8 feet thick, overlying glacial till. The native vegetation was prairie.

In a representative profile the surface layer is black and very dark gray light silty clay loam about 18 inches thick. The subsoil is about 32 inches thick. It is dark grayish-brown, friable silty clay loam in the upper part; light olive-brown, friable light silty clay loam and silt loam in the middle part; and mottled, grayish-brown and yellowish-brown, friable silt loam in the lower part. The substratum is mottled, grayish-brown and yellowish-brown, friable silt loam.

Available water capacity is high. Permeability is moderate. The content of available nitrogen is low to medium. The subsoil is low in available phosphorus and very low in available potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid.

These soils are very well suited to intensive use for row crops, and most areas are in row crops year after year. Artificial drainage is beneficial in some areas.

Representative profile of Muscatine silty clay loam, 0 to 2 percent slopes, in a cultivated field 450 feet east and

85 feet north of the southwest corner of sec. 3, T. 97 N., R. 16 W.

Ap—0 to 8 inches, black (10YR 2/1) light silty clay loam; very weak, fine, granular structure; friable; neutral; abrupt boundary.

A12—8 to 13 inches, black (10YR 2/1) light silty clay loam; weak, fine, granular structure; friable; neutral; clear boundary.

A13—13 to 18 inches, very dark gray (10YR 3/1) light silty clay loam; common, fine, very dark grayish-brown (2.5Y 3/2) mottles; moderate, very fine, subangular blocky structure; friable; few, patchy, grainy, gray (10YR 6/1) ped coatings when dry; medium acid; clear boundary.

B1—18 to 22 inches, dark grayish-brown (2.5Y 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) kneaded; nearly continuous very dark gray (10YR 3/1) coatings on peds; moderate, very fine, subangular blocky structure; friable; few, patchy, grainy, gray (10YR 6/1) ped coatings when dry; medium acid; clear boundary.

B21t—22 to 26 inches, dark grayish-brown (2.5Y 4/2) medium silty clay loam; discontinuous very dark gray (10YR 3/1) coatings on peds; moderate, fine, subangular blocky structure; friable; few, thin, patchy clay films and clay-lined pores; few strong-brown (7.5YR 5/6) oxide concentrations; few dusky-red (2.5YR 3/2) oxide concentrations; slightly acid; clear boundary.

B22t—26 to 33 inches, light olive-brown (2.5Y 5/4) light silty clay loam; common, fine, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few, thin, patchy clay films and few, dark, clay-filled pores; few, very fine, dark-red (2.5YR 3/6) oxide concentrations; neutral; gradual boundary.

B31—33 to 39 inches, light olive-brown (2.5Y 5/4) silt loam; weak, coarse, subangular blocky structure; friable; few dark reddish-brown (5YR 3/4) and black (5YR 2/1) oxide concentrations; neutral; clear boundary.

B32—39 to 50 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) silt loam; weak, coarse, prismatic structure; friable; few reddish-brown (5YR 4/4) and dark reddish-brown (5YR 2/2) oxide concentrations; neutral; clear boundary.

C—50 to 60 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) silt loam; massive; friable; mildly alkaline; slight effervescence.

The solum is generally about 4 feet thick, but it ranges from 40 to 60 inches. Muscatine soils are medium acid to strongly acid in the A horizon and upper part of the B horizon and medium acid to neutral in the middle and lower parts of the B horizon.

The B horizon is 30 to 35 inches thick and centers on dark grayish brown (10YR to 2.5Y 4/2) in the upper part. Color values are 5 or 6, and chroma ranges from 2 to 6 in the lower part. The B2t horizon is silty clay loam that ranges from 27 to 35 percent clay. The maximum clay in the B horizon is in the upper part of the B2t horizon, and below this the clay content decreases with depth.

Muscatine soils formed in about the same kind of materials as Atterberry, Garwin, and Tama soils and are in the same drainage class as Klinger soils. They are not so well drained as Tama soils and have a grayer B horizon. They are better drained and have a browner B horizon than Garwin soils. They have a thicker A1 horizon than Atterberry soils and do not have an A2 horizon. Unlike Klinger soils, they formed in deep loess and have less sand in the lower part of the solum.

Muscatine silty clay loam, 0 to 2 percent slopes (119).—This soil is in lower concave positions and on convex ridges on uplands. It is associated with Atterberry and Tama soils upslope and Garwin soils downslope. Most areas are 5 to 50 acres in size.

This soil is well suited to intensive use for row crops. Artificial drainage benefits some areas in years of high precipitation. Capability unit I–3.

Nasset Series

The Nasset series consists of nearly level to gently sloping, well-drained soils on uplands. The nearly level soils are in high areas, and the gently sloping soils are on long ridges and side slopes. All formed in loess and underlying loamy sediment. Limestone bedrock is at a dpth of 40 to 60 inches. A thin layer of clayey limestone residuum generally is on the surface of the underlying limestone bedrock. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer, about 4 inches thick, is brown, friable silt loam. The subsoil is about 37 inches thick. It is brown friable silt loam in the upper part and yellowish-brown light silty clay loam in the middle part. The lower part is yellowish-brown, very friable loam overlying a layer of yellowish-red, very firm clay. The substratum is fractured limestone bedrock.

Available water capacity is medium to high. Permeability is moderate in most of the profile but is very slow in the clayey residuum. The content of available nitrogen is low. The subsoil is low in available phosphorus and very low in available potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Nasset soils are well suited to row crops. Sloping areas are subject to erosion if cultivated.

Representative profile of Nasset silt loam, 0 to 2 percent slopes, in a cultivated field near the northeast corner of SE¼NE¼ sec. 26, T. 98 N., R. 17 W.

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam, brownish gray (10YR 5/2) dry; moderate, fine and very fine, granular structure; friable; neutral; clear boundary.

A2—7 to 11 inches, brown (10YR 4/3) silt loam; very dark brown (10YR 2/2) coatings on peds; weak, medium, platy structure; friable; thin, grainy, pale-brown (10YR 6/3) coatings on peds when dry; neutral; clear boundary.

B1—11 to 18 inches, brown (10YR 4/3) heavy silt loam; nearly continuous dark-brown (10YR 3/3) coatings on peds; moderate, very fine and fine, subangular blocky structure; friable; light-gray (10YR 7/2) grainy coatings on faces of peds when dry; slightly acid; clear boundary.

B21t—18 to 25 inches, yellowish-brown (10YR 5/4) light silty clay loam; moderate, fine, subangular blocky structure; friable; thin discontinuous clay films on faces of peds and in root channels; light-gray (10YR 7/2) grainy coatings when dry; medium acid; gradual boundary.

B22t—25 to 31 inches, yellowish-brown (10YR 5/4) light silty clay loam; moderate, very fine, prismatic structure parting to moderate, fine, subangular blocky; friable; thick, patchy, very dark brown (10YR 2/2) clay films on faces of prisms and peds and in root channels; few light-gray (10YR 7/2) grainy coatings when dry; very strongly acid; clear boundary.

IIB31—31 to 40 inches, yellowish-brown (10YR 5/6) light loam; common, medium, dark-brown (7.5YR 4/4) mottles; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; very friable; strongly acid; abrupt boundary.

IIIB32—40 to 48 inches, yellowish-red (5YR 4/6) clay; moderate, fine, subangular blocky structure; very firm; medium acid; abrupt boundary.

IIIR—48 inches, fractured limestone bedrock.

The solum is generally 44 to 54 inches thick but it ranges from 40 to 60 inches. The Ap or A1 horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and from 6 to 9 inches in thickness. The loess is 24 to 36 inches thick.

The IIB horizon ranges from heavy sandy loam to light clay loam. The IIIB horizon just above the shattered bedrock is generally clay or silty clay 2 to 8 inches thick. The shattered upper part of the bedrock is 2 to 5 feet thick and is 5 to 15 percent loamy material in crevices and a thin layer of clay residuum on the slabs of limestone.

These soils have a loam texture in the lower part of the B horizon, and are therefore outside the range defined for the the series. This difference, however, does not greatly alter the usefulness and behavior of these soils.

Nasset soils are associated with Dubuque, Ashdale, Sogn, and Waucoma soils and formed in similar material. They have a darker, thicker A horizon and are deeper over bedrock than Dubuque soils. They have a thinner A1 horizon than Ashdale soils, and they have an A2 horizon. They contain less sand and more silt in the A horizon and upper part of the B horizon than Waucoma soils. They are deeper over bedrock than Sogn soils.

Nasset silt loam, 0 to 2 percent slopes (904).—This soil is on high uplands. It generally is just above gently sloping Nasset or Waucoma soils. Most areas are 4 to 20 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few areas where bedrock is at a depth of less than 40 inches and a few areas where it is at a depth of more than 60 inches.

This soil is well suited to cultivated crops, and it is generally associated with large areas of other well-suited, well-drained soils. Capability unit I–2.

Nasset silt loam, 2 to 5 percent slopes (904B).—This soil is on long, convex side slopes and ridge crests. It is generally associated with Ashdale soils and with areas of nearly level Waubeek soils upslope and Dubuque and Sogn soils downslope.

Included with this soil in mapping were a few areas where the bedrock is at a depth of less than 40 inches and a few areas where it is at a depth of more than 60 inches. Also included were a few areas where the surface layer is lighter colored and lower in content of organic matter.

This soil is well suited to cultivated crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Oran Series

The Oran series consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. The nearly level soils are on broad upland ridges, and the gently sloping soils are on long, slightly convex side slopes. All formed in 14 to 24 inches of loamy materials and the underlying glacial till. In most places a layer of pebbles forms the contact line between the overburden and the glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark gray loam about 7 inches thick. The subsurface layer, about 5 inches thick, is dark grayish-brown, friable loam. The subsoil is about 39 inches thick. It is mottled yellowish-brown and grayish-brown, friable loam in the upper part; mottled strong-brown and grayish-brown, friable and firm loam in the middle part; and mottled gray and strong-brown, firm loam in the lower part. The substratum is yellowish-brown, firm loam.

Available water capacity is high. The rate at which water moves through the friable overburden differs considerably from the rate at which it moves through the glacial till. Permeability is moderately slow in the till. Water moves more rapidly in the overburden and accumulates at the contact, which produces a seasonally perched water table. The content of available nitrogen is low to medium. The subsoil is low to very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are medium acid to very strongly acid.

These soils are well suited to row crops. Artificial drainage is beneficial in some areas. The more sloping soils are subject to slight erosion if cultivated.

Representative profile of Oran loam, 0 to 2 percent slopes, in a cultivated field 500 feet north and 540 feet east of the southwest corner of SE¼ sec. 10, T. 100 N., R. 16 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam; weak, fine, granular structure; friable; slightly acid; abrupt boundary.

A2—7 to 12 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish-brown (2.5Y 3/2) coatings on peds; weak, medium, platy structure; friable; considerable mixing of very dark gray (10YR 3/1) in upper two-thirds of horizon; very strongly acid; gradual boundary.

B1—12 to 18 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, fine, subangular blocky structure; friable; very strongly acid; clear boundary.

IIB21—18 to 23 inches, mottled strong-brown (7.5YR 5/6) and grayish brown (2.5Y 5/2) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; band of pebbles, ½ inch to 3 inches in diameter, in lower part of horizon; grayish-brown (2.5Y 5/2) grainy coatings on prisms and peds when dry; very strongly acid; clear boundary.

IIB22t—23 to 32 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown (10YR 5/2) heavy loam; discontinuous gray (5Y 5/1) coatings on prisms; weak, medium, prismatic structure parting to weak, fine and medium, subangular blocky; firm; few discontinuous clay films; few black oxide concentrations; few pebbles; strongly acid; gradual boundary.

IIB3t—32 to 51 inches, mottled, gray (5Y 5/1) and strong-brown (7.5YR 5/6) heavy loam; gray (5Y 5/1) coatings on prisms; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; firm; few pores filled with very dark gray (10YR 3/1) clay; medium acid; gradual boundary.

IIC—51 to 60 inches, yellowish-brown (10YR 5/6) loam; many, medium and large, prominent, olive-gray (5Y 5/2) mottles; massive; firm; few black oxide concentrations; few pebbles; neutral.

The solum is generally 3½ to 5 feet thick. The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1) or very dark brown (10YR 2/2) and from 6 to 9 inches in thickness. It ranges from loam to silt loam that has a high content of sand. The A2 horizon ranges from dark grayish-brown (10YR or 2.5Y 4/2) to grayish-brown (10YR 5/2) and brown (10YR 5/3) loam to silt loam that has a high content of sand.

The IIB and IIC horizons generally are mottled in hues of 10YR or 2.5Y, values of 4 and 5, and chroma of 2 to 8. They range from loam to light clay loam or sandy clay loam.

Oran soils are associated with Bassett, Pinicon, Readlyn, and Tripoli soils and formed in similar materials. They are also associated with Clyde, Floyd, and Schley soils. They differ from Clyde, Floyd, Readlyn, and Tripoli soils in having an A2 horizon and a thinner A1 horizon. They have a grayer B horizon than Bassett soils and are not so well drained. They have a thicker, darker A horizon than Pinicon soils.

Oran loam, 0 to 2 percent slopes (471).—In most places this soil is on broad ridges or high upland flats. It is associated with Clyde, Readlyn, and Tripoli soils. Most areas are 5 to 60 acres in size, but a few are much larger. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas of Readlyn soils that have a thicker surface layer and of Schley soils that have a more stratified subsoil.

This soil is well suited to intensive use for row crops. Artificial drainage is beneficial in some areas in years of normal or high precipitation. Capability unit I–3.

Oran loam, 2 to 5 percent slopes (471B).—This soil is mostly on long, convex side slopes and broad, rounded ridge crests. In a few places it is on concave downslope and cove positions. It is associated with Bassett soils upslope and Clyde, Floyd and Schley soils downslope. Most areas are 5 to 30 acres in size. This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick.

Included with this soil in mapping were a few small areas of Readlyn soils that have a thicker surface layer and of Schley soils that have a more stratified and water-bearing subsoil.

This soil is well suited to row crops, but it is subject to slight erosion if cultivated. Capability unit IIe–3.

Ostrander Series

The Ostrander series consists of nearly level to gently sloping, well-drained soils on uplands. These soils are on ridge crests and side slopes. They formed in 25 to 35 inches of loamy material and the underlying friable glacial till or loamy sediment derived from glacial till. In many places a layer of pebbles forms the contact line between the loamy overburden and the underlying glacial material. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loam about 16 inches thick. The subsoil is about 38 inches thick. It is brown and dark yellowish-brown, friable loam in the upper part and yellowish-brown, friable sandy clay loam in the lower part. The substratum is yellowish-brown, firm sandy clay loam till.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is medium to low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Ostrander soils are well suited to row crops. Gently sloping soils are subject to erosion if cultivated.

Representative profile of Ostrander loam, 2 to 5 percent slopes, in a cultivated field 215 feet north and 10 feet west of the southeast corner of SW¼ sec. 10, T. 100 N., R. 15 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; cloddy, breaking to weak, very fine and fine, granular structure; friable; strongly acid; abrupt boundary.

A3—8 to 16 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate, very fine and fine, granular structure; friable; strongly acid; gradual boundary.

B1—16 to 24 inches, brown (10YR 4/3) loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine and medium, subangular blocky structure; friable; strongly acid; gradual boundary.

B21—24 to 32 inches, dark yellowish-brown (10YR 4/4) loam; discontinuous brown (10YR 4/3) coatings on peds; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; medium acid; gradual boundary.

IIB22—32 to 42 inches, yellowish-brown (10YR 5/6) sandy clay loam; few, fine, faint strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few pebbles, 2 millimeters in diameter; medium acid; gradual boundary.

IIB3—42 to 54 inches, yellowish-brown (10YR 5/4) sandy clay loam; few, medium, distinct, grayish-brown (10YR 5/2) mottles and coarse, prominent, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure; friable; few pebbles, 2 millimeters in diameter; slightly acid; abrupt boundary.

IIIC—54 to 77 inches, yellowish-brown (10YR 5/4) sandy clay loam; common, medium, distinct, grayish-brown (2.5Y 5/2) mottles and prominent, strong-brown (7.5YR 5/8) mottles; massive; firm; few dark oxide concentrations; mildly alkaline; slight effervescence.

The solum is generally 4 to 6 feet thick. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). The A3 horizon ranges from very dark grayish brown (10YR 3/2) to dark brown (10YR 3/3). The A horizon ranges from loam to silt loam that has a high content of sand.

The IIB horizon ranges from sandy clay loam or loam to heavy sandy loam. Mottles that have a chroma of 2 are below a depth of 3 feet in places. In many places a pebble band occurs at the contact of the overburden with IIB horizon. In places where there is a IIIB3 horizon, a second pebble band is at the contact with the firm IIIC or IIIB3 horizon.

Ostrander soils are generally associated with Atkinson, Clyde, Dickinson, Dinsdale, Floyd, Kenyon, and Racine soils. They have a more friable B horizon and are better drained than Kenyon soils. They are better drained than Clyde and Floyd soils. They have a thicker A1 horizon than Racine soils. They have more sand and less silt in the A horizon and upper part of the B horizon than Dinsdale soils. In contrast with Atkinson soils, they are not underlain by limestone bedrock at a depth of 40 to 60 inches. They contain less sand throughout than Dickinson soils.

Ostrander loam, 0 to 2 percent slopes (394).—This soil is mostly on high upland flats or ridge crests. It is associated with Atkinson, Dickinson, Dinsdale, Floyd, Racine, and Schley soils. Areas are generally 5 to 80 acres in size, but some are larger. Most of the Ostrander soils in Iowa, unlike this one, have slopes of more than 2 percent. This soil, however, is underlain by limestone bedrock within a depth of 10 to 15 feet and thus has a lower water table. Thus this soil is well drained, even though it is nearly level.

Included with this soil in mapping were a few small areas that have bedrock at a depth of 40 to 60 inches. Also included in the other areas were small sandy spots that are more droughty.

This soil is well suited to intensive use for row crops and is generally associated with other well-suited soils. Capability unit I–2.

Ostrander loam, 2 to 5 percent slopes (394B).—This soil is on long, convex ridges and side slopes. In many places it occupies downslope positions and typically is above Clyde, Floyd, or Schley soils. Areas are generally 4 to 15 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas where bedrock is at a depth of 40 to 60 inches and some eroded spots where the surface layer is dark brown and lower in organic matter. Also included, in other areas, were sandy spots that are more droughty.

This soil is well suited to row crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Pinicon Series

The Pinicon series consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. The nearly level soils are on broad ridge crests, and the gently sloping soils are on long, slightly convex side slopes. All formed in 16 to 24 inches of loamy material and the underlying glacial till. In most places a layer of pebbles forms the contact line between the loamy overburden and the glacial till. The native vegetation was trees.

In a representative profile the surface layer is dark grayish-brown loam about 6 inches thick. The subsurface layer, about 6 inches thick, is grayish-brown, friable silt loam. The subsoil extends to a depth of about 60 inches. It is grayish-brown, friable loam in the upper part; mottled strong-brown, grayish-brown, and light brownish-gray, firm loam in the middle part; and mottled strong-brown and gray, firm loam in the lower part.

Available water capacity is high. The rate at which water moves through the loamy overburden differs considerably from the rate at whch it moves through the glacial till. Permeability is moderate in the loamy overburden and moderately slow in the till. Water moves more rapidly in the overburden and accumulates at the till contact, which produces wet, seepy spots in some years. The content of available nitrogen is low to very low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Pinicon soils are suited to row crops if properly managed. Tile drainage is beneficial in years of normal or above-normal rainfall.

Representative profile of Pinicon loam, 1 to 4 percent slopes, in a cultivated field 540 feet north and 275 feet west of the southeast corner of NW¼NE¼ sec. 25, T. 99 N., R. 16 W.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) loam; cloddy, breaking to weak, fine and very fine, granular structure; friable; few dark oxide concentrations; medium acid; abrupt boundary.

A2—6 to 12 inches, grayish-brown (10YR 5/2) silt loam high in content of sand; few, fine, yellowish-brown (10YR 5/6) mottles; weak, thin, platy structure; friable; few, fine, dark-brown (7.5 YR 4/4) oxide mottles; light-gray (10YR 7/2) grainy coatings on plates when dry; strongly acid; clear boundary.

B1—12 to 20 inches, grayish-brown (2.5Y 5/2) loam; common, fine, prominent, yellowish-brown (10YR 5/6) mottles; very fine, subangular blocky structure; friable; few dark oxide concentrations; very strongly acid; clear boundary.

IIB21t—20 to 28 inches, strong-brown (7.5YR 5/6) heavy loam; many, medium, prominent, grayish-brown (2.5Y 5/2) mottles and few, fine, faint, dark-brown (7.5YR 4/4) mottles; weak, prismatic structure parting to weak, medium, subangular blocky; firm; pebbles at surface of horizon; few dark oxide concentrations; nearly continuous light-gray (10YR 7/2) coatings on prisms; few patchy clay films; strongly acid; gradual boundary.

IIB22t—28 to 39 inches, mottled strong-brown (7.5YR 5/6) and light brownish-gray (2.5Y 6/2) heavy loam; moderate, medium, prismatic structure parting to weak, medium, subangular blocky; firm; common, fine, soft, dark oxide concentrations, continuous light-gray (10YR 7/2 dry) grainy coatings on prisms; clay-lined pores and root channels; strongly acid; gradual boundary.

IIB3t—39 to 60 inches, mottled strong-brown (7.5YR 5/8) and gray (5Y 6/1) loam; weak, medium, prismatic structure; firm; many, dark, soft oxide concentrations; very dark gray (10YR 3/1) clay-lined root channels; medium acid.

The solum is generally about 40 to 60 inches thick, but it is as much as 72 inches thick in places. The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) and from 1 to 4 inches in thickness. The Ap or A1 horizon is silt loam that has a high content of sand or loam. The A2 horizon is of similar texture and ranges from grayish brown (10YR 5/2) to brown (10YR 5/3). In some cultivated areas, the A2 horizon is wholly incorporated into the plow layer.

The IIB2 horizon is mottled in hues of 2.5Y to 7.5YR, values of 4 to 6, and chroma of 2 to 6. The IIB2 and IIB3 horizons range from loam to light clay loam. The IIB horizon ranges from medium to very strongly acid. Depth to carbonates ranges from 40 to 80 inches.

Pinicon soils are associated with Bassett, Coggon, Oran, Renova, and Schley soils. They have a thinner A1 horizon than Oran, Bassett, and Schley soils. They are more poorly drained and have a grayer B horizon than Bassett, Coggon, and Renova soils.

Pinicon silt loam, 1 to 4 percent slopes (303B).—This soil is on broad ridge crests and long, slightly convex side slopes. In a few places it is in concave downslope and cove positions. It is associated with Bassett, Coggon, Oran, Renova, and Schley soils. Most areas are 5 to 40 acres in size.

This soil is suited to row crops. It can be farmed without tile drainage, but improved drainage is beneficial and earlier fieldwork is possible. Because permeability differs in the loamy overburden from that in the underlying glacial till, which is at a depth of about 1½ to 2 feet, water tends to accumulate at this contact and produces a temporary high water table. The more sloping areas of this soil are subject to slight erosion if cultivated. Capability unit IIw–2.

Protivin Series

The Protivin series consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. These soils are on broad ridges and on long, slightly convex side slopes. They formed in 16 to 24 inches of loamy material and the underlying very firm, clay loam glacial till. In most places a layer of pebbles and stones forms the contact between the overburden and the glacial till.

In a representative profile the surface layer is black and very dark grayish-brown loam about 18 inches thick. The subsoil is about 32 inches thick. It is olive-brown, friable loam in the upper part. Below this, it is mottled strong-brown, gray, and yellowish-brown, very firm clay loam. The substratum is mottled strong-brown and gray, very firm clay loam.

Available water capacity is high. The rate at which water moves through the loamy overburden differs considerably from the rate at which it moves through the glacial till. Permeability is moderate in the overburden and slow in the clay loam till. Water tends to move more rapidly in the overburden and accumulates at the till contact, which produces a seasonally perched water table. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally slightly acid to medium acid.

Protivin soils are suited to intensive use for row crops if properly managed. Placement and spacing of tile are very important because the subsoil is slowly permeable.

Representative profile of Protivin loam, 1 to 4 percent slopes, in a cultivated field 150 feet south and 415 feet east of the northwest corner of NE¼ sec. 34, T. 98 N., R. 15 W.

Ap—0 to 7 inches, black (10YR 2/1) heavy loam; weak, fine, subangular blocky structure; neutral; abrupt boundary.

A12—7 to 14 inches, black (10YR 2/1) heavy loam; very weak, very fine, subangular blocky structure; friable; slightly acid; clear boundary.

A3—14 to 18 inches, very dark grayish-brown (2.5Y 3/2) loam; common, medium, distinct, olive-brown (2.5Y 4/4) mottles; weak, fine, subangular blocky structure; friable; slightly acid; clear boundary.

B1—18 to 22 inches, olive-brown (2.5Y 4/4) heavy loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; clear boundary.

IIB21t—22 to 33 inches, yellowish-brown (10YR 5/6) clay loam; many, medium, prominent, gray (5Y 5/1) mottles and few, fine, faint, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very firm; distinct, continuous, gray (5Y 5/1) coatings on prisms and peds; very dark gray (N 3/0) clay films in some root channels; band of pebbles, ½ inch in diameter; medium acid; gradual boundary.

IIB22t—33 to 43 inches, mottled strong-brown (7.5YR 5/6), gray (5Y 5/1), and yellowish-brown (10YR 5/6) clay loam; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very firm; continuous gray (5Y 6/1) coatings on prisms; nearly continuous gray (5Y 6/1) coatings on peds; thin, discontinuous, very dark gray (10YR 3/1) clay films on faces of peds and in root channels; medium acid; gradual boundary.

IIB3—43 to 50 inches, mottled gray (5Y 5/1), yellowish-brown (10YR 5/6), and strong-brown (7.5YR 5/8) clay loam; weak, coarse, subangular blocky structure; very firm; discontinuous gray (5Y 5/1) coatings on peds; neutral; clear boundary.

IIC—50 to 60 inches, mottled strong-brown (7:5YR 5/6) and gray (5Y 5/1) clay loam; massive; very firm; few white carbonate concentrations ½ inch in diameter; mildly alkaline; slight effervescence.

The solum is generally 3½ to 5 feet thick. The A1 horizon ranges from 10 to 16 inches in thickness. The A3 horizon is very dark grayish brown (10YR 3/2 or 2.5Y 3/2), but it ranges to very dark gray (10YR 3/1). The A horizon is generally heavy loam that has a low content of sand, but it ranges to silt loam that has a high content of sand, light silty clay loam that has a high content of sand, or light clay loam. The upper part of the B horizon has a value of 4 and chroma of 2 to 4 in hue of 2.5Y and chroma of 2 in hue of 10YR. Mottles have a higher chroma. Depth to very firm clay loam till ranges from 18 to 36 inches.

Protivin soils formed in about the same kind of material as Cresco, Jameston, Lourdes, and Riceville soils. They have a thicker A1 horizon than Riceville soils. They are not so well drained as Cresco and Lourdes soils, and the upper part of the B horizon is grayer and mottled. They have a thicker, dark-colored A horizon than Lourdes soils. They are better drained and have browner B1 and IIB horizons than Jameston soils.

Protivin loam, 1 to 4 percent slopes (798B).—This soil is on long, convex side slopes and broad, rounded ridge crests. In a few places it occupies concave downslope and cove positions. It is associated with Clyde, Cresco, Jameston, and Riceville soils. It is generally below Cresco soils and above Clyde or Jameston soils. In some places it is above Floyd soils. Most areas of this soil range from 3 to about 40 acres in size, but a few areas range to 200 acres and cross two or three farms.

This soil is suited to intensive use for row crops if properly managed. Because of the slowly permeable subsoil, wetness and seepage are limitations in wet seasons. Tile drainage is beneficial during these times. Spacing and placement of tile lines are important. A drainage system should be designed to intercept laterally moving water successfully to drain these slowly permeable soils. The more sloping areas are subject to slight erosion if cultivated. Capability unit IIw-3.

Racine Series

The Racine series consists of nearly level to moderately sloping, well-drained soils on uplands. These nearly level soils are on broad flats; the nearly level to gently sloping soils are on ridge crests; and gently sloping to moderately sloping soils are on side slopes. All formed in 13 to 30 inches of loamy material over friable, reworked glacial till or loamy sediment derived from glacial till. In many places a layer of pebbles and stones forms the contact line between the loamy overburden and the underlying material. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown, friable silt loam about 7 inches thick. The subsurface layer, about 7 inches thick, is dark-brown, friable silt loam. The subsoil is about 40 inches thick. It is yellowish-brown, friable loam in the upper part; grayish-brown to light olive-brown, friable loam in the middle part; and yellowish-brown and strong-brown, firm loam in the lower part.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Racine soils are suited to row crops. The more sloping areas are subject to erosion if cultivated.

Representative profile of Racine silt loam, 2 to 5 percent slopes, in a cultivated field of 670 feet and 30 feet south of the northwest corner of SW¼ sec. 2, T. 97 N., R. 17 W.

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam high in content of sand; weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—7 to 14 inches, dark-brown (10YR 4/3) silt loam high in content of sand; weak, medium, platy structure parting to moderate, fine, granular; slightly darker coatings on peds; few, patchy, light-gray (10YR 7/2) coatings when dry; neutral; clear boundary.

IIB21—14 to 23 inches, yellowish-brown (10YR 5/4) loam; discontinuous dark yellowish-brown (10YR 4/4) coatings on peds; moderate, fine, subangular blocky structure; friable; band of pebbles, ½ inch to 2½ inches in diameter, in upper part; medium acid; gradual boundary.

IIB22t—23 to 29 inches, yellowish-brown (10YR 5/6) loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; moderate, fine, subangular blocky structure; friable; few dark-brown (7.5YR 3/3) clay films on faces of peds; few, thin, light-gray (10YR 7/2) grainy coatings when dry; strongly acid; clear boundary.

IIB23t—29 to 37 inches, yellowish-brown (10YR 5/6) loam; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; common very dark gray (10YR 3/1) and dark-brown (7.5YR 3/2) clay films on faces of peds and in root channels and in large patchy areas along prisms; pebble band in upper part; thin, light-gray (10YR 7/2) grainy coatings on prisms when dry; strongly acid; gradual boundary.

IIB31t—37 to 50 inches, grayish-brown to light olive-brown (2.5Y 5/3) heavy loam; many, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few dark-brown (7.5YR 3/2) clay films on faces of peds and prisms; neutral; gradual boundary.

IIIB32t—50 to 55 inches, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) heavy loam; weak, coarse, prismatic structure parting to very weak, coarse, subangular blocky; firm; few dark-brown (7.5YR 3/2) clay films on faces of peds; few, soft, dark-brown (7.5YR 3/2) oxide concentrations; neutral; clear boundary.

IIIC—55 to 60 inches, yellowish-brown (10YR 5/6) loam; massive; firm; mildly alkaline; slight effervescence.

The solum is generally 4 to 5 feet thick. The A horizon ranges from very dark brown (10YR 2/2) to very dark grayish-brown (10YR 3/2) loam to silt loam that has a high content of sand. The A2 horizon ranges from silt loam that has a high content of sand to loam.

The upper part of the IIB horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) and has grayish mottles below a depth of 36 inches in some places. The IIB horizon ranges from loam or sandy clay loam to light clay loam that has thin horizons of sandy loam.

The C horizon is generally strong-brown or yellowish-brown loam or sandy clay loam. Depth to carbonates ranges from 4½ to 7 feet.

Racine soils are commonly associated with Bassett, Floyd, Ostrander, Renova, Sattre, Schley, Waubeek, Waucoma, and Waukee soils. They are deeper over grayish mottles and have a more friable B horizon than Bassett soils. They have more sand and less silt in the A horizon and upper part of the B horizon than Waubeek soils. They have a medium-textured C horizon, but Sattre and Waukee soils are underlain by sand and gravel. They have a thicker A1 horizon or a darker colored Ap horizon than Renova soils. They are better drained and have a browner B horizon than Floyd and Schley soils. They have a thinner, lighter colored A horizon than Ostrander soils. They are not underlain by bedrock at a depth of 40 to 60 inches as are Waucoma soils.

Racine silt loam, 0 to 2 percent slopes (482).—In most places this soil is on high upland ridge crests or flats. Most areas are 4 to 20 acres in size. Most of the Racine soils in Iowa, unlike this one, have slopes of more than 2 percent. This soil, however, is underlain by limestone bedrock at a depth of 10 to 15 feet and thus has a lower water table. Consequently, it is well drained even though it is nearly level.

This soil is well suited to intensive use for row crops. Capability unit I–2.

Racine silt loam, 2 to 5 percent slopes (482B).—This soil is on long, convex ridges and side slopes. In many places it is upslope from Floyd and Schley soils or more sloping areas of Racine soils. In some areas it is associated with Waucoma soils. Most areas are 4 to 20 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small eroded areas where the surface layer is dark brown and lower in organic matter. Also included, in the downslope positions, were areas where lenses of sandy material are between depths of 3 and 4 feet.

This soil is well suited to row crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Racine silt loam, 5 to 9 percent slopes (482C).—This soil is on long, convex ridges and side slopes. In many places it is upslope from Floyd and Schley soils. Most areas are 3 to 7 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is a little lighter in color. In some places are eroded spots where the surface is brown and dark brown and is lower in content of organic matter.

Included with this soil in mapping in the downslope position were areas where lenses of sandy material are between depths of 3 and 4 feet. Also included were a few areas where the soil is eroded and lower in content of organic matter.

This soil is suited to row crops. It is subject to moderate erosion if cultivated. Capabality unit IIIe–1.

Readlyn Series

The Readlyn series consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. These soils are on broad ridges and on long, slightly convex side slopes. They formed in 14 to 24 inches of loamy materials and the underlying glacial till. In most places a layer of pebbles forms the contact line between the overburden and the glacial till. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark gray, friable loam about 16 inches thick. The subsoil is about 26 inches thick. It is dark grayish-brown, friable loam in the upper part. Below this, it is mottled yellowish-brown and grayish-brown, firm loam. The substratum is mottled, yellowish-brown and grayish-brown, firm loam.

Available water capacity is high. The rate at which water moves through the friable overburden differs considerably from the rate at which it moves through the firm glacial till. Permeability is moderate in the overburden and moderately slow in the till. Water moves more rapidly in the overburden and accumulates at the till contact, which produces a seasonally perched water table. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Readlyn soils are well suited to row crops. Artificial drainage is beneficial in some areas. The more sloping areas are subject to slight erosion if cultivated.

Representative profile of Readlyn loam, 0 to 2 percent slopes, in a cultivated field 1,155 feet north and 47 feet west of the southeast corner of sec. 13, T. 100 N., R. 16 W.

Ap—0 to 10 inches, black (10YR 2/1) loam; weak, fine granular structure; friable; many roots; neutral; clear boundary.

A3—10 to 16 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) loam; weak, fine, subangular blocky structure; friable; few roots; medium acid; clear boundary.

B1—16 to 20 inches, dark grayish-brown (2.5Y 4/2) loam; few, fine, distinct, olive-brown (2.5Y 4/4) mottles; very dark grayish-brown (2.5Y 3/2) coatings on peds; weak, fine, subangular blocky structure; friable; strongly acid; clear boundary.

IIB2—20 to 29 inches, yellowish-brown (10YR 5/6) heavy loam; many, medium, prominent, grayish-brown (2.5Y 5/2) mottles; weak, medium, prismatic structure parting to weak, fine, subangular blocky; firm; discontinous grayish-brown (2.5Y 5/2) coatings on prisms and peds; distinct band of pebbles ½ inch to 5 inches in diameter in upper part of horizon; medium acid; gradual boundary.

IIB3—29 to 42 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; moderate, medium, prismatic structure parting to weak, moderate, subangular blocky; firm; nearly continuous grayish-brown (2.5Y 5/2) coatings on prisms; few, thin, discontinuous clay films on faces of prisms; few dark oxide concentrations; neutral; gradual boundary.

IIC—42 to 60 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; massive; firm; few dark oxide concentrations; neutral.

The solum is generally 3½ to 5 feet thick. The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2), from loam to silty clay loam, and from 10 to 14 inches in thickness.

The B1 horizon is generally dark grayish brown (10YR to 2.5Y 4/2). The IIB horizon ranges from loam to light clay loam or sandy clay loam.

The C horizon ranges from yellowish brown (10YR 5/4 or 5/6) to strong brown (7.5YR 5/6) and has grayish-brown (10YR or 2.5Y 5/2) mottles.

Readlyn soils are associated with Kenyon, Oran, Pinicon, and Tripoli soils and formed in similar materials. They are also commonly associated with Clyde and Floyd soils. They have a grayer B horizon and are not so well drained as the associated Kenyon soils. They have a browner B horizon and are better drained than Clyde and Tripoli soils. They are more acid, firmer, and less stratified in the B horizon than Floyd soils. Readlyn soils lack the A2 horizon of Oran and Pinicon soils and have a thicker A1 horizon.

Readlyn loam, 0 to 2 percent slopes (399).—In most places this soil is on broad ridges or high upland flats. It is associated with Clyde, Floyd, Kenyon, Oran, and Tripoli soils. Most areas are 5 to 40 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas of Oran soils that have a thinner surface layer and a few small areas of Tripoli soils that are not so well drained.

This soil is well suited to intensive use for row crops. Artificial drainage benefits some areas in years of high precipitation. Capability unit I–3.

Readlyn loam, 2 to 5 percent slopes (399B).—In most places this soil is on long, convex side slopes and broad, rounded ridge crests. In a few places it is in concave downslope and cove positions. It is associated with Clyde, Floyd, and Kenyon soils. Most areas are 5 to 20 acres in size. This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick.

Included with this soil in mapping were a few small areas of Floyd soils that have a stratified subsoil and a few small areas of Oran soils that have a thinner surface layer.

This soil is well suited to row crops. It is subject to slight erosion if cultivated. Some areas benefit from artificial drainage in years of heavy precipitation. Capability unit IIe–3.

Renova Series

The Renova series consists of gently sloping, well-drained soils on uplands. These soils are on ridge crests. They formed in 13 to 30 inches of loamy material and the underlying reworked glacial till or loamy sediment derived from glacial till. In many places a layer of pebbles and stones forms the contact line between the loamy overburden and the underlying material. The native vegetation was trees.

In a representative profile the surface layer is black loam about 4 inches thick. The subsurface layer, about 4 inches thick, is brown, friable loam. The subsoil extends to a depth of about 60 inches. It is yellowish-brown, friable loam in the upper part; yellowish-brown, very friable light sandy clay loam in the middle part; and yellowish-brown, friable sandy clay loam in the lower part.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is very low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are generally medium acid to very strongly acid.

Renova soils are suited to row crops. They are subject to erosion if cultivated.

Representative profile of Renova loam, 2 to 5 percent slopes, in an open wooded pasture 700 feet east and 160 feet north of the southwest corner of NE¼SE¼ sec. 23, T. 99 N., R. 15 W.

A1—0 to 4 inches, black (10YR 2/1) loam; moderate, fine and very fine, granular structure; friable; neutral; clear boundary.

A2—4 to 8 inches, brown (10YR 4/3) loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on plates; moderate, medium, platy structure; friable; medium acid; clear boundary.

B1—8 to 13 inches, yellowish-brown (10YR 5/4) loam; discontinuous brown (10YR 4/3) coatings on peds; moderate, very fine and fine, subangular blocky structure; friable; strongly acid; gradual boundary.

B21—13 to 18 inches, yellowish-brown (10YR 5/4) loam; weak, fine and medium, subangular blocky structure; friable; very strongly acid; abrupt boundary.

IIB22—18 to 23 inches, yellowish-brown (10YR 5/4) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; pebble band at top and bottom of horizon; very strongly acid; clear boundary.

IIB23t—23 to 32 inches, yellowish-brown (10YR 5/6) light sandy clay loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; very friable; few pebbles, 2 millimeters in diameter; very strongly acid; gradual boundary.

IIB31t—32 to 38 inches, yellowish-brown (10YR 5/6) light sandy clay loam; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very friable; dark-gray (10YR 4/1) and dark grayish-brown (10YR 4/2) thin clay films on faces of prisms and peds and in root channels; common, fine, dark oxide concentrations; very strongly acid; gradual boundary.

IIB32—38 to 60 inches, yellowish-brown (10YR 5/4 and 5/6) light sandy clay loam; weak, medium, prismatic structure parting to weak, medium and coarse, subangular blocky; friable; few dark grayish-brown (10YR 4/2) clay films; common dark oxide concentrations; very strongly acid.

The solum is generally 4 to 5 feet thick. The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) and is generally 2 to 5 inches thick. The Ap horizon in cultivated areas is generally dark grayish brown (10YR 4/2). The A1, Ap A2, and B1 horizons are silt loam or loam.

The IIB horizon ranges from brown ((10YR 4/3) to yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) that has grayish mottles below a depth of 36 inches. The IIB horizon ranges from loam or sandy clay loam to light clay loam that has thin horizons of sandy loam.

The C horizon is loam or sandy clay loam. Depth to carbonates ranges from 4½ to 7 feet.

Renova soils are commonly associated with Bassett, Coggon, Racine, Roseville, Schley, and Waucoma soils. They are better drained and have a more friable IIB horizon than Coggon soils. They have a thinner A1 horizon than Racine, Bassett, and Schley soils. They have a browner B horizon and are better drained than Schley soils. They are not underlain by limestone bedrock at a depth of 40 to 60 inches as are Roseville and Waucoma soils.

Renova loam, 2 to 5 percent slopes (491B).—This soil is on long, convex ridges and side slopes. In some places it is upslope from Schley soils and the more sloping areas of Racine soils. In other areas it is associated with Roseville and Waucoma soils. Most areas are between 5 and 20 acres in size, but a few are larger.

Included with this soil in mapping were a few, small, eroded areas where the surface layer is dark brown. Also included, in the downslope position, were areas where lenses of sandy material are between depths of 3 and 4 feet.

This soil is suited to row crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Riceville Series

The Riceville series consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. These soils are on broad ridges and long side slopes. They formed in 14 to 24 inches of loamy material and the underlying glacial till of very firm clay loam. In most places a layer of pebbles and stones forms the contact line between the loamy overburden and the glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown heavy silt loam about 8 inches thick. The subsurface layer, about 4 inches thick, is dark grayish-brown and grayish-brown, friable light silty clay loam. The subsoil is about 32 inches thick. In the upper part it is grayish-brown, friable light silty clay loam and grayish-brown, firm clay loam. Below this, it is mottled gray and strong-brown, very firm clay loam. The substratum is yellowish-brown, very firm clay loam.

The available water capacity is high. The rate at which water moves through the loamy overburden differs considerably from the rate at which it moves through the glacial till. Permeability is moderate in the loamy overburden and slow in the underlying till. Water moves more rapidly in the overburden and tends to accumulate at the till contact, which produces a seasonally perched water table and sidehill seepage in wet years. The content of available nitrogen is low, and the subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Riceville soils are suited to row crops if they are properly managed. The placement and spacing of tile are important in obtaining effective drainage, because the subsoil is slowly permeable.

Representative profile of Riceville silt loam, 1 to 4 percent slopes, in a cultivated field 160 feet south and 205 feet east of the northwest corner of the SW¼SW¼ sec. 29, T. 98 N., R. 15 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy silt loam high in content of sand; moderate, very fine and fine, subangular blocky structure; friable; neutral; abrupt boundary.

A2—8 to 12 inches, dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) light silty clay loam high in content of sand; common, fine, distinct, strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/6) mottles; weak, thick, platy structure parting to moderate, very fine, subangular blocky; friable; strongly acid; clear boundary.

B1—12 to 16 inches, grayish-brown (2.5Y 5/2) light silty clay loam high in content of sand; discontinuous dark grayish-brown (10YR 4/2) coatings on peds; common, fine, prominent, strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/6) mottles; moderate, very fine, subangular blocky structure; friable; few dark-gray (10YR 4/1) organic stains; strongly acid; clear boundary.

IIB21—16 to 20 inches, grayish-brown (2.5Y 5/2) light clay loam; many, fine, prominent, strong-brown (7.5YR 5/6) mottles; moderate, medium, prismatic structure parting to strong, very fine, subangular blocky; firm; continuous grayish-brown (2.5Y 5/2) coatings on prisms; strongly acid; clear boundary.

IIB22t—20 to 25 inches, mottled gray (5Y 5/1) and strong-brown (7.5YR 5/6) clay loam; moderate, medium, prismatic structure parting to moderate, medium, angular blocky; very firm; common dark-gray (10YR 4/1) clay films on faces of peds and in root channels; moderately thick, light-gray (10YR 7/1 dry), grainy coatings on prisms; strongly acid; clear boundary.

IIB23t—25 to 35 inches, mottled gray (5Y 5/1) and strong-brown (7.5YR 5/6) clay loam; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; firm; patchy dark-gray (10YR 4/1) clay films on faces of peds; moderately thick dark-gray (10YR 4/1) clay films in root channels; strongly acid; gradual boundary.

IIB3t—35 to 44 inches, mottled gray (5Y 5/1) and strong-brown (7.5YR 5/6) clay loam that has gray (5Y 5/1) coatings on prisms; moderate, coarse, prismatic structure; very firm; thick dark-gray (10YR 4/1) clay films in root channels; few, coarse, prominent yellowish-red (5YR 4/6) oxide concentrations; neutral; abrupt boundary.

IIC—44 to 60 inches, yellowish-brown (10YR 5/6) clay loam; many, fine, medium-gray (5Y 6/1) mottles; very weak prismatic structure; very firm; few dark-gray (10YR 4/1) clay films; mildly alkaline; slight effervescence.

The solum generally ranges from 3½ to 5 feet in thickness. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A horizon ranges from silt loam that has a high content of sand to loam. The A2 horizon ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (10YR 5/2). In some cultivated areas all of the A2 horizon is incorporated in the plow layer.

The B1 horizon ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (10YR 5/2). It ranges from light silty clay loam that has a high content of sand to heavy loam. The IIB horizon generally has mottles of gray (5Y 5/1) or grayish brown (10YR or 2.5Y 5/2) and strong brown (7.5YR 5/6) or yellowish brown (10YR 5/6).

The C horizon ranges from yellowish brown (10YR 5/6) or strong brown (7.5YR 5/6) mottled with gray (5Y 6/1) to a dominantly gray (5Y 6/1) matrix mottled with strong brown (7.5YR 5/6) to yellowish brown (10YR 5/6). Depth to carbonates ranges from 40 to 60 inches.

Riceville soils formed in about the same kind of material as Cresco, Jameston, Lourdes, and Protivin soils. They have a grayer B horizon than Lourdes soils and are not so well drained. They have a thinner A1 horizon than Cresco, Jameston, and Protivin soils. They are better drained than Jameston soils.

Riceville silt loam, 1 to 4 percent slopes (784B).—This soil is mainly on long, convex side slopes and broad, rounded ridge crests. A few areas are in concave downslope and cove positions. This soil is associated with the Clyde, Lourdes, Jameston, and Protivin soils. It is generally below Clyde, Jameston, or Lourdes soils on the landscape, and in some places it is above Floyd and Schley soils. Most areas range from 3 to about 40 acres in size, but a few are much larger.

Included with this soil in mapping, adjacent to streams in the eastern part of the county, were a few acres of soils that have a lighter colored surface layer and a lower content of organic matter. Also included were a few wooded areas.

If this soil is properly managed, it is suited to row crops. It is subject to slight erosion in the more sloping areas if cultivated. Because of the slowly permeable subsoil, wetness and seepage are limitations to farming in wet seasons. Tile drainage helps to reduce wetness, but careful spacing and placement of the tile are needed. A drainage system that is designed to intercept laterally moving water is an efficient means of draining this slowly permeable soil. Capability unit IIw-3.

Rockton Series

The Rockton series consists of gently sloping to moderately sloping, well-drained soils on uplands. These soils are on ridge crests and side slopes. They form in 20 to about 40 inches of loamy material over limestone bedrock. In places a thin clayey layer of limestone residuum overlies the limestone bedrock. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark brown loam about 14 inches thick. The subsoil, about 12 inches thick, is dark-brown and brown, friable clay loam. Below the subsoil is about 3 feet of shattered limestone bedrock containing some earthy material. It is underlain by massive limestone bedrock.

The available water capacity is low to medium, and permeability is moderate. The content of available nitrogen is low to medium, and the subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid.

Rockton soils are suited to row crops but are subject to erosion. If the more sloping areas are cultivated, measures are needed to control further erosion, which would decrease the soil material available for plant root development and moisture supply. Rockton soils are droughty in years of normal or below-normal rainfall.

Representative profile of Rockton loam, moderately deep, 2 to 5 percent slopes, in a cultivated field 410 feet east and 30 feet north of the southwest corner of the NE¼ sec. 3, T. 97 N., R. 17 W.

Ap—0 to 6 inches, black (10YR 2/1) loam; weak, fine, granular structure; many roots; medium acid; clear boundary.

A12—6 to 11 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak, fine, granular structure; friable; common roots; medium acid; gradual boundary.

A3—11 to 14 inches, very dark brown (10YR 2/2) light clay loam; black (10YR 2/1) coatings on peds; weak, fine, granular structure; friable; medium acid; gradual boundary.

B21t—14 to 18 inches, dark-brown (10YR 3/3) clay loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; moderate, fine, subangular blocky structure; friable; few, dark, patchy clay films; common roots; medium acid; gradual boundary.

B22t—18 to 26 inches, brown (10YR 4/3) clay loam; moderate, fine, subangular blocky strucure; friable; common very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) clay films; common roots; neutral; abrupt boundary.

IIR1—26 to 60 inches, shattered limestone bedrock that is 5 to 15 percent earthy material, by volume.

IIR2—60 inches, level bedded limestone.

The thickness of the solum, which is the same as the depth to limestone, is generally 24 to 36 inches, but it ranges from 20 to 40 inches. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). The A3 horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The A horizon ranges from loam to silt loam.

The upper part of the B horizon ranges from dark brown (10YR 3/3) to brown (10YR 4/3), and from loam to clay loam. If present, clayey material just above the shattered bedrock is clay or silty clay 2 to 6 inches thick.

The shattered upper part of the limestone ranges from 2 to 5 feet in thickness. It is 5 to 15 percent, by volume, material in crevices and a thin layer of clay residuum on the slabs of limestone. The thickness of the shattered bedrock decreases with increasing slope.

Rockton soils formed in about the same kind of material as Atkinson, Ashdale, Kensett, Roseville, Sogn, Waucoma, Whalan, and Winneshiek soils. They are shallower over bedrock than Ashdale and Atkinson soils. They have a thicker A1 horizon than Roseville, Whalan, Waucoma, and Winneshiek soils. They are deeper over bedrock than Sogn soils. They have a browner B horizon and are better drained than Kensett soils.

Rockton loam, moderately deep, 2 to 5 percent slopes (214B).—This soil is mainly on long, convex side slopes and ridge crests downslope from nearly level Ashdale and Atkinson soils and other soils underlain by limestone bedrock. It is commonly upslope from the more sloping Rockton and Sogn soils and from Huntsville and Terril soils in drainageways. Most areas range from 4 to 30 acres in size. This soil has the profile described as representative of the series, but in a few spots bedrock is near the surface or exposed.

This soil is suited to row crops, but it tends to be droughty in years of normal or below-normal rainfall because of its limited root zone. It is subject to slight erosion if cultivated. Capability unit IIe-4.

Rockton loam, moderately deep, 5 to 9 percent slopes (214C).—This soil is on ridge crests and convex side slopes. It is generally near less sloping Atkinson and Rockton soils, and in some areas it is upslope from steep Sogn soils. Nearly level to gently sloping Huntsville and Terril soils are in many adjacent drainageways. Most areas range from 4 to 15 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is not quite so thick. In some small eroded spots the surface layer is brown and dark brown and the content of organic matter is lower. Depth to limestone bedrock is 20 to 34 inches in most places. In a few spots bedrock is near the surface or exposed.

This soil is suited to row crops, but it tends to be somewhat droughty in years of normal or below-normal rainfall because it has a limited root zone. It is subject to moderate erosion if cultivated. Capability unit IIIe–3.

Rockton silt loam, moderately deep, 2 to 5 percent slopes (104B).—This soil is mainly on long, convex side slopes and ridge crests downslope from nearly level Ashdale soils. Huntsville soils are in most of the adjacent drainageways. Most areas are 4 to 15 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer and upper part of the subsoil are lower in sand content and higher in silt, and the depth to limestone is generally slightly greater.

This soil is suited to intensive use for row crops, but it tends to be somewhat droughty in years of normal or below-normal rainfall because it has a limited root zone. It is subject to slight erosion if cultivated. Capability unit IIe–4.

Roseville Series

The Roseville series consists of gently sloping, well-drained soils on uplands. These soils are on convex ridges and side slopes. They formed in 40 to 60 inches of silty and loamy material and a thin layer of clayey limestone residuum over limestone bedrock. The native vegetation was trees.

In a representative profile the surface layer is very dark brown silt loam about 4 inches thick. The subsurface layer, about 5 inches thick, is brown, friable silt loam. The subsoil is about 35 inches thick. It is dark yellowish-brown, friable silt loam in the upper part; yellowish-brown and brown, friable and firm sandy loam to sandy clay loam in the middle part; and dark-brown, very firm clay in the lower part. Below the subsoil is shattered limestone bedrock. The shattered bedrock generally is 5 to 15 percent loamy materials in crevices and thin layers of clayey material on the slabs of limestone.

Available water capacity is medium to high. Permeability is moderate in the upper part and very slow in the thin layer of clayey residuum. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Roseville soils are suited to row crops. They are subject to slight erosion if cultivated.

Representative profile of Roseville silt loam, 2 to 5 percent slopes, in a stand of native hardwoods 340 feet west and 95 feet north of the southeast corner of SW¼NW¼ sec. 34, T. 100 N., R. 18 W.

A1—0 to 4 inches, very dark brown (10YR 2/2) silt loam; moderate, very fine, granular structure; friable; neutral; abrupt boundary.

A2—4 to 9 inches, brown (10YR 4/3) silt loam; dark grayish-brown (10YR 4/2) coatings on peds; moderate, thin, platy structure; friable; medium acid; clear boundary.

B1—9 to 17 inches, dark yellowish-brown (10YR 4/4) silt loam high in content of sand; brown (10YR 4/3) coatings on peds; moderate, fine, subangular blocky structure; friable; light-gray (10YR 7/1 dry) grainy coatings on peds; medium acid; clear boundary.

B21t—17 to 21 inches, dark yellowish-brown (10YR 4/4) heavy silt loam high in content of sand; strong, fine, angular and subangular blocky structure; friable; common, patchy, dark-brown (7.5YR 3/2) and few, thick, dark reddish-brown (5YR 3/2) clay films on faces of peds; light-gray (10YR 7/1) grainy coatings when dry; medium acid; clear boundary.

IIB22t—21 to 25 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, medium, prismatic structure breaking to moderate, fine, subangular blocky; friable; common, dark-brown (10YR 3/3) and 7.5YR 3/2), patchy clay films on faces of prisms and peds; light-gray (10YR 7/2) grainy coatings when dry; few pebbles throughout; medium acid; clear boundary.

IIB31t—25 to 33 inches, yellowish-brown (10YR 5/4) sandy loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; light-gray (10YR 7/2) grainy coatings on prisms when dry; few dark-brown (7.5YR 3/2) clay films; medium acid; clear boundary.

IIB32t—33 to 40 inches, brown (7.5YR 4/4) sandy clay loam; very weak, coarse, prismatic structure parting to very weak, subangular blocky; firm; common, patchy, thick, dark-brown (7.5YR 3/2) clay films on prisms; medium acid; clear boundary.

IIIB33t—40 to 44 inches, dark-brown (7.5YR 3/2 and 4/4) clay; moderate, fine and medium, angular and subangular blocky structure; very firm; few, thick, black (5YR 2/1) clay flows in root channels; abrupt boundary.

IIIR—44 inches, shattered limestone bedrock.

The solum is generally 44 to 54 inches thick, but it ranges from 40 to 60 inches. The Ap horizon, if present, is dark grayish brown (10YR 4/2). The A1, Ap, A2 horizons and upper part of the B horizon range from silt loam to loam.

The IIB horizon ranges from heavy sandy loam to light clay loam. The IIIB horizon, just above the shattered bedrock, is generally clay or silty clay 2 to 6 inches thick. The shattered upper part of the bedrock ranges from 2 to 5 feet in thickness. It is 5 to 15 percent loamy material in crevices and a thin layer of clayey residuum on the slabs of limestone.

Roseville soils formed in about the same kind of material as Atkinson, Rockton, Waucoma, Whalan, and Winneshiek soils. They are deeper over bedrock than Rockton, Sogn, Whalan, and Winneshiek soils. They have a thinner A1 horizon or a lighter colored Ap horizon than Atkinson, Rockton, Sogn, Waucoma, and Winneshiek soils.

Roseville silt loam, 2 to 5 percent slopes (805B).—This soil is on convex side slopes and ridge crests. It is generally upslope from steeper Sogn, Whalan, and Winneshiek soils. Most areas are 4 to 20 acres in size. In a few spots, bedrock is at a depth of less than 40 inches; in others it is at a depth of more than 60 inches.

This soil is suited to cultivated crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Sattre Series

The Sattre series consists of nearly level, well-drained soils on stream benches. A few areas are on uplands. These soils formed in 30 to 40 inches of loamy material and the underlying sand and gravel. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 9 inches thick. The subsurface layer, about 3 inches thick, is brown, friable silt loam. The subsoil is about 33 inches thick. It is dark yellowish-brown, friable loam in the upper part; yellowish-brown, friable loam in the middle part; and brown and yellowish-brown, very friable loamy sand in the lower part. The substratum is yellowish-brown and strong-brown gravelly sand.

Available water capacity is medium. Permeability is moderate in the loamy material and rapid to very rapid in the underlying sandy material. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are medium acid to strongly acid.

Sattre soils are well suited to row crops, but they are droughty in some years. Sloping areas are subject to erosion if cultivated.

Representative profile of Sattre silt loam, 0 to 2 percent slopes, in a cultivated field 200 feet east and 80 feet south of the northwest corner of sec. 8, T. 97 N., R. 15 W.

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) silt loam high in content of sand; moderate, fine, granular structure; friable; medium acid; abrupt boundary.

A2—9 to 12 inches, brown (10Y 4/3) silt loam high in content of sand; nearly continuous, very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium, platy structure; friable; medium acid; clear boundary.

B1t—12 to 18 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; moderate, very fine, subangular blocky structure; friable; few, thin, grainy coatings when dry; few, thin, discontinuous, dark-brown (10YR 3/3) clay films on faces of peds; medium acid; clear boundary.

B21t—18 to 25 inches, yellowish-brown (10YR 5/4) loam; discontinuous dark yellowish-brown (10YR 4/4) coatings on peds; moderate, very fine, subangular blocky structure; friable; thin, discontinuous, dark-brown (10YR 3/3) clay films on ped faces; strongly acid; clear boundary.

B22t—25 to 36 inches, yellowish-brown (10YR 5/4) loam; moderate, very fine and fine, subangular blocky structure; friable; thin, discontinuous, dark-brown (10YR 3/3) clay films on faces of peds; strongly acid; clear boundary.

IIB3—36 to 45 inches, brown (10YR 5/3) and yellowish-brown (10Y 5/6) loamy sand; few, fine, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure parting to very weak, coarse, subangular blocky; very friable; some clay bridging of sand grains; strongly acid; abrupt boundary.

IIC—45 to 50 inches, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) gravelly sand; single grained; loose; some clay bridging of sand grains and pebbles; strongly acid.

The solum is generally 3 to 4 feet thick. Depth of loamy materials over the gravelly sand and loamy sand ranges from 30 to 40 inches. The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and from 6 to 9 inches in thickness. It ranges from silt loam that has a high content of sand to loam. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 4/3) and from silt loam that has a high content of sand to loam.

The upper part of the B horizon ranges from brown (10YR 4/3 and 7.5YR 4/4) to yellowish brown (10YR 5/6). The IIB horizon ranges from brown (10YR 5/3) to yellowish brown (10YR 5/6) and from loamy sand to sand that has some gravel.

The IIC horizon ranges from yellowish brown (10YR 5/6) to strong brown (7.5YR 5/8) and from loamy sand to gravelly sand.

Sattre soils formed in about the same kind of material as Hayfield, Lawler, Saude, Wapsie, and Waukee soils. They are deeper over sand or gravel than associated Wapsie soils. They have an A2 horizon and a thinner A1 horizon than Saude soils. They are better drained and have a browner B horizon than Hayfield and Lawler soils. They have a thinner A1 horizon than Waukee soils.

Sattre silt loam, 0 to 2 percent slopes (778).—This soil is on stream benches. It is associated with other bench soils, such as Hayfield, Lawler, Saude, and Wapsie soils. Most areas are 4 to 10 acres in size, but a few are larger. Included in mapping were a few small areas that have sandy materials at a depth of less than 30 inches.

This soil is well suited to row crops, but it is droughty in some years unless rainfall is timely. Capability unit I–2.

Saude Series

The Saude series consists of nearly level to gently sloping, well-drained soils on stream benches and uplands. They formed in 20 to 36 inches of loamy materials and the underlying sand and gravel. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and dark-brown loam about 20 inches thick. The subsoil is about 15 inches thick. It is brown, friable light sandy clay loam in the upper part and yellowish-brown, very friable loamy sand in the lower part. The substratum is yellowish-brown, gravelly sand.

Available water capacity is medium to low. Permeability is moderate to moderately rapid in the loamy materials and rapid to very rapid in the underlying sandy material. On uplands, glacial till generally is at a depth of 6 to 15 feet. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are medium acid to strongly acid.

Saude soils are well suited to row crops, but they are slightly droughty in years of average rainfall. Sloping areas are subject to erosion if cultivated.

Representative profile of Saude loam, 0 to 2 percent slopes, 95 feet east of the northwest corner of SW¼SW¼ sec. 13, T. 97 N., R. 17 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; moderate, very fine and fine, granular structure; friable; slightly acid; abrupt boundary.

A12—8 to 15 inches, very dark brown (10YR 2/2) loam; moderate, fine and very fine, granular structure; friable; slightly acid; gradual boundary.

A3—15 to 20 inches, dark-brown (10YR 3/3) loam; moderate, very fine and fine, granular structure; friable; medium acid; clear boundary.

B21—20 to 26 inches, brown (10YR 4/3) light sandy clay loam; discontinuous dark-brown (10YR 3/3) coatings on peds; moderate, very fine, subangular blocky structure; friable; medium acid; clear boundary.

B22—26 to 29 inches, dark yellowish-brown (10YR 4/4) coarse sandy loam; dark-brown (10YR 3/3) coatings on peds; moderate, very fine, subangular blocky structure; friable; medium acid; abrupt boundary.

IIB3—29 to 35 inches, yellowish-brown (10YR 5/6) loamy sand; very weak, coarse, subangular blocky structure; very friable; weakly cemented when dry; some clay bridging of sand grains; medium acid; clear boundary.

IIC1—35 to 42 inches, yellowish-brown (10YR 5/6) gravelly sand; single grained; very friable; slightly cemented when dry; strong-brown (7.5YR 5/6) clay films coat sand grains in a band 3 inches in diameter; medium acid.

IIC2—42 to 50 inches, yellowish-brown (10YR 5/6) gravelly sand; single grained; loose; medium acid.

The solum is generally 2½ to 3½ feet thick. Depth of loamy materials over the gravelly sand and loamy sand ranges from 20 to 36 inches. The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) and from 10 to 22 inches in thickness. It ranges from loam to silt loam that has a high content of sand.

The B horizon ranges from loam to light sandy clay loam and sandy loam in the upper part to loamy sand or gravelly sand in the lower part.

The C horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10 YR 5/6) and from loamy sand to gravelly sand.

Saude soils formed in about the same kind of material as Hayfield, Lawler, Marshan, Sattre, Wapsie, and Waukee soils. They have a thicker A horizon than Hayfield, Sattre, and Wapsie soils. They are better drained and have a browner B horizon than Hayfield, Lawler, and Marshan soils. They are shallower over sand and gravel than Waukee soils.

Saude loam, 0 to 2 percent slopes (177).—This soil is on stream benches and uplands. It is associated with Hayfield, Lawler, Marshan, Wapsie, and Waukee soils on the stream benches. It is associated with many well-drained soils underlain by glacial till and bedrock on uplands. Most areas are 4 to 40 acres in size. This soil has the profile described as representative of the series.

This soil is well suited to row crops, but it is slightly droughty in years of average or below average rainfall. Capability unit IIs–1.

Saude loam, 2 to 5 percent slopes (177B).—This soil is on larger stream benches and uplands. It is associated with Hayfield, Lawler, Marshan, Wapsie, and Waukee soils on the stream benches and with many of the well drained and moderately well drained soils on uplands. Most areas are 4 to 20 acres in size. This soil has a profile similar to that described as representative of the series, but the dark surface layer is not so thick.

This soil is well suited to row crops, but is slightly droughty in years of average or below average rainfall. It is subject to slight erosion if cultivated. Capability unit IIe–4.

Schley Series

The Schley series consists of somewhat poorly drained soils on uplands. These soils occupy slightly convex to concave downslope and cove positions. Slopes are 1 to 4 percent. The soils formed in 30 to 50 inches of loamy material and the underlying firm loam glacial till. The loamy material is stratified in the lower part. In some places a layer of pebbles forms the contact line between the loamy overburden and the stratified sediment or on the surface of the glacial till. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 8 inches thick. The subsurface layer, about 9 inches thick, is grayish-brown and brown, friable loam. The subsoil extends to a depth of about 60 inches. It is mottled grayish-brown, strong-brown, and light brownish-gray, friable light sandy clay loam in the upper and middle parts. The lower part is brown and strong-brown, firm heavy loam that has many gray mottles.

Available water capacity is high. Permeability is moderate in the upper part and moderately slow in the lower part. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers generally are medium acid to strongly acid. Wetness is caused, at least in part, by hillside seepage from Bassett, Kenyon, and other higher lying associated soils.

Schley soils are generally well suited to row crops if properly drained and managed.

Representative profile of Schley silt loam, 1 to 4 percent slopes, in a cultivated field 740 feet south and 120 feet east of the northwest corner of sec. 29, T. 100 N., R. 16 W.

Ap—0 to 8 inches, very dark grayish-brown (10 YR 3/2) silt loam high in content of sand; moderate, medium, platy structure parting to weak, fine, granular; friable; neutral; abrupt boundary.

A21—8 to 13 inches, grayish-brown (10YR 5/2) and brown (10YR 5/3) loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, platy structure parting to fine and very fine, granular; friable; slightly acid; clear boundary.

A22—13 to 17 inches, grayish-brown (10YR 5/2) loam; many, fine, distinct strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/6) mottles; weak, medium and thick, platy structure parting to moderate, very fine, subangular blocky; friable; strongly acid; clear boundary.

B21—17 to 24 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) light sandy clay loam; moderate, fine, subangular blocky structure; friable; band of pebbles, ¼ to ½ inch in diameter, at the top of the horizon; strongly acid; clear boundary.

B22—24 to 33 inches, strong-brown (7.5YR 5/6) light sandy clay loam; many, medium, distinct, light brownish-gray (10YR 6/2) mottles; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; nearly continuous light brownish-gray (10YR 6/2) coatings on prisms; few, fine and medium, prominent, yellowish-red (5YR 4/6) oxide concentrations; strongly acid; gradual boundary.

B31—33 to 48 inches, strong-brown (7.5YR 5/6) light sandy clay loam and sandy loam; many, medium, distinct, light brownish-gray (10YR 6/2) mottles; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; friable; few, fine, hard, rock oxide concentrations; nearly continuous light brownish-gray (10YR 6/2) coatings on prisms; medium acid; clear boundary.

IIB32t—48 to 60 inches, brown (7.5YR 4/4) and strong-brown (7.5YR 5/6) heavy loam; common, medium, prominent, gray (5Y 5/1) mottles; weak, coarse, prismatic structure; firm; common, fine, hard, dark oxide concentrations; dark-gray (10YR 4/1) clay films line root channels; medium acid.

The solum is generally 4 to 6 feet thick. The A1 or Ap horizon is generally black (10YR 2/1) or very dark grayish brown (10YR 3/2). The A2 horizon ranges from dark grayish brown (10YR to 2.5Y 4/2) to light brownish gray (10YR 6/2) and has mottles of higher chroma and mottles that commonly have redder hues. The A1 or Ap and A2 horizons are silt loam or loam.

The B1 horizon, if present, ranges from dark grayish brown (10YR or 2.5Y 4/2) to grayish brown (10YR 5/2) and brown (10YR 5/3) and has mottles of higher chroma in hues of 7.5YR to 2.5Y. It ranges from light silty clay loam that has a high content of sand to light sandy clay loam. The IIB horizon is generally mottled with hues of 2.5Y to 7.5YR, values of 4 to 6, and chroma of 2 to 8. The B2 horizon is generally heavy sandy loam, sandy clay loam, or loam. Depth to the IIB horizon ranges from 30 to 50 inches. Depth to carbonates is more than 50 inches.

Schley soils are in the same drainage class as Floyd, Franklin, Hayfield, Oran, and Riceville soils. They have a thinner A1 horizon than Floyd soils. They are more stratified and have a more friable B horizon than Oran and Riceville soils. They have more sand throughout the A and B horizons than Franklin soils. They lack the thick substratum of sandy and gravelly materials that is characteristic of Hayfield soils.

Schley silt loam, 1 to 4 percent slopes (407B).—This soil is on slightly convex to concave downslope positions on uplands. It is below the better drained Bassett, Keyon, and Lourdes soils, which formed in glacial till. Areas commonly range from 3 to 50 acres in size, but a few are much larger. Areas are generally narrow and in places extend across more than one farm.

Included with this soil in mapping were a few areas near Lourdes and Riceville soils where very firm clay loam till is below a depth of 40 inches.

This soil is generally well suited to row crops if properly drained and managed. The major limitation is wetness, but some areas are subject to erosion. Wetness is caused, at least in part, by sidehill seepage, so a drainage system that intercepts laterally moving water is the most successful. Capability unit IIw-2.

Sogn Series

The Sogn series consists of gently sloping to very steep, somewhat excessively drained soils on uplands and terrace escarpments. The gently sloping soils are on long ridge crests, and the moderately sloping to very steep soils are on side slopes. Some vertical and nearly vertical limestone escarpments are near streams. These soils formed in 4 to 15 inches of loamy materials and the underlying limestone bedrock. In some places a thin clayey layer is just above the limestone.

In a representative profile the surface layer is black, heavy loam about 12 inches thick. Below the surface layer is about 4 feet of shattered limestone bedrock that contains some earthy material. This is underlain by massive limestone bedrock.

Available water capacity is very low, and permeability is moderate. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate to high. These soils are slightly acid to neutral.

Sogn soils are poorly suited to row crops because of the shallowness to bedrock.

Representative profile of Sogn loam, 14 to 40 percent slopes, in a bluegrass pasture 650 feet south and 75 feet west of the northeast corner of sec. 12, T. 98 N., R. 18 W.

A1—0 to 12 inches, black (10YR 2/1) heavy loam; moderate, very fine and fine, granular structure; friable; few small pebbles in upper part; common pebbles, 1/4 to 1/2 inch in diameter, in lower part; slightly acid grading to neutral with depth; abrupt boundary.

IIR1—12 to 60 inches, shattered hard limestone bedrock; dark-colored material from A horizon makes up about 15 percent of volume and extends 3 to 6 inches into crevices and around limestone fragments; smaller amounts tongue downward to a depth of 24 inches.

IIR2—60 inches, level-bedded limestone bedrock.

The solum is generally about 12 inches thick, but it ranges from 4 to 15 inches. It is generally loam or clay loam. The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A3 horizon, if present, is generally very dark grayish brown (10YR 3/2). The shattered upper layer of limestone, 2 to 5 feet thick, is 5 to 15 percent clay loam to loamy sand. In places bits of clayey material are on the slabs and in the crevices in the upper part. As slope increases, the thickness of the shattered limestone generally decreases.

Sogn soils are shallower over bedrock than the associated Ashdale, Atkinson, Dubuque, Rockton, Roseville, Waucoma, Whalan, and Winneshiek soils.

Sogn loam, 2 to 5 percent slopes (412B).—This soil is above more sloping areas of Sogn soils, or is on side slopes. It is below nearly level to gently sloping Atkinson, Ashdale, Dubuque, Rockton, Waucoma, or Winneshiek soils on side slopes. Most areas are 2 to 8 acres in size.

This soil has a profile similar to that described as representative of the series, but is generally slightly deeper over bedrock. In some places, however, bedrock is near the surface or exposed.

Included with this soil in mapping were a few small areas where depth to bedrock is 15 to 30 inches.

This soil is poorly suited to row crops because of the limited root zone above the limestone bedrock. Limestone fragments commonly interfere with cultivation. The soil is subject to slight erosion if cultivated. Erosion is particularly serious on this soil because it further decreases the very limited root zone. Capability unit IVs-2.

Sogn loam, 5 to 14 percent slopes (412D).—This soil is on side slopes below less sloping Sogn soils and Ashdale, Atkinson, Dubuque, Rockton, Roseville, Waucoma, Whalan, and Winneshiek soils, or it is above steeper Sogn soils. Most areas are long and narrow and 4 to 15 acres in size. Some are larger.

This soil has a profile similar to that described as representative of the series. In many places, however, especially in the steeper areas, bedrock is exposed.

Included with this soil in mapping were a few small areas where depth to bedrock is 15 to 30 inches.

This soil is poorly suited to row crops. It has a limited root zone and is droughty. It is subject to moderate erosion if cultivated, and erosion decreases the limited root zone. It is better suited to hay or pasture than to other uses. Capability unit VIs-1.

Sogn loam, 14 to 40 percent slopes (412G).—This soil is on side slopes below less sloping Sogn, Atkinson, Dubuque, Rockton, Waucoma, Whalan, and Winneshiek soils. Many areas are long and narrow. Most areas are 4 to 20 acres in size, but they are more than 100 acres in places along the Cedar River.

This soil has the profile described as representative of the series. In some places, especially on the limestone escarpments along the Cedar River, hard-bedded limestone is exposed.

This soil is poorly suited to cultivation. It has a very limited root zone and is droughty. The steepest areas have limited value as pasture and are generally wooded. Capability unit VIIs-1.

Tama Series

The Tama series consists of nearly level to moderately sloping, well-drained soils on uplands. These soils occupy broad flats, ridges, and side slopes. They formed in loess deposits, 3 1/2 to 7 feet thick, over glacial till. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark brown, and dark-brown light silty clay loam about 20 inches thick. The subsoil extends to a depth of about 60 inches. It is brown, friable light silty clay loam in the upper part and yellowish-brown, friable silt loam in the lower part.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is low to medium. The subsoil is low in available phosphorus, and very low in available potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid.

Tama soils are well suited to row crops, but sloping areas are subject to erosion if cultivated.

Representative profile of Tama silty clay loam, 0 to 2 percent slopes, in a cultivated field 650 feet south and 35 feet east of the northwest corner of sec. 33, T. 98 N., R. 16 W.

Ap—0 to 8 inches, black (10YR 2/1) light silty clay loam; weak, very fine and fine, granular structure; friable; slightly acid; abrupt boundary.

A12—8 to 15 inches, very dark brown (10YR 2/2) light silty clay loam; nearly continuous black (10YR 2/1) coatings on peds; moderate, very fine, granular structure; friable; slightly acid; clear boundary.

A3—15 to 20 inches, dark-brown (10YR 3/3) light silty clay loam; nearly continuous very dark grayish-brown (10YR 3/2) coatings on peds; moderate, fine, granular structure; friable; medium acid; clear boundary.

B1—20 to 29 inches, brown (10YR 4/3) light silty clay loam; nearly continuous dark-brown (10YR 3/3) coatings on peds; moderate, very fine, subangular blocky structure; friable; few, grainy, gray coatings when dry; medium acid; gradual boundary.

B2t—29 to 42 inches, brown (10YR 4/3) light silty clay loam; nearly continuous dark brown (10YR 3/3) coatings on peds; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; friable, few, thin, discontinuous clay films; few, grainy, gray coatings when dry; strongly acid; gradual boundary.

B3—42 to 60 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, prismatic structure; friable; few, grainy, gray coatings when dry; strongly acid.

The solum is generally 4 to 5 feet thick, but it ranges from 3½ to 5½ feet. It is medium to strongly acid in the most acid part. It contains less than 10 percent sand to a depth of 40 inches. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon is silt loam or light silty clay loam.

The finest part of the B horizon averages between 27 and 32 percent clay. A few fine mottles of high and low chroma are in the lower part of the B horizon in places.

Tama soils formed in about the same kind of material as Atterberry, Downs, Fayette, Garwin, and Muscatine soils. They are better drained and have a browner B horizon than Atterberry, Garwin, and Muscatine soils. They have a thicker A1 horizon than Downs and Fayette soils.

Tama silty clay loam, 0 to 2 percent slopes (120).—This soil is on broad flats on uplands. It is associated with the nearly level to gently sloping Dinsdale, Downs, and Muscatine soils and with the gently sloping Tama soils. Most areas range from 10 to 80 acres in size, but some are as much as 300 acres. This soil has the profile described as representative of the series.

Included with this soil in mapping were small areas of Downs soils that have a thinner, dark surface layer. Also included were small areas of Huntsville soils, adjacent to the waterways, that have a thicker surface layer. This soil has limestone bedrock at a depth of 10 to 15 feet in places. For this reason the water table is lower.

This soil is well suited to intensive use for row crops. Capability unit I–2.

Tama silty clay loam, 2 to 5 percent slopes (120B).—This soil is on long, convex ridges and side slopes. It is associated with Dinsdale, Garwin, Huntsville, Muscatine, and other Tama soils. Most areas are 10 to 50 acres in size, but some areas are as large as 200 acres. This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick.

Included with this soil in mapping were small areas of Downs soils that have a thinner A1 horizon. Also included, adjacent to some of the waterways, were small areas of Huntsville soils that have a thicker A1 horizon. On the stronger slopes a few areas of Dinsdale soils that have glacial till between depths of 30 and 40 inches were also included.

This soil is well suited to row crops, but it is subject to slight erosion if cultivated. If erosion is controlled, it can be used intensively for row crops. Capability unit IIe–1.

Tama silty clay loam, 5 to 9 percent slopes, moderately eroded (120C2).—This soil occupies the tops of divides and side slopes. It is associated with less sloping Tama soils and with Huntsville and Muscatine soils. Most areas are 5 to 20 acres in size. This soil has a profile similar to that described as representative of the series, but the surface layer is thinner and lighter colored.

Included with this soil in mapping were a few small areas of moderately eroded Dinsdale soils that have glacial till between depths of 30 and 40 inches.

This soil is well suited to row crops. It is subject to moderate erosion if cultivated. Capability unit IIIe–1.

Terril Series

The Terril series consists of nearly level to gently sloping, moderately well drained soils. These soils are in upland waterways, narrow valleys, and on foot slopes. They formed in loamy alluvial sediment. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown loam about 30 inches thick. The subsoil extends to a depth of about 60 inches. It is dark-brown and dark yellowish-brown, friable loam and light sandy clay loam in the upper part and yellowish-brown, friable sandy loam in the lower part.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is low to medium. The subsoil is very low in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally slightly acid to medium acid.

Terril soils are subject to flooding of short duration. If properly managed and protected from flooding, they are well suited to row crops.

Representative profile of Terril loam, 0 to 2 percent slopes, in a cultivated field 60 feet north and 110 feet west of the southeast corner of NE¼ sec. 14, T. 97 N., R. 17 W.

Ap—0 to 8 inches, black (10YR 2/1) heavy loam; weak, fine, granular structure; friable; slightly acid; clear boundary.

A12—8 to 24 inches, very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak, fine, granular structure; friable; few stones 2 millimeters in diameter; slightly acid; gradual boundary.

A3—24 to 30 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate, very fine and fine, granular structure; friable; medium acid; clear boundary.

B1—30 to 34 inches, dark-brown (10YR 4/3) loam; very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) coatings on peds; moderate, very fine, subangular blocky structure; friable; medium acid; gradual boundary.

B2—34 to 40 inches, dark yellowish-brown (10YR 4/4) light sandy clay loam; dark-brown (10YR 4/3) coatings on peds; weak, fine and medium, subangular blocky structure; friable; few pebbles, 2 millimeters in diameter; medium acid; gradual boundary.

B3—40 to 60 inches, yellowish-brown (10YR 5/4) sandy loam; weak, medium, prismatic structure; friable; common pebbles, 2 millimeters in diameter; strongly acid.

The solum is generally 3½ to 5 feet thick. The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) and from 24 to 36 inches in thickness. The A horizon ranges from loam to silt loam that has a high content of sand.

The B horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/6). It is dominantly loam. In places thin layers of sandy loam are within a depth of 36 inches.

The C horizon, if present, ranges from loam to loamy sand and gravelly sand. Reaction is medium acid to strongly acid in the B horizon. Reaction of these soils is more acid than in the defined range for the series, but this difference does not greatly alter the usefulness or behavior of these soils.

Terril soils formed in about the same kind of material as Turlin, Coland, Hanlon, and Huntsville soils. They are better drained and have a browner B horizon than Coland and Turlin soils. They contain more sand and less silt than Huntsville soils, but they are not so sandy as Hanlon soils.

Terril loam, 0 to 2 percent slopes (27).—This soil generally is in waterways. It is associated with nearly level to moderately sloping, well-drained soils. In places it is in narrow upland valleys that have moderately steep sides. Most areas range from 3 to 15 acres in size. This soil has the profile described as representative of the series.

This soil is well suited to intensive use for row crops. There are no major limitations, but some areas are subject to flooding of short duration. Capability unit I–1.

Terril loam, 2 to 5 percent slopes (27B).—This soil is in waterways. It is associated with gently sloping to strongly sloping, well-drained soils that generally are underlain by limestone. In a few places it is in narrow upland valleys that have steep sides. Most areas range from 3 to 15 acres in size. Included in mapping were a few areas where limestone bedrock is between depths of 30 and 40 inches.

This soil is well suited to row crops. It is subject to slight sheet and gully erosion if cultivated. Some areas receive much runoff from adjacent soils at higher elevations and are subject to flooding of short duration. Erosion control on these adjacent soils reduces local runoff and siltation. Capability unit IIe–5.

Tripoli Series

The Tripoli series consists of nearly level, poorly drained soils on uplands. These soils are on flats and at the heads and along the upper parts of some of the shallow drainageways. They formed in 18 to 28 inches of loamy material and the underlying glacial till. In most places a layer of pebbles and stones forms the contact line between the overburden and the glacial till.

In a representative profile the surface layer is black and very dark gray silty clay loam about 20 inches thick. The subsoil is about 28 inches thick. It is olive-gray, friable light clay loam in the upper part; dark grayish-brown and olive-brown, friable heavy loam in the middle part; and mottled grayish-brown and yellowish-brown, firm loam in the lower part. The substratum is mottled yellowish-brown, strong-brown, and grayish-brown, firm loam.

Available water capacity is high. The rate at which water moves through the loamy overburden differs considerably from the rate at which it moves through the glacial till. Permeability is moderate in the loamy overburden and moderately slow in the underlying till. Water moves more rapidly in the overburden and accumulates at the till contact, which produces a seasonally perched water table. The content of available nitrogen is medium. The subsoil is very low to low in available phosphorus and potassium. The content of organic matter is very high. These soils are neutral to mildly alkaline.

If tile drainage is adequate, Tripoli soils are well suited to intensive use for row crops.

Representative profile of Tripoli silty clay loam, 0 to 2 percent slopes, in a cultivated field 250 feet west and 190 feet north of the southeast corner of SW¼ sec. 35, T. 98 N., R. 15 W.

Ap—0 to 8 inches, black (N 2/0) light silty clay loam high in content of sand; weak, fine and very fine, granular structure; friable; neutral; abrupt boundary.

A12—8 to 13 inches, black (N 2/0) light silty clay loam high in content of sand; moderate, fine and very fine, granular structure; friable; neutral; gradual boundary.

A3—13 to 20 inches, very dark gray (5Y 3/1) medium silty clay loam high in content of sand; moderate, fine and very fine, granular structure; friable; few, fine, yellowish-red (5YR 4/6) oxide concentrations; neutral; clear boundary.

B1g—20 to 24 inches, olive-gray (5Y 4/2) light clay loam; discontinuous very dark grayish-brown (2.5Y 3/2) and dark-gray (10 YR 4/1) coatings on peds; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; moderate, very fine, subangular blocky structure; friable; strong-brown (7.5YR 5/6) oxide concentrations; neutral; clear boundary.

IIB2—24 to 29 inches, dark grayish-brown (2.5Y 4/2) and olive-brown (2.5Y 4/4) heavy loam; common, medium, distinct, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; weak, very fine, subangular blocky structure; friable; few, patchy, dark-gray (10YR 4/1) coatings on peds; few strong-brown (7.5YR 5/8) and yellowish-red (5YR 4/6) oxide concentrations; few pebbles in upper part; neutral; clear boundary.

IIB3—29 to 48 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (10YR 5/2) loam; weak, coarse, prismatic structure parting to weak, medium and coarse, subangular blocky; firm; few strong-brown (7.5YR 5/8) oxide concentrations; neutral; abrupt boundary.

IIC—48 to 60 inches, mottled yellowish-brown (10YR 5/6), strong-brown (7.5YR 5/6), and grayish-brown (2.5Y 5/2) loam; massive; firm; moderately alkaline; slight effervescence.

The thickness of the solum, which is the same as the depth to carbonate, is generally 3 to 4 feet. The A1 horizon is black (N 2/0 to 10YR 2/1). The A3 horizon is generally present and is very dark gray (10YR 3/1 or 5Y 3/1). The A horizon ranges from 15 to 22 inches in thickness and is generally light or medium silty clay loam that has a high content of sand, but it ranges to light and medium clay loam.

The B1 horizon ranges from dark gray (10YR 4/1) to dark grayish brown (2.5Y 4/2) and olive gray (5Y 4/2). The B1 horizon has mottles of high and low chroma. It is light to medium silty clay loam that has a high content of sand and clay loam. The IIB2 horizon ranges from dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4) and has mottles of 7.5YR, 10YR, and 2.5Y hue in values of 4 and 5 and chroma of 2 to 8. The B2, B3, and C horizons are generally loam, but the range includes sandy clay loam and light clay loam.

Tripoli soils formed in about the same kind of material as Jameston and Readlyn soils, and they are in the same drainage class as Clyde and Maxfield soils. They are more poorly drained and have a grayer B horizon than Readlyn soils. They are more friable and contain less clay in the IIB and IIC horizons than Jameston soils. They have firmer consistence in the B horizon than Clyde soils, and they are not stratified. They contain more sand in the A horizon and upper part of the B horizon than Maxfield soils.

Tripoli silty clay loam, 0 to 2 percent slopes (398).—This soil is on upland flats and at the heads of and along the upper parts of some of the shallow upland drainageways. It is associated with Kenyon, Oran, and Readlyn soils upslope and with Clyde soils farther down the drainageway. Most areas are about 5 to 40 acres in size.

This soil is well suited to intensive use for row crops if drained and properly managed. It generally has good tilth, but it puddles if worked when wet. The major limitation is wetness, and tile drainage is needed for maximum production. Capability unit IIw–1.

Turlin Series

The Turlin series consists of nearly level, somewhat poorly drained soils on bottom lands. These soils are on flood plains of rivers and narrow intermittent streams. They formed in loamy, alluvial sediment.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown silt loam about 28 inches thick. The subsoil is about 20 inches thick. It is mottled brown and strong-brown, friable heavy sandy loam in the upper part and gray, firm heavy loam that has yellowish-brown mottles in the lower part. The substratum is gray, very friable heavy sandy loam grading to loamy sand with depth.

Available water capacity is high, and permeability is moderate. The content of available nitrogen is medium to low. The subsoil is medium to low in phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are medium acid to strongly acid.

These soils are commonly used intensively for row crops. Some frequently flooded areas are used for pasture.

Representative profile of Turlin silt loam, 0 to 2 percent slopes, in a bluegrass pasture 300 feet south and 70 feet west of the northeast corner of SW¼ sec. 32, T. 98 N., R. 15 W.

Ap—0 to 10 inches, black (10YR 2/1) silt loam high in content of sand; moderate, very fine, granular structure; friable; medium acid; gradual boundary.

A12—10 to 21 inches, very dark brown (10YR 2/2) heavy silt loam high in content of sand; black (10YR 2/1) coatings on peds in upper part of horizon; moderate, fine and very fine, granular structure; friable; strongly acid; gradual boundary.

A3—21 to 28 inches, very dark grayish-brown (10YR 3/2) heavy silt loam high in content of sand; very dark gray (10YR 3/1) coatings on peds; weak, medium, subangular blocky structure; friable; medium acid; clear boundary.

B2—28 to 36 inches, mottled brown (10YR 5/3) and strong-brown (7.5YR 5/6) heavy sandy loam; few, distinct yellowish-red (5YR 4/6) mottles; grayish-brown (10YR 5/2) coatings on peds; weak, medium, subangular blocky structure; friable; common, fine, dark reddish-brown (5YR 2/2) oxide concentrations in upper part of horizon; discontinuous, light brownish-gray (10YR 6/2), grainy coatings when dry; medium acid; clear boundary.

B31—36 to 39 inches, mottled strong-brown (7.5YR 5/8) and grayish-brown (10YR 5/2) sandy loam; very weak, medium, subangular blocky structure; very friable; some clay bridging of sand grains; discontinuous, light brownish-gray (10YR 6/2), grainy coatings when dry; medium acid; clear boundary.

B32—39 to 48 inches, gray (5Y 6/1) heavy loam; many, prominent, medium, yellowish-brown (10YR 5/8) mottles; weak, medium, prismatic structure; firm; few, fine, soft, dark reddish-brown (5YR 3/4) oxide concentrations; few, discontinuous, very dark gray (10YR 3/1) clay fills in root channels; neutral; clear boundary.

C—48 to 60 inches, gray (5Y 6/1) heavy sandy loam grading to loamy sand with depth; few, fine, prominent, yellowish-brown (10YR 5/8) mottles; massive; very friable; neutral.

The solum is generally 3½ to 5 feet thick. The A horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) in color and from 24 to 36 inches in thickness. It is dominantly silt loam, but it ranges to loam that has a relatively low content of sand and to silty clay loam that has a high content of sand. The B horizon above a depth of 40 inches ranges from sandy loam to light clay loam. Depth to textures coarser than sandy loam is 48 inches or more. The B horizon is generally medium acid, but it ranges from slightly acid to strongly acid.

Turlin soils formed in about the same kind of material as Coland, Hanlon, Huntsville, and Terrill soils, and they are in the same drainage class as Floyd and Lawler soils. They are not so well drained as Terrill soils and have more grayish mottles in the B horizon. They have a thicker A horizon than Floyd and Lawler soils. They contain less sand than Hanlon soils and have colors of 2 chroma nearer the surface. They contain more sand and less silt than Huntsville soils. They are better drained than Coland soils.

Turlin silt loam, 0 to 2 percent slopes (96).—This soil is on bottom lands and is commonly adjacent to Coland soils. Areas range from about 3 to 20 acres in size.

This soil is occasionally wet because of flooding. It responds to good management and can be used intensively for row crops. Growth of corn is better than average during years of normal rainfall if flooding is not a problem. Many areas of this soil are cultivated; some are in pasture. Capability unit I–1.

Wapsie Series

The Wapsie series consists of nearly level to moderately sloping, well-drained soils on stream benches and uplands. They formed in 20 to 36 inches of loamy materials and the underlying sand and gravel. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish-brown loam about 8 inches thick. The subsurface layer, about 5 inches thick, is brown, friable loam. The subsoil is about 22 inches thick. It is dark yellowish-brown, friable loam and light sandy clay loam in the upper part; brown, very friable heavy sandy loam in the middle part; and strong-brown, very friable gravelly loamy sand in the lower part. The substratum is yellowish-brown and brown sand and gravelly sand.

Available water capacity is medium to low. Permeability is moderate to moderately rapid in the loamy material and rapid to very rapid in the underlying sandy material. On uplands, glacial till generally is at a depth of 6 to 15 feet. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are medium acid to strongly acid.

Wapsie soils are well suited to row crops, but they are slightly droughty in years of average rainfall. Sloping areas are subject to erosion if cultivated.

Representative profile of Wapsie loam, 0 to 2 percent slopes, in a cultivated field 210 feet north and 75 feet east of the southwest corner of SE¼SW¼ sec. 7, T. 98 N., R. 15 W.

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) light loam; moderate, fine, granular structure; friable; neutral; clear boundary.

A2—8 to 13 inches, brown (10YR 4/3) light loam; moderate, thin, platy structure; friable; many dark-brown (7.5YR 3/2) and few very dark grayish-brown (10YR 3/2) worm casts; few, grainy, pale-brown (10YR 6/3) coatings on plates; neutral; clear boundary.

B1—13 to 17 inches, dark yellowish-brown (10YR 4/4) loam; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21t—17 to 23 inches, dark yellowish-brown (10YR 4/4) light sandy clay loam; weak, medium and fine, subangular blocky structure; friable; very few, dark-brown (7.5YR 3/2), thin, discontinuous clay films; strongly acid; abrupt boundary.

B22t—23 to 27 inches, brown (7.5YR 4/4) heavy sandy loam; weak, medium, subangular blocky structure; very friable; few very dark grayish-brown (10YR 3/2) clay films on faces of peds; common fine pebbles, as much as 1 inch in diameter; strongly acid; gradual boundary.

IIB3—27 to 35 inches, strong-brown (7.5YR 5/6) gravelly loamy sand; weak, medium, subangular blocky structure; very friable; about 15 percent gravel; some clay bridging of sand grains; strongly acid; gradual boundary.

IIC1—35 to 40 inches, yellowish-brown (10YR 5/6) fine sand; very weak, medium, subangular blocky structure; very friable; few dark reddish-brown (5YR 3/3) and yellowish-red (5YR 4/8) oxide concentrations; strongly acid; clear boundary.

IIC2—40 to 55 inches, mottled yellowish-brown (10YR 5/6) and brown (7.5YR 4/4) coarse sand; single grained; loose; medium acid; gradual boundary.

IIC3—55 to 60 inches, brown (7.5YR 4/4) very fine gravelly sand; single grained; loose; moderately alkaline; slight effervescence.

The solum is generally 2½ to 3½ feet thick. Depth of loamy materials over the gravelly loamy sand ranges from 20 to 36 inches. The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and from 6 to 9 inches in thickness. It ranges from loam to silt loam that has a high content of sand. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 4/3) and from loam to silt loam that has a high content of sand.

The B horizon ranges from brown (10YR 4/3 and 7.5YR 4/4) to yellowish brown (10YR 5/6) and from sandy loam to loam or sandy clay loam in the upper part to gravelly loamy sand or sand in the lower part.

The C horizon ranges from brown (7.5YR 4/4) to yellowish brown (10YR 5/6) and from loamy sand that has some gravel to gravelly sand.

Wapsie soils formed in about the same kind of material as Flagler, Hayfield, Lawler, Sattre, and Saude soils. They are shallower over sand or gravel than Sattre soils. They have an A2 horizon and a thinner A1 horizon than Saude soils. They are better drained and have a browner B horizon than Hayfield and Lawler soils. They contain less sand in the upper part of the B horizon and have a thinner dark A horizon than Flagler soils.

Wapsie loam, 0 to 2 percent slopes (777).—This soil is on stream benches. It is associated with other bench soils, such as Hayfield, Lilah, Sattre, and Saude soils. Most areas are 5 to 40 acres in size, but a few are much larger. This soil has the profile described as representative of the series.

This soil is suited to row crops, but it is slightly droughty in years of average rainfall. Capability unit IIs–1.

Wapsie loam, 2 to 5 percent slopes (777B).—This soil is on larger stream benches and uplands. It is associated with Hayfield, Lilah, Sattre, and Saude soils on benches. It is associated with many of the well drained and moderately well drained soils on uplands. Most areas are 5 to 40 acres in size.

This soil is suited to row crops, but it is slightly droughty in years of average rainfall. It is subject to slight erosion if cultivated. Capability group IIe–4.

Wapsie loam, 5 to 9 percent slopes (777C).—This soil is on high uplands and terrace escarpments. It is associated with well-drained soils on uplands and is adjacent to Lilah and Saude soils and less sloping Wapsie soils on terraces. Most areas are 3 to 10 acres in size. This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick.

Included with this soil in mapping were a few small areas of Lilah soils that have more sand in the surface layer and subsoil.

This soil is suited to row crops, but it is droughty and is subject to moderate erosion if cultivated. Capability unit IIIe–3.

Waubeek Series

The Waubeek series consists of nearly level to gently sloping, well drained and moderately well drained soils on uplands. These soils are on flats, ridge crests, and side slopes. They formed in 20 to 40 inches of loess and the underlying glacial till. In many places a layer of pebbles is at or near the contact line between the loess and the underlying glacial material. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer, about 5 inches thick, is dark grayish-brown, friable silt loam. The subsoil extends to a depth of about 72 inches. It is brown, friable heavy silt loam and light silty clay loam in the upper part; yellowish-brown, friable silty clay loam in the middle part; and yellowish-brown, friable and firm loam in the lower part.

Available water capacity is high. Permeability is moderate in the loess and moderately slow in the underlying till. The content of available nitrogen is low to very low. The subsoil is low in available phosphorus and very low in available potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Waubeek soils are well suited to row crops and are generally associated with large areas of other well-suited soils. Gently sloping areas are subject to slight erosion if cultivated.

Representative profile of Waubeek silt loam, 2 to 5 percent slopes, in a pasture 725 feet north and 215 feet west of the southeast corner of sec. 25, T. 100 N., R. 17 W.

A1—0 to 8 inches, very dark brown (10YR 2/2) silt loam; moderate, fine and very fine, granular structure; friable; slightly acid; clear boundary.

A2—8 to 13 inches, dark grayish-brown (10YR 4/2) silt loam; nearly continuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium, platy structure parting to moderate, very fine, subangular blocky; friable; light-gray (10Y 7/1) grainy coatings when dry; medium acid; clear boundary.

B1—13 to 18 inches, brown (10YR 4/3) heavy silt loam; discontinuous dark grayish-brown (10YR 4/2) coatings on peds; moderate and strong, very fine and fine, subangular blocky structure; thin light-gray (10YR 7/1) grainy coatings when dry; strongly acid; clear boundary.

B21t—18 to 23 inches, brown (10YR 4/3) light silty clay loam; moderate and strong, very fine and fine, subangular blocky structure; friable; few, patchy, dark-brown (10YR 3/3) clay films; very strongly acid; gradual boundary.

B22t—23 to 27 inches, yellowish-brown (10YR 5/4) silty clay loam; weak, fine, subangular blocky structure; friable; thin discontinuous clay films on faces of peds; very strongly acid; gradual boundary.

B23t—27 to 31 inches, yellowish-brown (10YR 5/4) light silty clay loam; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; few, thin, discontinuous, brown (10YR 4/3) clay films; very strongly acid; clear boundary.

IIB31t—31 to 51 inches, yellowish-brown (10YR 5/6) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few, thin, dark-gray (10YR 4/1) clay films in root channels; few, thin, discontinuous, brown (10 YR 4/3) clay films on faces of prisms and peds; few, fine, dark oxide concentrations; strongly acid; clear boundary.

IIB32—51 to 72 inches, yellowish-brown (10YR 5/6) loam; weak, medium, prismatic structure; firm; few dark-gray (10YR 4/1) clay films in root channels; few reddish-brown (5YR 4/4) oxide concentrations ½ inch in diameter; neutral.

The solum is generally 4½ to 6 feet thick. The depth of loess ranges from 20 to 40 inches, but it is generally 24 to 32 inches. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) in color and from 6 to 9 inches in thickness. The content of sand in the A horizon and the part of the B horizon that formed in the loess ranges from 3 to 10 percent, but it is higher near the till contact.

The IIB horizon is generally loam, but it ranges to sandy clay loam and, in some places, to light clay loam. In places discontinuous lenses of sandy loam to sand, 1 to 8 inches thick, are between the loess and the till.

Waubeek soils formed in about the same kind of material as Dinsdale, Downs, Franklin, Klinger, Maxfield, and Tama soils. They have a browner B horizon and are better drained than Franklin, Klinger, and Maxfield soils. They have a thinner A1 horizon than Dinsdale soils. They formed in loess deposits 20 to 40 inches thick over glacial till, but Downs and Tama soils formed in loess deposits more than 40 inches thick.

Waubeek silt loam, 0 to 2 percent slopes (771).—This soil is on flats and convex ridges on uplands. It is commonly just above nearly level Franklin, Klinger, and Maxfield soils and adjacent to Dinsdale or Racine soils. In other areas it is associated with such soils as Ashdale, Nasset, and Waucoma soils that are underlain by limestone bedrock at a depth of 40 to 60 inches. Most areas are 5 to 40 acres in size.

Included with this soil in mapping were a few small areas where bedrock is at a depth of 40 to 60 inches. Also included were a few small areas that have a lighter colored surface layer that is lower in content of organic matter and a few areas that are not so well drained.

This soil is well suited to cultivated crops and is generally associated with other well-suited soils. Capability unit I-2.

Waubeek silt loam, 2 to 5 percent slopes (771B).—This soil is on long, convex side slopes and ridge crests. It generally is just above Franklin, Klinger, and Maxfield soils and adjacent to Dinsdale and Racine soils. In some areas it is associated with soils underlain by limestone bedrock. Most areas are 5 to 10 acres in size, but some areas are much larger. This soil has the profile described as representative of the series.

Included with this soil in mapping were a few small areas that have limestone at a depth of 30 to 60 inches, a few areas that have glacial material at a depth of less than 20 inches, a few areas not so well drained, and a few areas that have a lighter colored surface layer that is lower in content of organic matter.

This soil is well suited to cultivated crops and is generally associated with other well-suited soils. It is subject to slight erosion if cultivated. Capability unit IIe-1.

Waucoma Series

The Waucoma series consists of nearly level and gently sloping, well-drained soils on uplands. These soils are on flats, long ridges, and side slopes. They formed in 40 to 60 inches of loamy material and a thin layer of limestone residuum over limestone bedrock. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 7 inches thick. The subsurface layer, about 4 inches thick, is brown, friable silt loam. The subsoil is about 36 inches thick. It is brown and yellowish-brown, friable heavy loam in the upper part; dark yellowish-brown, friable sandy loam and light sandy clay loam in the middle part; and yellowish-brown, very firm clay in the lower part. Below the subsoil is shattered limestone bedrock.

Available water capacity is medium to high, and permeability is moderate. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid to strongly acid.

Waucoma soils are well suited to row crops. Sloping areas are subject to erosion if cultivated.

Representative profile of Waucoma silt loam, 2 to 5 percent slopes, in a cultivated field 125 feet north and 25 feet east of the southwest corner of NE¼ sec. 20, T. 98 N., R. 17 W.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam high in content of sand; weak, very fine and fine, granular structure; friable; neutral; abrupt boundary.

A2—7 to 11 inches, brown (10YR 4/3) silt loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium platy structure; friable; neutral; clear boundary.

B21t—11 to 15 inches, brown (10YR 4/3) heavy loam; very weak, medium, prismatic structure parting to weak, fine and very fine, subangular blocky; friable; thin, discontinuous, dark-brown (10YR 3/3) clay films on faces of prisms and peds; neutral; clear boundary.

B22t—15 to 30 inches, dark yellowish-brown (10YR 4/4) heavy loam; brown (10YR 4/3) coatings on peds; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few, thin, discontinuous, dark-brown (10YR 3/3) clay films on faces of prisms and peds; slightly acid; clear boundary.

B23t—30 to 38 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; discontinuous brown (10YR 4/3) coatings on peds; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few, thin, discontinuous, dark-brown (10YR 3/3) clay films on faces of prisms and peds; slightly acid; clear boundary.

B31t—38 to 45 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/4) sandy loam grading to light sandy clay loam at a depth of 41 inches; weak, coarse, prismatic structure parting to very weak, medium and coarse, subangular blocky; few, thin, discontinuous clay films; very friable; medium acid; gradual boundary.

IIB32t—45 to 47 inches, yellowish-brown (10YR 5/4) clay; strong, fine, angular blocky structure; very firm; nearly continuous very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2) clay films on faces of peds; slightly acid; abrupt boundary.

IIR—47 inches, shattered limestone bedrock.

The solum is generally 44 to 54 inches thick, but it ranges from 40 to 60 inches. The Ap or A1 horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The A1, Ap, and A2 horizons range from loam to silt loam.

The B2 horizon ranges from heavy sandy loam to light clay loam. The IIB horizon just above the shattered bedrock is generally clay or silty clay 2 to 6 inches thick. The shattered upper part of the bedrock ranges from 2 to 5 feet in thickness and is 5 to 15 percent loamy material in crevices and a thin layer of clayey residuum on the slabs of limestone.

Waucoma soils formed in about the same kind of material as Atkinson, Ashdale, Kensett, Rockton, Roseville, Sogn, Whalan, and Winneshiek soils. They are deeper over bedrock than Kensett, Rockton, Sogn, Whalan, and Winneshiek soils. They have a thinner A1 horizon than Ashdale, Atkinson, Kensett, and Rockton soils. They have a thicker A1 horizon than Roseville and Whalan soils. They have a browner B horizon and are better drained than Kensett soils.

Waucoma silt loam, 0 to 2 percent slopes (913).—This soil is on high uplands. It is generally just above gently sloping Waucoma and Winneshiek soils and adjacent to Racine soils. Most areas are 4 to 80 acres in size, but some are larger.

In a few spots, bedrock is at a depth of less than 40 inches, and in a few other places it is at a depth of more than 60 inches.

This soil is well suited to cultivated crops, and it is generally associated with large areas of other well-suited, well-drained soils. Capability unit I–2.

Waucoma silt loam, 2 to 5 percent slopes (913B).—This soil is on long, convex side slopes and ridge crests. It generally is associated with Racine and Winneshiek soils, more nearly level Waucoma soils, and other well-drained soils underlain by limestone bedrock. Most areas are 4 to 30 acres in size, but some are larger.

This soil has the profile described as representative of the series. In a few spots, bedrock is at a depth of less than 40 inches. In other places it is at a depth of more than 60 inches.

This soil is well suited to cultivated crops and is generally associated with large areas of other well-suited soils. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Waukee Series

The Waukee series consists of nearly level to gently sloping, well-drained soils. These soils are generally on stream benches but are occasionally on uplands. They formed in 35 to 40 inches of silty and loamy materials and the underlying sand and gravel. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown heavy silt loam about 13 inches thick. The subsoil is about 27 inches thick. It is brown, friable heavy silt loam in the upper part; dark yellowish-brown and yellowish-brown, friable heavy loam in the middle part; and dark yellowish-brown, friable and very friable sandy clay loam and gravelly loamy sand in the lower part. The substratum is yellowish-brown, gravelly loamy sand.

Available water capacity is medium to high. Permeability is moderate in the upper part and rapid to very rapid in the lower part. The content of available nitrogen is low to medium. The subsoil is low to medium in available phosphorus and potassium. The content of organic matter is high. Unless these soils are limed, the upper layers are generally medium acid.

Waukee soils are well suited to row crops. The gently sloping areas are subject to slight erosion if cultivated.

Representative profile of Waukee silt loam, 0 to 2 percent slopes, in a cultivated field 450 feet north and 110 feet west of the southeast corner of sec. 10, T. 98 N., R. 17 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy silt loam; cloddy, breaking to weak, very fine and fine, granular structure; friable; neutral; abrupt boundary.

A12—8 to 13 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; very dark brown (10YR 2/2) coatings on peds; moderate, very fine and fine, granular structure; friable; slightly acid; clear boundary.

B1—13 to 18 inches, brown (10YR 4/3) heavy silt loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; moderate, fine and very fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21—18 to 24 inches, dark yellowish-brown (10YR 4/4) heavy loam; brown (10YR 4/3) coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B22—24 to 32 inches, yellowish-brown (10YR 5/4) heavy loam; dark yellowish-brown (10YR 4/4) coatings on peds; weak, medium, subangular blocky structure; friable; few, very fine, dark oxide concentrations; medium acid; abrupt boundary.

B23t—32 to 36 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; weak, coarse, subangular blocky structure; friable; clay bridging of sand grains; few pebbles; common fine gravel; medium acid; abrupt boundary.

IIB3t—36 to 40 inches, dark yellowish-brown (10YR 4/4) gravelly loamy sand; weak, coarse, subangular blocky structure; very friable; few, fine, strong-brown (7.5YR 5/6) oxide concentrations; some clay bridging of sand grains; medium acid; clear boundary.

IIC—40 to 60 inches, yellowish-brown (10YR 5/6) gravelly loamy sand; single grained; loose; slightly cemented; medium acid.

The solum is generally 3 to 4 feet thick. The A1 or Ap horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A horizon is silt loam that is generally 8 to 12 percent sand but ranges to 20 percent.

The B1 horizon ranges from silt loam or light silty clay loam that has a high content of sand to loam. The contrasting textures of gravelly loamy sand or sand are at a depth of 35 to 40 inches.

Waukee soils formed in about the same kind of material as Hayfield, Lawler, Sattre, and Saude soils. They have a thicker A1 horizon than Hayfield, Sattre, and Wapsie soils and lack an A2 horizon. They have a browner subsoil than

Hayfield and Lawler soils and are better drained. They are not so shallow to sand and gravel as Saude soils.

Waukee silt loam, 0 to 2 percent slopes (178).—This soil is on stream benches and uplands. It is associated with Lawler, Turlin, and Huntsville soils downslope and with Ashdale, Atkinson, Dickinson, Dinsdale, Ostrander, and Saude soils adjacent and generally upslope. Most areas are 5 to 50 acres in size, but some areas are smaller or larger. This soil has the profile described as representative of the series.

Included with the soil in mapping were a few small areas where sand or gravel is somewhat closer to the surface and a few other areas where limestone bedrock is within a depth of 30 to 50 inches.

This soil is well suited to cultivated crops, and it is generally associated with other soils that are also well suited. Capability unit I–2.

Waukee silt loam, 2 to 5 percent slopes (178B).—This soil is on steam benches, ridges, and side slopes on uplands. It is associated with Lawler, Huntsville, and Turlin soils downslope and with Atkinson, Ashdale, Ostrander, Dickinson, Dinsdale, and Rockton soils adjacent or upslope. Most areas are 3 to 8 acres in size. This soil has a profile similar to that described as representative of the series, but the surface layer is slightly thinner.

Included with this soil in mapping were a few small areas where sand or gravel is somewhat closer to the surface than is typical and a few other areas where bedrock is within a depth of 30 to 50 inches.

This soil is well suited to cultivated crops. It is subject to slight erosion if cultivated. Capability unit IIe–1.

Whalan Series

The Whalan series consists of gently sloping to moderately sloping, well-drained soils on uplands. These soils are on long ridges and side slopes. They formed in about 30 to 40 inches of loamy material and a thin layer of limestone residuum over limestone bedrock. The native vegetation was trees.

In a representative profile the surface layer is dark grayish-brown loam about 5 inches thick. The subsoil is about 29 inches thick. It is dark-brown and dark yellowish-brown, friable heavy loam in the upper part; yellowish-brown, friable sandy clay loam in the middle part; and yellowish-brown, very firm clay in the lower part. Below the subsoil is shattered limestone bedrock.

Available water capacity is low to medium. Permeability is moderate in the loamy material and very slow in the clayey residuum. The content of available nitrogen is very low to low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is low. Unless these soils are limed, the upper layers are medium acid to strongly acid.

Whalan soils are suited to row crops. Erosion control measures are needed if the gently sloping areas are cultivated, because any erosion further decreases the soil material available for plant root development and storage of moisture. These soils are droughty in years of normal or below-normal rainfall.

Representative profile of Whalan loam, deep, 2 to 5 percent slopes, in a cultivated field 420 feet north and 55 feet east of the southwest corner of sec. 21, T. 98 N., R. 17 W.

Ap—0 to 5 inches, dark grayish-brown (10YR 4/2) loam; moderate, very fine, subangular blocky structure; friable; slightly acid; abrupt boundary.

B1—5 to 9 inches, dark-brown (10YR 4/3) heavy loam; moderate, very fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21t—9 to 16 inches, dark yellowish-brown (10YR 4/4) heavy loam; nearly continuous brown (10YR 4/3) coatings on peds; weak, medium, prismatic structure parting to moderate, very fine and fine, subangular blocky; friable; few very dark grayish-brown (10YR 3/2) clay fills in old root channels; discontinuous dark-brown (10YR 3/3) clay films on faces of prisms and peds; very strongly acid; clear boundary.

B22t—16 to 22 inches, yellowish-brown (10YR 5/4) sandy clay loam; discontinuous brown (10YR 4/3) coatings on peds; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; friable; common dark-brown (10YR 3/3 and 7.5YR 3/2) clay films on faces of prisms and peds; strongly acid; clear boundary.

B23t—22 to 26 inches, yellowish-brown (10YR 5/4) sandy clay loam; weak, medium, prismatic structure parting to weak and moderate, fine and medium, subangular blocky; friable; few, thin, discontinuous, dark-brown (10YR 3/3) clay films on faces of peds; few small pebbles throughout; medium acid; clear boundary.

B24t—26 to 29 inches, yellowish-brown (10YR 5/6) heavy clay loam; moderate, fine, subangular blocky structure; firm; thin, discontinuous, dark-brown (7.5YR 3/2) clay films; slightly acid; clear boundary.

IIB3t—29 to 34 inches, yellowish-brown (10YR 5/6) clay; strong, very fine, subangular and angular blocky structure; very firm; very dark grayish-brown (10YR 3/2) and dark-brown (7.5YR 3/2) clay films; neutral; abrupt boundary.

IIR—34 inches, shattered limestone bedrock.

The solum is generally 30 to 40 inches thick, but it ranges from 20 to 40 inches. The A1 horizon in uncultivated areas is very dark gray (10YR 3/1) and less than 4 inches thick. The A1, Ap, and A2 horizons range from loam to silt loam.

The upper part of the B horizon ranges from loam and sandy clay loam to light clay loam. The IIB horizon just above the shattered bedrock is generally clay or silty clay 2 to 6 inches thick. The shattered upper part of the bedrock ranges from 2 to 5 feet in thickness and generally is 5 to 15 percent loamy materials in crevices and a thin layer of clayey residuum on the slabs of limestone.

Whalan soils are associated with Atkinson, Kensett, Rockton, Roseville, Sogn, Winneshiek, and Waucoma soils and formed in similar materials. They have a thinner A1 horizon than Atkinson, Kensett, Sogn, Rockton, Waucoma, and Winneshiek soils. They are deeper over bedrock than Sogn soils. They are shallower over bedrock than Roseville soils.

Whalan loam, deep, 2 to 5 percent slopes (205B).—In most places this soil is on long, convex side slopes and ridge crests. It is above more sloping areas of Sogn, Whalan, or Winneshiek and adjacent to the Roseville soils. Most areas are 4 to 20 acres in size.

This soil has the profile described as representative of the series. In a few spots, bedrock is near the surface or exposed, and in other places it is at depth of more than 40 inches.

This soil is suited to row crops, but because it has a limited root zone it tends to be droughty in years of normal or below-normal rainfall. It is subject to slight erosion if cultivated. Capability unit IIe–4.

Whalan loam, deep, 5 to 9 percent slopes (205C).—This soil is on ridge crests and side slopes. It is generally associated with less sloping Whalan, Roseville, and Winneshiek soils. In some areas it is above steeper Sogn and Winneshiek soils. Most areas are 4 to 10 acres in size.

This soil has a profile similar to that described as representative of the series, but is commonly shallower over bedrock. In some eroded spots the surface layer is brown. Depth to limestone bedrock is generally 24 to 34 inches. In a few spots bedrock is near the surface or exposed.

This soil is suited to row crops, but because it has a limited root zone it tends to be droughty in years of normal or below-normal rainfall. It is subject to moderate erosion if cultivated. Erosion decreases the already limited root zone. Capability unit IIIe-3.

Winneshiek Series

The Winneshiek series consists of nearly level to moderately steep, well-drained soils on uplands. These soils are nearly level in high areas, gently sloping on long ridges, and gently sloping to moderately steep on side slopes. They formed in 20 to 40 inches of loamy materials and a thin layer of limestone residuum over limestone bedrock.

In a representative profile the surface layer is very dark brown heavy loam about 7 inches thick. The subsurface layer, about 3 inches thick, is brown, friable loam. The subsoil is about 17 inches thick. It is brown and yellowish-brown, friable heavy loam in the upper part and dark yellowish-brown and dark-brown, very firm heavy clay loam and clay in the lower part. Below the subsoil is shattered limestone bedrock.

Available water capacity is low to medium. Permeability is moderate in the loamy material and slow in the clayey residuum. The content of available nitrogen is low. The subsoil is very low in available phosphorus and potassium. The content of organic matter is moderate. Unless these soils are limed, the upper layers are generally medium acid.

Winneshiek soils are suited to row crops. Erosion control measures are needed if the more sloping areas are cultivated, because any further erosion decreases the soil material available for plant root development and moisture supply. These soils are droughty in years of normal or below-normal rainfall.

Representative profile of Winneshiek loam, moderately deep, 2 to 5 percent slopes, in a cultivated field 305 feet south and 115 feet east of the northwest corner of SW1/4 sec. 12, T. 97 N., R. 17 W.

Ap—0 to 7 inches, very dark brown (10YR 2/2) heavy loam; moderate, very fine and fine, granular structure; friable; neutral; clear boundary.

A2—7 to 10 inches, brown (10YR 4/3) loam; discontinuous very dark brown (10YR 2/2) coatings on peds; moderate, thin, platy structure; friable; slightly acid; clear boundary.

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

B21—14 to 21 inches, dark yellowish-brown (10YR 4/4) heavy loam; moderate, very fine and fine, subangular blocky structure; friable; medium acid; clear boundary.

B22t—21 to 25 inches, dark yellowish-brown (10YR 4/4) heavy clay loam; moderate, fine, subangular blocky structure; very firm; discontinuous, thin, dark-brown (10YR 3/3) clay films on faces of peds; pebble band in upper part of horizon; medium acid; clear boundary.

IIB23t—25 to 27 inches, dark-brown (7.5YR 4/3) clay; moderate, fine, subangular blocky structure; very firm; thin, nearly continuous, reddish-gray (5YR 5/2) clay films on faces of peds; neutral; abrupt boundary.

IIR—27 inches, shattered limestone bedrock.

The solum is generally 24 to 36 inches thick, but it ranges from 20 to 40 inches. The A1 horizon in uncultivated areas is generally black (10YR 2/1) and 3 to 6 inches thick. The A1, Ap, and A2 horizons range from loam to silt loam.

The upper part of the B horizon ranges from loam to clay loam. The horizon just above the shattered limestone bedrock is clay or silty clay 2 to 6 inches thick. The shattered upper part of the bedrock ranges from 2 to 5 feet in thickness and generally is 5 to 15 percent loamy material in crevices and a thin layer of clayey residuum on the slabs of limestone. As slope increases, the thickness of shattered limestone bedrock decreases.

Winneshiek soils are associated with Atkinson, Rockton, Roseville, Sogn, Waucoma, and Whalan soils and formed in similar materials. They have a thinner A1 horizon than Atkinson and Rockton soils. They have a thicker A1 horizon than Roseville and Whalan soils. They are shallower over bedrock than Atkinson, Roseville, and Waucoma soils. They are deeper over bedrock than Sogn soils.

Winneshiek loam, moderately deep, 0 to 2 percent slopes (714).—In most places this soil is on high uplands. It is adjacent to nearly level Waucoma soils and above gently sloping Winneshiek soils. Most areas are 4 to 10 acres in size, but a few are larger.

This soil is suited to intensive use for row crops. It has a limited root zone and tends to be somewhat droughty in years of normal or below-normal rainfall. Capability unit IIs-1.

Winneshiek loam, moderately deep, 2 to 5 percent slopes (714B).—In most places this soil is on long, convex side slopes and ridge crests. It commonly is associated with Waucoma soils. It generally is above more sloping Winneshiek or Sogn soils. Most areas are 4 to 30 acres in size.

This soil has the profile described as representative of the series. In a few spots, bedrock is near the surface or exposed. In a few other places it is at a depth of more than 40 inches.

This soil is suited to row crops, but because it has a limited root zone, it tends to be somewhat droughty in years of normal or below normal rainfall. It is subject to slight erosion if cultivated. Capability unit IIe-4.

Winneshiek loam, moderately deep, 5 to 9 percent slopes (714C).—This soil is on ridge crests and side slopes. It generally is associated with less sloping Waucoma and Winneshiek soils. In some areas it is above steeper Winneshiek and Sogn soils. Most areas are long and narrow and are 4 to 20 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick. In some eroded spots the surface layer is browner and lower in content of organic matter. Depth to limestone bedrock is 20 to 34 inches in most places, but in a few spots it is near the surface or exposed.

This soil is suited to row crops, but because it has a limited root zone, it tends to be droughty in years of normal or below normal rainfall. It is subject to moderate erosion if cultivated. Erosion decreases the already limited root zone. Capability unit IIIe-3.

Winneshiek loam, moderately deep, 9 to 14 percent slopes (714D).—In most places this soil is on short side slopes or the upper parts of long side slopes. In many places it is above steep Sogn soils. Most areas are long and are 4 to 15 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is not so thick and the soil is generally shallower over bedrock. In some eroded spots the surface layer is brown and lower in content of organic matter. Depth to limestone bedrock is about 2 feet in most places, but in a few spots it is near the surface or exposed.

This soil is suited to row crops if erosion is controlled. It has a limited root zone and tends to be droughty in years of normal or below normal rainfall. It is subject to severe erosion if cultivated. Erosion decreases the already limited root zone. Capability unit IVe–1.

Use and Management of the Soils

This section describes briefly the use and management of the soils in the county for crops and pasture. It defines the system of capability classification used by the Soil Conservation Service; suggests the use and management of soils by capability units; and shows predicted yield data of the principal crops on all the arable soils in the county. This part of the survey also reports data from engineering tests and interpretations of soil properties that affect highway construction and other engineering structures.

Use and Management of the Soils for Crops

Mitchell County has a total of 298,816 acres. According to the 1970 State of Iowa Annual Farm Census, 174,933 acres was in crops, 33,625 acres was in pasture, and 18,243 acres was in hay. Corn, soybeans, oats, and legume-grass hay are the main crops. Most of the permanent pasture is in bluegrass; other areas are in grass-legume mixtures, such as alfalfa-bromegrass. Most of the soils used for permanent bluegrass pasture are not in crops because they are wet. Tile drainage is needed. Each year many more acres are tile drained and cropped. The Clyde, Floyd, and Marshan soils are the dominant soils that have not been drained and remain in pasture.

Many soils are subject to erosion. Erosion control is needed on Bassett, Cresco, Downs, Fayette, Kenyon, Lourdes, Racine, Tama, Whalan, and Winneshiek soils. Erosion control and drainage conflict to some extent in the Bassett, Cresco, Kenyon, and Lourdes soils because of the different permeability in the loamy surface material and the glacial till of the subsoil. Water moves more rapidly in the loamy material and then tends to accumulate at the till contact, where it causes a seasonally perched water table and sidehill seepage during wet periods. On such soils a combination of terracing and tiling is most likely to be successful. Gully control structures and grassed waterways are needed in watercourses. The Dinsdale, Downs, and Tama soils and some of the Fayette soils generally have long, uniform slopes and are well suited to erosion control practices.

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 so used, and the way they respond to treatment (*11*). 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.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These levels are described 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:

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 not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

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

Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture, range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (No class VIII soils in Mitchell 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 only some parts of the United States, and not in Mitchell County, 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, range, woodland, wildlife, 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-4 or IIIe-4. 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 paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Mitchell County are described and suggestions for the use and management of the soils are given. The soil series represented in each unit are named, but not all soils of a given series are in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

This unit consists of level or nearly level, moderately well drained and somewhat poorly drained soils on flood plains and in narrow upland valleys. These are soils of the Huntsville, Terril, and Turlin series.

These soils are high in content of organic matter, and they generally have good tilth. They are subject to occasional flooding. Turlin silt loam is not so well aerated as the other soils, and in some years it benefits from tile drains.

These soils are well suited to row crops and hay and pasture plants. Under good management that includes proper use of fertilizer, these soils can be used for row crops year after year. Many of these soils in narrow upland drainageways are associated with soils in capability units IIe and IIIe. Soils on the broader flood plains are generally associated with the soils of capability unit IIw-4.

CAPABILITY UNIT I-2

This unit consists of level to nearly level, well-drained and moderately well drained soils on uplands and benches. These are soils of the Ashdale, Atkinson, Bassett, Dinsdale, Kenyon, Nasset, Racine, Sattre, Tama, Ostrander, Waubeek, Waucoma, and Waukee series.

These soils range from high to moderate in content of organic matter. They generally have good tilth. They are moderate and moderately slow in permeability. Available water capacity is medium or high, depending on soil type.

These soils are well suited to row crops and hay and pasture plants. Under good management that includes proper use of fertilizer, these soils are suitable for row crops year after year. In many places, areas of these soils are associated with soils of capability units I-1 and I-3. They are of sufficient size to be farmed separately from wet soils or soils that have a hazard of erosion. In places they are closely associated with soils in the IIw and IIe groups.

CAPABILITY UNIT I-3

This unit consists of level to nearly level, somewhat poorly drained soils on uplands and benches. These soils are of the Atterberry, Franklin, Hayfield, Klinger, Muscatine, Lawler, Oran, and Readlyn series.

These soils generally have good tilth. They range from high to moderate in content of organic matter. Permeability ranges from moderate to moderately slow. Available water capacity is high in all but the deep Lawler and Hayfield soils, which are medium in available water capacity.

These soils are well suited to row crops and hay and pasture plants. In places, they are too wet for planting early in spring because the water table is seasonally high. They benefit from tile drainage in some years, and tile permits consistent and timely fieldwork. Under good management that includes proper use of fertilizer, these soils are suitable for row crops year after year. In many places, areas of these soils are of sufficient size that they are farmed separately from wet soils or soils subject to erosion. In places they are closely associated with soils of the IIe and IIw groups.

CAPABILITY UNIT IIe-1

This unit consists of gently sloping, well drained and moderately well drained soils on uplands and benches. These soils are of the Ashdale, Atkinson, Bassett, Coggon, Dinsdale, Downs, Fayette, Kenyon, Nasset, Ostrander, Racine, Renova, Roseville, Tama, Waubeek, Waucoma, and Waukee series.

These soils are well aerated and generally have good tilth. They range from high to low in content of organic matter. Available water capacity is high to medium.

These soils are well suited to row crops and hay and pasture plants. Where they are terraced, row crops can be grown year after year. In most places the soils are closely associated with soils in the I, IIw, and other IIe groups, and the cropping systems and management practices used on associated soils influence use of these soils in places.

The major management needs are control of erosion, maintenance of organic matter and fertility, and improvement or maintenance of soil tilth. Terraces, grassed waterways, and contour farming help to control runoff and erosion. If Ashdale, Atkinson, Nasset, Roseville, and Waucoma soils are terraced, cuts should be somewhat limited, because limestone bedrock is at a depth of 40 to 60 inches. If the Bassett, Coggon, and Kenyon soils are cultivated, exposure of glacial till should be held to a minimum, because the subsoil has characteristics unfavorable for tillage.

CAPABILITY UNIT IIe-2

This unit consists of gently sloping, moderately well drained soils on uplands. These are soils of the Cresco, Donnan, and Lourdes series.

These soils have a very firm subsoil at a depth of about 20 to 30 inches. Permeability is slow and very slow, and movement of water and air is somewhat restricted in the subsoil. The content of organic matter is high to moderate.

These soils are suited to row crops and hay and pasture plants. Corn is the major crop. In most places the soils are associated with soils in the IIw and other IIe groups.

The major management needs are control of erosion and wetness in spring, maintenance of organic matter and fertility, and maintenance of tilth. Providing adequate drainage and controlling erosion are difficult and conflict to some extent. The long, uniform slopes are well suited to contouring, but this practice slows down the movement of surface water and lets more of it soak into the soil. The extra water entering the soil complicates drainage, especially during wet periods. Where soils are used intensively for row crops, a combination of terracing and tile drainage is needed. Terrace cuts should be held to a minimum so that the underlying, very firm subsoil is not exposed in the channels. Careful placement and spacing of tile are important because the subsoil is slowly and very slowly permeable.

CAPABILITY UNIT IIe-3

This unit consists of gently sloping, somewhat poorly drained soils on uplands. These soils are of the Oran and Readlyn series.

These soils have a seasonally high water table. Tilth is generally good. The content of organic matter is high in the Readlyn soils and moderate in Oran soils.

These soils are well suited to row crops and hay and pasture plants. Most areas are cultivated, and corn is the main crop. These soils are generally closely associated with soils in the I, IIw, and other IIe groups. In places management is determined by the associated soils.

Major management needs are control of erosion, proper drainage, maintenance of organic matter and fertility, and improvement and maintenance of soil tilth. Tile drainage is beneficial in wet years, and in many years it improves the timeliness of fieldwork. These soils are subject to sheet erosion. Providing adequate drainage and controlling erosion are difficult. Practices that provide drainage and reduce erosion, such as a combination of terracing and tiling, are the most desirable. If terraced and drained, the soils can be used intensively for row crops without excessive soil loss. The exposure of the glacial till subsoil in the terrace channels should be held to a minimum, because the subsoil is low in fertility.

CAPABILITY UNIT IIe-4

This unit consists of gently sloping, somewhat excessively drained and well drained soils on uplands and benches. These soils are of the Bixby, Dubuque, Rockton, Saude, Wapsie, Whalan and Winneshiek series, and the Dickinson-Ostrander complex and Lamont-Renova complex.

These soils are about 2 to 3 feet deep over sand and gravel or limestone bedrock. They are well aerated and generally have good tilth. They have moderate depth for root development, and in dry periods are somewhat droughty. The content of organic matter ranges from moderate to low, except in Rockton soils where it is high.

These soils are suited to row crops and hay and pasture plants. They are slightly droughty unless rainfall is above average and very timely. Much of the acreage is cultivated, but areas near streams are commonly in timber. Most of the soils are closely associated with soils in I and IIw and in other IIe groups.

The major management needs are controlling erosion, conserving available moisture, maintaining the levels of organic matter and fertility, and improving and maintaining good tilth. Somewhat less corn can be grown per acre than on the deeper soils because the soils in this unit have a limited root zone. Contour farming and the use of terraces and grassed waterways help to control runoff and erosion. Where these practices are used, row crops can be grown more frequently in the rotation without excessive soil loss. Terrace cuts should generally be held to a minimum in the Dubuque, Rockton, Whalan, and Winneshiek soils to avoid exposing the underlying limestone bedrock in the terrace channels. Bedrock in these soils interferes with terrace construction in places.

CAPABILITY UNIT IIe-5

This unit consists of gently sloping, moderately well drained and well drained soils in narrow upland drainageways and on low side slopes. These soils are of the Huntsville and Terril series.

The soils in this unit are moderate in permeability and have high available water capacity.

These soils are well suited to cultivated crops, but they are commonly associated with steeper soils in such an intricate pattern that use is determined by the adjoining soils. Areas large enough to be managed alone can be used intensively for row crops; areas that are small and surrounded by steep soils are commonly left in grass. Corn is the main row crop.

These soils generally do not need tile drainage. They receive runoff from soils upslope, however, and some areas are subject to gullying where water concentrates. Diversion terraces are beneficial if properly placed upslope to intercept local runoff.

CAPABILITY UNIT IIw-1

This unit consists of nearly level to gently sloping, poorly drained soils on uplands and benches. These soils are of the Ansgar, Canisteo, Clyde, Floyd, Garwin, Jameston, Marshan, Maxfield, and Tripoli series.

These soils are very high to moderate in content of organic matter. They have a seasonally high water table unless they are drained. The Clyde, Tripoli, and Jameston soils have stones and boulders on the surface in places.

These soils are well suited to cultivated crops and hay and pasture plants if they are tile drained. Under good management that includes drainage and proper use of fertilizer, these soils are suited to intensive use for row crops. Most areas are used for cultivated crops. Corn is the major crop. A few areas of Clyde and Marshan soils are in permanent pasture.

The main management needs are providing artificial drainage and maintaining and improving soil tilth.

In areas of Jameston silty clay loam, tile should be installed near the surface and more closely spaced than in other soils in this unit, because the lower part of the subsoil is compact and slowly permeable. If tile is to be installed in Marshan soils, the sand or gravel in the substratum has to be considered. The water-bearing sands can make the installation of tile difficult. In places boulders interfere with tiling of the Clyde soils. Some areas of Ansgar soils are in small depressions, where tile outlets are somewhat difficult to find.

CAPABILITY UNIT IIw-2

This unit consists of nearly level to gently sloping, somewhat poorly drained soils on uplands. These soils are of the Floyd, Pinicon, and Schley series.

In periods of high rainfall and early in spring, the water table is near the surface unless the soil is drained.

Floyd soils are high in content of organic matter, Pinicon soils are low, and Schley soils are moderate. If artificially drained, all are well suited to row crops; undrained areas are commonly in pasture.

These soils have good tilth. The major management needs are drainage and the maintenance of fertility.

Tile drainage is needed. Wetness of the Floyd and Schley soils is caused, at least in part, by hillside seepage from the Bassett, Cresco, Kenyon, and other soils upslope. A drainage system that intercepts laterally moving water is most likely to be successful because it protects against sidehill seepage. In areas where sheet erosion is causing excessive soil loss, a combination of terracing and tile can be used.

CAPABILITY UNIT IIw-3

This unit consists of level to gently sloping soils on uplands. These are soils of the Donnan, Kensett, Protivin, and Riceville series.

These soils are moderately permeable in the upper part, but they are very slowly permeable in the lower part. An exception is the Kensett soil, which is only about 36 inches deep over limestone. Thus, it has a seasonally perched water table that, in turn, results in sidehill seepage. In all soils of the unit, the content of organic matter ranges from moderate to high.

These soils are suited to cultivated crops and hay and pasture plants. Most areas are cultivated. Corn is the major crop.

The major management needs are controlling wetness and maintaining fertility. Erosion is a hazard in some of the gently sloping areas. Tile is beneficial in the Donnan, Protivin, and Riceville soils in wet years. Tile should be installed nearer the surface and more closely spaced in the Donnan, Protivin, and Riceville soils than in other soils in the county, because the lower part of the subsoil is compact and very slowly permeable. Tile does not drain all areas satisfactorily. Because wetness is caused, at least in part, by hillside seepage, a tile system that intercepts water is most likely to be successful. The underlying bedrock in Kensett soils makes tile installation difficult.

If used intensively for row crops, some of the gently sloping Protivin and Riceville soils are subject to erosion. Providing adequate drainage and controlling erosion are difficult because they conflict to some extent. Contouring or terracing slows down the movement of surface water and lets more of it soak into the soil. The extra water entering the soil complicates drainage, especially during wet periods. A combination of tiling and terracing is needed in places. Under intensive management that includes terracing, row crops can be grown more frequently in the rotation. Terrace cuts should be held to a minimum so that the underlying very firm subsoil is not exposed in the terrace channels.

CAPABILITY UNIT IIw-4

This unit consists of level to nearly level, dark-colored, somewhat poorly drained to poorly drained soils on flood plains and in upland valleys. These soils are of the Coland and Calco series and the Coland-Turlin complex. This unit of the Turlin soil is closely associated with Coland soil and is not shown separately on the map.

Permeability is moderately slow in the Calco soil and moderate in the rest. The content of organic matter is high to very high. Occasional flooding is a hazard, but is of short duration. The Coland and Calco soils are poorly drained and benefit from tile drainage in some years, but good tile outlets are not always available. Some areas benefit from flood protection.

If areas of these soils are large enough to be farmed separately or with adjacent soils, they are well suited to crops. Corn is the major crop. Some small areas are associated with other soils more difficult to till, and these areas are in pasture.

CAPABILITY UNIT IIs-1

This unit consists of level to nearly level, well-drained and somewhat poorly drained soils on uplands and benches. These are soils of the Bixby, Hayfield, Lawler, Saude, Wapsie, and Winneshiek series and the Dickinson-Ostrander complexes.

These soils are generally about 2 to 3 feet deep over sand, gravel, or limestone bedrock. Exceptions are the Ostrander soils. The content of organic matter ranges from high to low. Lawler and Hayfield soils are not so well aerated as the rest of the soils in the unit. All of the soils generally have good tilth. They have a shallow root zone, however, and unless rainfall is above normal or rains are very timely, they are slightly droughty. The Bixby, Hayfield, Lawler, Saude, and Wapsie soils are underlain by sand and gravel at a depth of about 2 to 3 feet. The Winneshiek soils are underlain by limestone at a depth of about 2 to 3 feet. Dickinson soils are underlain by sand at a depth of about 3 feet.

These soils are suited to row crops and hay and pasture plants. Most areas are cultivated. Corn is the major crop. Under good management that includes proper use of fertilizer, these soils are suitable for row crops year after year, but year-to-year variation is expected because droughtiness is a slight hazard. These soils are generally closely associated with soils in the I, IIw, and IIe groups and are farmed along with them.

The major management need is conserving available moisture during dry periods. Somewhat less corn can be planted per acre than on the deeper soils because the root zone is limited. In years of heavy rainfall, the Lawler, Hayfield, and Kensett soils benefit from artificial drainage in places. Installing tile in Kensett soils is difficult because they are only moderately deep over limestone bedrock.

CAPABILITY UNIT IIs-2

The only soil in this unit, Hanlon sandy loam, 0 to 2 percent slopes, is a moderately well drained soil on flood plains.

This soil is moderate to high in content of organic matter, is well aerated, and has good tilth. In dry periods it has a somewhat limited moisture reserve because it is moderately coarse textured. It is subject to occasional flooding of short duration.

This soil is generally well suited to row crops and moderately well suited to hay and pasture plants. Many areas are cultivated. Corn is the major crop. Under good management that includes proper use of fertilizer, this soil is suitable for intensive use for row crops, but year-to-year variation is expected in places because drought is a slight hazard. This soil is associated with soils of the I, IIw, and IIs groups.

The major management needs are conserving available water during dry periods and preventing soil blowing in the early part of the growing season. Somewhat less corn should be planted per acre than on the finer textured soils because the moisture reserve is limited. If this soil is used for crops, control of soil blowing is needed.

CAPABILITY UNIT IIIe-1

This unit consists of sloping to strongly sloping, well drained to moderately well drained soils on uplands. These soils are of the Bassett, Downs, Fayette, Kenyon, Racine, and Tama series.

These soils are well aerated and generally have good tilth. The content of organic matter ranges from high to low, depending on texture and the amount of erosion. Available water capacity is high.

These soils are well suited to hay and pasture plants and to row crops if they are protected from erosion. They are productive if well managed. They are suited to corn, soybeans, and oats. Cultivated crops are grown in most areas, and corn is the major crop. These soils are closely associated with soils in other IIIe and IIe groups. Consequently, use and management are determined in places by the use of the associated soils.

The major management needs are controlling erosion, maintaining organic matter and fertility, and improving and maintaining tilth. The hazard of erosion is more severe on the strongly sloping Fayette soils than on the other soils in this group.

CAPABILITY UNIT IIIe-2

This unit consists of moderately sloping, moderately well drained soils on uplands. These are soils of the Cresco and Lourdes series.

These soils have a very firm, very slowly permeable subsoil below a depth of 20 to 26 inches. The content of organic matter ranges from high to low, depending on texture and the amount of erosion.

These soils are suited to hay and pasture plants and to row crops if they are protected from erosion. Most areas are used for cultivated crops. Corn is the major crop. The soils are generally managed along with soils in the IIw, IIe, and other IIIe groups.

The major management needs are control of erosion, improvement of drainage, and maintenance of fertility. Providing erosion control and drainage are difficult because they conflict to some extent. Terraces, waterways, and contour farming help to control runoff and erosion. Under good management that includes terracing, waterways, and contouring, more years of row crops can be grown without excessive soil loss. If these soils are terraced, terrace cuts should be held to a minimum so that the underlying very firm, low-fertility subsoil is not exposed in the terrace channels. Terracing and contouring reduce soil loss but tend to increase wetness. A combination of terracing and tiling is needed in places.

CAPABILITY UNIT IIIe-3

This unit consists of moderately sloping, well drained to somewhat excessively drained soils on uplands and benches. These are soils of the Dubuque, Rockton, Wapsie, Whalan, and Winneshiek series.

These soils are moderately deep over sand and gravel or limestone bedrock. The Dubuque, Rockton, Whalan, and Winneshiek soils are underlain by limestone within a depth of 30 inches, and the Wapsie soils are underlain by sand and gravel. All are well aerated and generally have good tilth. They have a moderately deep root zone, but in dry periods they have a somewhat limited moisture reserve. They are somewhat droughty unless rains are timely. The content of organic matter ranges from high to low, depending on texture and the amount of erosion.

These soils are well suited to hay and pasture plants and to row crops if they are protected from erosion. Most areas are cultivated, but some or wooded. Corn is the major crop. Year-to-year variations in productivity can be expected because droughtiness is a slight hazard. Most areas are managed along with soils in the IIe groups and other IIIe groups.

The major management needs are controlling erosion, conserving available moisture, and maintaining the levels of organic matter and fertility. Somewhat less corn should be planted per acre than on deeper soils because the root zone is limited. Terraces, grassed waterways, and contour farming help to control runoff and erosion. If mechanical measures are not used, row crops should be grown less frequently to keep within allowable soil loss. Under good management that includes contour farming, terraces, and grassed waterways, more years of row crops can be grown without excessive soil loss. Terrace cuts should be held to a minimum so that the underlying limestone bedrock or sand or gravel is not exposed in terrace channels. Limestone interferes with terrace construction in some places.

CAPABILITY UNIT IIIe-4

This unit consists of gently sloping to moderately sloping, well drained and somewhat excessively drained soils on uplands and benches. These soils are of the Dickinson, Flagler, and Lamont series.

These soils are moderately deep over sand or sand and gravel. The Flagler soils are underlain by sand and gravel at a depth of about 30 inches, and the Lamont and Dickinson soils are underlain by sand and loamy sand. The Dickinson and Flagler soils are medium in content of organic matter, and Lamont soils are low. The soils are well aerated, have low available water capacity, and have moderately rapid permeability. In dry periods they have a limited moisture reserve because they are moderately coarse textured, and unless rains are timely they are droughty.

These soils are suited to row crops and hay and pasture plants. Most areas are cultivated. Corn is the major crop. Under good management these soils are moderately productive, but year-to-year variations can be expected because they tend to be droughty. The major management needs are conserving available water and preventing water erosion and soil blowing. Less corn should be planted per acre than on finer textured soils because the moisture reserve is limited. Terraces, grassed waterways, and contour farming help to control runoff and erosion. The moderately sloping Dickinson and Lamont soils are subject to a greater erosion hazard than the others. Under very good management that includes terracing, grassed waterways, and contour farming, more years of row crops can be grown without excessive soil loss.

CAPABILITY UNIT IIIw-1

The only soil in this unit is the level to gently sloping, dark-colored, very poorly drained Muck, moderately deep.

This soil has an organic surface layer that ranges from 18 to 52 inches deep over medium-textured and coarse-textured mineral soil. Unless artificially drained, the water table is at or near the surface, varying with the season. Natural soil aeration is poor.

This soil is unsuitable for cultivation unless drained. Undrained areas are wet continually. If properly drained, this soil is suited to row crops and can be farmed intensively. It is somewhat cold and is slow to warm up in spring. Undrained areas are in permanent pasture or are idle. They do not make good pasture unless improved and drained. Muck is generally wet and boggy, and much of the time it is too unstable to support the weight of grazing animals. It is generally associated with soils in the IIw and IIe groups.

Muck is generally wet because it is in or near sidehill seeps or spring areas where water is commonly under pressure and seeps to the surface. Drainage systems designed to intercept seepage water are likely to be successful. A few areas in depressions or on flats near streams are difficult to drain because the grade is insufficient. If tile drains are placed above the mineral soil material, shrinkage of the organic material alters the alinement and the title may not function properly.

CAPABILITY UNIT IIIs-1

This unit consists of level to nearly level, dark-colored to light-colored, well drained and somewhat excessively drained soils on benches and uplands. These are soils of the Dickinson, Flagler, and Lamont series.

These soils are moderately deep over sand or sand and gravel. The Dickinson and Flagler soils are moderate in content of organic matter, and Lamont soils are low. All are well aerated. All have low available water capacity and moderately rapid to very rapid permeability. In dry periods they have a limited moisture reserve because they are moderately coarse textured, and unless rains are timely they are somewhat droughty.

These soils are suited to row crops and hay and pasture plants. Most areas are cultivated, and corn is the major crop. Under good management these soils are well suited to row crops, but year-to-year variations in productivity can be expected because they tend to be droughty. These soils can be used intensively for row crops. They commonly are in small areas associated with soils that are less droughty or are wet and require drainage. In places use is determined by the surrounding soils.

The major management needs are conserving available water and preventing soil blowing. Less corn should be planted per acre than on finer textured soils because the moisture reserve is limited. Unless these soils are protected by vegetation, soil blowing is a hazard in some years. Blowing sand sometimes damages newly seeded crops. If crops are grown, practices that control soil blowing are beneficial.

CAPABILITY UNIT IVe-1

The only soil in this unit is Winneshiek loam, moderately deep, 9 to 14 percent slopes. This soil is on uplands. It is well drained and moderately deep over limestone bedrock.

Limestone bedrock is at a depth of about 2 feet. Available water capacity is low. Permeability is moderate in the upper part and slow in the clayey residuum. This soil has a moderately deep root zone, but in dry periods it has a somewhat limited moisture reserve. The content of organic matter ranges from moderate to low.

This soil is better suited to hay and pasture plants than to row crops. Row crops can be grow occasionally if erosion control practices are applied. Some areas are cultivated, but many are pastured or wooded. Most areas are managed along with soils in the IIIe and VIs groups.

The major management needs are controlling erosion, conserving available moisture, maintaining the levels of organic matter and fertility, and improving tilth. Shallowness over limestone bedrock interferes with terrace construction, especially in areas where this soil is closely associated with the Sogn soils.

CAPABILITY UNIT IVs-1

This unit consists of level to nearly level, excessively drained soils on uplands and benches. These are soils of the Burkhardt and Lilah series.

These soils are shallow over sand and gravel. They have low to very low available water capacity. Permeability is moderately rapid to very rapid. Burkhardt soils are moderate in content of organic matter, and Lilah soils are low. Both soils are well aerated and have good tilth.

Many areas of these soils are cultivated. Corn is the major crop. These are low-producing soils because their moisture holding capacity is low. Many small areas are associated with larger areas of more productive soils and are generally managed along with those soils. Unless rainfall is above normal and timely, extreme year-to-year variations in yields can be expected because drought is a severe hazard.

The major management needs are conserving available water and preventing soil blowing. Unless these soils are protected by vegetation, soil blowing is a hazard. Less corn should be planted per acre than on finer textured soils because the moisture reserve is limited. If Lilah and Burkhardt soils are used for crops, practices that control soil blowing are beneficial.

CAPABILITY UNIT IVs-2

This unit consists of gently sloping to moderately sloping, excessively drained soils on uplands and benches. These soils are of the Burkhardt, Lilah, and Sogn series.

These soils are shallow over sand, gravel, and limestone. They have low to very low available water capacity. Permeability ranges from moderate to very rapid. The Sogn soils have limestone bedrock at a depth of about 12 inches; the Burkhardt and Lilah soils are underlain by sand and gravel. All are medium to low in content of organic matter. They have very little moisture reserve for dry periods. In most years droughtiness reduces productivity.

These soils are better suited to pasture than to row crops. Row crops can be grown more frequently in the rotation, if soil-conserving practices are used to prevent excessive soil loss.

Major management needs are conserving available water and preventing soil blowing and water erosion. Soil blowing and water erosion are hazards unless these soils are protected by vegetation. Newly seeded crops on these and adjoining soils are commonly damaged by blowing sand. The Sogn soils are less subject to soil blowing than the Burkhardt and Lilah soils. Less corn should be planted per acre than on finer textured or deeper soils because the moisture reserve is limited. Minimum tillage, contour farming, and grass waterways help to control runoff and erosion. Limestone bedrock commonly crops out on the Sogn soil and interferes with mechanical practices, such as terracing.

CAPABILITY UNIT Vw-1

This unit consists of level to nearly level, poorly drained to excessively drained Alluvial land and Coland and Turlin soils on bottom lands. All are severely channeled and frequently flooded.

The content of organic matter is medium to very high in most areas, but very low in a few. Alluvial land is sandy and droughty in some places and poorly drained in others. The Coland soil is poorly drained, but the Turlin soil is generally adequately drained.

These soils are so frequently flooded and so dissected by old stream channels and by the present meandering streams that they are generally unsuitable for cultivation. The overall topography is generally level. A few of the numerous stream channels and swales contain water throughout the year. Many individual areas of these soils are large. Most of the acreage is timbered or supports scattered trees and grass. Only a small acreage is cultivated. Some areas are used for wildlife and recreational purposes. In years when the frequency of flooding is less than usual, some small areas are used for crops. These soils are better suited to pasture, woodland, wildlife habitat, or recreation than to other uses.

CAPABILITY UNIT VIs-1

Sogn loam, 5 to 14 percent slopes, is the only soil in this unit. This is a somewhat excessively drained soil on uplands.

This soil is shallow over limestone bedrock. It is generally moderate in content of organic matter, very low in available water capacity, and moderately permeable.

This soil is better suited to hay and pasture than to row crops. Overgrazing of pasture increases the hazard of erosion. Many areas are managed along with soils in the IIIe-3 and IVe-1 groups. Some areas are associated with steeper Sogn soils. Areas too small to be managed as pasture or for hay are better suited to wildlife or to woodland than to other uses. Small areas associated with more productive soils are in row crops.

Conserving available moisture is the major management need. Erosion is severe because the soil is shallow over limestone bedrock. The limestone outcrops make some areas difficult to till.

CAPABILITY UNIT VIIw-1

This unit consists only of Marsh—depressional and flat areas that are wet throughout the year and impound water part of the time. Areas are generally near streams, and water is at or near the surface throughout the year. Ponds and intermittent ponds were included in the areas mapped.

Most areas of Marsh are difficult to drain adequately for cultivated crops without the expenditure of large sums of money. They are commonly managed as permanent pasture along with soils of the IIw, IIIw, and Vw capability groups. The quality of the pasture is poor because the natural vegetation is dominantly cattails, rushes, sedges, and other water-tolerant plants that are unpalatable to grazing animals. Most areas are better suited to wildlife habitat than to other uses. Preserved in their natural state, they offer a refuge for waterfowl and other wildlife.

CAPABILITY UNIT VIIs-1

The one soil in this unit, Sogn loam, 14 to 40 percent slopes, is an excessively drained soil on uplands. It is shallow over limestone bedrock. It is moderate to low in content of organic matter, depending on the degree of erosion. It is well aerated, but has a very limited moisture reserve.

This soil is not suited to cultivated crops. If well managed, some areas on the lesser slopes are suited to hay crops. Steeper areas are better suited to woodland or wildlife habitat than to other uses.

The major management needs are conserving available moisture and controlling erosion. Many areas are not accessible to farm machinery and grazing animals.

Yield predictions

Table 2 shows predicted average acre yields of the principal crops for the arable soils of the county. These are yields to be expected under a high level of management. Under this level of management, seedbed preparation, planting, and tillage provide for adequate stands of adopted varieties; erosion is controlled; organic-matter content and tilth are maintained; the level of fertility for each crop is maintained, as indicated by soil tests and field trials; the water level is controlled in wet soils; excellent weed and pest control is provided; and fieldwork is timely.

Many available sources of yield information were used to make these predictions, including data from the Federal census and the Iowa farm census; data from experimental farms and from experiments made cooperatively with farmers; and from on-the-farm experience by soil scientists, extension workers, and others.

The yield predictions are meant to serve as guides, because they are only approximate values. Of more value than actual yield figures to many users is the comparison of yields for different soils. These relationships are likely to remain constant over a period of years. 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.

Use of the Soils for Engineering

For many years engineers have studied soil properties and characteristics that affect construction, and they have devised systems of soil classification based on these characteristics. Most studies have been at the site of construction, because general information about the soils and engineering practices has not been readily available.

With a soil map for identification of soil areas, the interpretations reported here will be useful in engineering planning. It is emphasized that additional sampling and testing for specific engineering works are needed, especially where heavy loads and deep excavations are involved.

Among the properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil 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 systems for disposal of sewage and refuse.

TABLE 2.—*Predicted average acre yields of principal crops under high level management*

[Absence of a figure indicates that the crop is not suited to the soil or is not generally grown on it]

Soil	Corn	Soybeans	Oats	Alfalfa and brome	
				Hay	Pasture
	Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Alluvial land, channeled					120
Ansgar silt loam, 0 to 2 percent slopes	93	35	74	3. 7	185
Ashdale silt loam, 0 to 2 percent slopes	118	45	94	5. 0	250
Ashdale silt loam, 2 to 5 percent slopes	115	43	92	4. 8	240
Atkinson loam, 0 to 2 percent slopes	110	42	88	4. 6	230
Atkinson loam, 2 to 5 percent slopes	105	40	84	4. 4	220
Atterberry silt loam, 0 to 2 percent slopes	122	46	98	5. 1	255
Bassett loam, 0 to 2 percent slopes	106	40	85	4. 5	225
Bassett loam, 2 to 5 percent slopes	104	40	83	4. 4	220
Bassett loam, 5 to 9 percent slopes	99	38	79	4. 2	210
Bassett loam, 5 to 9 percent slopes, moderately eroded	96	36	77	4. 0	200
Bixby loam, 0 to 2 percent slopes	70	26	56	2. 5	125
Bixby loam, 2 to 5 percent slopes	68	25	55	2. 4	120
Burkhardt sandy loam, 0 to 3 percent slopes	42	16	34	1. 5	75
Burkhardt sandy loam, 3 to 9 percent slopes	36	14	29	1. 3	65
Calco silty clay loam, 0 to 2 percent slopes	95	36	76	3. 8	190
Canisteo silty clay loam, 0 to 2 percent slopes	105	40	84	4. 2	210
Clyde silty clay loam, 0 to 3 percent slopes	95	36	76	3. 8	190
Clyde-Floyd complex, 1 to 4 percent slopes	100	38	80	4. 0	200
Coggon loam, 2 to 5 percent slopes	99	38	79	4. 0	200
Coland silty clay loam, 0 to 2 percent slopes	100	38	80	4. 0	200
Coland-Turlin complex, 0 to 2 percent slopes	99	38	79	3. 9	180
Coland-Turlin complex, channeled, 0 to 2 percent slopes					150
Cresco loam, 2 to 5 percent slopes	88	33	70	3. 7	185
Cresco loam, 5 to 9 percent slopes	83	32	66	3. 5	175
Dickinson fine sandy loam, 0 to 2 percent slopes	83	32	62	3. 0	150
Dickinson fine sandy loam, 2 to 5 percent slopes	81	31	60	3. 0	150
Dickinson-Ostrander complex, 0 to 2 percent slopes	90	34	72	3. 3	165
Dickinson-Ostrander complex, 2 to 5 percent slopes	88	33	70	3. 2	160
Dinsdale silty clay loam, 0 to 2 percent slopes	118	45	94	5. 0	250
Dinsdale silty clay loam, 2 to 5 percent slopes	116	44	93	4. 9	245
Donnan silt loam, 0 to 2 percent slopes	72	27	58	2. 9	145
Donnan silt loam, 2 to 5 percent slopes	70	26	56	2. 8	140
Downs silt loam, 2 to 5 percent slopes	115	44	92	4. 8	240
Downs silt loam, 5 to 9 percent slopes, moderately eroded	107	41	86	4. 5	225
Downs silt loam, 9 to 14 percent slopes, moderately eroded	99	38	79	4. 2	210
Dubuque silt loam, moderately deep, 2 to 5 percent slopes	73	28	58	3. 1	115
Dubuque silt loam, moderately deep, 5 to 9 percent slopes	68	26	54	2. 8	140
Fayette silt loam, 2 to 5 percent slopes	110	42	88	4. 6	230
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	102	39	82	4. 3	215
Flagler sandy loam, 0 to 2 percent slopes	63	24	47	2. 6	130
Flagler sandy loam, 2 to 5 percent slopes	61	23	46	2. 5	125
Floyd loam, 1 to 4 percent slopes	104	40	83	4. 2	210
Franklin silt loam, 1 to 3 percent slopes	115	44	92	4. 8	240
Garwin silty clay loam, 0 to 2 percent slopes	120	47	96	5. 0	250
Hanlon sandy loam, 0 to 2 percent slopes	90	34	72	3. 0	150
Hayfield loam, deep, 0 to 2 percent slopes	94	36	75	4. 0	200
Hayfield loam, moderately deep, 0 to 2 percent slopes	79	30	63	3. 0	150
Huntsville silt loam, 0 to 2 percent slopes	125	48	93	5. 2	260
Huntsville silt loam, 2 to 5 percent slopes	122	46	91	5. 0	250
Jameston silty clay loam, 0 to 2 percent	80	30	65	3. 4	170
Kensett silt loam, 0 to 2 percent slopes	98	37	78	4. 1	205
Kenyon loam, 0 to 2 percent slopes	112	43	90	4. 7	235
Kenyon loam, 2 to 5 percent slopes	110	42	88	4. 6	230
Kenyon loam, 5 to 9 percent slopes	105	40	84	4. 4	220
Kenyon loam, 5 to 9 percent slopes, moderately eroded	102	39	82	4. 3	215
Klinger silty clay loam, 0 to 2 percent slopes	121	46	97	5. 1	255
Lamont fine sandy loam, 0 to 2 percent slopes	69	26	55	2. 5	125
Lamont fine sandy loam, 2 to 5 percent slopes	67	25	54	2. 4	120
Lamont fine sandy loam, 5 to 9 percent slopes	62	24	50	2. 2	110
Lamont-Renova complex, 2 to 5 percent slopes	83	31	66	3. 0	150
Lawler loam, deep, 0 to 2 percent slopes	100	38	80	4. 2	210
Lawler loam, moderately deep, 0 to 2 percent slopes	85	42	68	3. 6	180
Lilah sandy loam, 0 to 3 percent slopes	45	17	36	1. 6	80
Lilah sandy loam, 3 to 9 percent slopes	38	15	30	1. 3	65

See footnote at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under high level management*—Continued

Soil	Corn	Soybeans	Oats	Alfalfa and brome	
				Hay	Pasture
	Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Lourdes loam, 2 to 5 percent slopes	82	31	65	3. 4	170
Lourdes loam, 5 to 9 percent slopes	77	29	62	3. 2	160
Lourdes loam, 5 to 9 percent slopes, moderately eroded	72	27	57	3. 0	150
Marshan clay loam, deep, 0 to 2 percent slopes	98	37	78	3. 9	195
Marshan clay loam, moderately deep, 0 to 2 percent slopes	88	33	70	3. 5	175
Maxfield silty clay loam, 0 to 2 percent slopes	115	44	92	4. 4	220
Muck, moderately deep	85	32	68	3. 4	170
Muscatine silty clay loam, 0 to 2 percent slopes	127	48	102	5. 3	265
Nasset silt loam, 0 to 2 percent slopes	104	40	83	4. 4	220
Nasset silt loam, 2 to 5 percent slopes	102	39	82	4. 3	215
Oran loam, 0 to 2 percent slopes	106	40	85	4. 5	225
Oran loam, 2 to 5 percent slopes	104	40	83	4. 4	220
Ostrander loam, 0 to 2 percent slopes	112	43	90	4. 7	235
Ostrander loam, 2 to 5 percent slopes	110	42	88	4. 6	230
Pinicon loam, 1 to 4 percent slopes	102	38	82	4. 3	215
Protivin loam, 1 to 4 percent slopes	88	33	70	3. 7	185
Racine silt loam, 0 to 2 percent slopes	106	40	85	4. 5	225
Racine silt loam, 2 to 5 percent slopes	104	39	83	4. 4	220
Racine silt loam, 5 to 9 percent slopes	99	37	79	4. 2	210
Readlyn loam, 0 to 2 percent slopes	112	43	90	4. 7	235
Readlyn loam, 2 to 5 percent slopes	110	42	88	4. 6	230
Renova loam, 2 to 5 percent slopes	99	38	79	4. 2	210
Riceville silt loam, 1 to 4 percent slopes	84	32	67	3. 5	175
Rockton loam, moderately deep, 2 to 5 percent slopes	76	29	60	3. 0	150
Rockton loam, moderately deep, 5 to 9 percent slopes	71	27	57	2. 8	140
Rockton silt loam, moderately deep, 2 to 5 percent slopes	86	33	69	3. 6	180
Roseville silt loam, 2 to 5 percent slopes	90	34	72	3. 8	190
Sattre silt loam, 0 to 2 percent slopes	93	35	75	3. 9	195
Saude loam, 0 to 2 percent slopes	78	30	62	3. 3	165
Saude loam, 2 to 5 percent slopes	76	29	60	3. 0	150
Schley silt loam, 1 to 4 percent slopes	100	38	80	4. 2	210
Sogn loam, 2 to 5 percent slopes	46	17	37	2. 0	100
Sogn loam, 5 to 14 percent slopes	----------	----------	26	1. 4	70
Sogn loam, 14 to 40 percent slopes	----------	----------	20	1. 0	50
Tama silty clay loam, 0 to 2 percent slopes	123	47	98	5. 2	260
Tama silty clay loam, 2 to 5 percent slopes	121	46	97	5. 1	255
Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	113	43	90	4. 7	235
Terril loam, 0 to 2 percent slopes	118	45	94	5. 0	250
Terril loam, 2 to 5 percent slopes	115	44	92	4. 8	240
Tripoli silty clay loam, 0 to 2 percent slopes	108	41	86	4. 3	215
Turlin silt loam, 0 to 2 percent slopes	120	45	96	5. 0	250
Wapsie loam, 0 to 2 percent slopes	72	27	57	3. 0	150
Wapsie loam, 2 to 5 percent slopes	70	27	56	3. 9	145
Wapsie loam, 5 to 9 percent slopes	65	25	52	2. 7	135
Waubeek silt loam, 0 to 2 percent slopes	115	44	92	4. 8	240
Waubeek silt loam, 2 to 5 percent slopes	113	43	90	4. 7	235
Waucoma silt loam, 0 to 2 percent slopes	100	38	80	4. 2	210
Waucoma silt loam, 2 to 5 percent slopes	98	37	78	4. 1	205
Waukee silt loam, 0 to 2 percent slopes	98	37	78	4. 1	205
Waukee silt loam, 2 to 5 percent slopes	96	36	77	4. 0	200
Whalan loam, deep, 2 to 5 percent slopes	84	32	68	3. 5	175
Whalan loam, deep, 5 to 9 percent slopes	79	30	63	3. 3	165
Winneshiek loam, moderately deep, 0 to 2 percent slopes	72	27	58	3. 0	150
Winneshiek loam, moderately deep, 2 to 5 percent slopes	70	26	56	2. 9	145
Winneshiek loam, moderately deep, 5 to 9 percent slopes	65	25	52	2. 7	135
Winneshiek loam, moderately deep, 9 to 14 percent slopes	56	21	45	2. 3	115

[1] AUD (animal-unit-days) is a term used to express the carrying capacity of pasture. It is the number of days that 1 acre will provide grazing for 1 animal unit—1,000 pounds of live weight—without damage to the pasture.

This soil survey contains information that will assist engineers in many phases of their planning. It can be used to—

1. Make studies of soil and land use that aid in the selection and development of industrial, business, residential, and recreational sites.
2. Assist in planning and designing drainage and irrigation structures and in planning all structural work for soil and water conservation.
3. Make general surveys of soil and ground conditions that aid in selecting highway and airport locations and in planning more detailed soil surveys for these locations if needed.
4. Locate probable sources of sand, gravel, or rock for structural use.
5. Correlate pavement and road rock performance with kinds of soils, and thus develop information useful in development and maintenance of roads, culverts, bridges, etc.
6. Determine the suitability of soils for cross-country movement of heavy equipment.
7. Supplement information obtained from aerial photographs, other published reports, and miscellaneous soil information.

Some terms used by the soil scientist may be unfamiliar to the engineer, and some—silt, sand, and clay, for example—have special meanings in soil science. These and other special terms used in a soil survey are defined in the Glossary in the back of this survey.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system, soil materials are classified in seven principal groups. These groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of fine textured, clayey soils having low strength when wet.

Some engineers prefer to use the Unified Soil Classification System (*12*). In this system, soil materials are identified as coarse-grained (8 classes), fine-grained (6 classes), or highly organic. Approximate classification can be made in the field. Estimated classification of the soils in the county is given in table 3.

Engineering data are given in tables 3 and 4. Table 3 shows several estimated soil properties significant in engineering, and table 4 gives interpretations of soil properties for various engineering uses.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 3. 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 3.

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

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.

Soil texture is described in table 3 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 modifer 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.

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.

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 3 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 plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH values 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 with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils cause much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Engineering interpretations

The estimated interpretations in table 4 are based on the engineering properties of soils shown in table 3, 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 Mitchell County. In table 4, ratings summarize the limitation or suitability of the soils for all listed purposes except for drainage of cropland and pasture, irrigation, ponds and reservoirs, embankments, and terraces and diversions. For these particular uses, table 4 lists those soil features not to be overlooked in planning, installation, and maintenance.

TABLE 3.—*Estimated 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 that may have in the first column. The symbol> means

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table [2]	Depth from surface	USDA texture	Classification: Unified	Classification: AASHO
	Feet	*Feet*	*Inches*			
Alluvial land, channeled: C315. Too variable for valid estimates.	>10					
Ansgar: 760	>10	1–3	0–12	Silt loam	ML or CL	A–4 or A–6
			12–28	Silty clay loam	CL	A–7
			28–72	Heavy loam and sandy clay loam.	CL	A–6
Ashdale: 804, 804B	3½–5	>5	0–20	Silt loam	OL or ML	A–4 or A–6
			20–29	Silty clay loam	CL	A–7
			29–40	Heavy loam and clay loam.	CL	A–6
			40–42	Clay	CH	A–7
			42	Shattered limestone bedrock.		
Atkinson: 813, 813B	3½–5	>5	0–20	Heavy loam	CL	A–6
			20–43	Loam	CL	A–6
			43–48	Clay	CH	A–7
			48	Limestone bedrock.		
Atterberry: 291	>10	2–4	0–11	Silt loam	ML	A–4 or A–6
			11–33	Silty clay loam	CL	A–7
			33–60	Silt loam	ML or CL	A–6 or A–7
Bassett: 171, 171B, 171C, 171C2	>5	[3] 1½–2	0–18	Loam	CL or ML	A–6 or A–4
			18–39	Loam	CL	A–6
			39–60	Light sandy clay loam	CL	A–6
Bixby: 265, 265B	>10	>5	0–11	Loam	CL	A–4 or A–6
			11–19	Loam	CL	A–6
			19–27	Sandy clay loam	SC or CL	A–6
			27–60	Loamy sand	SM or SP	A–2 or A–1–b
Burkhardt: 285, 285C	>10	>5	0–7	Heavy sandy loam	SM	A–4 or A–2
			7–17	Fine gravelly sandy loam	SM or SC	A–2
			17–65	Fine gravelly loamy sand and gravelly sand.	SW or SM	A–1–b
Calco: 733	>10	1–3	0–36	Silty clay loam	OL, MH or CL	A–7
			36–45	Clay loam and loam	CL	A–6
			45–60	Sandy loam	SC or SM	A–4 or A–2
Canisteo: 507	>10	1–3	0–17	Silty clay loam	MH or CL	A–7
			17–26	Silty clay loam	CL	A–6 or A–7
			26–50	Loam	CL	A–6
*Clyde: 84, 391B. For Floyd part of 391B, see Floyd series.	>10	1–3	0–21	Silty clay loam	CL, OL or MH	A–7
			21–32	Clay loam	CL	A–7 or A–6
			32–60	Loam and sandy loam	CL or SC	A–6
Coggon: 302B	>5	[3] 1⅓–2	0–16	Loam	ML or CL	A–4 or A–6
			16–65	Loam	CL	A–6
			65–80	Loam	CL	A–6
*Coland: 135, 235, C235. For Turlin parts of 235 and C235, see Turlin series.	>10	1–3	0–40	Silty clay loam and clay loam.	CL or OH	A–7
			40–60	Stratified sandy loam, clay loam, and loamy sand.	CL, SM or SC	A–6 and A–2–4

See footnotes at end of table.

properties of soils [1]

different properties and limitations. For this reason it is necessary to follow carefully the instructions for referring to other series that appear greater than; the symbol < means less than]

Percentage of material less than 3 inches in diameter 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.)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	----------	100	95–100	25–40	5–15	0.6–2.0	0.20–0.22	5.1–6.5	Moderate.
----------	----------	100	95–100	41–50	20–30	0.6–2.0	0.18–0.20	5–1–6.0	Moderate to high.
95–100	90–95	80–90	50–65	25–35	11–20	0.2–0.6	0.17–0.19	5.6–6.5	Moderate.
----------	----------	100	95–100	25–40	8–12	0.6–2.0	0.21–0.23	5.6–6.5	Moderate.
----------	----------	100	95–100	41–50	20–30	0.6–2.0	0.18–0.20	5.1–6.0	Moderate to high.
95–100	90–100	85–90	50–75	25–35	11–20	0.6–2.0	0.17–0.19	5.6–7.3	Moderate.
90–95	90–95	90–95	70–90	55–70	30–45	<0.06	0.12–0.15	7.4–7.8	High.
----------	100	95–100	70–85	25–35	11–20	0.6–2.0	0.20–0.22	5.6–6.5	Moderate.
95–100	90–95	85–90	60–75	30–40	11–20	0.6–2.0	0.17–0.19	5.1–6.0	Moderate.
90–100	90–95	90–95	70–90	55–70	30–45	<0.06	0.12–0.15	5.6–7.3	High.
----------	----------	100	95–100	25–40	5–15	0.6–2.0	0.21–0.23	5.1–6.5	Moderate.
----------	----------	100	95–100	41–50	20–30	0.6–2.0	0.18–0.20	5.1–6.0	Moderate to high.
----------	----------	100	95–100	35–45	11–20	0.6–2.0	0.19–0.21	5.6–7.4	Moderate.
----------	100	95–100	65–85	25–35	5–15	0.6–2.0	0.19–0.21	5.1–6.5	Moderate.
95–100	90–95	85–90	55–75	30–40	11–20	0.2–0.6	0.17–0.19	4.5–5.5	Moderate.
90–95	90–95	85–90	50–65	30–40	11–20	0.2–0.6	0.17–0.19	5.1–6.0	Moderate.
100	95–100	90–95	55–75	25–35	5–10	0.6–2.0	0.18–0.20	5.1–6.0	Moderate.
95–100	95–100	80–90	55–75	35–40	11–15	0.6–2.0	0.17–0.19	5.1–6.5	Moderate.
95–100	95–100	75–85	35–60	25–40	11–15	0.6–2.0	0.14–0.16	5.1–6.0	Moderate.
85–100	70–95	40–60	3–20	----------	[4] NP	6.0–>20.0	0.04–0.06	5.1–6.0	Low or none.
90–100	95–100	50–70	25–40	10–20	5–10	6.0–20.0	0.12–0.14	5.6–6.5	Low.
70–90	65–80	40–60	20–35	10–20	5–10	6.0–20.0	0.06–0.08	5.6–6.5	Low.
70–90	70–85	20–40	3–15	----------	NP	>20.0	0.02–0.04	5.1–6.0	Very low or none.
----------	----------	100	80–95	50–60	25–35	0.2–0.6	0.21–0.23	7.5–7.8	High.
100	95–100	95–100	75–85	30–40	20–30	0.2–2.0	0.17–0.19	7.4–7.6	Moderate to high.
100	95–100	60–80	20–40	10–20	5–10	6.0–20.0	0.11–0.13	7.2–7.5	Low.
----------	----------	100	80–90	50–60	25–35	0.6–2.0	0.21–0.23	7.5–7.8	High.
----------	100	95–100	80–90	40–50	25–35	0.6–2.0	0.18–0.20	7.4–7.6	High.
100	95–100	85–90	50–70	30–40	15–25	0.6–2.0	0.17–0.19	7.4–7.6	Moderate.
----------	100	95–100	75–95	45–65	15–25	0.6–2.0	0.20–0.22	6.1–7.3	High.
95–100	90–100	85–90	50–65	30–50	15–25	0.6–2.0	0.15–0.19	6.6–7.3	Moderate.
95–100	90–95	85–90	40–60	15–35	5–20	0.6–2.0	0.13–0.17	6.6–7.8	Moderate.
----------	100	95–100	65–80	20–35	5–15	0.6–2.0	0.19–0.21	4.5–6.0	Moderate.
95–100	90–95	85–90	50–65	30–40	11–20	0.2–0.6	0.17–0.19	4.5–6.0	Moderate.
95–100	90–95	85–90	50–65	30–40	11–20	0.2–0.6	0.17–0.19	6.1–7.8	Moderate.
----------	100	95–100	75–90	45–55	20–30	0.2–0.6	0.20–0.22	6.1–7.3	Moderate to high.
100	90–100	50–80	20–60	15–40	5–15	0.2–0.6	0.10–0.15	6.1–7.3	Moderate to low.

TABLE 3.—*Estimated engineering*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table [2]			Unified	AASHO
	Feet	*Feet*	*Inches*			
Cresco: 783B, 783C	>5	[3] 1⅓–2	0–18	Heavy loam	CL or OL	A–7 or A–6
			18–43	Clay loam	CL	A–6 or A–7
			43–60	Clay loam	CL	A–6
*Dickinson: 175, 175B, 575, 575B. For Ostrander parts of 575 and 575B, see Ostrander series.	>5	>5	0–30	Fine sandy loam	SM or SC	A–4 or A–2
			30–36	Loamy fine sand	SM or SP	A–2
			36–60	Sand	SP or SM	A–3 or A–2
Dinsdale: 377, 377B	>5	[3] 2½–3½	0–19	Light silty clay loam	OL, ML or CL	A–6 or A–7
			19–27	Light silty clay loam	CL	A–7 or A–6
			27–60	Loam	CL	A–6
Donnan: 782, 782B	>10	[3] 1½–3	0–12	Silt loam	ML or CL	A–4 or A–6
			12–24	Silty clay loam	CL	A–7
			24–60	Silty clay	CH	A–7
Downs: 162B, 162C2, 162D2	>5	>5	0–9	Silt loam	ML	A–4
			9–23	Silty clay loam	CL	A–7 or A–6
			23–60	Silt loam	CL	A–6
Dubuque: 183B, 183C	1½–3½	>5	0–13	Silt loam	ML	A–4
			13–24	Silty clay loam	CL	A–7 or A–6
			24–28	Clay	CH	A–7
			28	Limestone bedrock.		
Fayette: 163B, 163C2	>5	>5	0–9	Silt loam	ML	A–4
			9–36	Heavy silt loam and light silty clay loam.	CL	A–6 or A–7
			36–60	Silt loam	CL	A–6
Flagler: 284, 284B	>10	>5	0–20	Sandy loam	SM or SC	A–4 or A–2
			20–32	Sandy loam	SM or SC	A–4 or A–2
			32–48	Gravelly loamy sand and gravelly sand.	SW, SP or SM–SW	A–1–b
Floyd: 198B	>10	2–4	0–20	Heavy loam	OL or MH	A–7
			20–32	Stratified loam and sandy loam.	SM or SC	A–2–4 or A–4
			32–60	Heavy loam	CL	A–6
Franklin: 761	>10	2–4	0–13	Silt loam	ML or ML–CL	A–4 or A–6
			13–27	Silty clay loam	CL	A–7
			27–60	Heavy loam	CL	A–6
Garwin: 118	>10	1–3	0–18	Silty clay loam	CL or OH	A–7
			18–23	Silty clay loam	CL	A–7
			23–60	Silt loam	CL	A–6 or A–7
Hanlon: 536	>10	3–5	0–50	Fine sandy loam	SM or SC	A–4
			50–69	Sandy loam	SM or SC	A–4 or A–2
Hayfield:						
726	>10	2–4	0–11	Loam	CL or ML	A–6 or A–4
			11–36	Loam and sandy clay loam.	CL	A–6
			36–60	Gravelly loamy sand, gravelly sand, and sand.	SM or SP	A–2 or A–1–b
725	>10	2–4	0–11	Loam	CL	A–6
			11–24	Loam and sandy loam	CL or SC	A–6 or A–4
			24–50	Gravelly loamy sand, gravelly sand, and sand.	SM or SP	A–2 or A–1–b

See footnotes at end of table.

properties of soils [1]—Continued

Percentage of material less than 3 inches in diameter 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.)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----	100	95–100	70–80	35–50	11–20	0. 6–2. 0	0. 20–0. 22	5. 1–6. 5	Moderate.
95–100	90–95	80–90	60–70	35–45	18–25	0. 06–0. 2	0. 15–0. 17	5. 1–6. 5	Moderate to high.
95–100	90–95	80–90	60–70	30–40	11–20	0. 06–0. 2	0. 17–0. 19	6. 6–7. 8	Moderate.
----	100	85–95	30–50	15–30	5–10	2. 0–6. 0	0. 12–0. 15	5. 6–6. 5	Low.
----	100	80–95	3–20	15–30	5–10	6. 0–20. 0	0. 08–0. 10	5. 1–6. 0	Very low or none.
----	100	65–90	3–20	----	NP	6. 0–20. 0	0. 02–0. 04	5. 1–6. 0	None.
----	100	95–100	95–100	30–50	11–20	0. 6–2. 0	0. 21–0. 23	5. 6–6. 5	Moderate.
----	100	95–100	95–100	41–50	15–25	0. 6–2. 0	0. 18–0. 20	5. 1–6. 0	Moderate to high.
95–100	90–100	85–90	50–65	25–35	11–20	0. 2–0. 6	0. 17–0. 19	5. 1–6. 5	Moderate.
----	100	95–100	90–100	30–40	5–15	0. 6–2. 0	0. 20–0. 22	5. 1–6. 0	Moderate.
----	100	95–100	90–100	41–50	20–25	0. 6–2. 0	0. 18–0. 20	4. 5–5. 5	Moderate to high.
----	100	95–100	90–95	55–70	30–40	<0. 06	0. 14–0. 16	5. 1–7. 0	High.
----	----	100	95–100	30–40	5–10	0. 6–2. 0	0. 21–0. 23	5. 6–6. 5	Moderate.
----	----	100	95–100	35–45	15–25	0. 6–2. 0	0. 18–0. 20	5. 1–6. 0	Moderate to high.
----	----	100	95–100	30–40	11–20	0. 6–2. 0	0. 18–0. 20	5. 1–6. 0	Moderate.
----	----	100	95–100	30–40	5–10	0. 6–2. 0	0. 21–0. 23	5. 6–6. 5	Moderate.
----	----	100	95–100	35–45	15–25	0. 6–2. 0	0. 18–0. 20	5. 6–6. 0	Moderate to high.
95–100	90–95	90–95	65–90	55–70	30–45	<0. 06	0. 15–0. 17	5. 6–7. 3	High.
----	----	100	95–100	30–40	5–10	0. 6–2. 0	0. 21–0. 23	5. 6–6. 5	Moderate.
----	----	100	95–100	35–45	15–25	0. 6–2. 0	0. 18–0. 20	4. 5–6. 0	Moderate to high.
----	100	95–100	80–100	30–40	11–20	0. 6–2. 0	0. 18–0. 20	5. 1–6. 0	Moderate.
95–100	90–95	60–70	25–40	15–30	5–10	2. 0–6. 0	0. 12–0. 14	5. 6–6. 5	Low.
95–100	90–95	50–70	25–40	15–30	5–10	2. 0–6. 0	0. 11–0. 13	5. 6–6. 5	Low.
70–90	70–85	20–40	3–12	----	NP	>20. 0	0. 02–0. 04	5. 6–6. 5	Very low or none.
100	75–90	95–100	70–80	45–65	15–20	0. 6–2. 0	0. 18–0. 20	6. 1–7. 3	Moderate.
80–100	75–95	65–80	20–50	15–35	5–20	0. 6–6. 0	0. 14–0. 16	6. 1–7. 3	Moderate to low.
90–95	95–100	85–90	50–65	25–40	11–25	0. 2–0. 6	0. 17–0. 19	6. 6–7. 8	Moderate.
----	----	100	95–100	25–40	5–15	0. 6–2. 0	0. 21–0. 23	5. 1–6. 0	Moderate.
----	----	100	95–100	41–50	20–30	0. 6–2. 0	0. 18–0. 20	4. 5–5. 5	Moderate to high.
95–100	90–95	80–90	50–65	25–35	11–20	0. 2–0. 6	0. 17–0. 19	5. 1–6. 5	Moderate.
----	----	100	95–100	45–55	15–25	0. 2–0. 6	0. 21–0. 23	6. 4–7. 4	High.
----	----	100	95–100	40–50	20–30	0. 2–0. 6	0. 18–0. 20	6. 4–7. 4	High.
----	----	100	95–100	35–45	15–25	0. 6–2. 0	0. 20–0. 22	6. 6–7. 4	Moderate.
----	100	85–90	35–50	20–30	5–10	2. 0–6. 0	0. 15–0. 17	6. 1–7. 3	Low.
----	100	80–85	25–45	15–30	5–10	2. 0–6. 0	0. 08–0. 10	6. 1–7. 3	Low.
95–100	95–100	85–90	60–80	30–40	5–15	0. 6–2. 0	0. 17–0. 19	4. 5–6. 0	Moderate.
95–100	90–95	80–90	50–75	25–35	11–20	0. 6–2. 0	0. 15–0. 17	4. 5–5. 5	Moderate.
80–95	70–90	40–60	3–15	----	NP	6. 0–>20. 0	0. 02–0. 04	5. 1–6. 0	None.
95–100	95–100	85–90	60–80	30–40	5–15	0. 6–2. 0	0. 17–0. 19	4. 5–6. 0	Moderate.
95–100	90–95	80–90	40–60	20–30	5–15	0. 6–2. 0	0. 15–0. 17	4. 5–6. 0	Moderate.
80–95	70–90	40–60	3–15	----	NP	6. 0–>20. 0	0. 02–0. 04	5. 1–6. 0	None.

TABLE 3.—*Estimated engineering*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table [2]	Depth from surface	USDA texture	Classification: Unified	Classification: AASHO
	Feet	*Feet*	*Inches*			
Huntsville: 98, 98B	>5	>5	0–32	Heavy silt loam	OL or ML	A–4
			32–60	Silt loam	ML or CL	A–4 or A–6
Jameston: 797	>10	1–3	0–22	Silty clay loam	OL or CL	A–7
			22–60	Clay loam	CL	A–6
Kensett: 188	2–3½	2–4	0–18	Heavy silt loam	OL, ML or CL	A–6 or A–7
			18–28	Light clay loam	CL	A–6
			28–36	Sandy loam	SM or SC	A–4 or A–2
			36	Limestone bedrock		
Kenyon: 83, 83B, 83C, 83C2	>5	[3] 1½–2	0–17	Loam	CL	A–6
			17–21	Loam	CL	A–6
			21–60	Loam	CL	A–6
Klinger: 184	>10	2–4	0–18	Silty clay loam	CL, ML or OL	A–7
			18–27	Silty clay loam	CL	A–7
			27–60	Loam	CL	A–6
*Lamont: 110, 110B, 110C, 610B. For Renova part of 610B, see Renova series.	>5	>5	0–14	Fine sandy loam	SM or SC	A–2 or A–4
			14–31	Fine sandy loam	SC or SM	A–2 or A–4
			31–60	Sand	SM or SP	A–3 or A–2
Lawler:						
226	>10	2–4	0–16	Heavy loam	CL or OL	A–6 or A–7
			16–38	Light clay loam and sandy clay loam.	CL	A–6
			38–60	Gravelly loamy sand and gravelly sand.	SM, SW or SP	A–2 or A–1–b
225	>10	2–4	0–16	Heavy loam	CL or OL	A–6 or A–7
			16–30	Light clay loam and sandy clay loam.	CL	A–6
			30–60	Gravelly loamy sand and gravelly sand.	SM, SW or SP	A–2 or A–1–b
Lilah: 776, 776C	>10	>5	0–7	Sandy loam	SM	A–2 or A–4
			7–20	Sandy loam	SM	A–2
			20–60	Fine gravelly loamy sand	SM or SW	A–1–b
Lourdes: 781B, 781C, 781C2	>5	[3] 1½–2	0–12	Loam	CL or OL	A–6
			12–18	Heavy loam	CL	A–6 or A–7
			18–60	Clay loam	CL	A–6 or A–7
Marsh: 354. Too variable for valid estimates.	>10	0				
Marshan:						
152	>10	1–3	0–21	Clay loam	OL, CL or OH	A–7
			21–36	Loam	CL	A–6
			36–60	Loamy sand and sand	SM, SW or SP	A–2 or A–1–b
151	>10	1–3	0–21	Clay loam	OL, CL or OH	A–7
			21–27	Loam	CL	A–6
			27–60	Loamy sand and sand	SM, SW or SP	A–2 or A–1–b
Maxfield: 382	>10	1–3	0–19	Silty clay loam	CL or OH	A–7
			19–29	Light silty clay loam and silt loam.	CL	A–7
			29–60	Loam	CL	A–6
Muck: 221	>10	0–1	0–34	Muck	Pt	Muck
			34–60	Loam, clay loam or silty clay loam.	CL	A–6 or A–7

See footnotes at end of table.

properties of soils [1]—Continued

Percentage of material less than 3 inches in diameter 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	Permea-bility	Available water capacity	Reaction	Shrink-swell potential
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	100	95–100	95–100	30–40	5–10	0. 6–2. 0	0. 22–0. 24	5. 6–7. 3	Moderate.
----------	100	95–100	95–100	30–40	8–12	0. 6–2. 0	0. 20–0. 22	5. 1–6. 0	Moderate.
----------	100	95–100	80–90	41–50	15–25	0. 6–2. 0	0. 21–0. 23	6. 1–7. 3	High.
95–100	90–95	85–90	60–70	30–40	11–20	0. 06–0. 2	0. 17–0. 19	6. 6–7. 8	Moderate to high.
----------	100	95–100	75–85	35–45	11–20	0. 6–2. 0	0. 21–0. 23	5. 6–6. 5	Moderate.
95–100	90–95	90–95	60–75	30–40	15–20	0. 6–2. 0	0. 17–0. 19	5. 6–6. 5	Moderate.
95–100	90–95	60–75	25–50	15–25	5–10	2. 0–6. 0	0. 11–0. 13	5. 6–6. 5	Low.
----------	100	95–100	65–85	25–35	11–20	0. 6–2. 0	0. 20–0. 22	5. 6–6. 5	Moderate.
95–100	90–95	85–90	55–75	30–40	11–20	0. 6–2. 0	0. 17–0. 19	5. 1–6. 0	Moderate.
95–100	90–95	85–90	50–65	30–40	11–20	0. 2–0. 6	0. 17–0. 19	5. 1–7. 4	Moderate.
----------	100	95–100	95–100	41–50	15–25	0. 6–2. 0	0. 21–0. 023	5. 6–6. 5	Moderate.
----------	100	95–100	95–100	41–50	20–30	0. 6–2. 0	0. 18–0. 20	6. 1–7. 0	Moderate to high.
95–100	90–95	85–90	50–65	25–35	11–20	0. 2–0. 6	0. 17–0. 19	6. 6–7. 8	Moderate.
----------	100	90–95	25–50	15–30	5–10	2. 0–6. 0	0. 12–0. 15	5. 1–6. 0	Low.
----------	100	90–95	30–50	15–30	5–10	2. 0–6. 0	0. 12–0. 14	5. 6–6. 0	Low.
----------	100	70–80	3–20	----------	NP	6. 0–>20. 0	0. 02–0. 04	5. 1–6. 0	None.
95–100	95–100	90–95	60–80	35–45	15–25	0. 6–2. 0	0. 20–0. 22	5. 6–6. 5	Moderate.
95–100	95–100	80–90	55–75	25–35	11–20	0. 6–2. 0	0. 16–0. 18	5. 6–6. 5	Moderate.
80–95	70–90	40–60	3–15	----------	NP	6. 0–>20. 0	0. 02–0. 04	5. 6–6. 5	None.
95–100	95–100	90–95	60–80	35–45	15–25	0. 6–2. 0	0. 20–0. 22	5. 6–6. 5	Moderate.
95–100	95–100	80–90	55–75	25–35	11–20	0. 6–2. 0	0. 16–0. 18	5. 6–6. 5	Moderate.
80–95	70–90	40–60	3–15	----------	NP	6. 0–20. 0	0. 02–0. 04	5. 6–6. 5	None.
95–100	90–95	50–70	25–40	10–20	5–10	2. 0–6. 0	0. 10–0. 12	5. 1–6. 5	Low.
90–95	80–85	40–60	20–35	10–20	5–10	2. 0–6. 0	0. 08–0. 10	5. 1–6. 5	Low.
70–90	60–75	20–35	3–15	----------	NP	6. 0–>20. 0	0. 02–0. 04	4. 5–6. 0	None.
----------	100	95–100	70–85	30–40	11–15	0. 6–2. 0	0. 18–0. 20	5. 1–6. 0	Moderate.
100	95–100	90–95	50–70	30–45	20–25	0. 6–2. 0	0. 16–0. 18	4. 5–5. 6	Moderate.
95–100	95–100	85–90	55–70	35–45	15–25	0. 06–0. 2	0. 15–0. 17	5. 1–7. 8	Moderate to high.
100	95–100	90–95	70–85	45–55	20–25	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3	High.
95–100	90–95	80–90	50–75	30–40	15–20	0. 6–2. 0	0. 17–0. 19	6. 6–7. 3	Moderate.
80–95	70–95	40–60	5–15	----------	NP	6. 0–>20. 0	0. 04–0. 06	6. 6–7. 3	Very low or none.
100	95–100	90–95	70–85	45–55	20–25	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3	High.
95–100	90–95	80–90	50–75	30–40	15–20	0. 6–2. 0	0. 17–0. 19	6. 6–7. 3	Moderate.
80–95	70–95	40–60	5–15	----------	NP	6. 0–>20. 0	0. 04–0. 06	6. 6–7. 3	Very low or none.
----------	----------	100	95–100	45–55	15–25	0. 6–2. 0	0. 21–0. 23	6. 6–7. 3	High.
----------	----------	100	95–100	41–50	25–35	0. 6–2. 0	0. 18–0. 20	6. 6–7. 3	High or moderate.
95–100	90–95	85–90	55–70	25–35	11–20	0. 2–0. 6	0. 17–0. 19	6. 6–7. 8	Moderate.
----------	----------	----------	----------	----------	----------	2. 0–6. 0	0. 25–0. 50	6. 6–7. 3	Moderate.
----------	100	90–100	50–80	35–45	15–25	0. 2–0. 6	0. 19–0. 21	6. 6–7. 5	Moderate.

TABLE 3.—*Estimated engineering*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table [2]			Unified	AASHO
	Feet	*Feet*	*Inches*			
Muscatine: 119	>10	2–4	0–18	Silty clay loam	ML, CL or OL	A–7
			18–33	Silty clay loam	CL	A–7
			33–60	Silt loam	CL	A–6 or A–7
Nasset: 904, 904B	3½–5	>5	0–11	Silt loam	ML	A–4
			11–40	Heavy silt loam, light silty clay loam, and loam.	CL	A–7 or A–6
			40–48	Clay	CH	A–7
			48	Limestone bedrock.		
Oran: 471, 471B	>10	2–4	0–12	Loam	CL	A–6
			12–18	Loam	CL	A–6
			18–60	Loam	CL	A–6
Ostrander: 394, 394B	>5	>5	0–16	Loam	CL	A–6
			16–32	Loam	CL or SC	A–6
			32–60	Sandy clay loam	CL or SC	A–6
Pinicon: 303B	>10	2–4	0–12	Silt loam	ML or CL	A–4
			12–20	Silty clay loam	CL	A–7 or A–6
			20–60	Loam	CL	A–6
Protivin: 798B	>10	2–3	0–22	Heavy loam	OL, MH or CL	A–7
			22–60	Clay loam	CL	A–6 or A–7
Racine: 482, 482B, 482C	>5	>5	0–14	Silt loam	ML or CL	A–4
			14–50	Loam	CL or SC	A–6
			50–60	Loam	CL or SC	A–6
Readlyn: 399, 399B	>10	2–4	0–16	Loam	CL	A–6
			16–20	Loam	CL	A–6
			20–60	Heavy loam	CL	A–6
Renova: 491B	>5	>5	0–8	Loam	ML or CL	A–4 or A–6
			8–18	Loam	CL	A–6
			18–60	Loam and sandy clay loam.	CL or SC	A–6
Riceville: 784B	>10	2–3	0–8	Heavy silt loam	CL or ML	A–6 or A–7
			8–16	Silty clay loam	CL	A–6 or A–7
			16–60	Clay loam	CL	A–6
Rockton:						
214B, 214C	1½–2½	>5	0–18	Loam and clay loam	CL	A–6
			18–26	Clay loam	CL	A–6
			26	Limestone bedrock.		
104B	1½–2½	>5	0–18	Silt loam	OL, ML or CL	A–4 or A–6
			18–26	Clay loam	CL	A–6
			26	Limestone bedrock.		
Roseville: 805B	3½–5	>5	0–9	Silt loam	ML	A–4
			9–21	Silt loam	ML or CL	A–6
			21–40	Loam, sandy loam, and sandy clay loam.	CL or SC	A–6 or A–4
			40–44	Clay	CH	A–7
			44	Limestone bedrock.		
Sattre: 778	>10	>5	0–12	Silt loam	ML	A–4
			12–36	Loam	CL or SC	A–6
			36–60	Loamy sand and gravelly sand.	SM, SP or SW	A–2 or A–1–b
Saude: 177, 177B	>10	>5	0–20	Loam	CL	A–6
			20–29	Light sandy clay loam and sandy loam.	CL or SC	A–4 or A–6
			29–60	Loamy sand and gravelly sand.	SM, SP or SW	A–2 or A–1–b

See footnotes at end of table.

properties of soils [1]—Continued

Percentage of material less than 3 inches in diameter passing sieve—				Liquid limit	Plasticity index	Permea-bility	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.)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	----------	100	95–100	40–50	15–25	0.6–2.0	0.21–0.23	5.6–6.5	High.
----------	----------	100	95–100	45–55	25–35	0.6–2.0	0.18–0.20	5.6–7.0	High.
----------	----------	100	95–100	30–45	15–25	0.6–2.0	0.20–0.22	6.1–7.8	Moderate.
----------	100	95–100	95–100	30–40	5–10	0.6–2.0	0.21–0.23	5.6–6.0	Moderate.
----------	100	95–100	90–100	35–45	15–25	0.6–2.0	0.18–0.20	5.1–6.0	Moderate to high.
95–100	90–95	90–95	65–90	55–70	35–45	<0.06	0.15–0.17	5.6–7.3	High.
----------	100	95–100	70–90	25–35	11–15	0.6–2.0	0.18–0.20	5.0–6.5	Moderate.
95–100	90–95	90–95	50–70	30–40	11–20	0.6–2.0	0.17–0.19	4.5–6.0	Moderate.
95–100	90–95	85–90	50–65	30–40	11–20	0.2–0.6	0.17–0.19	5.6–7.8	Moderate.
100	95–100	95–100	65–85	25–35	11–15	0.6–2.0	0.20–0.22	5.1–6.0	Moderate.
95–100	90–95	85–90	40–65	30–40	11–20	0.6–2.0	0.17–0.19	5.1–6.0	Moderate.
95–100	90–95	80–90	40–70	30–40	11–20	0.6–2.0	0.15–0.17	5.6–7.8	Moderate.
----------	100	95–100	75–85	20–30	5–10	0.6–2.0	0.21–0.23	4.5–6.0	Moderate.
95–100	95–100	90–95	85–90	35–45	11–20	0.6–2.0	0.18–0.20	4.5–6.0	Moderate.
95–100	90–95	85–90	50–65	30–40	11–20	0.2–0.6	0.17–0.19	4.5–7.3	Moderate.
----------	100	95–100	70–85	45–55	15–25	0.6–2.0	0.20–0.22	5.6–6.5	Moderate.
95–100	95–100	85–90	60–75	30–40	15–25	0.06–0.2	0.15–0.17	5.6–7.8	Moderate to high.
----------	100	95–100	75–85	20–30	5–10	0.6–2.0	0.21–0.23	5.1–6.0	Moderate.
95–100	90–95	85–90	40–60	30–40	11–20	0.6–2.0	0.17–0.19	5.1–7.3	Moderate.
95–100	90–95	80–90	40–70	30–40	11–20	0.6–2.0	0.17–0.19	6.6–7.8	Moderate.
----------	100	95–100	70–80	30–40	11–20	0.6–2.0	0.20–0.22	5.6–6.0	Moderate.
95–100	90–95	85–90	55–75	30–40	11–20	0.6–2.0	0.17–0.19	5.1–6.0	Moderate.
95–100	90–95	85–90	50–65	30–40	11–20	0.2–0.6	0.17–0.19	5.6–7.8	Moderate.
----------	100	95–100	75–85	20–35	4–12	0.6–2.0	0.21–0.23	4.5–6.0	Moderate.
----------	100	90–95	55–75	30–40	11–20	0.6–2.0	0.17–0.19	4.5–6.0	Moderate.
95–100	90–95	80–90	40–70	30–40	11–20	0.6–2.0	0.17–0.19	4.5–7.3	Moderate.
----------	100	95–100	75–85	35–45	11–20	0.6–2.0	0.20–0.22	5.1–6.0	Moderate.
----------	100	95–100	75–85	35–45	15–25	0.6–2.0	0.18–0.20	5.1–6.0	Moderate to high.
95–100	90–100	85–90	60–70	30–40	15–25	0.06–0.2	0.15–0.17	5.1–7.8	Moderate to high.
----------	100	95–100	60–80	25–35	11–20	0.6–2.0	0.20–0.22	5.6–6.5	Moderate.
95–100	95–100	85–90	55–75	30–40	11–20	0.6–2.0	0.17–0.19	6.1–7.3	Moderate.
----------	100	95–100	90–100	25–35	8–12	0.6–2.0	0.21–0.23	5.6–6.5	Moderate.
100	95–100	85–90	55–75	30–40	11–20	0.6–2.0	0.17–0.19	6.1–7.3	Moderate to high.
----------	100	95–100	85–95	25–35	5–10	0.6–2.0	0.21–0.23	5.6–6.0	Moderate.
----------	100	95–100	80–90	30–40	11–15	0.6–2.0	0.20–0.22	5.1–6.0	Moderate.
90–95	95–100	85–90	45–65	20–35	3–15	0.6–2.0	0.16–0.18	5.1–6.0	Moderate.
95–100	90–95	90–95	65–90	55–70	30–45	<0.06	0.15–0.17	5.6–7.3	High.
100	95–100	95–100	80–100	30–40	5–10	0.6–2.0	0.20–0.22	5.1–6.0	Moderate.
95–100	90–95	95–100	45–65	30–40	11–20	0.6–2.0	0.17–0.19	5.1–6.0	Moderate.
80–95	70–95	40–60	3–15	----------	NP	6.3–>20.0	0.02–0.04	5.1–5.6	Very low or none.
95–100	95–100	90–95	55–80	25–35	11–15	0.6–2.0	0.20–0.22	5.1–6.5	Moderate.
95–100	90–95	85–90	35–60	25–40	8–12	0.6–6.0	0.15–0.17	5.1–6.0	Moderate to low.
80–95	70–95	40–60	3–15	----------	NP	6.0–20.0	0.02–0.04	5.6–6.0	Very low or none.

TABLE 3.—*Estimated engineering*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table [2]			Unified	AASHO
	Feet	*Feet*	*Inches*			
Schley: 407B	>10	2-4	0-17	Silt loam and loam	CL or ML	A-6 or A-4
			17-48	Light sandy clay loam and sandy loam.	CL or SC	A-4 or A-6
			48-60	Heavy loam	CL or SC	A-6
Sogn: 412B, 412D, 412G	½-1½	>5	0-12	Heavy loam	CL	A-6
			12	Limestone bedrock.		
Tama: 120, 120B, 120C2	>5	>5	0-20	Light silty clay loam	OL, ML or CL	A-6 or A-7
			20-42	Light silty clay loam	CL	A-7 or A-6
			42-60	Silt loam	CL	A-6 or A-7
Terrill: 27, 27B	>5	>4	0-30	Loam	CL	A-6
			30-40	Loam and sandy clay loam.	CL	A-6
			40-60	Sandy loam	SC or SM	A-4 or A-2
Tripoli: 398	>10	1-3	0-20	Silty clay loam	OL or CL	A-7 or A-6
			20-24	Light clay loam	CL	A-6
			24-60	Loam	CL	A-6
Turlin: 96	>10	2-4	0-28	Silt loam	OL or CL	A-4 or A-6
			28-48	Heavy loam and heavy sandy loam.	CL, SC or SM	A-4 or A-6
			48-60	Heavy sandy loam	SC or SM	A-4 or A-2
Wapsie: 777, 777B, 777C	>10	>5	0-13	Light loam	CL or CL-ML	A-4
			13-27	Loam, sandy clay loam, and sandy loam.	CL or SC	A-4 or A-6
			27-60	Gravelly loamy sand and sand.	SM, SP or SW	A-2 or A-1-b
Waubeek: 771, 771B	>5	[3] 2½-3½	0-13	Silt loam	ML or CL	A-4
			13-31	Silt loam and silty clay loam.	CL	A-7 or A-6
			31-72	Loam	CL	A-6
Waucoma: 913, 913B	3½-5	>5	0-11	Silt loam	ML or CL	A-4 or A-6
			11-30	Loam	CL	A-6
			30-47	Sandy loam and sandy clay loam.	CL, SM or SC	A-4 or A-6
			47	Limestone bedrock.		
Waukee: 178, 178B	>5	>5	0-18	Heavy silt loam	ML or CL	A-4 or A-6
			18-36	Loam and sandy clay loam.	CL	A-6
			36-60	Gravelly loamy sand	SM or SP	A-2 or A-1-b
Whalan: 205B, 205C	1½-3½	>5	0-5	Loam	ML or CL	A-4 or A-6
			5-26	Loam and sandy clay loam.	CL	A-6
			26-29	Heavy clay loam	CL	A-6
			29-34	Clay	CH	A-7
			34	Limestone bedrock.		
Winneshiek: 714, 714B, 714C, 714D	1½-3½	>5	0-10	Loam	CL or ML	A-4
			10-21	Heavy loam	CL	A-6
			21-27	Heavy clay loam and clay.	CL or CH	A-7
			27	Limestone bedrock.		

[1] Reviewed by Donald A. Anderson, soil engineer, Iowa State Highway Commission.
[2] Depths are for undrained areas. In wet soils that are tiled, the water table is generally below the the tile line at a depth of 3 to 4 feet.

properties of soils [1]—Continued

Percentage of material less than 3 inches in diameter 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.)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	100	95–100	75–85	30–40	5–15	0. 6–2. 0	0. 18–0. 20	5. 1–6. 0	Moderate.
90–95	90–95	75–85	35–65	15–30	8–15	0. 6–2. 0	0. 14–0. 16	4. 5–5. 5	Moderate.
95–100	90–95	85–90	45–65	25–35	11–20	0. 2–0. 6	0. 17–0. 19	5. 6–7. 3	Moderate.
75–100	75–95	70–85	60–80	25–35	11–20	0. 6–2. 0	0. 18–0. 20	6. 1–7. 3	Moderate.
----------	----------	100	95–100	40–50	11–20	0. 6–2. 0	0. 21–0. 23	5. 6–6. 5	Moderate to high.
----------	----------	100	95–100	41–50	15–25	0. 6–2. 0	0. 18–0. 20	5. 1–5. 6	Moderate to high.
----------	----------	100	95–100	35–45	15–25	0. 6–2. 0	0. 20–0. 22	5. 1–6. 0	Moderate.
----------	100	95–100	80–90	30–40	11–20	0. 6–2. 0	0. 20–0. 22	5. 6–6. 5	Moderate.
----------	100	90–95	65–80	25–40	11–20	0. 6–2. 0	0. 17–0. 19	5. 6–6. 5	Moderate.
95–100	85–95	90–95	20–50	15–25	5–10	2. 0–6. 0	0. 12–0. 14	5. 1–6. 0	Low.
----------	100	95–100	80–90	35–45	15–25	0. 6–2. 0	0. 21–0. 23	6. 6–7. 3	Moderate to high.
----------	100	90–95	75–85	30–40	11–20	0. 6–2. 0	0. 17–0. 19	6. 6–7. 3	Moderate.
95–100	90–95	85–90	55–70	30–40	11–20	0. 2–0. 6	0. 17–0. 19	6. 6–8. 4	Moderate.
----------	100	95–100	80–90	30–40	8–12	0. 6–2. 0	0. 21–0. 23	5. 1–6. 5	Moderate.
95–100	95–100	85–90	35–60	20–40	5–15	0. 6–6. 0	0. 15–0. 17	5. 1–6. 0	Moderate.
95–100	95–100	75–85	30–50	15–25	5–10	2. 0–6. 0	0. 12–0. 14	6. 1–7. 3	Low.
100	95–100	90–95	55–75	25–35	5–10	0. 6–2. 0	0. 18–0. 20	5. 1–6. 0	Moderate.
95–100	95–100	85–90	40–60	20–35	8–15	0. 6–2. 0	0. 14–0. 16	5. 1–6. 0	Moderate.
85–100	70–95	40–60	3–15	----------	NP	6. 0–>20. 0	0. 02–0. 04	5. 1–8. 0	Very low or none.
----------	100	95–100	95–100	30–40	5–10	0. 6–2. 0	0. 20–0. 22	5. 1–6. 0	Moderate.
----------	100	95–100	95–100	35–45	15–25	0. 6–2. 0	0. 18–0. 20	5. 0–6. 0	Moderate to high.
95–100	90–95	85–90	50–65	30–40	11–20	0. 2–0. 6	0. 17–0. 19	5. 0–7. 3	Moderate.
----------	100	95–100	70–85	25–35	8–12	0. 6–2. 0	0. 19–0. 21	5. 6–6. 5	Moderate.
95–100	90–95	85–90	55–70	30–40	11–20	0. 6–2. 0	0. 17–0. 19	5. 1–6. 0	Moderate.
95–100	90–95	75–85	35–70	20–30	8–12	0. 6–2. 0	0. 15–0. 17	5. 1–7. 3	Moderate.
----------	100	95–100	70–85	30–40	8–12	0. 6–2. 0	0. 20–0. 22	5. 6–6. 5	Moderate.
95–100	95–100	85–90	55–75	25–40	11–20	0. 6–2. 0	0. 17–0. 19	5. 6–6. 0	Moderate.
85–95	70–90	40–60	3–15	----------	NP	6. 0–>20. 0	0. 02–0. 04	5. 6–6. 0	Very low.
100	95–100	95–100	60–80	25–35	8–12	0. 6–2. 0	0. 18–0. 20	5. 6–6. 5	Moderate.
95–100	90–95	85–90	60–70	30–40	11–20	0. 6–2. 0	0. 17–0. 19	5. 1–6. 0	Moderate.
95–100	90–95	85–90	65–75	30–40	11–20	0. 2–0. 6	0. 16–0. 18	5. 6–7. 3	Moderate to high.
95–100	90–95	90–95	65–90	55–70	30–45	<0. 06	0. 15–0. 17	5. 6–7. 3	High.
----------	100	95–100	60–80	25–35	8–12	0. 6–2. 0	0. 20–0. 22	5. 6–6. 5	Moderate.
95–100	90–95	85–90	60–70	30–40	11–20	0. 6–2. 0	0. 17–0. 19	5. 1–6. 0	Moderate.
95–100	90–95	90–95	65–90	45–60	30–40	0. 06–0. 2	0. 15–0. 17	5. 6–7. 3	High.

[3] Perched water table during extended wet periods.
[4] Nonplastic.

TABLE 4.—*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 that may that appear in

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Alluvial land: C 315.	Severe: subject to frequent flooding; high water table in some areas; variable permeability.	Severe: subject to frequent flooding; high content of organic matter in surface layer in most areas; rapid permeability in places.	Severe: subject to frequent flooding; variable permeability.	Severe: subject to frequent flooding; variable material.	Variable, good to poor: onsite investigation needed; variable drainage.
Ansgar: 760	Severe: seasonal high water table at a depth of 1 to 3 feet; marginal percolation rate; moderately slow permeability.	Slight: moderate content of organic matter in surface layer; moderately slow permeability.	Moderate to severe: seasonal high water table; poorly drained; moderately slow permeability; glacial till at a depth of 2 to 3 feet.	Moderate to severe: seasonal high water table; poorly drained; high susceptibility to frost action.	Fair: seasonal high water table; poorly drained; medium compressibility below a depth of 2½ feet; moderate to high shrink-swell potential.
Ashdale: 804, 804B.	Moderate: satisfactory percolation rate; bedrock at a depth of 3½ to 5 feet; danger of contamination of ground water.	Severe: shattered bedrock at a depth of 3½ to 5 feet; danger of contamination of ground water.	Severe: porous shattered bedrock at a depth of 3½ to 5 feet.	Slight to moderate: high content of organic matter in surface layer; bedrock at a depth of 3½ to 5 feet; well drained; moderate to igh shrink-swell potential.	Fair: moderate to high shrink-swell potential; shattered limestone at a depth of 3½ to 5 feet.
Atkinson: 813, 813B.	Moderate: bedrock at a depth of 3½ to 5 feet; satisfactory percolation rate; danger of contamination of ground water.	Severe: shattered limestone bedrock at a depth of 3½ to 5 feet; danger of contamination of ground water.	Severe: porous shattered bedrock at a depth of 3½ to 5 feet.	Slight: high content of organic matter in surface layer; bedrock at a depth of 3½ to 5 feet; fair to good bearing capacity and shear strength above limestone.	Fair to good above limestone bedrock: clayey material more than 6 inches thick above limestone; limestone below a depth of 3½ to 5 feet good if crushed.
Atterberry: 291	Moderate: seasonal high water table at a depth of 2 to 4 feet; satisfactory percolation rate; moderate permeability.	Moderate: moderate permeability; difficult to compact to high density; moderate content of organic matter.	Moderate: seasonal high water table; moderate permeability to a depth of about 5 feet, moderately slowly permeable glacial till below a depth of about 5 feet.	Moderate: seasonal high water table; moderate to high shrink-swell potential.	Fair to poor: medium to high compressibility; moderate to high shrink-swell potential; seasonal high water table at a depth of 2 to 4 feet.

See footnote at end of table.

interpretations [1]

have different properties and limitations For this reason it is necessary to follow carefully the instructions for referring to other series the first column]

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Variable: sand bars generally adjacent to streams.	Variable, but good to fair in most places.	High content of organic matter in surface layer in most areas; variable permeability; too porous to hold water in places; subject to frequent flooding.	Variable, but generally high content of organic matter in surface layer; moderate to high shrink-swell potential in many areas; difficult to compact; low resistance to piping in some areas.	Subject to frequent flooding; high water table in some areas; difficult to obtain adequate tile outlets in places; some depressed areas subject to ponding for long periods.	Not needed: nearly level.
Not suitable: no sand or gravel.	Good in upper ½ to 1 foot, fair to a depth of 2 feet, poor below: poorly drained.	Moderately slow permeability; seasonal high water table; level topography.	Medium to low shear strength; low permeability if compacted; medium compressibility; easily compacted to high density below a depth of 2 to 3 feet.	Seasonal high water table; moderately slow permeability; surface drainage needed in ponded areas.	Not needed: nearly level.
Not suitable: no sand or gravel.	Good to a depth of 1½ feet, fair to a depth of 2½ feet, poor below: limestone bedrock at a depth of 3½ to 5 feet; high content of organic matter; friable.	Shattered bedrock at a depth of 3½ to 5 feet; too porous to hold water.	Limited material available; high content of organic matter in surface layer; limestone bedrock at a depth of 3½ to 5 feet; difficult to compact to high density above a depth of 2½ feet; medium permeability if compacted.	Well drained	Soil features favorable except limestone at a depth of 3½ to 5 feet.
Not suitable: no sand or gravel.	Good to a depth of 1½ feet; poor below: high content of organic matter; friable.	Shattered bedrock at a depth of 3½ to 5 feet; too porous to hold water.	Limited material available; high content of organic matter in surface layer; good workability below a depth of 1½ to 2 feet; easily compacted to high density; moderate shrink-swell potential.	Well drained	Soil features favorable, except limestone at a depth of 3½ to 5 feet.
Not suitable: no sand or gravel.	Good in upper ½ to 1 foot, fair below: moderate content of organic matter; friable.	Moderate permeability; uniform material; fair to poor compaction characteristics.	Medium to low shear strength; medium permeability if compacted; fair to poor compaction characteristics; fair to good workability.	Seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Terraces not needed: nearly level.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Bassett: 171, 171B, 171C, 171C2.	Slight to moderate: marginal percolation rate; moderately slow permeability below a depth of about 2 feet; perched water table during extended wet periods.	Slight where slopes are less than 2 percent, moderate where slopes are 2 to 9 percent; sand pockets in places; moderately slow permeability.	Slight: moderately slow permeability in glacial till; limestone bedrock at a depth of 10 to 15 feet in places.	Slight to moderate: fair to good bearing capacity; moderate shrink-swell potential; seepage in some cuts; high susceptibility to frost action; perched water table during extended wet periods.	Good below a depth of about 2½ feet: low compressibility; good workability; moderate shrink-swell potential.
Bixby: 265, 265B.	Slight: rapid to very rapid permeability; satisfactory percolation rate; moderate danger of contamination of ground water.	Severe: substratum too porous to hold water; severe danger of contamination of ground water.	Severe: porous substratum; danger of contamination of ground water.	Slight: fair bearing capacity to a depth of 2½ feet, good bearing capacity below a depth of about 2½ feet; low shrink-swell potential.	Good below a depth of about 2½ feet: very low compressibility; good workability; low shrink-swell potential.
Burkhardt: 285, 285C.	Slight where slopes are less than 5 percent, moderate where slopes are 5 to 9 percent: very rapid permeability; satisfactory percolation rate; danger of contamination of ground water.	Severe: very rapid permeability; substratum too porous to hold water; danger of contamination of ground water.	Severe: porous substratum; very rapid permeability; danger of contamination of ground water.	Slight: good bearing capacity; good shear strength; low shrink-swell potential.	Good: well graded sand and gravel; very low to negligible compressibility; low shrink-swell potential.
Calco: 733	Severe: seasonal high water table; subject to flooding; marginal percolation rate.	Severe: subject to flooding; seasonal high water table; high content of organic matter in surface layer; moderately slow permeability.	Severe: subject to flooding; poorly drained.	Severe: high content of organic matter in surface layer; seasonal high water table; subject to flooding; poorly drained; moderate to high shrink-swell potential.	Poor: high content of organic matter; medium to high compressibility; seasonal high water table; moderate to high shrink-swell potential.
Canisteo: 507	Severe: seasonal high water table; satisfactory percolation rate.	Moderate: receives local runoff; high content of organic matter in surface layer; moderate permeability.	Severe: seasonal high water table; receives local runoff; poorly drained.	Severe: high content of organic matter in surface layer; seasonal high water table; moderate to high shrink-swell potential; high susceptibility to frost action.	Poor: high content of organic matter; moderate to high shrink-swell potential; seasonal high water table.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Fair to good in upper 1 to 1½ feet, poor below: moderate content of organic matter.	Moderately slow permeability; sand pockets and lenses in places.	Good stability; easily compacted to high density; medium compressibility; low permeability if compacted.	Generally not needed: tile drainage needed for hillside seepage in places.	Low-fertility, high-density subsoil; tile drainage needed where wet spots develop after terracing; poor workability in exposed subsoil; long uniform slopes.
Good source of sand below a depth of about 2½ feet: poorly graded; small amount of gravel.	Good in upper ½ to 1 foot, fair to a depth of 2 feet, poor below a depth of 2 feet: friable; low content of organic matter.	Substratum too porous to hold water; rapid to very rapid permeability below a depth of about 2½ feet.	Good stability; medium to high shear strength; medium to low resistance to piping; good compaction characteristics.	Well drained	Generally not needed
Good: well graded sand and gravel below a depth of about 1½ feet.	Fair to a depth of 1½ feet, very poor below.	Shallow to sands and gravels of rapid to very rapid permeability; too porous to hold water.	High permeability if compacted; medium to high susceptibility to piping; good compaction characteristics.	Excessively drained	Shallow to sands and gravels; highly erodible; short irregular slopes; difficult to maintain ridge and channel.
Not suitable: no sand or gravel.	Fair to poor to a depth of 3 feet; seasonal high water table; poorly drained.	Nearly level; seasonal high water table; high content of organic matter; moderately slow permeability.	High content of organic matter in surface layer; low to medium permeability if compacted; medium to low shear strength; fair to poor compaction characteristics.	Seasonal high water table; subject to flooding; moderate permeability; difficult to obtain adequate tile outlets in some areas.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Fair to poor to a depth of 1½ feet, poor below: seasonal high water table; poorly drained.	Nearly level; seasonal high water table; high content of organic matter in surface layer; moderate permeability.	High content of organic matter; low to medium permeability if compacted; medium to low shear strength to a depth of 1½ feet; fair to poor compaction characteristics.	Seasonal high water table; moderate permeability.	Terraces not needed: nearly level.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
*Clyde: 84, 391B. For Floyd part of 391B, see Floyd series.	Severe: seasonal high water table; subject to concentrated runoff; satisfactory percolation rate.	Severe: receives local runoff; high content of organic matter in surface layer; sandy lenses in subsoil.	Severe: high water table; poorly drained; moderately slowly permeable glacial till below a depth of 3 to 4 feet.	Severe: high content of organic matter in surface layer; seasonal high water table; moderate to high shrink-swell potential; high susceptibility to frost action.	Poor: high content of organic matter; medium to high shrink-swell potential; seasonal high water table.
Coggon: 302B	Moderate: moderately slow permeability; perched water table during extended wet periods; marginal percolation rate.	Slight: moderately slow permeability; sand pockets in places.	Slight: moderately slow permeability.	Slight to moderate: moderate shrink-swell potential; seepage in some cuts; susceptible to frost action; perched water table during extended wet periods.	Fair to a depth of 1 to 1½ feet, good below: medium to low compressibility; easily compacted to high density.
*Coland: 135, 235, C235. For Turlin parts of 235 and C235, see Turlin series.	Severe: subject to flooding; seasonal high water table; marginal percolation rate.	Severe: subject to flooding; high content of organic matter in surface layer; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: high content of organic matter to a depth of about 3 feet; seasonal high water table; subject to flooding.	Poor: high content o' organic matter; seasonal high water table; moderate to high shrink-swell potential.
Cresco: 783B, 783C.	Severe on all slopes: slow permeability; perched water table during wet periods; unsatisfactory percolation rate.	Moderate where slopes are 2 to 9 percent: sand pockets in places; high content of organic matter in surface layer; slow permeability.	Slight: perched water table during wet periods; slowly permeable glacial till.	Moderate: high content of organic matter in surface layer; susceptible to frost action; moderate to high shrink-swell potential; perched water table during wet periods.	Good below a depth of about 2 feet; medium to low compressibility; fair to good bearing capacity; moderate to high shrink-swell potential; easily compacted to high density.
*Dickinson: 175, 175B, 575, 575B. For Ostrander parts of 575 and 575B, see Ostrander series.	Slight: rapid permeability in lower subsoil; moderate danger of contamination of ground water; satisfactory percolation rate.	Severe: rapid permeability in lower subsoil; too porous to hold water; danger of of contamination of ground water.	Moderate to severe: degree of limitation depends on depth to less permeable glacial till in substratum; glacial till below a depth of 5 to 6 feet.	Slight: highly erodible; seepage in some cuts in uplands; loose sand hinders hauling in places; low shrink-swell potential.	Good: good workability; low compressibility; good bearing capacity if confined; low shrink-swell potential.
Dinsdale: 377, 377B.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent: moderate permeability in upper part, moderately slow in lower part; satisfactory percolation rate.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent: high content of organic matter in surface layer; moderately slow permeability below a depth of about 2 to 3 feet.	Slight: moderately slow permeability; glacial till at a depth of about 3 feet; limestone at a depth of 10 to 15 feet in some areas.	Moderate: high content of organic matter in surface layer; moderate to high shrink-swell potential; moderate susceptibility to frost action.	Fair to a depth of 2 to 3 feet, fair to good below: high content of organic matter in surface layer; easily compacted to high density below a depth of 2 to 3 feet; moderate to high shrink-swell potential.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Fair to a depth of 1 to 2 feet; seasonal high water table; poorly drained high content of organic matter.	Sandy lenses and pockets in places; high content of organic matter in surface layer; moderately slow permeability below a depth of 3 to 4 feet.	Fair to poor compaction characteristics in upper part, good below; low shear strength in upper part, medium shear strength in lower part.	Seasonal high water table; stones and boulders interfere with tile installation in places; moderate to moderately slow permeability; wetness partly caused by seepage.	Generally not needed: nearly level.
Not suitable: no sand or gravel.	Fair to a depth of 1 to 1½ feet, poor below: low content of organic matter.	Moderately slow permeability; sand pockets and lenses in places.	Medium to low shear strength; easily compacted to high density; low permeability if compacted.	Generally not needed: tile drainage needed for hillside seepage in places.	Low-fertility, high-density subsoil; tile drainage needed where wet spots develop after terracing; poor workability of subsoil.
Not suitable: no sand or gravel.	Fair to a depth of 3 to 4 feet: seasonal high water table; high content of organic matter; poorly drained.	High content of organic matter in surface layer; moderately slow permeability; sub- to flooding.	High content of organic matter to a depth of 3 to 4 feet; low shear strength; low to medium permeability if compacted; difficult to compact to high density.	Seasonal high water table; subject to flooding; moderately slow permeability; difficult to obtain adequate tile outlets in places.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Good to a depth of 1 to 1½ feet, poor below: high content of organic matter.	Slow permeability below a depth of 1½ to 2 feet; sand pockets and lenses in places.	High content of organic matter in surface layer; medium to low shear strength; easily compacted to high density; low permeability if compacted.	Seasonally wet; tile drainage needed for hillside seepage in places; slow permeability.	Low-fertility, high-density subsoil; terrace installation increases wetness in places.
Fair to good source of sand below a depth of about 3 feet: poorly graded fine and medium sand; unsuitable as source of gravel.	Good to a depth of 2 feet, poor below: sandy loam; moderate content of organic matter.	Substratum too porous to hold water; rapid permeability below a depth of about 2 feet.	Medium shear strength; low compressibility; poor resistance to piping; high permeability if compacted.	Somewhat excessively drained.	Highly erodible; difficult to maintain ridge and channel; loose sand hinders construction in places.
Not suitable: no sand or gravel.	Good in upper 2½ feet, poor below: high content of organic matter in surface layer.	High content of organic matter in surface layer; moderately slow permeability below a depth of 2 to 3 feet; pockets and lenses of sand in places.	Medium to low shear strength; medium to low permeability if compacted; fair to good compaction characteristics.	Well drained and moderately well drained.	All soil features favorable: long uniform slopes.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Donnan: 782, 782B.	Severe: very slow permeability in subsoil; unsatisfactory percolation rate.	Slight where slopes are less than 2 percent, moderate where slopes are 2 to 5 percent: very slow permeability below a depth of about 2 feet.	Moderate to severe: perched water table in wet seasons; very poor workability in subsoil; very slow permeability below a depth of about 2 feet.	Severe: perched water table in wet periods; high shrink-swell potential.	Fair to poor to a depth of 1 to 2 feet, poor below: high shrink-swell potential; poor workability.
Downs: 162B, 162C2, 162D2.	Slight where slopes are less than 5 percent, moderate where slopes are 2 to 9 percent, severe where slopes are more than 9 percent: moderate permeability; satisfactory percolation rate.	Moderate where slopes are 2 to 9 percent, severe where slopes are more than 9 percent: moderate permeability.	Moderate: moderately permeable loess 5 feet or more thick; limestone bedrock or glacial till below a depth of 5 to 10 feet in some areas.	Slight to moderate: moderate to high shrink-swell potential; highly erodible; easy to vegetate.	Fair to poor: moderate to high shrink-swell potential; medium to high compressibility.
Dubuque: 183B, 183C.	Severe: shallow to shattered limestone; danger of contamination of ground water; satisfactory percolation rate.	Severe: shallow to shattered limestone; danger of contamination of ground water.	Severe: shallow to shattered limestone; danger of contamination of ground water.	Bedrock at a depth of about 2 to 2½ feet; upper 2 to 5 feet of bedrock is shattered; moderate to high shrink-swell potential above bedrock.	Fair to poor to a depth of 2 to 2½ feet; bedrock below a depth of 2 to 2½ feet good if crushed.
Fayette: 163B, 163C2.	Slight where slopes are less than 5 percent, moderate where slopes are 5 to 9 percent: moderate permeability; satisfactory percolation rate.	Moderate: moderate permeability; uniform material.	Moderate: moderately permeable loess more than 5 feet thick; limestone bedrock at a depth of 5 to 10 feet in some areas.	Slight to moderate: well drained; moderate to high shrink-swell potential; highly erodible.	Fair to poor: medium compressibility; moderate to high shrink-swell potential; well drained.
Flagler: 284, 284B.	Slight: moderately rapid to very rapid permeability; severe danger of contamination of ground water; satisfactory percolation rate.	Severe: moderately rapid to very rapid permeability; substratum too porous to hold water; severe danger of contamination of ground water.	Severe: rapid to very rapid permeability; porous; danger of contamination of ground water.	Slight: good bearing capacity; low to no shrink-swell potential.	Good: well graded sand and gravel below a depth of 2½ to 3 feet; very low compressibility; low to no shrink-swell potential.
Floyd: 198B	Severe: seasonal high water table; moderate permeability in upper part; satisfactory percolation rate.	Moderate: high content of organic matter in surface layer; variable material; sand pockets and strata in places, moderately slow permeability below a depth of about 3 feet.	Moderate to severe: seasonal high water table; receives local runoff; moderately slowly permeable glacial till below a depth of about 3 to 4 feet.	Moderate to severe: somewhat poorly drained; seasonal high water table; high content of organic matter in surface layer; high susceptibility to frost action.	Fair: high content of organic matter to a depth of 2 feet; seasonal high water table; moderate shrink-swell potential.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Fair to good to a depth of 1 to 2 feet, very poor below.	Very slow permeability; variable material; sand pockets in places.	Medium to low shear strength; poor compaction characteristics; high compressibility.	Perched water table in wet periods; very slow permeability.	Low-fertility, clay subsoil; terrace installation increases wetness in places.
Not suitable: no sand or gravel.	Good in upper ½ to 1 foot, fair below: moderate content of organic matter; friable.	Moderate permeability; uniform material; fair to poor compaction characteristics.	Medium to low shear strength; medium permeability if compacted; fair to poor compaction characteristics; medium susceptibility to piping.	Well drained	All soil features favorable.
Not suitable: no sand or gravel.	Good to a depth of ½ to 1 foot, fair to poor below: limestone bedrock below a depth of 2 to 2½ feet.	Shallow to porous shattered bedrock.	Shallow to shattered bedrock; limited material available; medium to low shear strength above rock; medium permeability if compacted.	Well drained	Shallow to limestone; bedrock hinders construction in places.
Not suitable: no sand or gravel.	Good to a depth of ½ to 1 foot, fair to poor below: low content of organic matter.	Moderate permeability; uniform material; fair to poor compaction characteristics.	Medium to low shear strength; medium compressibility; medium permeability if compacted; fair to poor compaction characteristics.	Well drained	All soil features favorable.
Good source of sand below a depth of 2½ to 3 feet, fair source of gravel below a depth of 2½ to 3 feet: too many fines in places.	Fair to good to a depth of 1½ feet, fair to a depth of 2½ feet, poor below: moderate content of organic matter.	Rapid to very rapid permeability.	Medium to high shear strength; low compressibility; medium to high susceptibility to piping; fair to good compaction characteristics.	Excessively drained	Sandy subsoil; highly erodible; difficult to maintain ridge and channel.
Not suitable: no sand or gravel.	Good to a depth of 1½ to 2 feet, fair to a depth of 2 to 3 feet, poor below: high content of organic matter.	High content of organic matter in surface layer; sand lenses and pockets in many places; variable material; moderately slow permeability below a depth of about 3 feet.	Medium to low shear strength; high content of organic matter in surface layer; low permeability if compacted below a depth of about 2 to 3 feet; good compaction characteristics below a depth of about 2 to 3 feet.	Seasonal high water table; moderate permeability in upper part; wetness partly caused by laterally moving water.	Generally not needed: tile drainage needed where terraces installed.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Franklin: 761	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability below a depth of about 2 to 3 feet; marginal percolation rate.	Slight to moderate: seasonal high water table; moderately slow permeability below a depth of 2 to 3 feet.	Moderate: seasonal high water table; moderately slowly permeable glacial till below a depth of about 2 to 3 feet.	Moderately drained to somewhat poorly drained; seasonal high water table; moderate to high shrink-swell potential; high susceptibility to frost action.	Moderate to high shrink-swell potential; good compaction characteristics below a depth of 2 to 3 feet; seasonal high water table.
Garwin: 118	Severe: seasonal high water table; marginal percolation rate.	Moderate: receives local runoff; high content of organic matter in surface layer; seasonal high water table; moderate permeability below a depth of about 2 feet.	Severe: seasonal high water table; receives local runoff; moderately permeable loess below a depth of 2 to 3 feet, 6 or more feet thick.	Severe: high content of organic matter in surface layer; seasonal high water table; high shrink-swell potential.	Poor: high content of organic matter; medium to high compressibility; high shrink-swell potential; seasonal high water table.
Hanlon: 536	Moderate: moderately rapid permeability; occasional overflow; moderate danger of contamination of ground water; satisfactory percolation rate.	Severe: moderately rapid permeability; occasional overflow.	Severe: moderately rapid permeability; subject to occasional flooding.	Nearly level; subject to occasional flooding; deep cuts encounter saturated sand in places; low shrink-swell potential.	Fair to a depth of 3 to 4 feet, good below: good workability; low compressibility; low shrink-swell potential.
Hayfield: 726	Moderate: seasonal high water table at a depth of 2 to 4 feet; moderate danger of contamination of ground water; satisfactory percolation rate.	Severe: rapid to very rapid permeability in substratum; danger of contamination of ground water.	Severe: seasonal high water table at a depth of 2 to 4 feet; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Seasonal high water table at a depth of 2 to 4 feet; moderate to low shrink-swell potential; somewhat poorly drained.	Fair in upper 3 feet, good below: very low compressibility; good workability; seasonal high water table at a depth of 2 to 4 feet.
725	Moderate: seasonal high water table at a depth of 2 to 4 feet; severe danger of contamination of ground water; satisfactory percolation rate.	Severe: rapid to very rapid permeability in substratum; danger of contamination of ground water.	Severe: seasonal high water table at a depth of 2 to 4 feet; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Seasonal high water table at a depth of 2 to 4 feet: moderate to low shrink-swell potential; somewhat poorly drained.	Fair in upper 2 feet, good below: very low compressibility; good workability; seasonal high water table at a depth of 2 to 4 feet.
Huntsville: 98, 98B.	Moderate: local flooding can damage filter field; moderate permeability; satisfactory percolation rate.	Moderate: subject to local short-duration flooding; high content of organic matter in surface layer; moderate permeability.	Moderate to severe: degree of limitation depends on amount of flooding and depth to bedrock; bedrock at a depth of 5 to 10 feet in places; moderate permeability.	Moderate: subject to local short-duration flooding; high content of organic matter; moderate shrink-swell potential.	Poor: medium to high compressibility; high content of organic matter; moderate shrink-swell potential.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Good to a depth of ½ to 1 foot, fair to a depth of 2½ feet, poor below: moderate content of organic matter.	Moderate permeability in upper 2 to 3 feet, moderately slow below; sand pockets and lenses in places.	Medium to low shear strength; low permeability if compacted below a depth of 2 to 3 feet; medium compressibility; good compaction characteristics below a depth of 2 to 3 feet.	Seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Fair: high content of organic matter; poorly drained.	High content of organic matter in surface layer; moderate permeability below a depth of about 2 feet.	Medium to low shear strength; medium to high compressibility; poor compaction characteristics.	Seasonal high water table at a depth of 1 to 3 feet; moderate permeability below a depth of about 2 feet.	Terraces not needed: nearly level.
Fair: poorly graded sand; little or no gravel.	Good in upper 3 to 4 feet: moderate to high content of organic matter.	Nearly level; moderately rapid permeability; occassional flooding.	Medium shear strength; low compressibility; medium to high susceptibility to piping.	Occasional flooding; somewhat excessively drained; moderately rapid permeability.	Terraces not needed; nearly level.
Good source of sand below a depth of about 3 feet: poorly graded sand; fair source of gravel: too many fines in places.	Good in upper 1 foot, fair to a depth of 3 feet, poor below: moderate content of organic matter.	Nearly level; rapid to very rapid permeability in substratum; seasonal high water table at a depth of 2 to 4 feet.	Medium to high shear strength below a depth of 3 feet; high permeability if compacted; fair to good compaction characteristics; medium to high susceptibility to piping.	Seasonal high water table; tile drainage needed in wet periods; tile placement difficult in places because of water-bearing sands.	Terraces not needed: nearly level.
Good source of sand below a depth of about 2 feet: poorly graded sand; fair source of gravel: too many fines in places.	Good in upper 1 foot, fair to a depth of 1 to 2 feet, poor below: moderate content of organic matter.	Nearly level; rapid to very rapid permeability in substratum; seasonal high water table at a depth of 2 to 4 feet.	Medium to high shear strength below a depth of 2 feet; high permeability if compacted; fair to poor compaction characteristics; medium to high susceptibility to piping.	Seasonal high water table; tile drainage needed in wet periods; tile placement difficult in places because of water-bearing sands.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Good: high content of organic matter to a depth of 3 or 4 feet.	High content of organic matter; moderate permeability; uniform material; subject to local short-duration flooding.	Low shear strength; medium permeability if compacted; fair to poor compaction characteristics; high content of organic matter.	Naturally well drained; receives local runoff.	Terraces not needed: soil properties favorable for diversions.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Jameston: 797	Severe: poorly drained; high water table; slow permeability; unsatisfactory percolation rate.	Slight: receives local runoff; high content of organic matter in surface layer; sand pockets in places; slow permeability.	Moderate: high water table; receives local runoff; slowly permeable glacial till.	Severe: high content of organic matter in surface layer; high water table; moderate to high shrink-swell potential; poorly drained; susceptible to frost action in pockets of water-bearing sands.	Poor in upper 2 feet, fair to good below: moderate to high shrink-swell potential; easily compacted to high density.
Kensett: 188	Severe: shattered limestone bedrock at a depth of 2½ to 3 feet; seasonal high water table at a depth of 2 to 4 feet; danger of contamination of ground water; satisfactory percolation rate.	Severe: high content of organic matter in surface layer; shattered limestone bedrock at a depth of 2½ to 3 feet; seasonal high water table at a depth of 2 to 4 feet; danger of contamination of ground water.	Severe: seasonal high water table; shattered limestone bedrock at a depth of 2½ to 3 feet; danger of contamination of ground water.	Moderate: high content of organic matter in surface layer; limestone at a depth of 2½ to 3 feet; somewhat poorly drained.	Poor: high content of organic matter in surface layer; limestone at a depth of 2½ to 3 feet, good if crushed; seasonal high water table at a depth of 2 to 4 feet.
Kenyon: 83, 83B, 83C, 83C2.	Slight to moderate where slopes are less than 5 percent, moderate where slopes are more than 5 percent: moderately slow permeability; marginal percolation rate.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 9 percent: sand strata in places; high content of organic matter in surface layer.	Slight: moderately slowly permeable glacial till; limestone at a depth of 10 to 15 feet in some areas.	Slight to moderate: high content of organic matter in surface layer; moderate shrink-swell potential; seepage in some cuts; high susceptibility to frost action in pockets of water-bearing sand.	Good below a depth of 1½ to 2 feet: low compressibility; easily compacted to high density.
Klinger: 184	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability; marginal percolation rate.	Moderate: high content of organic matter in surface layer; seasonal high water table; moderately slow permeability.	Moderate: seasonal high water table; some areas receive local runoff; moderately slowly permeable glacial till below a depth of about 3 feet.	Moderate: high content of organic matter in surface layer; somewhat poorly drained; moderate to high shrink-swell potential; susceptible to frost action.	Fair in upper 2 to 3 feet: medium to high compressibility; high content of organic matter in surface layer; good below a depth of 2 to 3 feet: low compressibility; easily compacted to high density.
*Lamont: 110, 110B, 110C, 610B. For Renova part of 610B, see Renova series.	Slight: rapid to very rapid permeability in lower subsoil; moderate danger of contamination of ground water; satisfactory percolation rate.	Severe: rapid to very rapid permeability in lower subsoil.	Moderate to severe: degree of limitation depends on depth to less permeable glacial till in substratum.	Highly erodible; loose sand hinders hauling in places; well drained; low shrink-swell potential.	Good: good workability; low to medium compressibility; low shrink-swell potential.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Good in upper 2 feet, poor below: high water table; poorly drained; high content of organic matter.	Slow permeability; high content of organic matter in surface layer; sand lenses and pockets in places.	Medium to low shear strength; high content of organic matter in surface layer; low permeability if compacted; good compaction characteristics.	High water table; slow permeability.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Good in upper 1½ feet, poor below: limestone at a depth of about 2½ to 3 feet; high content of organic matter in surface layer.	High content of organic matter in surface layer; shattered bedrock at a depth of 2½ to 3 feet; seasonal high water table at a depth of 2 to 4 feet.	High content of organic matter in surface layer; limited material available, bedrock at a depth of 2½ to 3 feet; low to medium permeability if compacted.	Seasonal high water table at a depth of 2 to 4 feet; shattered limestone bedrock at a depth of 2½ to 3 feet.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Good in upper 1½ feet, poor below a depth of about 2 feet: high content of organic matter.	Moderately slow permeability; sand pockets and lenses in places.	Medium to low shear strength; high content of organic matter in surface layer; low permeability if compacted; medium compressibility; good compaction characteristics.	Generally not needed: tile drainage needed for hillside seepage in places.	Low-fertility, high-density subsoil; wet spots develop after terracing in places; tile drainage needed where terraces installed.
Not suitable: no sand or gravel.	Good to a depth of 1½ feet, fair to a depth of 2½ feet, poor below: high content of organic matter.	High content of organic matter in surface layer; moderate permeability in upper part, moderately slow below a depth of 2 to 3 feet; sand pockets and lenses in places.	High content of organic matter in surface layer; medium to low shear strength; low permeability if compacted below a depth of 2 to 3 feet; good compaction characteristics below a depth of 2 to 3 feet.	Seasonally high water table at a depth of 2 to 4 feet; moderately slow permeability.	Terraces not needed: nearly level.
Good source of poorly graded sand below a depth of 2 feet; well graded sand and gravel below a depth of 3 feet in a few places on stream benches.	Fair in upper 2 feet, poor below: low content of organic matter.	Moderately rapid to very rapid permeability in substratum.	Medium shear strength; low to medium compressibility; medium to high susceptibility to piping.	Well drained	Highly erodible; difficult to maintain ridge and channel; loose sand hinders construction in places.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Lawler:					
226	Moderate: seasonal high water table at a depth of 2 to 4 feet; danger of contamination of ground water; satisfactory percolation rate.	Severe: rapid to very rapid permeability; substratum too porous to hold water; danger of contamination of ground water; high content of organic matter in surface layer.	Severe: seasonal high water table at a depth of 2 to 4 feet; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Moderate: seasonal high water table at a depth of 2 to 4 feet; high content of organic matter in surface layer; somewhat poorly drained; well graded sand below a depth of about 3 feet.	Good below a depth of about 3 feet; low compressibility; good workability; seasonal high water table at a depth of 2 to 4 feet; high content of organic matter in surface layer.
225	Moderate: seasonal high water table at a depth of 2 to 4 feet; danger of contamination of ground water; satisfactory percolation rate.	Severe: rapid to very rapid permeability; substratum too porous to hold water; danger of contamination of ground water; high content of organic matter in surface layer.	Severe: seasonal high water table at a depth of 2 to 4 feet; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Moderate: seasonal high water table at a depth of 2 to 4 feet; high content of organic matter in surface layer; somewhat poorly drained; well graded sand below a depth of about 2 feet.	Good below a depth of about 3 feet: low compressibility; good workability; seasonal high water table at a depth of 2 to 4 feet; high content of organic matter in surface layer.
Lilah: 776, 776C	Slight where slopes are less than 5 percent, moderate where slopes are more than 5 percent: rapid to very rapid permeability; severe danger of contamination of ground water; satisfactory percolation rate.	Severe: rapid to very rapid permeability; substratum too porous to hold water; severe danger of contamination of ground water.	Severe: rapid to very rapid permeability in substratum; danger of contamination of ground water.	Slight: good bearing capacity; low shrink-swell potential; erodible on sloping areas.	Good: well graded sand and gravel; low compressibility; low shrink-swell potential.
Lourdes: 781B, 781C, 781C2.	Severe on all slopes: slow permeability; perched water table during wet periods; unsatisfactory percolation rate.	Slight where slopes are less than 2 percent, moderate where slopes are 2 to 9 percent; slow permeability.	Slight: perched water table during wet period; slowly permeable glacial till.	Slight to moderate: moderate to high shrink-swell potential; seepage in some road cuts; perched water table during wet periods; susceptible to frost action.	Fair in upper 1½ feet, fair to good below: medium to low compressibility; moderate to high shrink-swell potential.
Marsh: 354	Very severe: water table at or near surface most of year; subject to frequent flooding and ponding.	Very severe: subject to frequent flooding and ponding; danger of contamination of ground water; variable permeability.	Very severe: water table at or near surface most of the year; variable permeability.	Very severe: water table at or near surface most of the year; subject to ponding and flooding; variable material.	Very poor: water table at or near surface most of the year; high content of organic matter.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Good source of sand below a depth of about 3 feet: well graded sand in places; fair source of gravel: too many fines in places.	Good to a depth of 1½ feet, fair to a depth of 1½ to 3 feet, poor below: high content of organic matter in surface layer.	Nearly level; rapid to very rapid permeability in substratum; seasonal high water table at a depth of 2 to 4 feet.	Medium to high shear strength below a depth of about 3 feet; medium to high permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 4 feet; tile drainage needed in wet periods; tile placement difficult in places because of water-bearing sands.	Terraces not needed: nearly level.
Good source of sand below a depth of about 2 feet: well graded sand in places; fair source of gravel: too many fines in places.	Good to a depth of 1½ feet, fair to a depth of 2½ feet, poor below: high content of organic matter in surface layer.	Nearly level; rapid to very rapid permeability in substratum; seasonal high water table at a depth of 2 to 4 feet.	Medium to high shear strength below a depth of about 2 feet; medium to high permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 4 feet; tile drainage needed in wet periods; tile placement difficult in places because of water-bearing sands.	Terraces not needed: nearly level.
Good source of well graded sand below a depth of 1 to 1½ feet, fair to good source of gravel: too many fines in places.	Fair to poor in upper 1 foot, very poor below: low content of organic matter.	Rapid to very rapid permeability in substratum; too porous to hold water.	Medium to high shear strength; medium to high susceptibility to piping; high permeability if compacted.	Excessively drained..	Shallow to sands and gravels; highly erodible; short to very short slopes; difficult to maintain ridge and channel.
Not suitable: no sand or gravel.	Good to a depth of ½ to 1 foot, poor below: moderate content of organic matter.	Slow permeability; sand pockets and lenses in places.	Medium to low shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonally wet and seepy; tile drainage needed for hillside seepage in places; slow permeability.	Low-fertility, high-density subsoil; terrace installation increases wetness in places; tile drainage needed.
Not suitable: no sand or gravel.	Poor: water table at or near surface most of the year.	Subject to flooding; water table at or near surface most of the year; variable material.	Water table at or near surface most of the year; variable material; erratic consolidation.	Not generally practical; water table at or near surface most of the year; satisfactory outlets difficult to obtain; subject to flooding and ponding.	Not applicable: depressional; permanently wet.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Marshan: 152	Severe: high water table; danger of contamination of ground water; satisfactory percolation rate.	Severe: high content of organic matter in surface layer; subject to occasional flooding; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Severe: high water table; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Severe: high content of organic matter in surface layer; seasonal high water table; poorly drained; subject to occasional flooding.	Poor in upper part: high content of organic matter; medium to high compressibility; seasonal high water table; good below a depth of about 3 feet: low compressibility; good workability.
151	Severe: high water table; danger of contamination of ground water; satisfactory percolation rate.	Severe: high content of organic matter in surface layer; subject to occasional flooding; rapid to very rapid permeability; danger of contamination of ground water.	Severe: high water table; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Severe: high content of organic matter in surface layer; seasonal high water table; poorly drained; subject to occasional flooding.	Very poor in upper part: high content of organic matter; medium to high compressibility; seasonal high water table; good below a depth of about 2 to 2½ feet: low compressibility; good workability.
Maxfield: 382	Severe: high water table; moderately slow permeability; marginal percolation rate.	Moderate: high content of organic matter in surface layer; seasonal high water table; poorly drained; moderately slow permeability.	Severe: high water table; poorly drained; moderately slowly permeable glacial till below a depth of about 3 feet.	Severe: high content of organic matter in surface layer; poorly drained; seasonal high water table; moderate to high shrink-swell potential.	Poor in upper 2 to 3 feet: high content of organic matter in surface layer; medium to high compressibility; seasonal high water table; good below a depth of 2 to 3 feet: medium to low compressibility; easily compacted to high density.
Muck: 221	Severe: very high water table; very poorly drained; subject to ponding.	Severe: organic material 18 to 52 inches thick; variable material below organic material.	Very severe: water table near surface; organic material 18 to 52 inches thick; variable material below organic material.	Very severe: highly compressible organic material 18 to 52 inches thick; water table at or near surface	Unsuitable for construction: organic material 18 to 52 inches thick.
Muscatine: 119	Moderate: seasonal high water table at a depth of 2 to 4 feet; moderate permeability; satisfactory percolation rate.	Moderate: high content of organic matter in surface layer; uniform material; moderate permeability.	Moderate: seasonal high water table at a depth of 2 to 4 feet; moderately permeable loess underlain by moderately slowly permeable glacial till below a depth of about 5 feet.	Moderate: high content of organic matter in surface layer; moderate to high shrink-swell potential; seasonal high water table at a depth of 2 to 4 feet.	Fair to poor: medium to high compressibility; high content of organic matter in surface layer; moderate to high shrink-swell potential; seasonal high water table at a depth of 2 to 4 feet.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Good source of well graded sand below a depth of about 3 feet, fair to poor source of gravel below a depth of about 3 feet: too many fines in most places.	Fair to a depth of 2 feet, poor below: seasonal high water table.	Rapid to very rapid permeability in substratum; seasonal high water table fills some dug ponds; high content of organic matter in surface layer.	High content of organic matter in surface layer; medium to low shear strength in upper part, medium to high in lower part; high permeability if compacted below a depth of about 3 feet; fair to good compaction characteristics.	Seasonal high water table; tile placement difficult in a few places because of water-bearing loose sands; suitable outlets difficult to obtain in places.	Terraces not needed: nearly level.
Good source of well graded sand below a depth of about 2 to 2½ feet, fair to poor source of gravel below a depth of about 3 feet: too many fines in most places.	Fair to a depth of 2 feet, poor below: seasonal high water table.	Rapid to very rapid permeability; seasonal high water table fills some dug ponds; high content of organic matter in surface layer.	High content of organic matter in surface layer; medium to low shear strength in upper part, medium to high in lower part; high permeability if compacted below a depth of about 2 feet; fair to good compaction characteristics.	Seasonal high water table; tile placement difficult in a few places because of water-bearing loose sands; suitable outlets difficult to obtain in places.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Fair to a depth of 2 feet, poor below: seasonal high water table.	High content of organic matter in surface layer; seasonal high water table; moderate permeability below a depth of 2 to 3 feet.	High content of organic matter in surface layer; low to medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonal high water table; moderately slow permeability.	Terraces not needed: nearly level.
Not suitable: no sand or gravel.	Poor, but soil material is good to a depth of about 3 feet if mixed with mineral soil: seasonal water table at or near the surface; very poorly drained.	Organic soil; mineral soil of variable texture below a depth of 18 to 52 inches in most places.	Organic soil to a depth of 18 to 52 inches; not suitable for embankments.	Very high seasonal water table; organic material; difficult to hold tile alinement in places.	Not applicable: organic soil.
Not suitable: no sand or gravel.	Good to a depth of 2 feet, fair below.	High content of organic matter in surface layer; moderate permeability; uniform material; difficult to compact to high density.	Medium to low shear strength; medium permeability if compacted; fair to poor compaction characteristics.	Seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Terraces not needed: nearly level.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Nasset: 904, 904B	Moderate: limestone bedrock at a depth of 3½ to 5 feet; danger of contamination of ground water through shattered bedrock; satisfactory percolation rate.	Severe: limestone bedrock at a depth of 3½ to 5 feet; danger of contamination of ground water through shattered bedrock.	Severe: porous shattered bedrock at a depth of 3½ to 5 feet.	Slight: bedrock at a depth of 3½ to 5 feet; moderate to high shrink-swell potential; well drained; clayey material above bedrock generally less than 8 inches thick.	Fair in upper 2½ feet: medium to high compressibility; fair to good below a depth of 2½ feet: limestone below a depth of 3½ to 5 feet good if crushed.
Oran: 471, 471B	Moderate to severe: seasonal high water table; moderately slow permeability; marginal percolation rate.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent: sand pockets in places; moderately slow permeability.	Moderate: seasonal high water table at a depth of 2 to 4 feet; moderately slowly permeable glacial till.	Moderate: somewhat poorly drained; moderate shrink-swell potential; susceptible to frost action in pockets of water-bearing sand.	Good below a depth of about 1½ feet: medium to low compressibility; seasonal high water table at a depth of 2 to 4 feet; easily compacted to high density.
Ostrander: 394, 394B.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent: moderate permeability; satisfactory percolation rate.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent; sand pockets in places; high content of organic matter in surface layer; moderate permeability.	Slight: well drained, moderately permeable glacial till; moderately slow permeability below a depth of about 5 feet; limestone bedrock at a depth of 10 to 15 feet in places.	Slight: well drained; moderate shrink-swell potential; good workability; high content of organic matter in surface layer; susceptible to frost action.	Fair in upper 2 feet, good below: medium to low compressibility; easily compacted to high density; moderate shrink-swell potential.
Pinicon: 303B	Moderate to severe: seasonal high water table; moderately slow permeability; marginal percolation rate.	Slight: easily compacted to high density; moderately slow permeability; sand pockets in places.	Moderate: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained; moderately slowly permeable glacial till.	Moderate: somewhat poorly drained; moderate shrink-swell potential; seepage in some cuts; susceptible to frost action in pockets of water-bearing sand.	Fair to a depth of about 1½ feet, good below: medium to low compressibility; seasonal perched water table; moderate shrink-swell potential.
Protivin: 798B	Severe: slow permeability; seasonal high water table; unsatisfactory percolation rate.	Slight: slow permeability; sand pockets in places; high content of organic matter in surface layer.	Moderate: seasonal high water table at a depth of 2 to 3 feet; somewhat poorly drained; slowly permeable glacial till.	Moderate: somewhat poorly drained; high content of organic matter in surface layer; high susceptibility to frost action; seepage likely in some cuts.	High content of organic matter in surface layer; fair to a depth of about 2 feet: good below: medium to low compressibility: seasonal high water table at a depth of 2 to 3 feet; moderate to high shrink-swell potential.
Racine: 482, 482B, 482C.	Slight to moderate where slopes are 0 to 2 percent, moderate where slopes are 2 to 9 percent: moderate permeability; satisfactory percolation rate.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 9 percent: sand pockets in places; moderate permeability.	Slight: well drained; moderately permeable glacial till.	Slight: well drained; moderate shrink-swell potential; susceptible to frost action.	Fair in upper 1 to 1½ feet, good below: medium to low compressibility; easily compacted to high density.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Good in upper ½ to 1 foot, fair to a depth of 2½ feet, poor below: moderate content of organic matter.	Shattered bedrock at a depth of 3½ to 5 feet; too porous to hold water.	Limited material available; bedrock at a depth of 3½ to 5 feet; medium to low shear strength; medium to low permeability if compacted.	Well drained	Soil features favorable, except limestone at a depth of 3½ to 5 feet.
Not suitable: no sand or gravel.	Fair to good in upper 1½ feet, poor below: moderate content of organic matter.	Moderately slow permeability; sand pockets and lenses in places.	Medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Low-fertility, high-density subsoil; poor workability in exposed glacial till; terrace installation increases wetness; long, smooth slopes.
Not suitable: no sand or gravel.	Good to a depth of about 1½ feet, fair to a depth of about 2 feet, poor below; high content of organic matter.	Sand pockets and lenses in many places; moderate permeability.	High content of organic matter in surface layer; medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Well drained	Low-fertility subsoil; generally long, smooth slopes.
Not suitable: no sand or gravel.	Fair in upper 1 to 1½ feet, poor below: low content of organic matter.	Moderately slow permeability; sand pockets and lenses in places.	Medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Low-fertility, high-density subsoil; poor workability in exposed glacial till; terrace installation increases wetness in places; tile drainage needed where terraces installed.
Not suitable: no sand or gravel.	Good to a depth of 1½ feet, poor below: high content of organic matter.	High content of organic matter in surface layer; slow permeability in subsoil; sand pockets and lenses in some areas.	High content of organic matter in surface layer; medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 3 feet; slow permeability in subsoil; tile drainage not adequate in places; care in spacing and placement of tile needed.	Low-fertility, high-density subsoil; very poor workability in exposed glacial till; terrace installation increases wetness; tile drainage needed where terraces installed.
Not suitable: no sand or gravel.	Fair to good in upper 1 to 1½ feet, poor below: moderate content of organic matter.	Sand pockets and lenses in many places; moderate permeability.	Medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Well drained	Low-fertility subsoil; long, uniform slopes.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Readlyn: 399, 399B.	Moderate to severe: seasonal high water table; moderately slow permeability; marginal percolation rate.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent: high content of organic matter in surface layer; moderately slow permeability.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderately slowly permeable glacial till.	Moderate: high content of organic matter in surface layer; somewhat poorly drained; moderate shrink-swell potential; susceptible to frost action.	Fair to a depth of 1½ feet, good below: medium to low compressibility; seasonal high water table at a depth of 2 to 4 feet; easily compacted to high density.
Renova: 491B	Slight: moderate permeability; well drained; satisfactory percolation rate.	Moderate where slopes are 2 to 5 percent; sand pockets in places; moderate permeability.	Slight: well drained; moderately permeable glacial till; limestone at a depth of 10 to 15 feet in places.	Slight: well drained; moderate shrink-swell potential; susceptible to frost action.	Fair to a depth of about 1½ feet, good below: medium to low compressibility; easily compacted to high density.
Riceville: 784B	Severe: slow permeability; seasonal high water table; unsatisfactory percolation rate.	Slight where slopes are less than 2 percent, moderate where slopes are 2 to 4 percent: sand pockets in places.	Moderate: seasonal high water table at a depth of 2 to 3 feet; slowly permeable glacial till.	Moderate: somewhat poorly drained; moderate to high shrink-swell potential; susceptible to frost action in pockets of water-bearing sand.	Fair to a depth of about 1½ feet, good below: medium to low compressibility; easily compacted to high density.
Rockton: 214B, 214C	Severe: shallow to shattered limestone; danger of contamination of ground water; satisfactory percolation rate.	Severe: shallow to shattered limestone; danger of contamination of ground water.	Severe: shallow to porous shattered bedrock.	Slight: high content of organic matter in surface layer; bedrock at a depth of 2 to 3 feet; upper 2 to 5 feet of bedrock is shattered; well drained.	Fair in upper 2 to 3 feet: limestone good if crushed.
104B	Severe: shallow to shattered limestone; danger of contamination of ground water; satisfactory percolation rate.	Severe: shallow to shattered limestone; danger of contamination of ground water.	Severe: shallow to porous shattered bedrock.	Slight: high content of organic matter in surface layer; bedrock at a depth of 2 to 3 feet; upper 2 to 5 feet of bedrock is shattered; well drained.	Fair in upper 2 to 3 feet: limestone good if crushed.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Good to a depth of about 1½ feet, poor below: high content of organic matter.	High content of organic matter in surface layer; moderately slow permeability in subsoil; sand pockets and lenses in places.	High content of organic matter in surface layer; medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Low-fertility, high-density subsoil; poor workability in exposed glacial till; terrace installation increases wetness; tile drainage needed where terraces installed.
Not suitable: no sand or gravel.	Good to a depth of about ½ foot, fair to a depth of 1½ feet, poor below: low content of organic matter.	Sand pockets and lenses in many places; moderate permeability.	Medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Well drained	Low-fertility subsoil; long, uniform slopes.
Not suitable: no sand or gravel.	Fair to a depth of 1½ feet, poor below: moderate content of organic matter.	Slow permeability; sand pockets and lenses in places.	Medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 3 feet; slow permeability; tile drainage not adequate in some areas.	Low-fertility, high-density subsoil; very poor workability in exposed glacial till; terrace installation increases wetness; tile drainage needed where terraces installed.
Not suitable: no sand or gravel.	Good in upper 1 foot, fair to a depth of 1 to about 2 feet, poor below: high content of organic matter.	Shallow to shattered bedrock; too porous to hold water.	High content of organic matter in surface layer; shallow to shattered bedrock; limited material available; medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Well drained	Shallow to limestone bedrock; bedrock hinders construction in places.
Not suitable: no sand or gravel.	Good in upper 1½ feet, fair to a depth of 2 feet, poor below: high content of organic matter.	Shallow to shattered bedrock; too porous to hold water.	High content of organic matter in surface layer; shallow to shattered bedrock; limited material available; medium to low shear strength; medium permeability if compacted; fair compaction characteristics.	Well drained	Shallow to limestone bedrock; bedrock hinders construction in places.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfills	Local roads and streets	Road fill
Roseville: 805B	Moderate: bedrock at a depth of 3½ to 5 feet; danger of contamination of ground water through shattered bedrock; satisfactory percolation rate.	Severe: danger of contamination of ground water; moderately permeable material over shattered bedrock at a depth of 3½ to 5 feet; clayey residuum over bedrock generally less than 6 inches thick.	Severe: porous shattered bedrock at a depth of 3½ to 5 feet; clayey residuum over bedrock generally less than 6 inches thick.	Slight: well drained; moderate shrink-swell potential; clayey residuum generally less than 6 inches thick; shattered limestone bedrock at a depth of 3½ to 5 feet.	Fair in upper 1½ to 2 feet, good below: limestone below a depth of 3½ to 5 feet good if crushed.
Sattre: 778	Slight: rapid to very rapid permeability in substratum; danger of contamination of ground water; satisfactory percolation rate.	Severe: substratum too porous to hold water; danger of contamination of ground water.	Severe: sandy material at a depth of about 3 feet; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Slight: well drained; very low or no shrink-swell potential in sandy material below a depth of about 3 feet.	Fair to a depth of about 3 feet, good below: very low compressibility; good workability; very low or no shrink-swell potential.
Saude: 177, 177B	Slight: rapid to very rapid permeability in substratum; danger of contamination of ground water; satisfactory percolation rate.	Severe: substratum too porous to hold water; danger of contamination of ground water.	Severe: sandy material at a depth of about 2 feet; rapid to very rapid permeability in substratum; danger of contamination of ground water.	Slight: well drained; very low or no shrink-swell potential in sandy material below a depth of about 2 feet.	Good below a depth of about 2 to 2½ feet: low compressibility; good workability; very low or no shrink-swell potential.
Schley: 407B	Severe: seasonal high water table; receives runoff; satisfactory percolation rate.	Moderate: subsoil stratified with coarse material; moderately slow permeability below a depth of about 3 to 4 feet.	Moderate to severe: seasonal high water table; receives local runoff; moderately slowly permeable glacial till below a depth of about 3 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table; high susceptibility to frost action in pockets of water-bearing sand.	Fair: seasonal high water table at a depth of 2 to 4 feet; medium to low compressibility; variable material to a depth of about 3 to 4 feet; material below easily compacted to high density.
Sogn: 412B, 412D, 412G.	Severe on all slopes: very shallow to shattered limestone.	Severe on all slopes: very shallow to shattered limestone.	Severe: very shallow to shattered limestone.	Severe: gently sloping to steep; very shallow to limestone bedrock.	Very shallow to limestone bedrock; bedrock good if crushed.
Tama: 120, 120B, 120C2.	Slight where slopes are less than 5 percent, moderate where slopes are 5 to 9 percent: moderate permeability; satisfactory percolation rate.	Moderate on all slopes; high content of organic matter in surface layer; uniform material; moderate permeability.	Slight: moderately permeable loess 3½ to 7 feet thick over moderately slowly permeable glacial till; limestone at a depth of 10 to 15 feet in places.	Slight to moderate: well drained; moderate to high shrink-swell potential; highly erodible; easy to vegetate.	Poor in upper 1½ feet, fair to poor below: medium compressibility; moderate to high shrink-swell potential.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levis	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Fair to a depth of 1½ feet, poor below: low content of organic matter.	Porous; shattered limestone bedrock at a depth of 3½ to 5 feet; moderate permeability over bedrock; clayey residuum generally less than 6 inches thick.	Medium shear strength; limited material available; shattered bedrock at a depth of 3½ to 5 feet; low permeability if compacted; fair to good compaction characteristics.	Well drained	Limestone bedrock at a depth of 3½ to 5 feet.
Good source of well graded sand below a depth of about 3 feet, fair source of gravel: too many fines in places.	Good in upper ½ foot, fair to a depth of about 3 feet, poor below: moderate content of organic matter.	Nearly level; rapidly to very rapidly permeable substratum at a depth of about 3 feet.	High shear strength below a depth of 2½ to 3 feet; high permeability if compacted; medium to high susceptibility to piping; fair to good compaction characteristics.	Well drained	Terraces not needed: nearly level.
Good source of well graded sand below a depth of about 2 feet, fair source of gravel: too many fines in places.	Good to a depth of 1½ feet, fair to a depth of 2 feet, poor below: high content of organic matter.	Rapid to very rapid permeability in substratum at a depth of about 2 feet.	High shear strength below a depth of about 2 feet; high permeability if compacted; medium to high susceptibility to piping; fair to good compaction characteristics.	Well drained	Generally not needed: short slopes.
Not suitable: no sand or gravel.	Good in upper ½ foot, fair to a depth of about 3 feet, poor below: moderate content of organic matter.	Sand lenses and pockets in many places; moderate over moderately slow permeability.	Medium shear strength; low permeability if compacted; fair to good compaction characteristics.	Seasonal high water table at a depth of 2 to 4 feet; moderate permeability; drainage designed to intercept seepage needed.	Not needed in many areas; tile drainage needed where terraces installed.
Not suitable: no sand or gravel.	Poor: very shallow to bedrock.	Very shallow to bedrock; too porous to hold water.	Very limited amount of material for fill; limestone bedrock at a depth of about 1 foot.	Somewhat excessively drained.	Very shallow to limestone bedrock; bedrock interferes with construction.
Not suitable: no sand or gravel.	Good to a depth of 1½ feet, fair below: high content of organic matter.	High content of organic matter in surface layer; moderate permeability; uniform material.	Medium to low shear strength; medium permeability if compacted; fair compaction characteristics; susceptible to piping.	Well drained	All features favorable.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitations for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Terril: 27, 27B	Slight: subject to local runoff; moderate permeability; satisfactory percolation rate.	Moderate: subject to local runoff; high content of organic matter; moderate permeability.	Moderate to severe: subject to runoff; moderate permeability, more rapid permeability in substratum; limestone at a depth of 3 to 5 feet in places.	Moderate: high content of organic matter in surface layer; subject to local flooding; moderate shrink-swell potential.	Poor: medium to high compressibility; high content of organic matter; difficult to compact to high density.
Tripoli: 398	Severe: high water table; moderately slow permeability; marginal percolation rate.	Slight: very high content of organic matter in surface layer; sand pockets in places; moderately slow permeability.	Moderate: seasonal high water table; poorly drained; moderately slowly permeable glacial till.	Severe: very high content of organic matter in surface layer; seasonal high water table; poorly drained; high susceptibility to frost action in water-bearing sand.	Poor in upper 2 feet, good below: medium to low compressibility; seasonal high water table.
Turlin: 96	Severe: subject to occasional flooding; seasonal high water table; moderate permeability; satisfactory percolation rate.	Severe: subject to occasional flooding; moderate permeability; danger of contamination of ground water; high content of organic matter in surface layer.	Severe: subject to flooding; moderately permeable alluvium, variable permeability below a depth of 4 to 5 feet.	Severe: high content of organic matter in surface layer; subject to occasional flooding; somewhat poorly drained; moderate shrink-swell potential.	Poor: medium to high compressibility; high content of organic matter; moderate shrink-swell potential.
Wapsie: 777, 777B, 777C.	Slight where slopes are less than 5 percent, moderate where slopes are more than 5 percent: rapid to very rapid permeability in substratum; danger of contamination of ground water; satisfactory percolation rate.	Severe: substratum too porous to hold water; danger of contamination of ground water.	Severe: rapid to very rapid permeability in substratum; danger of contamination of ground water.	Slight: well drained; very low or no shrink-swell potential in sandy material below a depth of about 2 feet.	Good below a depth of about 2 feet: very low compressibility; good workability; very low or no shrink-swell potential.
Waubeek: 771, 771B.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent: moderate permeability in upper part, moderately slow in lower part; satisfactory percolation rate.	Slight where slopes are 0 to 2 percent, moderate where slopes are 2 to 5 percent; moderately slow permeability below a depth of about 3 feet.	Slight: well-drained and moderately well drained; moderately slowly permeable glacial till below a depth of about 3 feet; limestone bedrock at a depth of 4 to 5 feet in some areas.	Slight to moderate: well drained and moderately well drained; moderate to high shrink-swell potential; susceptible to frost action.	Fair to poor in upper 2 to 3 feet: medium to high compressibility; good below a depth of 2 to 3 feet; low compressibility; good workability.

See footnote at end of table.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of crop-land and pasture	Terraces and diversions
Not suitable: too many fines in substratum.	Good to a depth of about 2½ feet, fair below: high content of organic matter.	High content of organic matter in surface layer; moderate permeability.	High content of organic matter in surface layer; medium to low shear strength; medium to low permeability if compacted; fair compaction characteristics.	Moderately well drained.	Soil features generally favorable.
Not suitable: no sand or gravel.	Fair in upper 1½ feet, poor below: high water table; very high content of organic matter.	Moderately slow permeability; very high content of organic matter in surface layer; sand lenses and pockets in places.	Very high content of organic matter in surface layer; medium shear strength; low permeability if compacted; fair to good compaction characteristics.	High water table; moderately slow permeability.	Terraces not needed: nearly level.
Generally not suitable: sandy material below a depth of 4 feet generally contains too many fines.	Good to a depth of about 2½ feet, fair to poor below: high content of organic matter.	Nearly level; high content of organic matter in surface layer; moderate permeability.	High content of organic matter in surface layer; medium to low shear strength; low to medium permeability if compacted; medium to high susceptibility to piping; fair compaction characteristics.	Seasonal high water table at a depth of 1½ to 2½ feet; subject to occasional flooding.	Terraces not needed: nearly level.
Good source of well graded sand below a depth of 2 to 2½ feet, fair source of gravel: too many fines in places.	Good in upper 1 foot, fair to a depth of 2 feet, poor below: moderate content of organic matter.	Substratum too porous to hold water; danger of contamination of ground water.	High shear strength below a depth of about 2 feet; high permeability if compacted; medium to high susceptibility to piping; fair to good compaction characteristics.	Well drained.	Sandy below a depth of about 2 feet.
Not suitable: no sand or gravel.	Good in upper ½ to 1 foot, fair to a depth of 2 to 3 feet, poor below: moderate content of organic matter.	Moderate permeability above a depth of 2 to 3 feet, moderately slow below.	Medium to low shear strength; low permeability if compacted below a depth of 2 to 3 feet; fair to good compaction characteristics.	Well drained and moderately drained.	All soil features favorable.

TABLE 4.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Waucoma: 913, 913B.	Slight: moderately permeable limestone at a depth of 3½ to 5 feet; danger of contamination of ground water; satisfactory percolation rate.	Severe on all slopes: danger of contamination of ground water through porous shattered bedrock.	Severe: shattered bedrock at a depth of 3½ to 5 feet.	Slight: well drained; shattered limestone at a depth of 3½ to 5 feet.	Fair to good in upper 3½ feet: limestone below a depth of 3½ feet good if crushed.
Waukee: 178, 178B.	Slight: danger of contamination of ground water; moderate permeability to a depth of about 3 feet, rapid to very rapid below; satisfactory percolation rate.	Severe: substratum too porous to hold water; danger of contamination of ground water; high content of organic matter in surface layer.	Severe: rapid to very rapid permeability in lower subsoil and substratum; danger of contamination of ground water.	Slight: high content of organic matter in surface layer; well drained; very low shrink-swell potential below a depth of 3 feet.	High content of organic matter in surface layer; good below a depth of about 3 feet; very low compressibility; good workability; low shrink-swell potential.
Whalan: 205B, 205C.	Moderate on all slopes: shattered limestone at a depth of about 2 to 3 feet; danger of contamination of ground water; satisfactory percolation rate.	Severe: shattered limestone at a depth of about 2 to 3 feet; danger of contamination of ground water; clayey residuum generally less than 6 inches thick.	Severe: shattered bedrock at a depth of about 2 to 3 feet; clayey residuum generally ally less than 6 inches thick.	Slight to moderate: shattered limestone bedrock at a depth of 2 to 3 feet; clayey residuum generally less than 6 inches thick.	Fair to good in upper 2 to 3 feet; limestone below good if crushed.
Winneshiek: 714, 714B, 714C, 714D.	Moderate where slopes are less than 9 percent, severe where slopes are more then 9 percent: shattered limestone at a depth of 2 to 3 feet; danger of contamination of ground water; satisfactory percolation rate.	Severe: shattered limestone at a depth of 2 to 3 feet; danger of contamination of ground water; clayey residuum generally less than 6 inches thick, not continuous.	Severe: shattered bedrock at a depth of 2 to 3 feet; clayey residuum generally less than 6 inches thick, not continuous.	Slight to moderate: shattered limestone bedrock at a depth of 2 to 3 feet; clayey residuum generally less than 6 inches thick, not continuous.	Fair to good in upper 2 to 3 feet; limestone below good if crushed.

[1] Reviewed by Donald A. Anderson, soil engineer, Iowa State Highway Commission.

interpretations [1]—Continued

Suitability as source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Not suitable: no sand or gravel.	Fair to good in upper 1 to 1½ feet, poor below: moderate content of organic matter.	Shattered bedrock at a depth of 3½ to 5 feet; too porous to hold water.	Medium shear strength; limited material available; low permeability if compacted; fair to good compaction characteristics.	Well drained	Limestone bedrock at a depth of about 3½ to 5 feet.
Good source of well graded sand below a depth of about 3 feet, fair source of gravel: too many fines in places.	Good to a depth of 1½ feet, fair to a depth of 3 feet, poor below: high content of organic matter.	Substratum too porous to hold water; rapid to very rapid permeability in substratum.	High shear strength below a depth of about 3 feet; high permeability if compacted; fair to good compaction characteristics.	Well drained	Sandy material below a depth of about 3 feet; slopes generally short.
Not suitable: no sand or gravel.	Fair to good in upper 1 foot, poor below: limestone at a depth of 2 to 3 feet; low content of organic matter.	Shattered bedrock at a depth of 2 to 3 feet; too porous to hold water; clayey residuum generally less than 6 inches thick.	Shattered bedrock at a depth of 2 to 3 feet; limited material available; medium shear strength; low permeability if compacted.	Well drained	Limestone at a depth of 2 to 3 feet hinders construction in places.
Not suitable: no sand or gravel.	Fair to good in upper 1 foot, poor below: limestone at a depth of 2 to 3 feet; moderate content of organic matter.	Shattered bedrock at a depth of 2 to 3 feet; too porous to hold water; clayey residuum generally less than 6 inches thick, not continuous.	Shattered bedrock at a depth of 2 to 3 feet; limited material available; medium shear strength; low permeability if compacted.	Well drained	Limestone at a depth of 2 to 3 feet hinders construction in places.

Soil limitations are indicated by the ratings *slight*, *moderate*, and *severe*. *Slight* means soil properties generally favorable for the rated use, or in other words, limitations that 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 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 so unfavorable for a particular use that overcoming the limitations 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 4.

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. If the floor needs to be leveled, depth to bedrock is 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 amounts 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 4 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 4, 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 asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and 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 AASHO 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 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 at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 4 provide guidance about where to look 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 take into account 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 in 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. Also considered in the ratings is damage that results 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 of 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.

Soil features affecting highway work [2]

The soils in Mitchell County that affect roadbuilding formed mainly in glacial till, loess, and alluvium. Limestone bedrock, however, is exposed along some of the stream valleys in the county. It is shallowest in soil associations 1, 2, and 3.

The glacial till is rock debris, principally sandy and clayey, that contains pebbles and boulders and a few pockets and strata of sand and gravel. The glacial till overlying the bedrock is generally the thickest in the eastern part of the county, but this thickness is variable. Loess, or windblown silt, mantles the glacial till in much of the county. Loess thickness over glacial till varies considerably, generally ranging from 2 to 8 feet. In general, the thickest deposits are in areas adjacent to Cedar River.

The glacial till in Mitchell County has a fairly high in-place density. It is stable at any moisture content and can be compacted readily to high density. The textural composition varies but, if the material is dry, the fines and coarse material provide a firm riding surface with little rebound after loading. The glacial till has good bearing capacity if compacted to maximum practical density, but it loses this bearing capacity if moisture is absorbed.

The Bassett, Coggon, Cresco, Jameston, Kenyon, Lourdes, Oran, Ostrander, Pinicon, Racine, Readlyn, Renova, Riceville, and Tripoli soils formed in glacial till. The texture of these soils is loam, clay loam, and sandy clay loam; and they are classified as A–6 or A–4. Pockets and lenses of sand are commonly in these soils and, in many places, are waterbearing. Where the road grade cuts through such deposits, frost heaving is likely unless the soil material is drained or unless the material above it is replaced with a granular backfill or with the more clayey glacial till.

Atterberry, Downs, Fayette, Garwin, Muscatine, Tama, and Walford soils are loess derived. They are silt loam and silty clay loam in texture and are classified dominantly as A–6, except in the surface layer. The Garwin, Muscatine, and Tama soils have a high content of organic matter in the surface layer and are difficult to compact to good density. The subsoil is silty clay loam. These materials are unstable to wheel loads when wet and do not make a desirable upper subgrade. These loess soils erode readily if runoff is concentrated. Sodding, paving, or check dams may be needed in gutters and ditches to prevent excessive erosion. A large acreage in Mitchell County has 2 to 3 feet of loess over glacial till. The soil properties in the upper part of these soils are like those of loess, and the lower part is like glacial till. These are the Ansgar, Dinsdale, Franklin, Maxfield, and Waubeek soils.

The soils of the bottom lands formed in recent alluvium washed from hills and uplands. Such soils as the Coland, Hanlon, Huntsville, Terril, and Turlin have a thick organic surface layer that may consolidate erratically under an embankment load. These soils have low in-place density; therefore, if an embankment is to be more than 15 feet in height, these soils should be carefully analyzed to be sure that they are strong enough to support it. Roadways through bottom lands should be constructed on a continuous embankment that extends above the flood level.

Limestone underlies the glacial till and loess and in places comes to the surface. Soils that are shallow to bedrock in Mitchell County are those of the Ashdale, Atkinson, Dubuque, Kensett, Nasset, Rockton, Roseville, Sogn, Waucoma, Whalan, and Winneshiek series. The residual subsoil of these soils just above the rock is undesirable for use in the upper subgrade because of its high clay content and nonuniform characteristics. However, this residual material is generally less than a foot thick and is discontinuous over the limestone. In areas where the limestone is not deeply buried below the glacial till or loess, sinkholes have developed, leaving depressions. Sinkholes are common in the western two-thirds of Mitchell County. Most of them are within a few miles of the Cedar River or its tributaries. Many of the sinkholes are shown on the soil map by a special spot symbol. Sinkholes do not provide enough support for the embankment for roadways or for other structures. Therefore, great care is needed to determine their location and extent during preliminary investigations, and to plug them at the rock surface during construction if they are below the roadway.

The Bixby, Burkhardt, Dickinson, Flagler, Hayfield, Lamont, Lawler, Lilah, Marshan, Sattre, Saude, Wapsie, and Waukee soils all formed in sandy material or have sandy material at depths of about 2 to 3 feet. These soils are possible sites for granular borrow for road construction. In the Dickinson and Lamont soils, however, the sand is fine grained, poorly graded, and lacks gravel. The Bixby, Burkhardt, Flagler, Hayfield, Lawler, Lilah, Marshan, Sattre, Saude, Wapsie, and Waukee soils offer good potential as sources of gravel. In the Hayfield, Lawler, and Marshan soils the high water table may interfere with excavation.

Included in table 4 are ratings that show the suitability of the soils of the county as a source of topsoil that can be used to promote the growth of vegetation on embankments, in cuts on slopes, and in ditches and as a source of borrow for road construction.

[2] By DONALD A. ANDERSON, soil engineer, Iowa State Highway Commission.

Formation and Classification of the Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the formation of the soils in Mitchell County. The second explains the system of soil classification currently used and classifies each soil series according to that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil materials (*3*).

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it 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 profile. It may be much or little, but some time is always required for differentiation of soil horizons. A long time generally is required for the development 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 development are unknown.

Parent material

The accumulation of parent material is the first step in the development of a soil. Some thin layers of a few soils in the county formed as the result of weathering of the bedrock. Most of the soils, however, formed in material that was transported from the site of the parent rock and redeposited at a new location through the action of glacial ice, water, wind, and gravity.

The principal parent materials in Mitchell County are glacial drift, loess, alluvium, and eolian, or wind-deposited, sand. Much less extensive parent materials are organic deposits and residuum.

Loess, a silty material deposited by wind, covers 40 percent of Mitchell County. It ranges in depth from about 2 to 8 feet and overlies both glacial till and limestone bedrock. In about 80 percent of the area, the loess has a depth of about 2 to 3 feet; in the remaining area it has a depth of about 3½ to 8 feet. Loess consists mostly of silt and some clay. It does not contain coarse sand or gravel, because those materials were too large to be moved by wind, but it does contain small amounts of very fine sand, generally less than 5 percent.

In Mitchell County the Dinsdale, Ansgar, Franklin, Klinger, Maxfield, and Waubeek soils formed in 2 to 3 feet of loess underlain by glacial till. Soils formed in loess 3½ to 8 feet deep are Tama, Downs, Atterberry, Fayette, Muscatine, and Garwin. Ashdale and Nasset soils formed in loess and glacial till underlain by bedrock at a depth of about 40 to 60 inches. Dubuque soils formed in thin deposits of loess underlain by bedrock. The Donnan soils formed in a thin layer of loess or loess-like material underlain by a paleosol developed in glacial material.

Glacial drift is material deposited by glaciers. The first of the glacial advances over Mitchell County was the Nebraskan Glaciation, which occurred some 750,000 years ago (*4*). It was followed by the Aftonian interglacial period. The Kansan Glaciation started about 500,000 years ago.

Glacial drift covers much of Mitchell County. In many areas, loess overlies the drift to depths of 2 to 8 feet. In other areas, about 44 percent of the county, a loamy mantle uniformly covers the drift to a depth of 1 or 2 feet. In the lower, concave sloping areas and in the waterways the loamy mantle is as much as 40 inches thick. A stone line or pebble band commonly separates the friable loamy overburden from the more dense, firm and very firm loam and clay loam glacial till. Pockets of coarse-textured material are within the glacial till in places.

Bassett, Clyde, Coggon, Cresco, Floyd, Jameston, Kenyon, Lourdes, Oran, Ostrander, Pinicon, Protivin, Racine, Readlyn, Renova, Riceville, Schley, and Tripoli soils formed in the loamy mantle overlying glacial till or till-derived sediment. Clyde, Floyd, and Schley soils are downslope and in drainageways, and the loamy overburden is thicker than on the other upland, glacial-derived soils (fig. 15). The Atkinson, Rockton, Sogn, Roseville, Waucoma, Whalan, and Winneshiek soils formed in loamy till-derived sediment that is underlain by limestone bedrock at a depth of 1 to 4 feet. The underlying till is very firm clay loam in Cresco, Jameston, Lourdes, Protivin, and Riceville soils. It is firm and is dominantly loam in Bassett, Coggon, Kenyon, Oran, Pinicon, Readlyn, and Tripoli soils. The till or till-derived sediment of the Ostrander, Racine, and Renova soils is friable and generally is loam, sandy clay loam, or sandy loam.

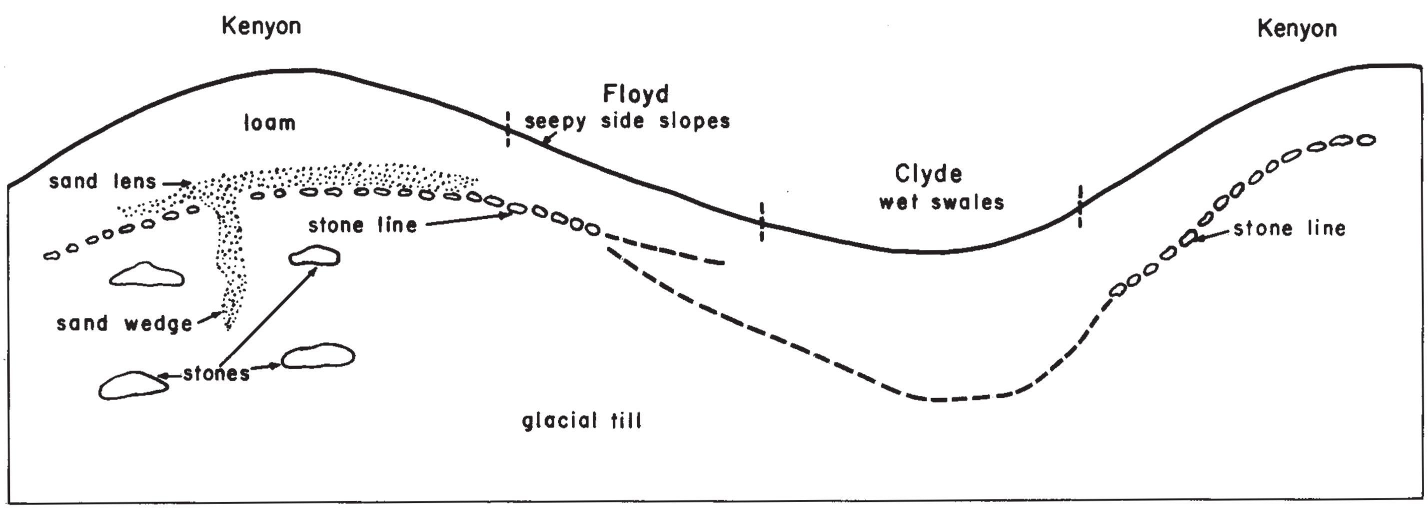

***Figure 15.*—Parent materials of the Kenyon, Floyd, and Clyde soils.**

The third and most recent glaciation to advance over Mitchell County was recognized (*5*) as the Iowa substage of the Wisconsin Glaciation. Recent studies of the presence and identification of Iowan glacial till indicate that the conclusions formed from studies made before 1960 are questionable. Intensive, detailed, geomorphic and stratigraphic work in the region (*2*) shows that the landscape is a multilevel sequence of erosion surfaces, and that many of the levels are cut into Kansan and Nebraskan till.

Boulders 3 to 15 feet in diameter are on the surface of some areas mantled by glacial drift. Boulders and stones 6 to 30 inches in diameter are concentrated in many of the upland drainageways on the Clyde and Floyd soils (fig. 16).

Alluvium is material that was deposited by water on flood plains along streams. In Mitchell County about 14 percent of the soil developed from waterlaid material. The major areas in which soils have formed in alluvium are along the Cedar River, Little Cedar River, Wapsipinicon River, and tributaries of these streams. Soils derived from alluvium are generally stratified and contain layers of sand, silt, or gravel. Much of the alluvium in Mitchell County washed from adjoining loamy overburden over glacial drift and has a texture of loam, sandy loam, or silty clay loam and silt loam high in content of sand. Examples are Coland, Hanlon, Terril, and Turlin soils. The Huntsville soils are lower in sand and formed in silty alluvium that washed from loess-covered uplands. Coland, Hanlon, and Turlin soils, on first bottom lands or very low terraces, are subject to flooding.

Textural differences are accompanied by some differences in chemical and mineralogical composition of the alluvium. Most of the soils are free of carbonates and are neutral to medium acid, but the Calco soils are alkaline.

The soils on terraces or second bottoms also consist of alluvium and vary in texture. Most are underlain by coarser textured material within depths of 2 to 3 feet. These soils are above the present flood plain and generally do not flood. They are the Burkhardt, Flagler, Hayfield, Lawler, Lamont, Lilah, Marshan, Sattre, Saude, Wapsie, and Waukee soils.

***Figure 16.*—Pile of granite boulders that have been removed from the adjacent glacial soils in the cultivated field.**

Eolian sand is wind deposited. It is not extensive in Mitchell County and covers about 2 percent of the acreage. Areas are along some of the valleys of the major streams and on low mounds or dunes within the glacial till plain, and they are underlain by till at various depths. Most of the areas on uplands are in the northern part of the county. Wind-deposited sand consists largely of very fine and fine quartz that is highly resistant to weathering. It has not been altered appreciably since it was deposited. The soils in Mitchell County that formed mainly in wind-deposited sand are Dickinson and Lamont soils.

Limestone residuum is material derived from the weathering of limestone bedrock. This clayey material or residuum generally is 2 to about 8 inches thick, but in some places residuum is not present. Deposition of glacial till and loess resulted in some of the soils in Mitchell County having multiple parent materials of quite different origin. An example is Ashdale soils that formed in loess overlying glacial materials that are underlain by residuum and limestone bedrock. All of these materials occur within a depth of less than 5 feet.

Rockton, Atkinson, Kensett, Roseville, Sogn, Waucoma, Whalan, and Winnesheik soils have a loamy overburden over residuum over limestone. Ashdale and Nasset soils have loess overlying till over residuum over bedrock. Dubuque soils formed in loess over residuum over bedrock.

Organic material deposits are the parent material of organic soils (peat or muck). Muck is in a more complete stage of decomposition of the original organic plant remains than peat. Muck soils occur 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. In Mitchell County the organic material generally is about 18 to 52 inches thick. A few deposits in small hill-like mounds are deeper (fig. 17).

Climate

According to available evidence, the soils of Mitchell County have been developing under the influence of a mid-continental, 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*, *13*). The morphology of most of the soils in the county indicates that the climate under which the soils formed is similar to the present one. At present the climate is fairly uniform throughout the county but is marked by wide seasonal extremes in temperature. Precipitation is distributed throughout the year.

Climate is a major factor in determining what soils develop from various plant materials. The rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by the climate. Temperature, rainfall, relative humidity, and length of 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, south-facing, dry, sandy soils have a local climate or micro-climate that is warmer and less humid than the average climate of nearby areas. Low-lying, poorly drained areas are wetter and colder than

Figure 17.—**Muck soils formed in organic mounds. Mounds formed in area where a seep or artesian water pressure kept the surface saturated.**

most areas around them. These contrasts account for some of the differences in soils within the same general climatic regions.

Plant and animal life

Plant and animal life are important factors in soil formation. Plant life is especially significant. Soil formation really begins with the coming of vegetation. As plants grow and die they add organic matter to the upper layers of soil material. The native grasses have myriads of fibrous roots that penetrate the soil to a depth of 10 to 20 inches and add large amounts of organic matter to the surface layer. Trees commonly feed on plant nutrients deep in the subsoil; consequently they add little organic matter to the surface layer, other than that gained from falling leaves and dead trees. Much of the organic matter from dead leaves and trees remains on the surface or is lost through decomposition.

Ashdale, Cresco, Dinsdale, and Kenyon soils are typical of those that formed under prairie. Clyde and Maxfield soils are representative of soils that formed under prairie grasses and water-tolerant plants. Coggon, Pinicon, and Fayette soils are typical of those that formed under trees. Downs, Oran, and Waubeek soils have properties intermediate between those of soils that formed entirely under prairie and soils that formed entirely under forest. Soils that formed under trees have a thin, dark surface layer generally less than 5 inches thick. They have a lighter colored A2 horizon immediately below the surface layer (fig. 18). In contrast, soils that formed under prairie vegetation contain a large amount of organic matter derived from roots, and they have a thick, dark surface layer.

The Kenyon, Bassett, and Coggon soils are members of a biosequence, or a group of soils that formed in the same parent material and under comparable environment except for native vegetation. The native vegetation has caused the main differences in morphology among the soils in this group.

Activities of burrowing animals and insects have some effect in loosening and aerating the upper few feet of the soils. Man's removal of trees and subsequent cultivation of crops tend to cause some soils to have a somewhat

Figure 18.—**Light colored area is Coggon and Pinicon loam. Somewhat darker area in upper right is Oran loam.**

thicker dark surface layer. In some sloping areas, however, cultivation followed by erosion has removed much of the dark surface layer.

Relief

Relief is an important cause of differences among soils. Indirectly, it influences soil development through its effect on drainage. In Mitchell County the relief ranges from level to steep. Many level or nearly level areas are frequently flooded and have a high or periodically high water table. Much of the rainfall runs off of more strongly sloping areas.

The Clyde, Marshan, Maxfield, and Tripoli soils formed under a high or periodically high water table and generally have a dominantly olive-gray subsoil. Soils that formed in areas where the water table was below the subsoil have a yellowish-brown subsoil, like Atkinson, Dinsdale, Downs, Ostrander, Renova, and Waubeek soils. Such soils as Floyd, Franklin, Klinger, Lawler, Muscatine, Oran, and Readlyn formed where natural drainage was intermediate, and they have a mottled grayish-brown subsoil. Of the soils that formed under prairie, those that have a high water table generally have more organic matter in the surface layer than those that have good natural drainage.

Aspect, as well as gradient, has significant influence. South-facing slopes generally are warmer and drier than north-facing slopes, and consequently support a different kind and amount of vegetation.

The influence of a porous, rapidly permeable parent material may override the influence of topography. Dickinson soils, for example, are somewhat excessively drained, even though they are no more than gently sloping, because they have moderately rapid to rapid permeability. Also, in some nearly level areas where the porous, fractured limestone bedrock is relatively close to the surface, well drained and moderately well drained Dinsdale and other well-drained soils occur where more poorly drained soils generally would be expected.

The Tripoli, Kenyon, and Readlyn soils are examples of some that formed in the same kind of parent material and under similar vegetation but that differ because of differences in topographic position. The Tripoli soils are on broad, level upland flats. Readlyn soils are on nearly level ridges and long, gentle, convex side slopes. Kenyon soils, except where fractured bedrock is within 5 to 15 feet of the surface, are on long, convex ridges and gentle or moderately sloping convex side slopes. Topography influences the drainage of these soils.

The Terril soils are on foot slopes and some narrow upland waterways. They have properties related to the soils upslope from which they receive sediments.

Many of the Sogn soils are steep and have very little soil development. Most of the water that falls on the surface layer runs off rather than into the soil.

Time

Time is necessary for the various processes of soil formation to take place. The amount of time necessary ranges from a few days for the formation of soils in fresh alluvial deposits, such as in the units shown on the map as Alluvial land, channeled, to thousands of years for the paleosols that today make up the subsoil of the Donnan soils. If other factors are favorable, the texture of the subsoil generally becomes finer and a greater amount of soluble materials are leached out as the soils continue to weather. Exceptions are soils that formed in quartz sand, such as the Dickinson soils, or in other materials that are resistant to weathering. Such soils do not change much over a long period of time. Other exceptions are steep soils that have a small amount of water infiltration and a large amount of runoff. Such soils weather more slowly than soils in stable, less sloping areas.

Where organic materials such as trees have 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 (*6*).

The loess in which the Downs, Fayette, and Tama soils of this region formed is probably about 14,000 to 20,000 years old. Recent studies show that the Iowa erosion surface formed during the time of loess deposition. Radiocarbon dates show this to be between 14,000 and 20,000 years ago. The Iowa soil beneath the loess could be as young as 14,000 years, which dates the close of the major loess deposition in Iowa. The Iowa surface, where covered by loam sediment, is younger than 14,000 years. About 36 percent of the soils in Mitchell County formed in this erodible loam sediment. These are the Bassett, Cresco, Ostrander, Kenyon, Lourdes, Pinicon, Readlyn, Riceville, Renova, and Tripoli soils. The Clyde, Floyd, and Schley soils are younger, because they are cut in and below these higher lying soils.

Radiocarbon dates from adjacent counties interpret some of the surface in Mitchell County as being as young as 2,000 to 6,000 years. This perhaps accounts for the weakly developed profile in the Clyde, Floyd, and Schley soils.

Time is needed for soil development, but the age of the parent material does not necessarily reflect the true age of the soil profile that formed in that material.

Man's influence on the soil

Important changes take place in the soil when it is drained and cultivated. Some of these changes have little effect on soil productivity; others have drastic effects. Changes caused by erosion generally are most apparent. Many of the cultivated soils in the county, particularly those that have steeper slopes, have lost some of the original surface layer through sheet erosion.

Man has done much to increase productivity of the soil and to reclaim areas not suitable for crops. For example, tile drainage has been installed in many places in the county and has lowered the water table sufficiently so that these areas can be used for crops. Through the use of commercial fertilizers, man has been able to counteract deficiencies in plant nutrients and make the soil more productive than the virgin soil. To date, most of the soils in Mitchell County have not been seriously affected by soil erosion. This is mainly because much of the county has low relief, and because past cropping patterns have included a fairly high percentage of grass in the rotation.

Man can improve the soil for more crop production by good management practices, or he can reduce soil fertility and production through improper land use.

For general information about the soils, the reader can refer to the section "General Soil Map," which describes broad patterns of soils in the county. Technical information is given in the section "Formation and Classification of the Soils." Many terms used in the soil descriptions and other sections are defined in the Glossary.

Classification of 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 to 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.

Thus, 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 applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system currently used for classifying soils was adopted for general use by the National Cooperative Soil Survey in 1965 (*10*, *8*). The current system is under continual study. Therefore, readers interested in developments of this system should search the latest literature available. Some of the classes in the current system are given for the soil series in table 5. The classes in the current system are briefly defined in the following paragraphs.

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 the basis for classification are 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.

Orders. Ten orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to given broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates.

Table 5 shows the two orders in Mitchell County, Alfisols and Mollisols. Alfisols are soils that have a clay-enriched B horizon that is high in base saturation. Mollisols have a thick surface layer that is darkened by organic matter.

Suborders. Each order is divided into suborders, primarily on the basis of those characteristics that seem to produce classes with the greatest genetic similarity. The

TABLE 5.—*Classification of the soils by higher categories*

Series	Family	Subgroup	Order
Ansgar	Fine-silty, mixed, mesic	Mollic Ochraqualfs	Alfisols.
Ashdale [1]	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Atkinson	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Atterberry [1]	Fine-silty, mixed, mesic	Udolic Ochraqualfs	Alfisols.
Bassett	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Bixby	Fine-loamy over sandy or sandy-skeletal, mixed mesic	Typic Hapludalfs	Alfisols.
Burkhardt	Sandy, mixed, mesic	Typic Hapludolls	Mollisols.
Calco [1]	Fine-silty, mixed, calcareous, mesic	Cumulic Haplaquolls	Mollisols.
Canisteo	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Clyde	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Coggon	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Coland	Fine-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Cresco	Fine-loamy, mixed, mesic	Typic Argiudolls (aquic)	Mollisols.
Dickinson	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Dinsdale	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Donnan	Fine-loamy over clayey, mixed, mesic (fine)	Aquollic Hapludalfs	Alfisols.
Downs	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Dubuque	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Fayette	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Flagler	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Floyd	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Franklin	Fine-silty, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Garwin [1]	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Hanlon	Coarse-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Hayfield	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Huntsville [1]	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Jameston	Fine-loamy, mixed, mesic	Typic Argiaquolls	Mollisols.
Kensett	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Kenyon	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Klinger	Fine-silty, mixed, mesic	Aquic Argiudolls (Hapludolls)	Mollisols.
Lamont	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Lawler	Fine-loamy over sand or sandy-skeletal, mixed, mesic	Aquic Hapludolls	Mollisols.
Lilah	Sandy, mixed, mesic	Psammentic Hapludalfs	Alfisols.
Lourdes	Fine-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Marshan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Haplaquolls	Mollisols.
Maxfield	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Muscatine	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Nasset [1]	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Oran	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Ostrander	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Pinicon	Fine-loamy, mixed, mesic	Aeric Ochraqualfs	Alfisols.
Protivin	Fine-loamy, mixed, mesic	Aquic Argiudolls	Mollisols.
Racine	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Readlyn	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Renova	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Riceville	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Rockton	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Roseville	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Sattre	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Mollic Hapludalfs	Alfisols.
Saude	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Hapludolls	Mollisols.
Schley	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Sogn	Loamy-mixed, mesic	Lithic Haplustolls	Mollisols.
Tama	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Terril [1]	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Tripoli	Fine-loamy, mixed	Typic Haplaquolls	Mollisols.
Turlin	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Wapsie	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Mollic Hapludalfs	Alfisols.
Waubeek	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Waucoma	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Waukee	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Whalan	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Winneshiek	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.

[1] The soils named in these series in Mitchell County are taxadjuncts. They are outside the range defined for the series in various ways. In Mitchell County—

Ashdale soils have loam and clay loam in the lower part of the B horizon.
Atterberry soils have a larger percentage of colors with a chroma of 2 or less between the Ap horizon and a depth of 30 inches.
Calco soils contain more sand than is typical.
Garwin soils have less clay in the B horizon.
Huntsville soils are more acid in the B horizon.
Nasset soils have loam in the lower part of the B horizon.
Terril soils are more acid than is typical.

suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect the presence or absence of wetness or soil differences resulting from the climate or vegetation.

GREAT GROUPS. Soil suborders are divided into great groups on the basis of unformity 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 have pans that interfere with the growth of roots or movement of water. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like.

SUBGROUPS. Great groups are divided into subgroups, one representing the central (typic) segment of the group, and the others, called "intergrades," which 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 name of the great group. An example is *Typic Hapludalf.*

FAMILIES. 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.

Some of the soils in Mitchell County do not fit in a series that has been recognized in the classification system, but recognition of a separate series would not serve any useful purpose. Such soils are named taxadjuncts to the series they strongly resemble, because they differ from those series in ways too small to be of consequence in interpreting their usefulness or behavior. In this survey soils named in the Ashdale, Atterberry, Calco, Garwin, Huntsville, Nasset, and Terril series are taxadjuncts to those series.

General Nature of the County

This section was prepared mainly for those not familiar with Mitchell County. It briefly describes the transportation, recreation, and farming in the county and the relief, drainage, and climate.

U.S. Highway 218, running dominantly north and south, and State Route 9, running east and west, intersect near the south-central part of the county. These routes are connected to all parts of the county by good asphalt or crushed rock roads.

Every farmstead is on an all-weather road. Osage, St. Ansgar, Mitchell, Orchard, McIntire, Mona, Otranto, Carpenter, and Riceville are on mainline railroads. Toeterville and Stacyville are on branch lines. Scheduled airline transportation is available at Mason City, Austin, and Rochester, all within 60 miles of the county.

There is a small municipal airport at Osage and a few private airports in other parts of the county. Bus transportation is available on the two main highways. Motor freight lines serve every trading center in the county.

The county is primarily rural but has a few industries, most of which are in Osage. Hog-buying stations and grain elevators are in most towns.

Nearly every town and village has a local park. Artificial lakes are on the Cedar River at Otranto and Mitchell and on the Little Cedar River at Stacyville.

In rural areas, hunting, fishing, and other forms of outdoor recreation are provided by rivers and creeks. Spring Creek, Turtle Creek, and the upper part of the Wapsipinicon River are spring fed and cold enough to be stocked with trout. The Cedar River is deeply entrenched in limestone bedrock and has limestone bluffs along much of its valley. The river road drive from State Route 9 northwest to the village of Mitchell is picturesque throughout much of the year. Mitchell County supports many kinds of wildlife that contribute to its recreation and to its economy. Pheasants are hunted throughout the county.

Farming

The trend in recent years has been toward a decrease in the number of farms and a corresponding increase in farm size. Livestock farms outnumber all other types, and most of the crops harvested, except soybeans, are consumed by livestock on the farms where the crops are grown.

Mitchell County had a total of 1,153 farms in 1970, according to the Iowa Annual Farm Census. In the same year 288,674 acres was in farms, and the average size of the farms was 250 acres. Most of the cultivated acreage that is added to a farm consists of former wetlands that have been tile drained and are suitable for cultivated crops.

According to the same 1970 census, 60.3 percent of the farmland in Mitchell County was owned by the operator, and 39.7 percent was tenant-operated. The percentage of owner-operator farms in Mitchell County is higher than the State average, which was 52.8 percent in 1970.

Some corn is sold as a cash crop, but the amount sold varies from year to year and depends largely on the price of feeder cattle, the market for fat cattle, the market for hogs, the cash price of corn, and the quality of the corn crop. Although corn is the principal grain crop, the acreage in soybeans has increased. The acreage in various grain crops in Mitchell County in 1970 was corn for all purposes, 96,302 acres; oats, 23,640 acres; soybeans for beans, 54,882 acres; and hay, 18,243 acres.

Hogs, beef cattle, and dairy cattle are the livestock most extensively raised in Mitchell County. The principal livestock marketed in 1970 was 147,908 hogs, 37,796 grain-fed cattle, and 3,540 grain-fed sheep and lambs. According to the 1970 census, 2-year-old milk cows numbered 6,744, 2-year-old beef cows on hand numbered 5,370, and lambs born numbered 2,772. Sows farrowed numbered 10,386 in the fall of 1970 and 11,657 in the spring of 1971.

Relief and Drainage

Most of Mitchell County is level or gently sloping. The stronger slopes are generally long, and a system of drainageways and small streams is generally well established. The narrow band of moderately sloping to steep topography along the Cedar River is in strong contrast to the rest of the county. The Cedar River and its tributaries drain much of the western part of Mitchell County, and several thousand acres are drained by a tributary of the Shell Rock River. The Little Cedar River and the Wapsipinicon River and their tributaries drain most of the eastern half of Mitchell County. Several hundred acres in the northeast corner of the county is in the Upper Iowa River watershed.

Sinkholes occur in the western two-thirds of Mitchell County (fig. 19), mostly within a few miles of the Cedar River or its tributaries. In Mitchell County the sinkholes are of two types, those that are open to the surface and are actively increasing in size and those that are not open but are mantled with soil material and are not actively growing. This second type is dominant.

Many of the sinkholes are shallow and are cultivated, but some are deep and not crossable with farm machinery. Each year several new ones form, generally after a period of heavy precipitation.

Sinkholes in Mitchell County form in areas where the soil material is less than 25 feet deep over the limestone bedrock. Most form in well-drained soils, though some form in wet soils. In most of these areas soil materials have washed down through crevices in the bedrock. Over the ages, small crevices are enlarged by surface water per-

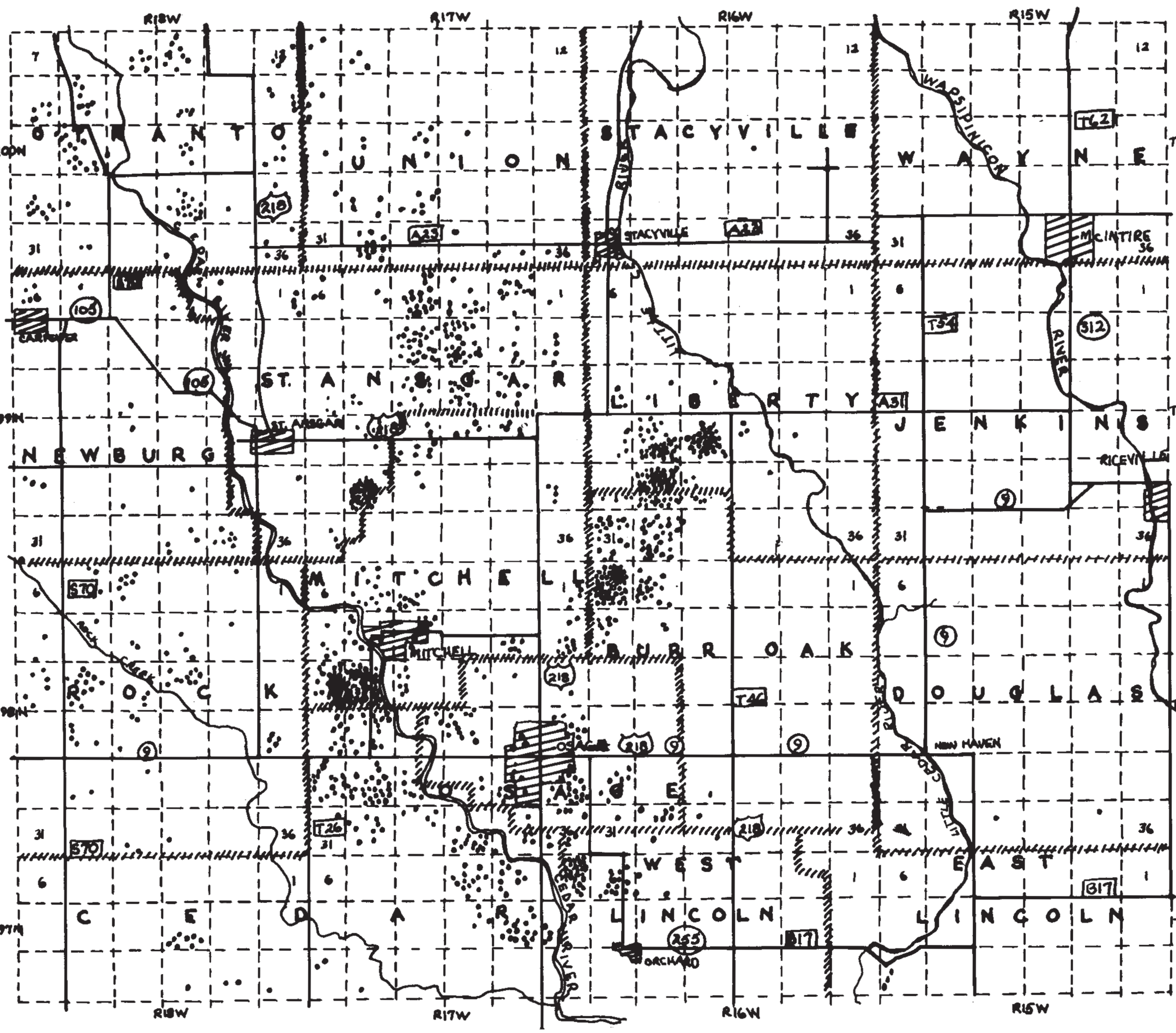

Figure 19.—Distribution of limestone sinkholes in Mitchell County.

colating downward and dissolving some of the bedrock, increasing the size of the underground channels. Some of the underground crevices and channels enlarge over a period of time to become caverns. Where a cavern is formed near the upper part of the bedrock surface, the roof may collapse, in which case a large sinkhole forms in a short time. In Mitchell County, nearly all of the sinkholes appear to be forming through vertical erosion of the soil material into the underground water system, rather than by the collapse of cavern ceilings.

Sinkholes are more of a hazard for underground water pollution than they are a limitation to the growing of crops. In a few areas, surface water that carries barnyard runoff and septic tank effluent drains into sinkholes. This surface runoff moves directly into underground water supplies, which thus become polluted. For this reason, active sinkholes that readily receive the surface runoff, with little or no filtering by a protective soil mantle, are a hazard to safe ground-water supplies (fig. 20).

Climate [3]

Mitchell County is in the northernmost tier of Iowa counties, the fourth from the northeast corner of the State. The county is primarily drained by the Wapsipinicon and Cedar Rivers sloping to the south-southeast.

The climatic data in tables 6 and 7 were recorded at Osage in the south-central part of Mitchell County. These data are representative of the county as a whole, except that showers vary greatly over short distances and the minimum temperatures on calm, clear nights may be several degrees lower in rural lowlands.

Some 70 percent of the annual total of about 31 inches of precipitation falls during the crop season from April 1 through September 30. During an average year, 185 days have a trace or more of precipitation, Heavier threshold amounts average 0.01 inch or more on 95 to 100 days, 0.10 inch or more on 60 days, and 0.50 inch on 20 days. At any point in Mitchell County, the daily rainfall exceeds 3.8 inches approximately once in 5 years, and once in a century a 6.2-inch rain falls in 24 hours. Most of the heavy showers fall in spring and summer when tillage is at a maximum and the soil erosion potential is high.

Average snow cover of an inch or more extends over 80 to 90 days per season. The first 1-inch snowfall normally occurs late in November, but has been as early as late in September. The average annual seasonal snowfall of about 40 inches makes up approximately 13 percent of the total annual precipitation.

Ideally, during crop planting, the topsoil is dry and the subsoil contains abundant moisture. Variations from the optimum are frequent. Without adequate subsoil moisture at the beginning of the season, rainfall is rarely sufficient to provide the inch of moisture per week needed for growing corn. Chances of receiving 1 inch of precipitation per week are about two in five during the latter half of May and June and decrease to one in three or four during July and August.

Temperatures have ranged from −35° F. on January 12, 1912 to 107° on July 14, 1936. On the average, 9 days a year have temperatures equal to or exceeding 90°, a threshold too hot for adequate corn growth or development. On about 163 days per year, freezing or colder temperatures are normally recorded.

[3] By Paul J. Waite, director of Iowa Weather Service and climatologist for Iowa.

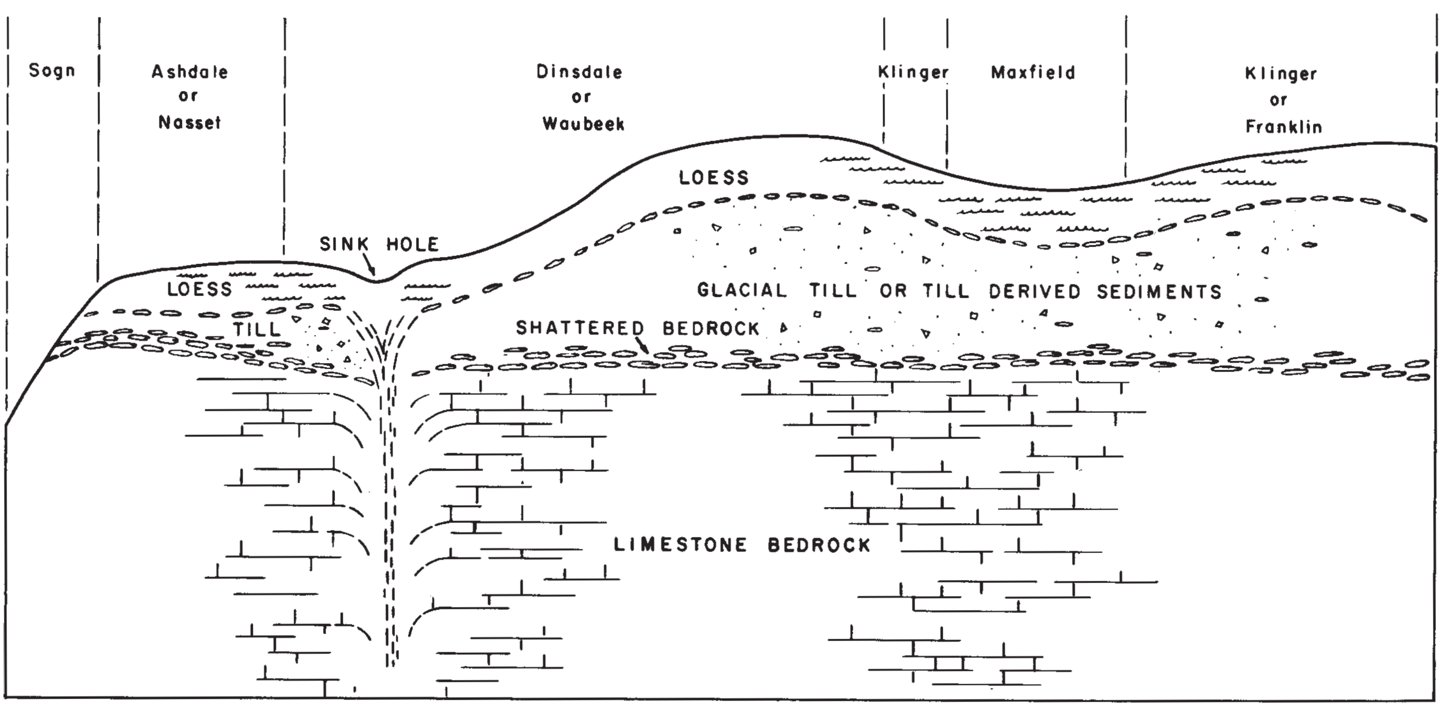

Figure 20.—Diagram of loess and till soil mantle overlying limestone bedrock. Sinkholes form in many places where depth to bedrock is about 5 to 20 feet.

TABLE 6.—*Temperature and precipitation*

[Data recorded at Osage, in Mitchell County]

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—	Number of days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
	°F	°F	°F	°F	Inches	Inches	Inches		Inches
January	26	7	44	−19	1.1	0.2	2.1	24	6
February	29	11	45	−13	.9	.1	1.7	21	7
March	40	22	62	0	1.9	.7	4.5	17	6
April	57	36	79	21	2.3	1.0	5.1	1	3
May	70	47	86	31	4.0	2.1	5.8	0	
June	79	57	91	43	4.8	1.7	7.2	0	
July	84	62	93	49	3.5	1.2	7.5	0	
August	82	60	92	46	4.0	.8	7.3	0	
September	74	50	87	33	3.2	.7	6.4	0	
October	63	40	81	23	2.0	.3	3.8	0	
November	43	25	65	5	1.8	.3	2.2	4	3
December	30	13	50	−13	1.0	.2	1.8	16	4
Year	57	36	95	−22	30.4	22.5	36.8	83	6

TABLE 7.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data recorded at Osage]

Probability	Dates 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 6	April 20	April 30	May 7	May 18.
2 years in 10 later than	March 31	April 14	April 25	May 2	May 13.
5 years in 10 later than	March 21	April 3	April 14	April 22	May 3.
Fall:					
1 year in 10 earlier than	October 27	October 20	October 9	October 1	September 20.
2 years in 10 earlier than	November 1	October 25	October 15	October 6	September 25.
5 years in 10 earlier than	November 12	November 5	October 26	October 17	October 5.

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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 subject to frequent or occasional flooding.

Bottom, second. The first terrace above the normal flood plain of a stream.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

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.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper part of the B horizons and have mottling in the lower part of the B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be lacking or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

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 solumn.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were 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.

Interfluve. The area between adjacent streams flowing in the same direction.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrasts—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

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.*

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	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

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.

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.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal, *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (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.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

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."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

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.

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GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. The capability classification system is explained, and general management of soils is described in the section "Use and Management of the Soils for Crops." Other information is given in tables as follows:

Acreage and extent of soils, table 1, page 14.
Predicted yields, table 2, page 73.
Engineering uses of the soils, tables 3 and 4, pages 76 to 111.

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page
27	Terril loam, 0 to 2 percent slopes	59	I-1	67
27B	Terril loam, 2 to 5 percent slopes	59	IIe-5	68
83	Kenyon loam, 0 to 2 percent slopes	37	I-2	67
83B	Kenyon loam, 2 to 5 percent slopes	37	IIe-1	67
83C	Kenyon loam, 5 to 9 percent slopes	37	IIIe-1	70
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded	37	IIIe-1	70
84	Clyde silty clay loam, 0 to 3 percent slopes	22	IIw-1	68
96	Turlin silt loam, 0 to 2 percent slopes	60	I-1	67
98	Huntsville silt loam, 0 to 2 percent slopes	35	I-1	67
98B	Huntsville silt loam, 2 to 5 percent slopes	35	IIe-5	68
104B	Rockton silt loam, moderately deep, 2 to 5 percent slopes	54	IIe-4	68
110	Lamont fine sandy loam, 0 to 2 percent slopes	39	IIIs-1	71
110B	Lamont fine sandy loam, 2 to 5 percent slopes	39	IIIe-4	70
110C	Lamont fine sandy loam, 5 to 9 percent slopes	39	IIIe-4	70
118	Garwin silty clay loam, 0 to 2 percent slopes	33	IIw-1	68
119	Muscatine silty clay loam, 0 to 2 percent slopes	45	I-3	67
120	Tama silty clay loam, 0 to 2 percent slopes	58	I-2	67
120B	Tama silty clay loam, 2 to 5 percent slopes	58	IIe-1	67
120C2	Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	58	IIIe-1	70
135	Coland silty clay loam, 0 to 2 percent slopes	23	IIw-4	69
151	Marshan clay loam, moderately deep, 0 to 2 percent slopes	43	IIw-1	68
152	Marshan clay loam, deep, 0 to 2 percent slopes	43	IIw-1	68
162B	Downs silt loam, 2 to 5 percent slopes	28	IIe-1	67
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded	28	IIIe-1	70
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded	28	IIIe-1	70
163B	Fayette silt loam, 2 to 5 percent slopes	30	IIe-1	67
163C2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded	30	IIIe-1	70
171	Bassett loam, 0 to 2 percent slopes	18	I-2	67
171B	Bassett loam, 2 to 5 percent slopes	18	IIe-1	67
171C	Bassett loam, 5 to 9 percent slopes	18	IIIe-1	70
171C2	Bassett loam, 5 to 9 percent slopes, moderately eroded	18	IIIe-1	70
175	Dickinson fine sandy loam, 0 to 2 percent slopes	25	IIIs-1	71
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	25	IIIe-4	70
177	Saude loam, 0 to 2 percent slopes	56	IIs-1	69
177B	Saude loam, 2 to 5 percent slopes	56	IIe-4	68
178	Waukee silt loam, 0 to 2 percent slopes	64	I-2	67
178B	Waukee silt loam, 2 to 5 percent slopes	64	IIe-1	67
183B	Dubuque silt loam, moderately deep, 2 to 5 percent slopes	29	IIe-4	68
183C	Dubuque silt loam, moderately deep, 5 to 9 percent slopes	29	IIIe-3	70
184	Klinger silty clay loam, 0 to 2 percent slopes	38	I-3	67
188	Kensett silt loam, 0 to 2 percent slopes	36	IIw-3	69
198B	Floyd loam, 1 to 4 percent slopes	31	IIw-2	68
205B	Whalan loam, deep, 2 to 5 percent slopes	64	IIe-4	68
205C	Whalan loam, deep, 5 to 9 percent slopes	64	IIIe-3	70
214B	Rockton loam, moderately deep, 2 to 5 percent slopes	53	IIe-4	68
214C	Rockton loam, moderately deep, 5 to 9 percent slopes	53	IIIe-3	70
221	Muck, moderately deep	44	IIIw-1	70
225	Lawler loam, moderately deep, 0 to 2 percent slopes	40	IIs-1	69
226	Lawler loam, deep, 0 to 2 percent slopes	40	I-3	67
235	Coland-Turlin complex, 0 to 2 percent slopes	24	IIw-4	69
C235	Coland-Turlin complex, channeled, 0 to 2 percent slopes	24	Vw-1	72

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page
265	Bixby loam, 0 to 2 percent slopes	19	IIs-1	69
265B	Bixby loam, 2 to 5 percent slopes	19	IIe-4	68
284	Flagler sandy loam, 0 to 2 percent slopes	31	IIIs-1	71
284B	Flagler sandy loam, 2 to 5 percent slopes	31	IIIe-4	70
285	Burkhardt sandy loam, 0 to 3 percent slopes	20	IVs-1	71
285C	Burkhardt sandy loam, 3 to 9 percent slopes	20	IVs-2	71
291	Atterberry silt loam, 0 to 2 percent slopes	17	I-3	67
302B	Coggon loam, 2 to 5 percent slopes	23	IIe-1	67
303B	Pinicon silt loam, 1 to 4 percent slopes	48	IIw-2	68
C315	Alluvial land, channeled	12	Vw-1	72
354	Marsh	42	VIIw-1	72
377	Dinsdale silty clay loam, 0 to 2 percent slopes	26	I-2	67
377B	Dinsdale silty clay loam, 2 to 5 percent slopes	27	IIe-1	67
382	Maxfield silty clay loam, 0 to 2 percent slopes	44	IIw-1	68
391B	Clyde-Floyd complex, 1 to 4 percent slopes	22	IIw-1	68
394	Ostrander loam, 0 to 2 percent slopes	47	I-2	67
394B	Ostrander loam, 2 to 5 percent slopes	47	IIe-1	67
398	Tripoli silty clay loam, 0 to 2 percent slopes	60	IIw-1	68
399	Readlyn loam, 0 to 2 percent slopes	51	I-3	67
399B	Readlyn loam, 2 to 5 percent slopes	51	IIe-3	68
407B	Schley silt loam, 1 to 4 percent slopes	57	IIw-2	68
412B	Sogn loam, 2 to 5 percent slopes	57	IVs-2	71
412D	Sogn loam, 5 to 14 percent slopes	57	VIs-1	72
412G	Sogn loam, 14 to 40 percent slopes	57	VIIs-1	72
471	Oran loam, 0 to 2 percent slopes	47	I-3	67
471B	Oran loam, 2 to 5 percent slopes	47	IIe-3	68
482	Racine silt loam, 0 to 2 percent slopes	50	I-2	67
482B	Racine silt loam, 2 to 5 percent slopes	50	IIe-1	67
482C	Racine silt loam, 5 to 9 percent slopes	50	IIIe-1	70
491B	Renova loam, 2 to 5 percent slopes	52	IIe-1	67
507	Canisteo silty clay loam, 0 to 2 percent slopes	21	IIw-1	68
536	Hanlon sandy loam, 0 to 2 percent slopes	33	IIs-2	69
575	Dickinson-Ostrander complex, 0 to 2 percent slopes	25	IIs-1	69
575B	Dickinson-Ostrander complex, 2 to 5 percent slopes	26	IIe-4	68
610B	Lamont-Renova complex, 2 to 5 percent slopes	39	IIe-4	68
714	Winneshiek loam, moderately deep, 0 to 2 percent slopes	65	IIs-1	69
714B	Winneshiek loam, moderately deep, 2 to 5 percent slopes	65	IIe-4	68
714C	Winneshiek loam, moderately deep, 5 to 9 percent slopes	65	IIIe-3	70
714D	Winneshiek loam, moderately deep, 9 to 14 percent slopes	65	IVe-1	71
725	Hayfield loam, moderately deep, 0 to 2 percent slopes	34	IIs-1	69
726	Hayfield loam, deep, 0 to 2 percent slopes	34	I-3	67
733	Calco silty clay loam, 0 to 2 percent slopes	20	IIw-4	69
760	Ansgar silt loam, 0 to 2 percent slopes	15	IIw-1	68
761	Franklin silt loam, 1 to 3 percent slopes	32	I-3	67
771	Waubeek silt loam, 0 to 2 percent slopes	62	I-2	67
771B	Waubeek silt loam, 2 to 5 percent slopes	62	IIe-1	67
776	Lilah sandy loam, 0 to 3 percent slopes	41	IVs-1	71
776C	Lilah sandy loam, 3 to 9 percent slopes	41	IVs-2	72
777	Wapsie loam, 0 to 2 percent slopes	61	IIs-1	69
777B	Wapsie loam, 2 to 5 percent slopes	61	IIe-4	68
777C	Wapsie loam, 5 to 9 percent slopes	61	IIIe-3	70
778	Sattre silt loam, 0 to 2 percent slopes	55	I-2	67
781B	Lourdes loam, 2 to 5 percent slopes	42	IIe-2	67
781C	Lourdes loam, 5 to 9 percent slopes	42	IIIe-2	70
781C2	Lourdes loam, 5 to 9 percent slopes, moderately eroded	42	IIIe-2	70
782	Donnan silt loam, 0 to 2 percent slopes	27	IIw-3	69
782B	Donnan silt loam, 2 to 5 percent slopes	27	IIe-2	67
783B	Cresco loam, 2 to 5 percent slopes	24	IIe-2	67
783C	Cresco loam, 5 to 9 percent slopes	25	IIIe-2	70

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit	
			Symbol	Page
784B	Riceville silt loam, 1 to 4 percent slopes	53	IIw-3	69
797	Jameston silty clay loam, 0 to 2 percent slopes	36	IIw-1	68
798B	Protivin loam, 1 to 4 percent slopes	49	IIw-3	69
804	Ashdale silt loam,0 to 2 percent slopes	16	I-2	67
804B	Ashdale silt loam, 2 to 5 percent slopes	16	IIe-1	67
805B	Roseville silt loam, 2 to 5 percent slopes	54	IIe-1	67
813	Atkinson loam, 0 to 2 percent slopes	16	I-2	67
813B	Atkinson loam, 2 to 5 percent slopes	16	IIe-1	67
904	Nasset silt loam, 0 to 2 percent slopes	46	I-2	67
904B	Nasset silt loam, 2 to 5 percent slopes	46	IIe-1	67
913	Waucoma silt loam, 0 to 2 percent slopes	63	I-2	67
913B	Waucoma silt loam, 2 to 5 percent slopes	63	IIe-1	67

Accessibility Statement