SOIL SURVEY OF

Fayette County, Iowa

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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1962–1972. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1975. This survey was made cooperatively by the Soil Conservation Service in cooperation with the Iowa Agriculture and Home Economics Experiment Station and 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 Fayette County Soil Conservation District. Funds appropriated by Fayette County and the State of Iowa were used to defray part of the cost of this survey.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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. 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 discussions of the capability units.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for trees.

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

Community planners and others concerned with suburban development can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and for schools and parks in the section "Engineering."

Engineers and builders can find, under "Engineering," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

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

Newcomers in Fayette County may be especially interested in the section "General soil map," where broad patterns of soil are described. They may also be interested in the information about the county given in the section "Environmental factors affecting soil use."

Cover: Typical area in Fayette County overlooking the town of Eldorado along the Turkey River in association 6.

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SOIL SURVEY OF FAYETTE COUNTY, IOWA

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FAYETTE COUNTY is in the northeastern part of Iowa (fig. 1). It has an area of 465,920 acres. The county straddles the boundary between the gently rolling glacial "Iowan Erosion Surface" and the rolling to steep loess hills along the Mississippi River. West Union is the county seat. Oelwein, the largest city in Fayette County, has a population of 7,700.

Fayette County's economy is based mainly on the production of livestock and cash grain. The main crops are corn, soybeans, and hay. Livestock production centers principally on marketed hogs.

How this survey was made

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

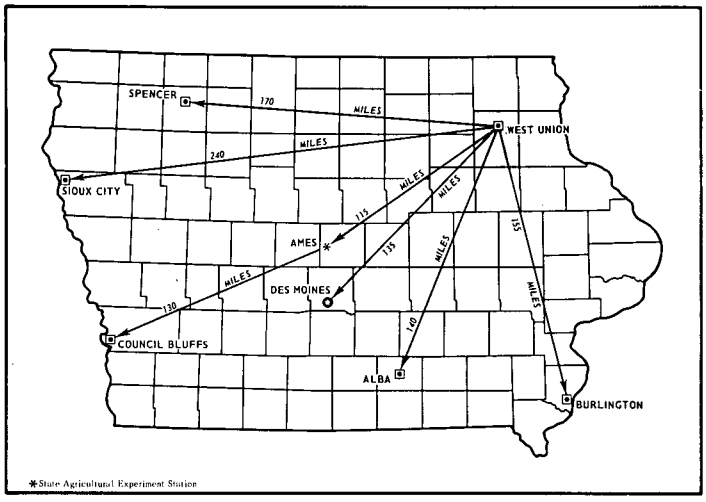

Figure 1.—Location of Fayette County in Iowa.

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. Floyd and Clyde, 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 (*15*).[1] 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, Fayette silt loam, 5 to 9 percent slopes, is one of several phases within the Fayette series.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a map-

[1] Italic numbers in parentheses refer to Literature Cited, p. 182.

ping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

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

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Fayette-Dubuque-Jacwin complex, 14 to 25 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called miscellaneous areas and are given descriptive names. Such a miscellaneous area in Fayette County is Sandy escarpments, 14 to 30 percent slopes.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind 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 its 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 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 Fayette County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in this survey are described on the pages that follow.

1. Kenyon-Clyde-Floyd association

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

This association is on uplands characterized mainly by long, gentle slopes, slightly rounded hills, and many low-gradient drainageways through which water moves slowly. The soils formed in loamy material and glacial till (fig. 2). They are nearly level to moderately sloping. In much of this area, stones and boulders are conspicuous features on the landscape in unimproved pasture. Fields and county roads in this association are in a rectangular pattern, and roads mostly follow section lines.

This association is the largest in Fayette County; it makes up about 49 percent of the county. It is about 35 percent Kenyon soils, 24 percent Clyde soils, 19 percent Floyd soils, 4 percent each Bassett and Cresco soils, and 14 percent minor soils. Minor soils in this association are Burkhardt, Dickinson, Donnan, Flagler, Olin, Oran, Ostrander, Readlyn, Rockton, Saude, Schley, Sparta, and Tripoli soils.

Kenyon soils are gently sloping on ridgetops and moderately sloping on side slopes. The soils are moderately well drained. They have a thick, dark, loamy surface layer. The subsoil is brown and mottled yellowish brown loam that contains stones and pebbles.

Clyde soils are in drainageways and lower concave positions on uplands. The soils are nearly level to gently sloping and poorly drained. They have a thick, dark, clay loam and silty clay loam surface layer. The subsoil is grayish stratified silty clay loam and sandy loam that grades to gray and yellowish brown mottled loam. Undrained pastures and drainageways contain stones and boulders.

Floyd soils are mainly in concave downslope positions. The soils are nearly level to gently sloping and are somewhat poorly drained. They have a thick, dark, loamy surface layer. The subsoil is yellowish brown mottled loam that contains stones and pebbles.

Bassett soils are gently sloping on ridgetops and

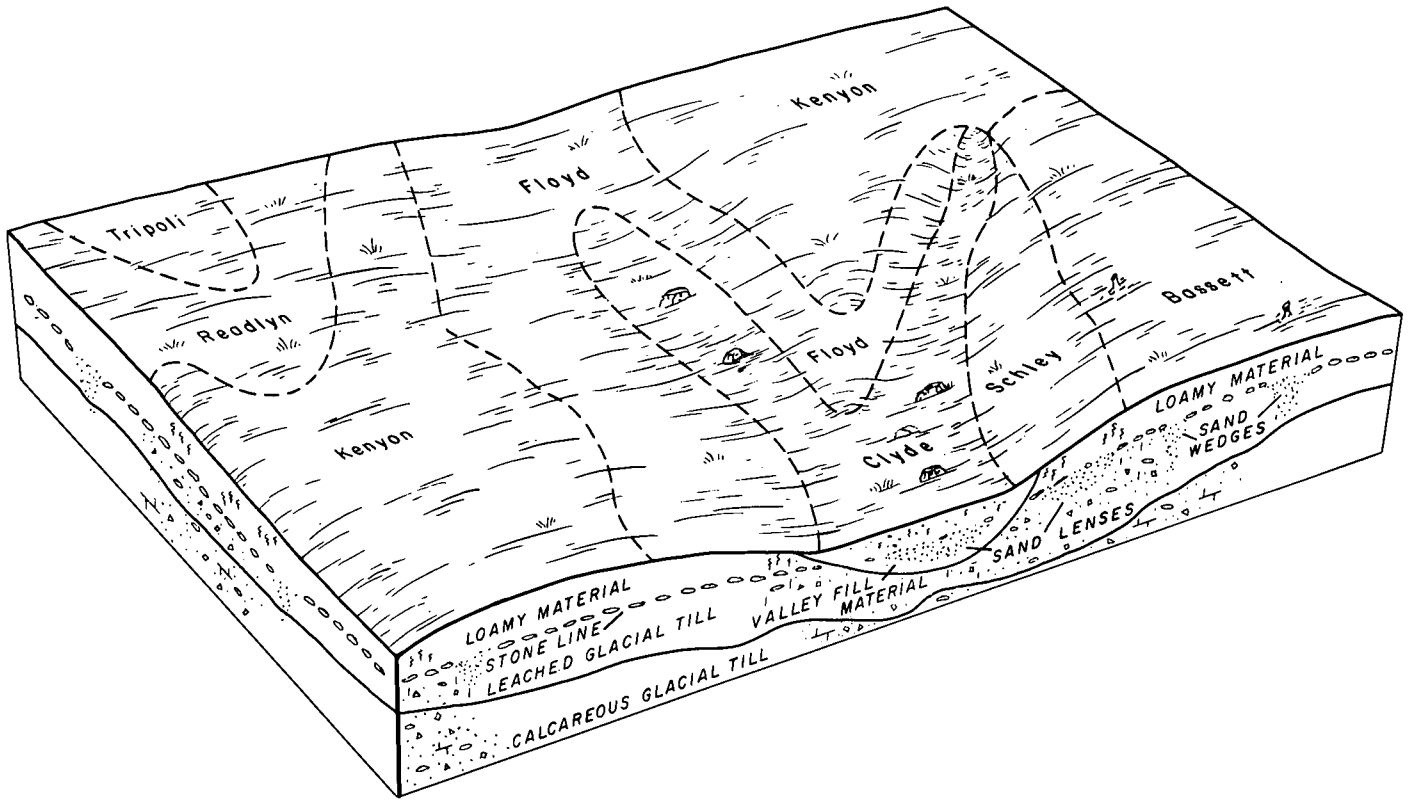

***Figure 2.*—Typical pattern of soils and underlying material in association 1.**

moderately sloping on side slopes. The soils are moderately well drained. They have a moderately thick, moderately dark, loamy surface layer. The subsoil is yellowish brown and grayish brown loam that contains stones and pebbles.

Cresco soils are gently sloping on ridgetops and moderately sloping on side slopes. The soils are moderately well drained. They have a thick, dark, heavy loam surface layer. The subsoil is strong brown and gray clay loam.

This association is well suited to row crops. Most of this association is cultivated. The principal management needs are improvement of drainage, control of erosion, and maintenance of fertility. Uncultivated areas are sandy or wet. Some wet areas remain undrained because of the many glacial boulders (fig. 3).

Clyde, Floyd, and Schley soils are wet partly because of hillside seepage. Where this is true, interceptor tile laid upslope from the wet spots is needed for drainage.

2. Readlyn-Oran-Tripoli association

Nearly level to gently sloping, somewhat poorly drained and poorly drained soils that formed in loamy material and glacial till; on uplands

This association is on broad upland flats that have few distinct drainageways. The soils formed in loamy material and glacial till. They are nearly level to gently sloping and somewhat poorly drained to poorly drained. Fields and county roads in this association are in a rectangular pattern. The roads generally follow the section lines. A typical example of this association is along the Bremer-Fayette County line road north and south of Oran.

This association makes up about 1 percent of the county. It is about 39 percent Readlyn soils, 34 percent Oran soils, 15 percent Tripoli soils, and 12 percent minor soils. Minor soils in this association are Bassett, Clyde, Dickinson, Floyd, Kenyon, Olin, Schley, and Sparta soils.

Readlyn soils are nearly level or gently sloping and are on broad, slightly convex side slopes. The soils are somewhat poorly drained. They have a thick, dark colored, loamy surface layer. The subsoil is grayish brown and yellowish brown, mottled loam till.

Oran soils are nearly level to gently sloping and are generally on broad, slightly convex side slopes. The soils are somewhat poorly drained. They have a relatively thin, moderately dark colored, loamy surface layer over a dark grayish brown subsurface layer. The subsoil is grayish brown and yellowish brown, mottled loam till.

Tripoli soils are nearly level and are in broad, slightly concave areas along the drainageways and in large ponded areas. The soils are poorly drained. They have a thick, dark colored, clay loam surface layer over grayish brown and yellowish brown loam till.

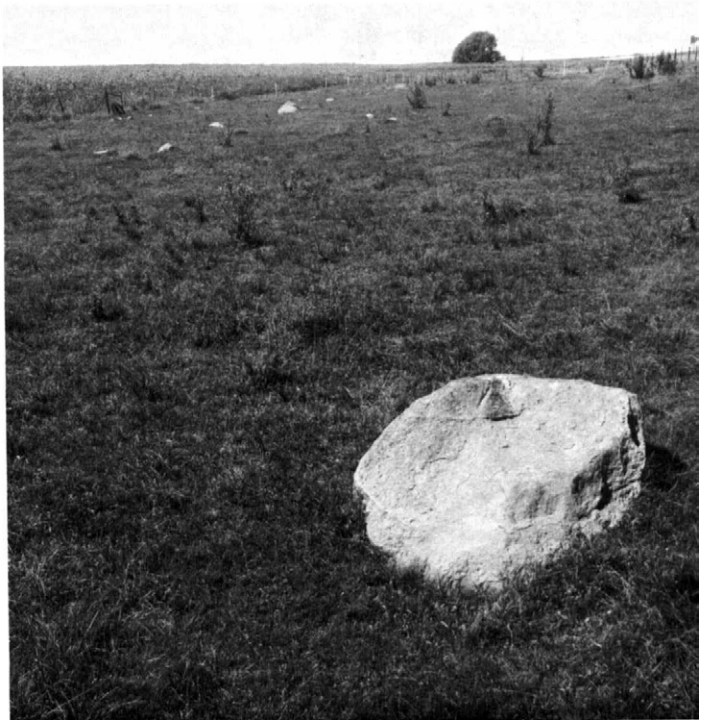

Figure 3.—Typical nontiled upland drainageway in Kenyon-Clyde-Floyd association. Many areas of Clyde soils in the county have been tiled, and the boulders have been removed.

This association is well suited to row crops. Almost all of this association is cultivated. A few areas are in permanent pasture. Although much of this area has been drained, improvement of drainage is still the principal management need. Maintenance of tilth and fertility are also management needs. In places stones or boulders interfere with cultivation and tile drainage.

3. Loamy Alluvial Land-Saude-Flagler association

Nearly level to moderately sloping, somewhat excessively drained to poorly drained soils that formed in loamy and sandy alluvial sediment; on bottom lands and stream benches

The soils on bottom lands and soils on benches form two distinct associations, but they are impractical to separate. This association is characterized by nearly level to moderately sloping soils, but there are a few strongly sloping to steep soils along the bench escarpments. The bottom lands are subject to frequent flooding, but most of the soils on the benches are generally free of flooding, except during very heavy rainfall or in some low areas. As the elevation increases away from the streams, the bench soils are less liable to flooding but in places they receive runoff from the adjacent hillsides. The farms and roads in this association commonly form irregular patterns; the shape of the fields is determined by the boundaries of streams, old stream meanders, and oxbows. Some of the roads parallel the rivers, but the network of roads is sketchy. The farmsteads are usually at higher elevations and are not subject to flooding.

This association makes up about 9 percent of the county. It is about 24 percent Loamy alluvial land, 21 percent Saude soils, 19 percent Flagler soils, 9 percent Lawler soils, 7 percent Marshan soils, and 20 percent minor soils. Minor soils in this association are Burkhardt, Coland, Dickinson, Spillville, and Wapsie soils.

Loamy alluvial land consists of clayey to sandy material that has been deposited by streams. It is frequently flooded and is well drained to poorly drained. Water commonly is ponded in the oxbows and remnants of former stream channels that dissect this land. It is generally nearly level. In places areas are undulating because of depressions or channels and natural levees that form during periods of flooding.

Saude soils are nearly level to moderately sloping and are on benches. The soils are well drained. They have a dark, loamy surface layer. The subsoil is brown and has sand and gravel below a depth of about 2 feet.

Flagler soils are nearly level to moderately sloping and are on benches. The soils are somewhat excessively drained. They have a dark, sandy loam surface layer. The subsoil is sandy loam and loamy sand that has coarse sand and gravel below a depth of about 2 feet.

This association is well suited to poorly suited to row crops. The management needs are control of flooding, improvement of drainage, control of erosion, and maintenance of tilth and fertility. The loamy alluvial land is used mainly for pasture or woodland although some areas that are flooded less frequently are being cropped. The Saude soils are used for cultivated crops, and yields are moderately good in years of normal rainfall. Flagler soils are droughty and yields are low, even if management is good.

4. Fayette-Nordness-Rock outcrop association

Moderately sloping to very steep, well drained and somewhat excessively drained soils that formed in loess overlying limestone bedrock and rock outcrops; on uplands

This association is on uplands characterized by narrow, moderately sloping to strongly sloping ridgetops and strongly sloping to very steep side slopes that are dissected by many side-valley waterways. Nearly all of this association is adjacent to the Turkey and Volga Rivers and their tributaries. The soils formed in loess over limestone bedrock. They are well drained and somewhat excessively drained (fig. 4). Typical of the landscape are narrow, meandering valleys bordered by very steep, irregular side slopes. On the side slopes, between the bottom lands and the highest upland ridges, are outcrops of limestone. The limestone forms steep bluffs 10 to 150 feet or more high.

This association is scenic. Only a few winding roads cross the valleys, and limestone outcrops are in many of the road cuts. Woodland and pasture border the bluffs in most places on the uplands. Scattered trees grow in the drainageways and along the fences, and there are many irregularly shaped timbered areas. A distinctive feature of the landscape is the patches of oak and hickory forest that remain from the native vegetation. Some of these timbered areas are large, ranging from 40 acres to 600 acres in size. The farmsteads are mostly on the ridgetops, although a few are in the small valleys. The fields are commonly small,

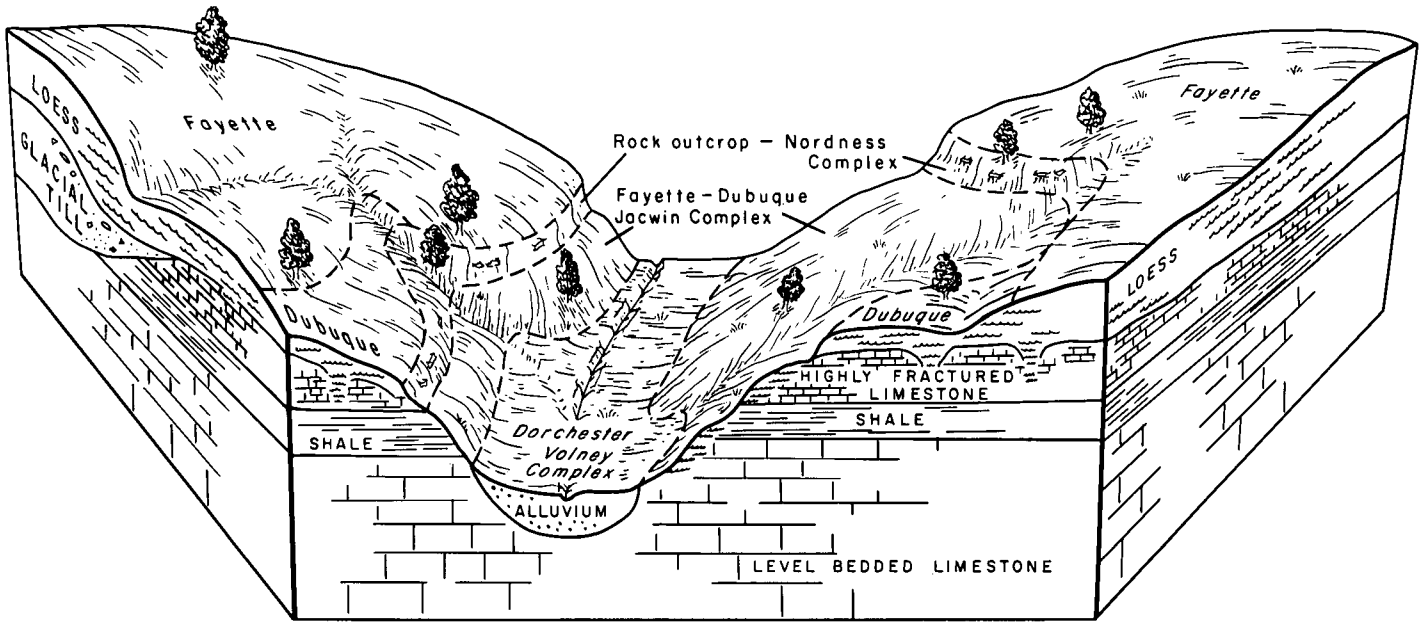

***Figure 4.*—Typical pattern of soils and underlying material in association 4.**

and they vary in shapes. County roads seldom follow the section lines.

This association makes up about 18 percent of the county. It is about 65 percent Fayette soils, 13 percent Nordness soils, 12 percent Rock outcrop, 4 percent Dubuque soils, and 6 percent minor soils. Minor soils in this association are Downs, Jacwin, Chaseburg, Dorchester, Volney, Fayette, and Dubuque soils.

Fayette soils are gently sloping to very steep and are on side slopes on uplands. The soils are well drained. They have a light colored silt loam surface layer where they are cultivated. The subsoil is dark yellowish brown silty clay loam that grades to silt loam as depth increases.

Nordness soils are gently sloping to steep and are on side slopes and escarpments on uplands. The soils are somewhat excessively drained. They have a light colored silt loam to loam surface layer. The subsoil is dark yellowish brown silt loam to silty clay loam. Limestone bedrock is at a depth of 5 to 18 inches.

Rock outcrop is outcrops of limestone bedrock on very steep side slopes and escarpments on uplands. In most places a thin layer of silt loam or loam overlies the limestone bedrock.

About half of this association is used for cultivated crops. The principal management needs are control of erosion and maintenance of tilth and fertility. Erosion is a concern, particularly in cultivated parts of ridgetops and valleys. Many of the soils are suited to row crops in a crop rotation, but farming on the contour, constructing terraces, and stripcropping are needed. The soils that are shallow over limestone bedrock can be used for pasture, woodland, or wildlife habitat.

Farming is diversified. Corn, oats, and hay are grown and fed to beef cattle, dairy cattle, and hogs. The livestock also use the available native pasture. The size of the average farm ranges from 160 to 200 acres, but the general trend is toward larger farms. Many farm buildings are unoccupied and deteriorating.

5. Downs-Fayette association

Gently sloping to moderately steep well drained soils that formed in loess on uplands

This association is on uplands characterized by gently sloping to moderately sloping narrow ridgetops and strongly sloping to moderately steep side slopes. The soils formed from loess more than 40 inches thick. They are well drained (fig. 5). The side slopes are dissected by many small drainageways, some of which have gullies that cannot be crossed with farm machinery. Scattered trees grow in the drainageways and along the fences in some places, and there are a few, small, irregularly shaped timbered areas in addition to the groves of trees around farmsteads. The farmsteads are mostly on ridgetops, although a few are in the small valleys. The fields are commonly small and have a variety of shapes. County roads often do not follow section lines.

This association makes up about 12 percent of the county. It is 60 percent Downs soils, 30 percent Fayette soils, and 10 percent minor soils. Minor soils in this association are Exette, Otter, and Huntsville soils.

Downs soils are gently sloping to strongly sloping and are on convex side slopes. The soils are well drained. They have a moderately thick, moderately dark silt loam surface layer over a lighter colored subsurface layer. The subsoil is dark yellowish brown silty clay loam that grades to silt loam as depth increases.

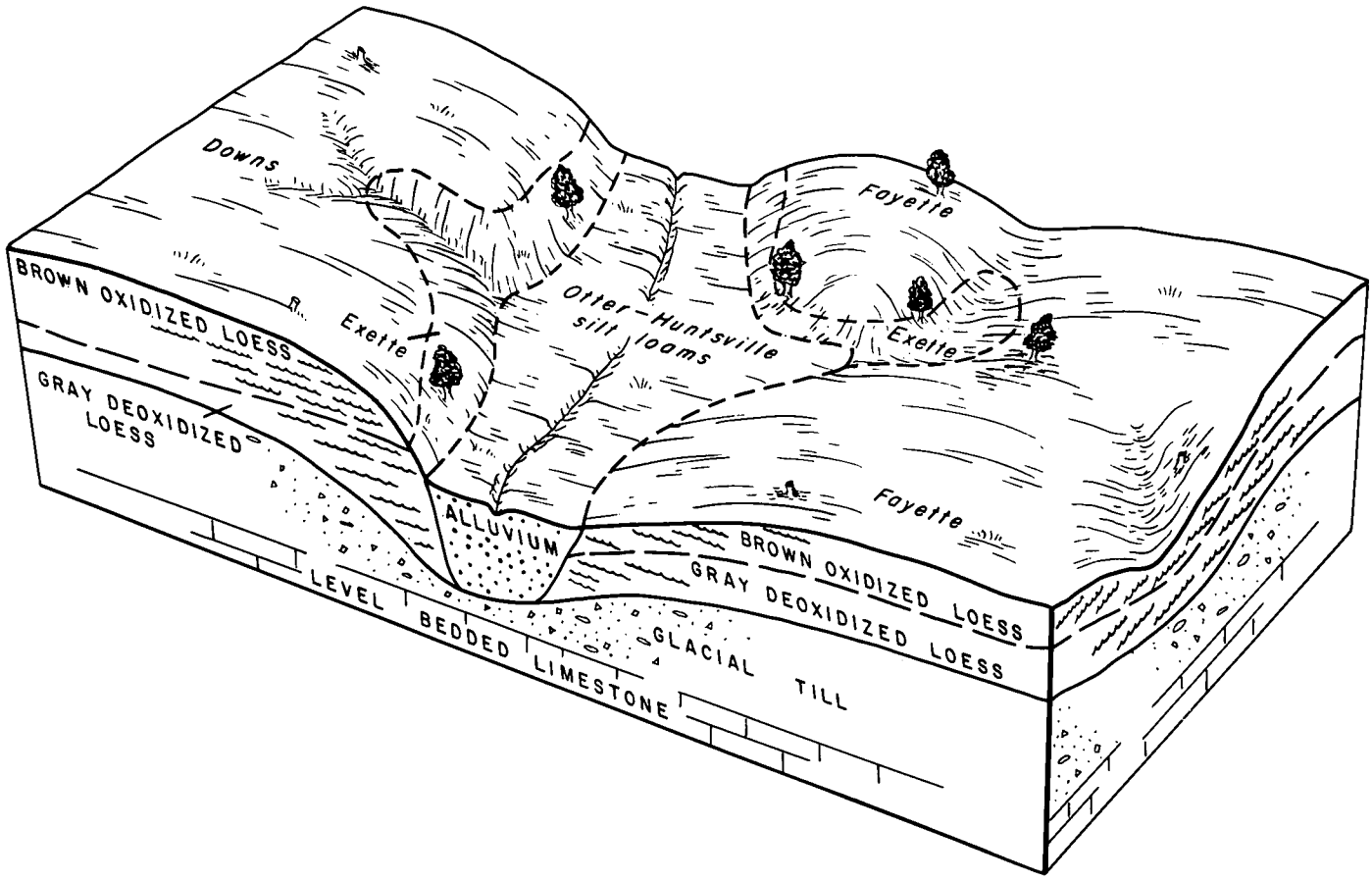

Figure 5.—**Typical pattern of soils and underlying material in association 5.**

Fayette soils are gently sloping to moderately steep and are on convex side slopes. They are usually more sloping than Downs soils. The soils are well drained. They have a light colored silt loam surface layer if cultivated. The subsoil is dark yellowish brown silty clay loam that grades to silt loam as depth increases.

This association is well suited to poorly suited to row crops. The soils are subject to erosion or are too steep for cultivated crops. The principal management needs are control of erosion and maintenance of tilth and fertility. Erosion is a concern, particularly in cultivated parts of ridgetops and valleys. In most areas row crops are grown in rotation with oats and hay, but farming on the contour, constructing terraces, and stripcropping are needed (fig. 6). Tile drainage is needed in some drainageways, and the gullies and drainageways need to be reshaped and seeded in some places. In places the drainageways limit the size of fields.

Farming is diversified. Corn is grown in rotation with oats and hay. A large part of the grain is fed to beef cattle, dairy cattle, and hogs. The size of the average farm is about 200 acres, but the trend is toward larger farms (fig. 7).

6. Dorchester-Saude-Wapsie association

Nearly level to moderately sloping, moderately well drained and well drained soils that formed in silty and loamy alluvial sediment on bottom lands and stream benches

This association is on bottom lands and stream benches characterized by nearly level to moderately sloping areas, but a few strongly sloping to steep areas are along the terrace escarpments. The soils on bottom lands and the soils on the benches form two distinct associations, but they are impractical to separate. The bottom lands are subject to high-velocity flooding of short duration. Most of the soils on the benches are usually free of flooding; however, in places, they receive runoff water from the adjacent hillsides (fig. 8).

This association is scenic. It is adjacent to the Turkey and Volga Rivers and their tributaries. Only a few winding roads cross the valleys. The farms and roads in this association commonly form irregular patterns. The shape of the fields is determined by the boundaries of streams, old stream meanders, and oxbows. Some of the roads parallel the rivers, but the network of roads is sketchy, and only a few roads

Figure 6.—**Grass seeded backslope of tile-inlet terrace in Downs-Fayette association.**

cross the rivers. The farmsteads are usually on the stream benches and are not subject to flooding.

This association makes up about 5 percent of the county. It is about 45 percent Dorchester soils, 20 percent Saude soils, 10 percent Wapsie soils, 8 percent Waukee soils, 6 percent Loamy alluvial land, 4 percent Spillville soils, and 7 percent minor soils. Minor soils in this association include Burkhardt, Caneek, Flagler, Hanlon, Richwood, and Canoe soils.

Dorchester soils are nearly level and are on bottom lands. They are subject to frequent, short-duration, high-velocity flooding. The soils are moderately well drained. They have a stratified, light colored silt loam surface layer that has been recently deposited and is

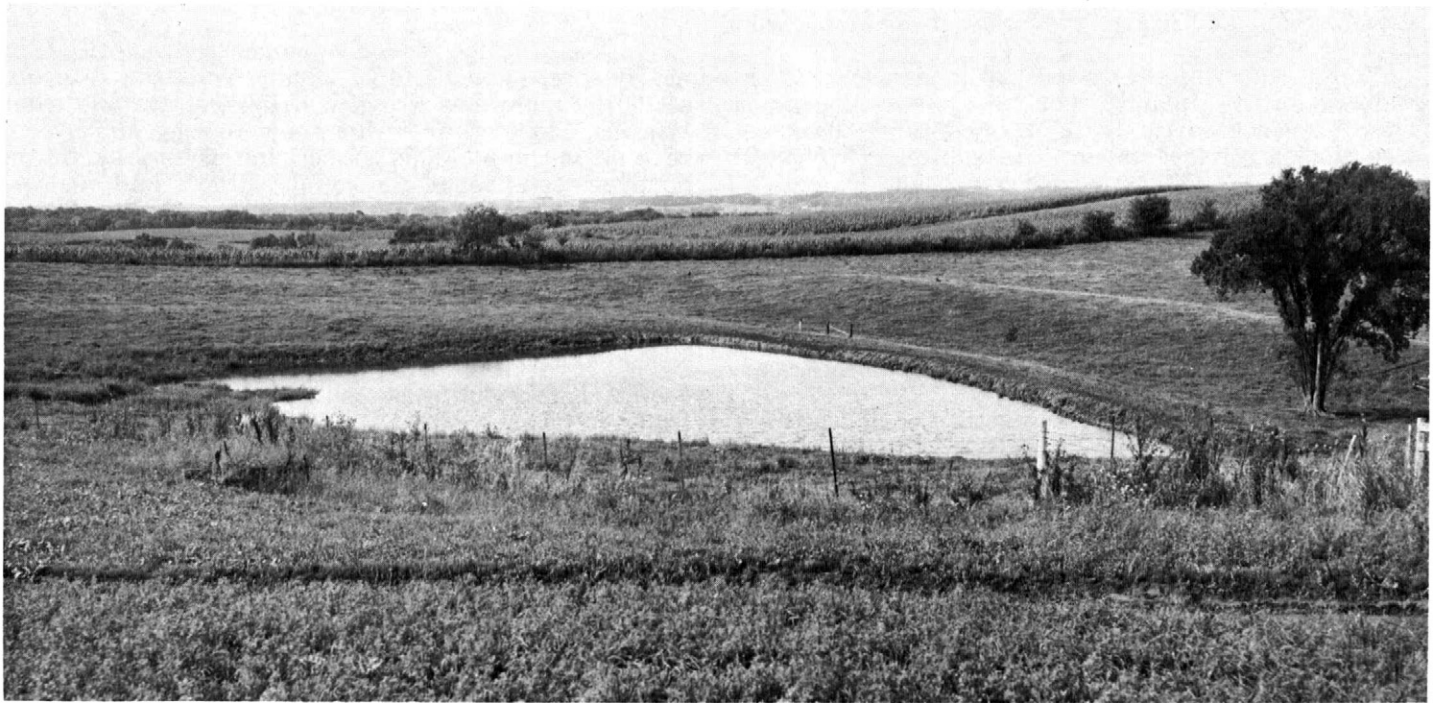

Figure 7.—**Farm pond that provides water for livestock, recreation, and wildlife in the Downs-Fayette association.**

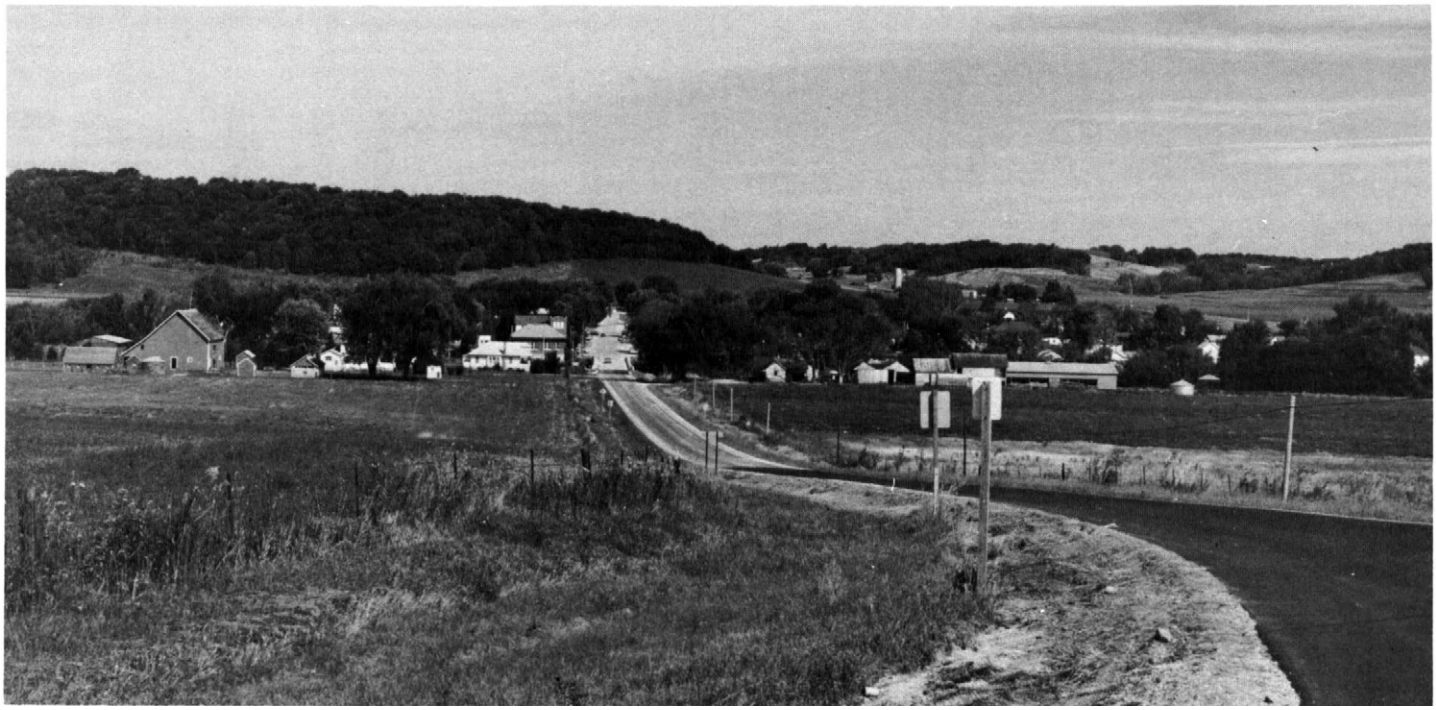

Figure 8.—**Typical area along the Volga River. Dorchester soils are in the stream valley, and Nordness soils are in the background.**

mildly alkaline. A dark colored silt loam buried soil is below a depth of about 3 feet.

Saude soils are nearly level to moderately sloping and on benches. The soils are well drained. They have a dark colored, loamy surface layer over a brown loamy subsoil. Sand and gravel are below a depth of about 2 feet.

Wapsie soils are nearly level to moderately sloping and are on the uplands. The soils are well drained. They have a moderately thick, moderately dark colored, loamy surface layer. The subsoil is yellowish brown loam. Sand and gravel are below a depth of about 2 feet.

Bassett soils are on summits, and the Schley soils are downslope from them. Clyde soils are in drainageways. Wapsie and Burkhardt soils are above the Bassett and Schley soils on the summits and knobs. This sequence often causes side slope seepage and formation of muck areas. Interceptor tile may be necessary to drain such areas.

This association is well suited to poorly suited to row crops. Corn, soybeans, small grain, and hay are the main crops. Organic matter content is moderately low to low. The available water capacity is high in the Bassett and Schley soils and is low to moderate in the Wapsie soils. Wapsie soils are droughty in some years. The main management needs are control of erosion, improvement of drainage, and maintenance of tilth and fertility.

Most of this association is used for cultivated crops. Some small areas of timber and undrained wet areas are used for permanent pasture and for wildlife habitat.

7. Bassett-Schley-Wapsie association

Nearly level to moderately sloping, well drained to somewhat poorly drained soils that formed in loamy material underlain by glacial till or sand and gravel; on uplands

This association is on uplands characterized by nearly level to moderately sloping soils that are dissected by many low gradient drainageways and small streams. Slopes range from short to long and are irregular in shape. This association is mainly in the northwestern part of the county. Stones and boulders are a conspicuous part of the landscape. Seepy areas of muck are common. Fields are generally rectangular in shape, and county roads generally follow section lines. Frequent small tracts of the original oak and hickory forest remain and are a distinctive feature of the landscape.

This association makes up about 6 percent of the county. It is about 50 percent Bassett soils, 18 percent Schley soils, 11 percent Wapsie soils, 9 percent Clyde soils, 5 percent Burkhardt soils, and 7 percent minor soils. Minor soils include Coggon, Flagler, Floyd, Kenyon, Olin, Palms, Saude, and Winneshiek soils.

Bassett soils are gently sloping on ridgetops and moderately sloping on side slopes. The soils are moderately well drained. They have a moderately thick, moderately dark colored, loamy surface layer over a yellowish brown and grayish brown subsoil that contains stones and pebbles.

Schley soils generally are nearly level to gently sloping and are in concave, downslope positions. The soils are somewhat poorly drained. They have a mod-

erately thick, moderately dark colored, loamy surface layer over a yellowish brown, mottled, stratified, loam subsoil that contains stones and pebbles.

Wapsie soils are nearly level to moderately sloping and are on benches. The soils are well drained. They have a moderately dark colored, loamy surface layer over yellowish brown loamy subsoil. Sand and gravel are below a depth of about 2 feet.

This association is well suited to poorly suited to crops. Row crops are grown intensively on this association. Yields are moderately good for the Saude and Wapsie soils in years of normal rainfall. The management needs are control of flooding on the bottom lands and maintenance of tilth and fertility on the benches. The bottom lands are flooded nearly every year for a short time. Flooding generally occurs during thaws early in spring or after heavy rains prior to the growing season. Soils on the benches are generally droughty in years of average or below average rainfall.

There are fewer farms than in other associations, and the farms range from 200 to 240 acres in size. Farming is diversified. A large part of the grain is fed to beef cattle, dairy cattle, and hogs.

Descriptions of the soils

This section describes the soil series and mapping units of Fayette 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 this survey was made," not all mapping units are members of a soil series. Loamy alluvial land and Marsh, for example, are miscellaneous areas 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 readers will prefer to use the short description of the profile in a paragraph preceding the technical description. The technical profile descriptions identify layers by A, B, and C horizons and gives ranges of properties. They are mainly used by 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. In the series description the available phosphorus and available potassium refer to estimated phosphorus and potassium in the subsoil. 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 the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*15*).

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit in which the mapping unit has been placed. The page where each mapping unit is described can be found by referring to the "Index to mapping units" at the front of this survey.

Backbone series

The Backbone series consists of moderately dark colored, somewhat excessively drained soils. These gently sloping to strongly sloping soils are on ridges and convex side slopes on uplands. Slopes are 2 to 14 percent. These soils formed in moderately coarse textured windblown sediment and the underlying very firm residuum over limestone bedrock. The native vegetation was mixed prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark grayish brown, very friable light fine sandy loam about 6 inches thick. The subsurface layer is dark grayish brown, very friable fine sandy loam about 3 inches thick. The subsoil extends to a depth of 34 inches. It is brown and dark yellowish brown, very friable loamy fine sand in the upper part; yellowish brown, firm clay loam in the middle part; and brown, very firm clay in the lower part. Below the subsoil is partially weathered, shattered limestone that has thin rinds of clay residuum. It is underlain by hard limestone bedrock.

Available water capacity is low to very low. Permeability is moderately rapid in the upper part and very rapid in the limestone bedrock. A thin, very slowly permeable layer is just above the limestone, but this layer is commonly not continuous. Available phosphorus is low, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The less sloping Backbone soils are used mainly for cultivated crops. The more sloping soils are used for pasture and woodland. The major limitations for crops are erosion and droughtiness.

Representative profile of Backbone fine sandy loam, 2 to 5 percent slopes, in a cultivated field, 358 feet north and 53 feet east of southwest corner of NW¼ NE¼ sec. 28, T. 91 N., R. 10 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) light fine sandy loam; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

A2—6 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam; very dark grayish brown (10YR 3/2) coatings on peds; weak fine subangular blocky structure parting to weak fine granular; very friable; neutral; clear smooth boundary.

B1—9 to 12 inches; brown (10YR 4/3) loamy fine sand; dark grayish brown (10YR 4/2) coatings on peds; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

B21—12 to 24 inches; dark yellowish brown (10YR 4/4) loamy fine sand; brown (10YR 4/3) coatings on peds; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

IIB22t—24 to 30 inches; yellowish brown (10YR 5/8) clay loam; strong medium and fine

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent
27B	Terril loam, 2 to 5 percent slopes	930	0.2
41	Sparta loamy fine sand, 0 to 2 percent slopes	350	0.1
41B	Sparta loamy fine sand, 2 to 5 percent slopes	1,245	0.3
41C	Sparta loamy fine sand, 5 to 9 percent slopes	585	0.1
41D	Sparta loamy fine sand, 9 to 14 percent slopes	280	0.1
63C	Chelsea loamy fine sand, 2 to 9 percent slopes	365	0.1
63E	Chelsea loamy fine sand, 14 to 25 percent slopes	490	0.1
83B	Kenyon loam, 2 to 5 percent slopes	75,090	16.1
83C	Kenyon loam, 5 to 9 percent slopes	4,725	1.0
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded	1,810	0.4
84	Clyde clay loam, 1 to 3 percent slopes	38,500	8.3
98	Huntsville silt loam, 0 to 2 percent slopes	450	0.1
98B	Huntsville silt loam, 2 to 5 percent slopes	365	0.1
109B	Backbone fine sandy loam, 2 to 5 percent slopes	680	0.1
109C	Backbone fine sandy loam, 5 to 9 percent slopes	585	0.1
109D	Backbone fine sandy loam, 9 to 14 percent slopes	310	0.1
110B	Lamont fine sandy loam, 1 to 5 percent slopes	280	0.1
110C	Lamont fine sandy loam, 5 to 14 percent slopes	470	0.1
115F	Sandy escarpments, 14 to 30 percent slopes	685	0.1
135	Coland clay loam, 0 to 2 percent slopes	940	0.2
C135	Coland clay loam, channeled, 0 to 2 percent slopes	1,815	0.4
142B	Chaseburg silt loam, 2 to 5 percent slopes	2,075	0.4
151	Marshan clay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,435	0.3
152	Marshan clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	2,020	0.4
158	Dorchester silt loam, 0 to 2 percent slopes	3,470	0.7
C158	Dorchester silt loam, channeled, 0 to 2 percent slopes	1,655	0.4
162B	Downs silt loam, 2 to 5 percent slopes	3,800	0.8
162C	Downs silt loam, 5 to 9 percent slopes	12,780	2.7
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded	3,120	0.7
162D	Downs silt loam, 9 to 14 percent slopes	570	0.1
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded	4,875	1.0
162E2	Downs silt loam, 14 to 18 percent slopes, moderately eroded	835	0.2
163B	Fayette silt loam, 2 to 5 percent slopes	910	0.2
163C	Fayette silt loam, 5 to 9 percent slopes	11,235	2.4
163C2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded	5,830	1.3
163D	Fayette silt loam, 9 to 14 percent slopes	2,565	0.6
163D2	Fayette silt loam, 9 to 14 percent slopes, moderately eroded	12,445	2.7
163D3	Fayette silt loam, 9 to 14 percent slopes, severely eroded	1,855	0.4
163E	Fayette silt loam, 14 to 18 percent slopes	3,090	0.7
163E2	Fayette silt loam, 14 to 18 percent slopes, moderately eroded	4,445	1.0
163E3	Fayette silt loam, 14 to 18 percent slopes, severely eroded	2,975	0.6
163F	Fayette silt loam, 18 to 25 percent slopes	2,750	0.6
163F2	Fayette silt loam, 18 to 25 percent slopes, moderately eroded	2,235	0.5
163F3	Fayette silt loam, 18 to 25 percent slopes, severely eroded	1,325	0.3
163G	Fayette silt loam, 25 to 40 percent slopes	2,385	0.5
171B	Bassett loam, 2 to 5 percent slopes	14,630	3.1
171C	Bassett loam, 5 to 9 percent slopes	2,580	0.6
171C2	Bassett loam, 5 to 9 percent slopes, moderately eroded	430	0.1
171D2	Bassett loam, 9 to 14 percent slopes, moderately eroded	210	(1)
171E2	Bassett loam, 14 to 18 percent slopes, moderately eroded	260	(1)
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	1,460	0.3
175C	Dickinson fine sandy loam, 5 to 9 percent slopes	485	0.1
175D	Dickinson fine sandy loam, 9 to 14 percent slopes	195	(1)
177	Saude loam, 0 to 2 percent slopes	5,125	1.1
177B	Saude loam, 2 to 5 percent slopes	2,925	0.6
177C	Saude loam, 5 to 9 percent slopes	470	0.1
178	Waukee loam, 0 to 2 percent slopes	1,050	0.2
178B	Waukee loam, 2 to 5 percent slopes	705	0.2
183C	Dubuque silt loam, 20 to 30 inches to limestone, 5 to 9 percent slopes	145	(1)
183D2	Dubuque silt loam, 20 to 30 inches to limestone, 9 to 14 percent slopes, moderately eroded	500	0.1
183E	Dubuque silt loam, 20 to 30 inches to limestone, 14 to 18 percent slopes	730	0.2
183E2	Dubuque silt loam, 20 to 30 inches to limestone, 14 to 18 percent slopes, moderately eroded	900	0.2
183F	Dubuque silt loam, 20 to 30 inches to limestone, 18 to 25 percent slopes	1,200	0.3
193	Camden silt loam, 0 to 2 percent slopes	445	0.1
198B	Floyd loam, 1 to 4 percent slopes	37,630	8.1
213	Rockton loam, 30 to 40 inches to limestone, 0 to 2 percent slopes	265	0.1
213B	Rockton loam, 30 to 40 inches to limestone, 2 to 5 percent slopes	1,085	0.2

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

Map symbol	Soil name	Acres	Percent
214	Rockton loam, 20 to 30 inches to limestone, 0 to 2 percent slopes	955	0.2
214B	Rockton loam, 20 to 30 inches to limestone, 2 to 5 percent slopes	2,575	0.6
214C	Rockton loam, 20 to 30 inches to limestone, 5 to 9 percent slopes	575	0.1
215E	Goss loam, 9 to 18 percent slopes	210	(1)
221	Palms muck, 1 to 4 percent slopes	860	0.2
225	Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	4,570	1.0
226	Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	945	0.2
265	Bixby loam, 0 to 2 percent slopes	375	0.1
265B	Bixby loam, 2 to 6 percent slopes	455	0.1
284	Flagler sandy loam, 0 to 2 percent slopes	2,485	0.5
284B	Flagler sandy loam, 2 to 5 percent slopes	5,155	1.1
284C	Flagler sandy loam, 5 to 9 percent slopes	600	0.1
285	Burkhardt sandy loam, 0 to 2 percent slopes	220	(1)
285B	Burkhardt sandy loam, 2 to 5 percent slopes	1,225	0.3
285C2	Burkhardt sandy loam, 5 to 9 percent slopes, moderately eroded	1,065	0.2
285E2	Burkhardt sandy loam, 9 to 18 percent slopes, moderately eroded	305	0.1
302B	Coggon loam, 2 to 5 percent slopes	955	0.2
302C	Coggon loam, 5 to 9 percent slopes	305	0.1
315	Loamy alluvial land	6,450	1.4
354	Marsh	105	(1)
391B	Clyde-Floyd complex, 1 to 4 percent slopes	25,230	5.4
394B	Ostrander loam, 2 to 5 percent slopes	4,260	0.9
394C	Ostrander loam, 5 to 9 percent slopes	875	0.2
394C2	Ostrander loam, 5 to 9 percent slopes, moderately eroded	325	0.1
398	Tripoli clay loam, 0 to 2 percent slopes	1,900	0.4
399	Readlyn loam, 0 to 2 percent slopes	3,015	0.6
399B	Readlyn loam, 2 to 5 percent slopes	2,725	0.6
407B	Schley loam, 1 to 4 percent slopes	5,825	1.3
408B	Olin fine sandy loam, 2 to 5 percent slopes	3,560	0.8
408C	Olin fine sandy loam, 5 to 9 percent slopes	795	0.2
409B	Dickinson fine sandy loam, till substratum, 2 to 5 percent slopes	2,425	0.5
409C	Dickinson fine sandy loam, till substratum, 5 to 9 percent slopes	535	0.1
444B	Jacwin loam, 2 to 5 percent slopes	310	0.1
444C	Jacwin loam, 5 to 9 percent slopes	675	0.1
444D	Jacwin loam, 9 to 14 percent slopes	225	(1)
471	Oran loam, 1 to 3 percent slopes	4,200	0.9
478G	Rock outcrop-Nordness complex, 25 to 60 percent slopes	17,280	3.7
480C	Orwood silt loam, 5 to 9 percent slopes	1,165	0.3
480D2	Orwood silt loam, 9 to 14 percent slopes, moderately eroded	1,155	0.2
480E2	Orwood silt loam, 14 to 18 percent slopes, moderately eroded	930	0.2
485	Spillville loam, 0 to 2 percent slopes	2,230	0.5
487B	Otter-Huntsville silt loams, 2 to 5 percent slopes	2,760	0.6
489	Ossian silt loam, 0 to 2 percent slopes	225	(1)
490	Caneek silt loam, 0 to 2 percent slopes	220	(1)
496B	Dorchester-Volney complex, 2 to 5 percent slopes	2,095	0.4
497F	Fayette-Dubuque-Jacwin complex 14 to 25 percent slopes	3,840	0.8
497G	Fayette-Dubuque-Jacwin complex, 25 to 40 percent slopes	1,215	0.3
499B	Nordness silt loam, 2 to 5 percent slopes	460	0.1
499D	Nordness silt loam, 5 to 14 percent slopes	1,015	0.2
499F	Nordness silt loam, 14 to 25 percent slopes	2,605	0.6
512B	Marlean loam, 2 to 5 percent slopes	455	0.1
512D	Marlean loam, 5 to 14 percent slopes	615	0.1
536	Hanlon fine sandy loam, 0 to 2 percent slopes	825	0.2
551	Calamine silty clay loam, 1 to 3 percent slopes	765	0.2
620B	Port Byron silt loam, 2 to 5 percent slopes	340	0.1
714	Winneshiek loam, 20 to 30 inches to limestone, 0 to 2 percent slopes	310	0.1
714B	Winneshiek loam, 20 to 30 inches to limestone, 2 to 5 percent slopes	1,875	0.4
714C	Winneshiek loam, 20 to 30 inches to limestone, 5 to 9 percent slopes	525	0.1
714D	Winneshiek loam, 20 to 30 inches to limestone, 9 to 14 percent slopes	210	(1)
725	Hayfield loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,525	0.3
763D2	Exette silt loam, 9 to 14 percent slopes, moderately eroded	5,105	1.1
763E2	Exette silt loam, 14 to 18 percent slopes, moderately eroded	2,260	0.5
763E3	Exette silt loam, 14 to 18 percent slopes, severely eroded	1,510	0.3
763F2	Exette silt loam, 18 to 25 percent slopes, moderately eroded	1,100	0.2
763F3	Exette silt loam, 18 to 25 percent slopes, severely eroded	800	0.2
777	Wapsie loam, 0 to 2 percent slopes	3,345	0.7
777B	Wapsie loam, 2 to 5 percent slopes	2,220	0.5

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

Map symbol	Soil name	Acres	Percent	Map symbol	Soil name	Acres	Percent
777C	Wapsie loam, 5 to 9 percent slopes	480	0.1	784B	Riceville loam, 1 to 4 percent slopes	520	0.1
781B	Lourdes loam, 2 to 5 percent slopes	1,300	0.3	798B	Protivin loam, 1 to 4 percent slopes	2,900	0.6
781C	Lourdes loam, 5 to 9 percent slopes	215	(1)	926	Canoe silt loam, 0 to 2 percent slopes	375	0.1
782	Donnan loam, 0 to 2 percent slopes	220	(1)	977	Richwood silt loam, 0 to 2 percent slopes	215	(1)
782B	Donnan loam, 2 to 5 percent slopes	2,650	0.6	978	Festina silt loam, 0 to 2 percent slopes	460	0.1
782C	Donnan loam, 5 to 9 percent slopes	280	0.1		Limestone quarries, water, sand and gravel pits, borrow areas, made land	1,210	0.3
783B	Cresco loam, 2 to 5 percent slopes	10,575	2.3		Total	465,920	100.0
783C	Cresco loam, 5 to 9 percent slopes	1,215	0.3				

[1] Less than 0.1 percent.

subangular blocky structure; firm; stone line at a depth of 24 inches; thin discontinuous brown (10YR 4/3) clay films; strongly acid; abrupt wavy boundary.

IIB23t—30 to 34 inches; brown (7.5YR 4/4) clay; strong coarse prismatic structure parting to strong medium subangular blocky; very firm; thick continuous yellowish red (5YR 4/6) clay films; many soft black (10YR 2/1) oxide concretions; strongly acid; abrupt wavy boundary.

IIR1—34 to 36 inches; soft limestone weathered along joints and partially fractured; limestone flags with reddish brown (5YR 4/4) and strong brown (7.5YR 5/6) clay residuum interbedded; mildly alkaline; strong effervescence.

IIR2—36 inches; hard fractured limestone bedrock.

The solum is 20 to 40 inches thick. It ranges from neutral to strongly acid in the most acid part. The soils formed in 20 to 40 inches of moderately coarse textured sediment and in the underlying very firm residuum weathered from limestone bedrock. The A1 or Ap horizon is typically very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 4/3 or 5/3) and is 2 to 4 inches thick. In eroded areas the A2 horizon may be wholly incorporated into the Ap horizon. The IIB23t horizon is heavy clay loam to clay and is 2 to 7 inches thick.

Backbone soils are associated with Chelsea, Lamont, and Nordness soils. They have limestone at a depth of less than 40 inches; Chelsea and Lamont soils do not. They have more sand in the A and B horizons than Nordness soils.

109B—Backbone fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on convex ridges and side slopes on uplands and in benchlike areas. Areas are about 10 acres in size and irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils that have a thicker and darker surface layer and are higher in organic matter and fertility than this Backbone soil.

This soil is suited to occasional row crops. It is droughty because of the shallowness to limestone bedrock. Crop yields are low unless rainfall is very timely. This soil is subject to soil blowing and water erosion if cultivated. The organic matter content is very low. Capability unit IIIe–4.

109C—Backbone fine sandy loam, 5 to 9 percent slopes. This moderately sloping soil is on convex ridges and side slopes on uplands. Areas are 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the depth to limestone is less.

Included with this soil in mapping are a few areas of moderately eroded soils that are lower in fertility and organic matter content than this Backbone soil.

This soil is poorly suited to cultivated crops. It is droughty and crop yields are low unless rainfall is above normal and very timely. It is subject to soil blowing and water erosion if cultivated. This soil is not well suited to terraces because of the shallowness to limestone bedrock. The organic matter content is very low. Capability unit IVe–2.

109D—Backbone fine sandy loam, 9 to 14 percent slopes. This strongly sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the depth to limestone is less, typically about 20 to 26 inches.

Included with this soil in mapping are a few areas of moderately eroded soils. Small areas of soils where the limestone bedrock is near to or is exposed at the

surface, and which are lower in productivity than this Backbone soil, are also included.

This soil is poorly suited to cultivated crops. It is better suited to pasture or woodland. It is droughty and crop yields are low unless rainfall is above normal and very timely. It is subject to soil blowing and water erosion if cultivated. The organic matter content is very low. Capability unit IVe–2.

Bassett series

The Bassett series consists of moderately dark, moderately well drained soils. These gently sloping to moderately steep soils are on convex ridges and side slopes on uplands. Slopes are 2 to 18 percent. These soils formed in 12 to 24 inches of loamy material and in the underlying firm glacial till. The native vegetation was mixed prairie grasses and deciduous trees. In most places a layer of stones and pebbles is at the contact of the loamy material and the glacial till.

In a representative profile the surface layer is very dark brown loam about 8 inches thick. The subsoil extends to a depth of 51 inches. In the upper part it is brown, friable loam; in the middle part it is yellowish brown, firm loam that has brown and grayish brown mottles; and in the lower part it is mottled yellowish brown and grayish brown, firm loam. The substratum is mottled yellowish brown and grayish brown, firm loam that is mildly alkaline and strongly effervescent.

Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow in the underlying firm glacial till. Water moves more rapidly in the upper loamy material than it does in the underlying glacial till. It accumulates at the till contact and causes wet, seepy areas in some years. Available phosphorus and potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The Bassett soils are used mainly for cultivated crops. The major limitation for crops is erosion. Providing adequate drainage and controlling erosion on these soils are difficult. The long, uniform slopes are well suited to cultivating on the contour and terracing, but these practices slow the movement of surface water, allowing more of it to soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of practices, such as terracing or mulch tillage and tile drainage, is suitable for these soils.

Representative profile of Bassett loam, 2 to 5 percent slopes, in a cultivated field, 126 feet west and 54 feet north of southeast corner of NE¼SW¼ sec. 4, T. 91 N., R. 10 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

B1—8 to 14 inches; brown (10YR 4/3) loam; some dark brown (10YR 3/3) coatings on peds; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

IIB21—14 to 22 inches; yellowish brown (10YR 5/6) heavy loam; brown (10YR 4/3) coatings on peds; weak medium subangular blocky structure; friable; pebble band at top of horizon; strongly acid; gradual smooth boundary.

IIB22t—22 to 37 inches; yellowish brown (10YR 5/6) heavy loam; grayish brown (10YR 5/2) ped coatings in the lower part; few fine distinct brown (10YR 5/3) mottles; weak medium prismatic structure parting to weak, medium, subangular blocky; firm; few thin discontinuous dark brown (7.5YR 4/2) clay films; strongly acid; gradual smooth boundary.

IIB3—37 to 51 inches; mottled yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) heavy loam; weak medium prismatic structure; firm; strongly acid; abrupt wavy boundary.

IIC—51 to 60 inches; mottled yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) loam; massive; firm; mildly alkaline; strong effervescence.

The solum is 40 to 55 inches thick. Carbonates are at a depth of 40 to 60 inches. The soils formed in 12 to 24 inches of loamy material and in the underlying glacial till. The A1 or Ap horizon is very dark brown (10YR 2/2) or very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). It is 6 to 9 inches thick. In undisturbed areas, the A2 horizon is brown (10YR 4/3) or dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2). In cultivated areas, it may be wholly incorporated into the Ap horizon. The IIB horizon is typically heavy loam, but in some places it is sandy clay loam and light clay loam. It ranges from medium acid to very strongly acid.

Bassett soils are associated with Schley, Floyd, and Clyde soils, and they formed in parent material similar to those of Oran and Kenyon soils. They are browner in the upper part of the B horizon than Oran soils. They have a thinner A horizon than Kenyon soils. Bassett soils are browner in the upper part of the B horizon and have a firmer, less stratified IIB horizon than Schley, Floyd, and Clyde soils.

171B—Bassett loam, 2 to 5 percent slopes. This gently sloping soil is on long, convex ridges and side slopes on uplands. Areas are 20 acres or more in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of sandy soils that are more droughty and less productive than this Bassett soil.

This soil is well suited to intensive row crops, such as corn and soybeans. It is subject to slight erosion if cultivated. Because of the difference in the permeability of the loamy material and the underlying glacial till at a depth of about 1½ feet, water accumulates at the contact of these materials and produces a temporary high water table, especially early in spring. A combination of terracing and tile drainage is needed because of the difficulty of providing adequate drainage and erosion control. Careful placement and spacing of tile are important because of the slowly permeable subsoil. The organic matter content is moderately low. Capability unit IIe–1.

171C—Bassett loam, 5 to 9 percent slopes. This moderately sloping soil is on short, convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is only about 6 inches thick.

Included with this soil in mapping are a few areas of moderately eroded soils in which part of the subsoil has been incorporated into the plow layer. Also included are a few small areas of sandy soils that are more droughty than this Bassett soil.

This soil is suited to row crops, such as corn and soybeans. It is subject to moderate to severe erosion if cultivated. Because of the difference in permeability in the loamy material and the underlying glacial till, water accumulates at the contact of these materials and then moves downhill along the contact. Because this soil is typically at a lower elevation than other Bassett soils, seepy spots are likely to occur in spring, especially in wet years. The organic matter content is moderately low. Capability unit IIIe–1.

171C2—Bassett loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on short, convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the plow layer is mixed with part of the subsoil and is lighter colored. Because of erosion, the surface layer is lower in organic matter content and the firm till subsoil of low fertility is shallower than in the less eroded Bassett soils.

Included with this soil in mapping are a few areas of sandy soils that are more droughty than this Bassett soil.

This soil is suited to row crops, such as corn and soybeans. It is subject to severe erosion if cultivated. In wet seasons field work is slightly delayed. Because of the difficulty in providing adequate erosion control and drainage, a combination of terracing and tile drainage is needed. The organic matter content is low. Capability unit IIIe–1.

171D2—Bassett loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on side slopes on uplands. Areas are about 5 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is lighter colored and material from the upper part of the subsoil has been mixed into the plow layer.

Included with this soil in mapping are small areas of soils that are severely eroded and are lower in organic matter content and fertility than this Bassett soil.

This soil is suited to row crops under good management, including control of erosion. It is subject to severe erosion if cultivated. The subsoil, which is exposed by construction of terraces, is low in fertility and needs additional fertilizer and organic matter for crop production. Because the lower part of the subsoil is also moderately slow in permeability, wet spots are present for short periods after the terrace construction. The organic matter content is low. Capability unit IIIe–2.

171E2—Bassett loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on the uplands. Areas are about 5 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored and material from the upper part of the subsoil has been mixed into the plow layer.

Included with this soil in mapping are a few areas of severely eroded soils that have little or no original topsoil left and that are lower in organic matter content and fertility than this Bassett soil.

This soil is poorly suited to cultivated crops. It is better suited to hay, pasture, or woodland. It is subject to severe erosion if cultivated. The organic matter content is low to very low. Capability unit IVe–1.

Bixby series

This Bixby series consists of light colored, well drained soils. These nearly level to moderately sloping soils are on alluvial benches along streams and in outwash areas on uplands. Slopes are 0 to 6 percent. These soils formed in 24 to 32 inches of medium textured alluvium and in the underlying coarse textured outwash. The native vegetation was deciduous trees.

In a representative profile the surface layer is very dark gray loam about 3 inches thick. The subsurface layer is brown loam about 6 inches thick. The subsoil extends to a depth of 30 inches. It is dark yellowish brown, friable sandy clay loam in the upper part; yellowish brown, friable heavy loam and light clay loam in the middle part; and yellowish brown, friable sandy clay loam in the lower part. The substratum is strong brown, medium and coarse sand that contains about 10 to 20 percent gravel.

Available water capacity is moderate. Permeability is moderate in the upper part of the soil and very rapid in the coarse textured substratum. Available phosphorus is low, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The Bixby soils are used mainly for cultivated crops and pasture. The major limitations for crops are droughtiness and erosion in the more sloping areas.

Representative profile of Bixby loam, 0 to 2 percent slopes, in a permanent pasture at edge of wooded area, 51 feet east and 102 feet south of northwest corner of sec. 30, T. 95 N., R. 10 W.:

A1—0 to 3 inches; very dark gray (10YR 3/1) loam; weak fine and very fine granular structure; friable; medium acid; clear smooth boundary.

A2—3 to 9 inches; brown (10YR 4/3) loam; dark grayish brown (10YR 4/2) coatings on peds; weak thin platy structure parting to weak fine subangular blocky; friable; strongly acid; clear smooth boundary.

B1—9 to 14 inches; dark yellowish brown (10YR 4/4) sandy clay loam; a few brown (10YR 4/3) coatings on peds; weak medium and fine subangular blocky struc-

ture; friable; strongly acid; gradual smooth boundary.

B21t—14 to 21 inches; yellowish brown (10YR 5/4) heavy loam; moderate medium subangular blocky structure; friable; thin discontinuous brown (7.5YR 4/4) clay films; very strongly acid; clear smooth boundary.

B22t—21 to 26 inches; yellowish brown (10YR 5/6) light clay loam; moderate medium subangular blocky structure; friable; thin discontinuous brown (7.5YR 4/4) clay films; very strongly acid; clear smooth boundary.

B3t—26 to 30 inches; yellowish brown (10YR 5/6) sandy clay loam; weak medium subangular blocky structure; friable; thin discontinuous brown (7.5YR 5/4) clay films; very strongly acid; abrupt wavy boundary.

IIC—30 to 60 inches; strong brown (7.5YR 5/6) medium and coarse sand; strata of brown (7.5YR 4/4) medium and coarse sand; single grained; loose; about 10 to 20 percent gravel; strongly acid.

The solum is 28 to 40 inches thick. Coarse textured material is at a depth of 24 to 32 inches. Carbonates are absent above a depth of 60 inches. The soil ranges from medium acid to very strongly acid in the most acid part. The A1 horizon is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and is 2 to 5 inches thick. The Ap horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) to brown (10YR 5/3). It is 4 to 8 inches thick, but in cultivated areas in places it is wholly incorporated into the Ap horizon. The B2t horizon is loam or heavy loam to light clay loam. The B3t horizon is sandy loam or sandy clay loam.

Bixby soils are associated with Coggon, Lamont, and Wapsie soils. They formed in parent material similar to that of Saude and Wapsie soils. They have a thinner A1 horizon and a lighter colored Ap horizon, where it is present, than Wapsie and Saude soils. They have less sand in the A horizon than Lamont soils. Bixby soils have more sand in the B and C horizons than Coggon soils and are not formed in glacial till as are Coggon soils.

265—Bixby loam, 0 to 2 percent slopes. This nearly level soil is on alluvial benches along streams. Areas are about 10 to 20 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that have a sandy loam surface layer and are more droughty than this Bixby soil.

This soil is suited to cultivated crops. It is susceptible to little runoff, but because of the coarse textured substratum, droughtiness is a limitation unless rainfall is above average or timely. The organic matter content is low. Capability unit IIs–1.

265B—Bixby loam, 2 to 6 percent slopes. This gently sloping to moderately sloping soil is in outwash areas on uplands and on stream benches. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the depth to sand and gravel is less.

Included with this soil in mapping are a few areas of soils that have steeper slopes and are subject to more erosion than this Bixby soil.

This soil is suited to cultivated crops. It is subject to slight to moderate erosion if cultivated. Because of the coarse textured substratum, droughtiness is a limitation if rainfall is not timely or above normal during the growing season. The organic matter content is very low. Capability unit IIe–2.

Burkhardt series

The Burkhardt series consists of dark colored, somewhat excessively drained soils. These nearly level to moderately steep soils are on stream benches and in outwash areas on uplands. Slopes are 0 to 18 percent. These soils formed in 15 to 20 inches of moderately coarse textured material and in the underlying coarse sand and gravel. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown, very dark grayish brown, and dark brown, friable sandy loam about 13 inches thick. The subsoil extends to a depth of 17 inches. It is yellowish brown, friable loam in the upper part and strong brown, very friable loamy sand in the lower part. The substratum is strong brown coarse sand and gravel.

Available water capacity is very low. Permeability is moderately rapid in the upper part of the soil and very rapid in the coarse textured substratum. Available phosphorus and available potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Burkhardt soils are used mainly for cultivated crops and pasture. The major limitation for crops is droughtiness. These soils are droughty even in years of average rainfall.

Representative profile of Burkhardt sandy loam, 2 to 5 percent slopes, in a cultivated field, 43 feet west and 360 feet south of the northeast corner of SE¼ SE¼ sec. 33, T. 91 N., R. 7 W.:

Ap—0 to 7 inches; very dark brown (10YR 2/2) sandy loam; cloddy parting to weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A12—7 to 11 inches; very dark grayish brown (10YR 3/2) sandy loam; weak medium and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A3—11 to 13 inches; dark brown (10YR 3/3) sandy loam; weak medium and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B2t—13 to 15 inches; yellowish brown (10YR 5/6) loam; moderate medium subangular blocky structure; friable; few thin discontinuous dark yellowish brown

(10YR 4/4) clay films; slightly acid; clear smooth boundary.

B3—15 to 17 inches; strong brown (7.5YR 5/6) loamy sand; very weak fine subangular blocky structure; very friable; about 10 percent 2-millimeter gravel; medium acid; clear smooth boundary.

C—17 to 60 inches; strong brown (7.5YR 5/6) stratified coarse sand and gravel; single grained; loose; about 40 percent gravel 2 millimeters and larger; strongly acid.

The solum is 16 to 24 inches thick. It is medium acid to very strongly acid in the most acid part. Coarse textured material is at a depth of 15 to 20 inches. The A1 or Ap horizon is black (10YR 2/1) to very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A horizon is 10 to 16 inches thick. It is typically sandy loam but is gravelly in places. The B2 horizon is light sandy clay loam or loam to gravelly loam sand or sand.

Burkhardt soils are associated with Sparta, Kenyon, Flagler, and Saude soils, and they formed in parent material similar to that of Flagler soils. They have a coarse textured C horizon at a shallower depth than Flagler and Saude soils. They have more clay and less sand in the A horizon than Sparta soils. Burkhardt soils have more sand throughout the solum than Kenyon soils and are not formed in glacial till, as are Kenyon soils.

285—Burkhardt sandy loam, 0 to 2 percent slopes. This nearly level soil is on stream benches. Areas are 10 to 20 acres in size and are irregular in shape.

Included with this soil in mapping are a few areas of soils that have a thinner, lighter colored surface layer and are lower in organic matter content and fertility than this Burkhardt soil.

This soil is poorly suited to row crops. It is subject to droughtiness even when rainfall is average. The crop yields depend on the amount and timeliness of rainfall. The organic matter content is low. Capability unit IVs–1.

285B—Burkhardt sandy loam, 2 to 5 percent slopes. This gently sloping soil is on stream benches and uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils that have a thinner, lighter colored surface layer and are lower in organic matter content and fertility than this Burkhardt soil.

This soil is poorly suited to row crops. It is subject to droughtiness and to soil blowing and water erosion if cultivated. The crop yields depend on the amount and timeliness of rainfall. The organic matter content is low. Capability unit IVs–1.

285C2—Burkhardt sandy loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is in outwash areas on uplands and in a few areas on stream benches. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored and has been partly removed by erosion. This soil is lower in fertility and organic matter content than uneroded Burkhardt soils.

Included with this soil in mapping are small areas of gravel outcrop that is more droughty and less productive than this Burkhardt soil.

This soil is poorly suited to row crops. It is subject to droughtiness and to severe soil blowing and water erosion if cultivated. The crop yields depend on the amount and timeliness of rainfall. The organic matter content is very low. Capability unit IVs–1.

285E2—Burkhardt sandy loam, 9 to 18 percent slopes, moderately eroded. This strongly sloping to moderately steep soil is in outwash areas on uplands. Areas are about 5 to 10 acres in size and are round. This soil is in high positions on the landscape and is above the less sloping Kenyon and Sparta soils.

This soil has a profile similar to the one described as representative of the series, but depth to the coarse textured material is generally less.

Included with this soil in mapping are a few areas of soils that have a thinner and lighter colored surface layer and are lower in organic matter content and fertility than this Burkhardt soil.

This soil is poorly suited to row crops. It is better suited to permanent pasture. It is subject to droughtiness even if rainfall is average. It is also susceptible to severe erosion if cultivated. The organic matter content is very low. Capability unit VIs–1.

Calamine series

The Calamine series consists of dark colored, poorly drained soils. These nearly level to gently sloping soils are on foot slopes on high structural benches below limestone outcrops. Slopes are 1 to 3 percent. These soils formed in 24 to 32 inches of moderately fine textured material and in the underlying very firm silty clay shale. The native vegetation was mixed prairie grasses that were tolerant to wetness.

In a representative profile the surface layer is black, friable silty clay loam about 17 inches thick. The subsoil extends to a depth of 40 inches. It is olive gray and olive, friable silty clay loam in the upper part; mottled olive and yellowish brown, friable silty clay loam in the middle part; and mottled greenish gray and yellowish brown, very firm calcareous silty clay in the lower part. The substratum is mottled greenish gray and yellowish brown, very firm calcareous silty clay shale.

Available water capacity is moderate. Permeability is moderately slow in the upper part of the soil and very slow in the silty clay shale. Available phosphorus and potassium are low. These soils are generally neutral in the surface layer and do not require liming.

The Calamine soils are mainly used for pasture. The major limitation for crops is wetness due to seepiness. Artificial drainage is needed, but this is difficult because the water that keeps these areas wet must be intercepted upslope before it seeps into the rooting zone.

Representative profile of Calamine silty clay loam, 1 to 3 percent slopes, in a permanent pasture, 309 feet south and 330 feet east of the northwest corner of SE¼ sec. 2, T. 94 N., R. 7 W.:

A1—0 to 10 inches; black (N 2/0) silty clay loam; moderate very fine and fine granular structure; friable; neutral; gradual smooth boundary.

A3—10 to 17 inches; black (10YR 2/1) heavy silty clay loam, weak medium subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

B2g—17 to 24 inches; olive gray (5Y 5/2) and olive (5Y 5/3) heavy silty clay loam; gray (5Y 5/1) coatings on peds; few fine prominent yellowish brown (10YR 5/8) mottles; moderate medium and fine subangular blocky structure parting to moderate very fine subangular blocky; friable; neutral; gradual smooth boundary.

B31—24 to 29 inches; mottled yellowish brown (10YR 5/8) and olive (5Y 5/3) heavy silty clay loam; few fine faint light olive gray (5Y 6/2) mottles; weak medium and fine subangular blocky structure; friable; neutral; clear smooth boundary.

IIB32g—29 to 40 inches; mottled greenish gray (5GY 6/1) and yellowish brown (10YR 5/6, 5/8) silty clay; moderate medium and fine prismatic structure parting to strong medium and fine subangular blocky; very firm; mildly alkaline; strong effervescence; gradual smooth boundary.

IIC—40 to 60 inches; mottled greenish gray (5GY 6/1) and yellowish brown (10YR 5/8) silty clay shale; massive; very firm; mildly alkaline; strong effervescence.

The solum is generally more than 36 inches thick, but it ranges from 30 to 50 inches in thickness. The solum is neutral or slightly acid in the most acid part. The soils formed in 24 or 32 inches of moderately fine textured material and in the underlying very firm silty clay shale. Carbonates are present in the lower part of the solum at a depth of 24 to 40 inches. The A horizon is typically silty clay loam but ranges to heavy loam and heavy silt loam that is high in sand. It is 15 to 24 inches thick. The B2 horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 2 to 6. The B2 and B3 horizons are typically silty clay loam but range to sandy clay loam. In places a thin stratum of sandy loam or loamy sand as much as 8 inches thick is between the moderately fine textured material and the clayey shale. Texture of the shale is silty clay or clay. In some places a small amount of fractured limestone is interbedded with the shale. Reaction of the shale is mildly alkaline.

These Calamine soils do not have the argillic horizon that is typical of the series, but this does not significantly alter their usefulness or behavior.

Calamine soils are associated with the Jacwin, Marlean, Rockton, Winneshiek, and Nordness soils and the Rock Outcrop-Nordness complex. They are not underlain by limestone bedrock as are Rockton, Marlean, Winneshiek, and Nordness soils. They have a grayer upper B horizon and are more poorly drained than Jacwin soils.

551—Calamine silty clay loam, 1 to 3 percent slopes. This nearly level to gently sloping soil is on slightly concave to slightly convex foot slopes on high structural benches on uplands. Areas are 10 to 20 acres in size and are irregular in shape.

Included with this soil in mapping are a few areas of soils in which the depth to clayey shale is 4 feet or more. Also included are areas of soils that have a loam texture above the shale and that commonly contain a sand lens as much as 2 feet thick. These areas may be more difficult to drain.

This soil is poorly suited to cultivated crops. It is subject to wetness caused by seepiness from soils upslope. Water from springs feed many areas. Artificial drainage is needed, but is difficult because the water feeding these areas must be intercepted upslope before it reaches the rooting zone. The organic matter content is high. Capability unit IIIw–2.

Camden series

The Camden series consists of light colored, well drained soils. These nearly level soils are on stream benches. Slopes are 0 to 2 percent. These soils formed in 36 to 45 inches of medium textured silty alluvium and in the underlying stratified outwash. The native vegetation was deciduous trees.

In a representative profile the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is brown silt loam about 3 inches thick. The subsoil extends to a depth of 55 inches. It is brown, friable silt loam in the upper part; yellowish brown, friable heavy silt loam and light clay loam in the middle part; and brown, friable clay loam and sandy clay loam with sandy loam strata in the lower part. The substratum is dark brown sandy loam and has some gravel and thin strata of sandy clay loam.

Available water capacity is moderate. Permeability is moderate in the upper part of the soil and moderately rapid to rapid in the coarser textured substratum. Available phosphorus is medium, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are acid.

Camden soils are mainly used for cultivated crops. The major limitation for crops is occasional runoff from the adjoining loess-covered uplands. These soils can be somewhat droughty during seasons of below normal rainfall.

Representative profile of Camden silt loam, 0 to 2 percent slopes, in a cultivated field, 520 feet west and 416 feet south of the northeast corner of SW¼SW¼ sec. 34, T. 95 N., R. 7 W.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; few very dark grayish brown (10YR 3/2) coatings on peds, light brownish gray (10YR 6/2) dry; cloddy parting to weak fine and very fine granular structure; friable; slightly acid; abrupt smooth boundary.

A2—8 to 11 inches; brown (10YR 4/3) silt loam; very weak thin platy structure; friable; slightly acid; clear smooth boundary.

B1—11 to 15 inches; brown (10YR 5/3) silt

loam; weak to moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21t—15 to 26 inches; yellowish brown (10YR 5/6) heavy silt loam; moderate to strong medium and fine angular blocky and subangular blocky structure; friable; thin discontinuous light gray (10YR 7/1) dry silt coatings on ped faces; thin discontinuous dark brown (10YR 3/3) clay films; slightly acid; clear smooth boundary.

IIB22t—26 to 31 inches; yellowish brown (10YR 5/6) light clay loam; moderate medium and fine angular blocky and subangular blocky structure; friable; thin discontinuous brown (10YR 4/3) clay films; friable; slightly acid; clear smooth boundary.

IIB31t—31 to 40 inches; brown (7.5YR 4/4) light clay loam; moderate medium and fine subangular blocky structure; friable; thin discontinuous dark brown (7.5YR 3/2) clay films; a few 2-millimeter pebbles; medium acid; clear smooth boundary.

IIB32t—40 to 55 inches; brown (7.5YR 4/4) sandy clay loam; thin strata of sandy loam; very weak medium and fine subangular blocky structure; very friable; thin discontinuous dark brown (7.5YR 3/2) clay films; common 2-millimeter pebbles and chert fragments; medium acid; clear smooth boundary.

IIC—55 to 60 inches; dark brown (7.5YR 3/2) sandy loam; 10 percent gravel; thin strata of sandy clay loam; single grained; loose; few chert fragments; slightly acid.

The solum is 40 to 60 inches thick. Coarse textured material is at a depth of 36 to 45 inches. Carbonates are absent above a depth of 60 inches. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 2 to 4 inches thick. The Ap horizon is dark grayish brown (10YR 4/2) to brown (10YR 4/3) or (10YR 5/3). The upper part of the B horizon, formed in silty alluvium, is silt loam or light silty clay loam. The IIB horizon, formed in stratified outwash, is clay loam or sandy clay loam to sandy loam, gravelly sandy loam, or loam. The B and IIB horizons have hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. The IIC horizon is gravelly sandy loam or loamy sand but in places has thin strata of sandy clay loam or loam.

Camden soils are associated with the Festina, Bixby, and Wapsie soils. They have a coarser textured C horizon than Festina soils. They have less sand in the A horizon and upper part of the B horizon than Bixby and Wapsie soils.

193—Camden silt loam, 0 to 2 percent slopes. This nearly level soil is on stream benches. Areas are about 10 acres in size and irregular in shape.

Included with this soil in mapping are areas of soils that have a thicker and darker surface layer. The surface layer and subsoil are loam or silt loam that are high in sand. They may be more droughty than this Camden soil.

This soil is well suited to cultivated crops. It is subject to runoff and sediment from soils upslope. It is subject to droughtiness when rainfall is below average. The organic matter content is low to very low. Capability unit I–1.

Caneek series

The Caneek series consists of moderately dark colored, somewhat poorly drained to poorly drained soils. These nearly level soils are on flood plains associated with the steep soils that formed in thin loess over limestone on uplands. Slopes are 0 to 2 percent. These soils formed in 20 to 36 inches of recently deposited, stratified, calcareous, silty alluvium and in the underlying older, dark, silty alluvium. They are commonly stratified, because each flood deposits fresh sediment on the surface. Because these soils are young, vegetation has not influenced the profile development.

In a representative profile the recently deposited material extends to a depth of 23 inches. It is dark gray, friable, mildly alkaline silt loam that has yellowish red and reddish brown mottles. A black silt loam buried soil is below a depth of 23 inches.

Available water capacity is high. Permeability is moderate. Available phosphorus is very low, and available potassium is low. The soils are mildly alkaline in the surface layer and do not require lime.

Caneek soils are used mainly for permanent pasture. The major limitations for crops are wetness and flooding. These soils are subject to numerous floods of short duration during the growing season.

Representative profile of Caneek silt loam, 0 to 2 percent slopes, in permanent pasture, 210 feet east and 86 feet south of the southeast corner of the SE¼ NW¼ sec. 2, T. 95 N., R. 9 W.:

C1g—0 to 12 inches; dark gray (5Y 4/1) silt loam, some very dark gray (5Y 3/1); few fine distinct yellowish red (5YR 4/6), reddish brown (5YR 4/4), and strong brown (7.5YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

C2g—12 to 23 inches; dark gray (5Y 4/1) silt loam; common fine distinct dark reddish brown (5YR 3/3) and very dark gray (N 3/0) mottles; very weak thin platy structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIAb—23 to 60 inches; black (N 2/0) silt loam, high in sand; very weak fine subangular blocky structure; friable; neutral.

These soils formed in 20 to 36 inches of recent, stratified calcareous, silty alluvium and in the underlying dark buried soil. The C horizon is typically dark gray (10YR 4/1) or dark grayish brown (10YR 4/2), but ranges to colors with hue of 5Y, value of 4 or 5, and chroma of 1 and 2. The C horizon is typically silt loam, but its range in texture includes thin layers of loam or silt loam high in sand. The IIAb horizon is typically silt loam, but ranges to light silty clay loam.

Caneek soils are associated with Dorchester, Ossian, and Huntsville soils, and they formed in parent material similar to that of Dorchester soils. They have a grayer C horizon than the Dorchester soils and are more poorly drained. They are lighter colored in the upper part of the profile than Ossian and Huntsville soils.

490—Caneek silt loam, 0 to 2 percent slopes. This nearly level soil is on bottom lands and low stream benches. Areas are about 10 acres in size and are irregular in shape.

Included with this soil in mapping are a few areas of soils that have 6 to 15 inches of sandy overwash. These areas are lower in productivity than this Caneek soil.

This soil is suited to row crops if well managed. It is subject to numerous floods of short duration during the growing season. Diversion terraces help to protect it from runoff. It has a seasonal high water table, and tile drainage is beneficial. The organic matter content is very low above a depth of 20 to 36 inches and high below this depth. Capability unit IIw–3.

Canoe series

The Canoe series consists of moderately dark colored, somewhat poorly drained soils. These nearly level soils are on benches along streams. Slopes are 0 to 2 percent. These soils formed in silty alluvium. The native vegetation was prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark grayish brown, friable 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 48 inches. It is grayish brown, friable silt loam in the upper part; mottled yellowish brown, grayish brown, and light brownish gray, friable silt loam in the middle part; and mottled strong brown and light brownish gray, friable silt loam in the lower part. The substratum is mottled strong brown, light olive gray, yellowish brown, and grayish brown, friable silt loam.

Available water capacity is high, and permeability is moderate. Available phosphorus is low to medium, and available potassium is very low. Unless these soils have been limed within the past 2 to 5 years, they are generally acid in the surface layer.

Canoe soils are used mainly for cultivated crops. The major limitation for crops is runoff from soils upslope. Tile drains are beneficial in wet years. Farming may be delayed during wet periods in areas that are not tiled.

Representative profile of Canoe silt loam, 0 to 2 percent slopes, in a cultivated field, 900 feet north and 24 feet west of the southwest corner of NE¼SE¼ sec. 26, T. 95 N., R. 8 W.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; moderate fine granular structure; friable; medium acid; abrupt smooth boundary.

A2—8 to 12 inches; grayish brown (10YR 5/2) silt loam; few fine distinct brown (7.5YR 4/4) mottles; moderate thin platy structure; friable; medium acid; clear smooth boundary.

B1—12 to 17 inches; grayish brown (10YR 5/2) silt loam; few fine distinct brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21—17 to 28 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) silt loam; light brownish gray (10YR 6/2) coatings on peds; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; common soft dark oxide concretions; very strongly acid; clear smooth boundary.

B22—28 to 37 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) silt loam; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; very strongly acid; clear smooth boundary.

B3—37 to 48 inches; mottled strong brown (7.5YR 5/6) and light brownish gray (2.5Y 6/2) silt loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; common soft dark oxide concretions; medium acid; clear smooth boundary.

C—48 to 60 inches; mottled strong brown (7.5YR 5/6), light olive gray (5Y 6/2), yellowish brown (10YR 5/4), and grayish brown (2.5Y 5/2) silt loam; massive with some vertical cleavage; friable; many soft dark oxide concretions; medium acid.

The solum is commonly 40 to 50 inches thick, but ranges from 36 to 60 inches. Coarse textured material is present in places below a depth of 48 inches. Carbonates are absent above a depth of 60 inches. The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) and is 6 to 9 inches thick. The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon is generally 4 to 12 inches thick, but in some places it may be partly incorporated into the Ap horizon. The B2 horizon is heavy silt loam or light silty clay loam.

Canoe soils are associated with Richwood and Festina soils, and they formed in parent material similar to that of Richwood and Festina soils. They are grayer in the upper part of the B horizon and are more poorly drained than Richwood and Festina soils.

926—Canoe silt loam, 0 to 2 percent slopes. This nearly level soil is on stream benches, mainly along the Turkey River where the upland soils are covered by loess. Areas are 10 to 20 acres in size and are irregular in shape.

Included with this soil in mapping are a few areas of soils where lighter colored silty overwash has been deposited on the surface from the adjoining uplands. These soils are lower in organic matter content in the surface layer than this Canoe soil. Also included are a few areas of soils that are darker and are higher in organic matter content.

This soil is well suited to cultivated crops. It is subject to runoff from soils upslope. Diversion terraces placed on the adjacent upland slopes help to protect this soil from overflow and silting. This soil is slightly wet and in places tile is needed to improve the timeliness of field operations. The organic matter content is moderate. Capability unit I–2.

Chaseburg series

The Chaseburg series consists of light colored, moderately well drained soils. These gently sloping soils are on alluvial fans and narrow upland waterways associated with steep loess soils. Slopes are 2 to 5 percent. These soils formed in recently deposited, silty alluvium. They are generally stratified, because each flood deposits fresh sediment on the surface. These soils are young, so vegetation has not influenced soil development.

In a representative profile the surface layer is dark grayish brown, friable silt loam about 8 inches thick. Below this, to a depth of 66 inches, is stratified, friable silt loam that is grayish brown, brown, dark grayish brown, and very dark grayish brown. A black heavy silt loam buried soil is below a depth of 66 inches.

Available water capacity is high, and permeability is moderate. Available phosphorus is medium, and available potassium is very low. These soils are generally neutral or slightly acid in reaction and do not require lime.

These soils are used mainly for cultivated crops and pasture. The major limitation for crops is flooding by runoff from the adjoining uplands. If not protected from overflow, young crops on these soils can be covered by sediment.

Representative profile of Chaseburg silt loam, 2 to 5 percent slopes, in permanent pasture, 310 feet west and 65 feet north of southeast corner of SW¼SE¼ sec. 11, T. 92 N., R. 7 W.:

A1—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

C—8 to 66 inches; stratified grayish brown (10YR 5/2), brown (10YR 5/3), and dark grayish brown (10YR 4/2) silt loam; thinner strata of very dark grayish brown (10YR 3/2) silt loam; massive but tending to be platy because of stratification; friable; slightly acid.

IIA1b—66 to 80 inches; black (10YR 2/1) heavy silt loam; massive; friable; neutral.

The solum is slightly acid or neutral. The A1 horizon is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), and dark grayish brown (10YR 4/2) and generally shows some evidence of stratification. The A1 horizon is 5 to 10 inches thick. The Ap horizon is dark grayish brown (10YR 4/2). The C horizon dominantly has hue of 10YR, value of 3, 4, or 5, and chroma of 1 through 3. Material coarser than silt loam is only in thin lenses at a depth of less than 40 inches.

Chaseburg soils are associated with Downs, Fayette, Dubuque, and Huntsville soils, and they formed in parent material similar to that of Dorchester soils. They have a thinner, more stratified solum than Downs, Fayette, Dubuque, and Huntsville soils. They have a lighter colored A horizon than Huntsville soils. Chaseburg soils have no carbonates at a depth of less than 60 inches, whereas Dorchester soils do.

142B—Chaseburg silt loam, 2 to 5 percent slopes. This gently sloping soil is in very narrow upland waterways, generally about 80 to 150 feet wide, and on alluvial fans. Areas are about 5 to 10 acres in size and are elongated in shape.

Included with this soil in mapping are areas of soils that are underlain by a dark buried soil at a depth of less than 36 inches.

This soil is suited to row crops. Many areas are farmed with the adjoining more sloping soils upslope or are used as grassed waterways. Inaccessible areas along the narrow drainageways are left in permanent pasture or woodland. This soil is subject to high-velocity, short-duration flooding. In some areas, seepage water from upland soils makes this soil seasonally wet. In these areas tile helps timely field operations. Some areas are dissected by gullies or numerous waterways. The organic matter content is very low. Capability unit IIe–4.

Chelsea series

The Chelsea series consists of light colored, excessively drained soils. These soils are gently sloping to steep on ridges and convex side slopes on uplands and are gently sloping to moderately sloping in a few areas on stream terraces. Slopes are 2 to 25 percent. These soils formed in coarse textured eolian sediment. The native vegetation was deciduous trees.

In a representative profile the surface layer is very dark gray loamy fine sand 2 inches thick. The subsurface layer is dark brown loamy fine sand and brown, dark yellowish brown, and yellowish brown fine sand that extends to a depth of 45 inches. It is underlain by yellowish brown fine sand with thin bands of strong brown sandy loam.

Available water capacity is very low, and permeability is rapid. Available subsoil phosphorus is very low, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Chelsea soils are used mainly for pasture and woodland. The major limitations for crops are erosion and droughtiness. These soils are better suited to permanent pasture, woodland, or wildlife habitat than most other uses.

Representative profile of Chelsea loamy fine sand, 2 to 9 percent slopes, in a wooded area, 48 feet east and 192 feet north of the southeast corner of SW¼NW¼ sec. 23, T. 95 N., R. 8 W.:

A1—0 to 2 inches; very dark gray (10YR 3/1) loamy fine sand; weak medium subangular blocky structure parting to weak fine and very fine granular; very friable; neutral; abrupt smooth boundary.

A21—2 to 5 inches; dark brown (10YR 3/3) loamy fine sand; few very dark gray (10YR 3/1) coatings and common very dark grayish brown (10YR 3/2) coat-

ings; weak medium platy structure parting to weak fine subangular blocky; very friable; slightly acid; clear smooth boundary.

A22—5 to 9 inches; brown (10YR 4/3) fine sand; single grained; loose; slightly acid; clear smooth boundary.

A23—9 to 23 inches; dark yellowish brown (10YR 4/4) fine sand; single grained; loose; few roots; strongly acid; clear smooth boundary.

A24—23 to 45 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; strongly acid; clear smooth boundary.

A&B—45 to 60 inches; light yellowish brown (10YR 6/4) fine sand; single grained; loose; some 1/2- to 1/4-inch thick bands of strong brown (7.5YR 5/6) light sandy loam in the upper part of the horizon that become numerous in lower part; medium acid.

The solum ranges from 4 feet to many feet in thickness. It is medium acid to strongly acid in the most acid part. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The Ap horizon is dark grayish brown (10YR 4/2) to dark brown (10YR 3/3) or brown (10YR 4/3). The A horizon is typically loamy fine sand but ranges to fine sand. The lamellae in the A&B horizon are 1/4 inch to 2 inches thick and have hue of 7.5YR or 10YR and chroma of 3 to 4. The uppermost lamella is at a depth of 3 to 4 feet.

Chelsea soils are associated with Sparta, Lamont, Backbone, and Fayette soils, and they formed in parent material similar to that of Sparta, Lamont, and Dickinson soils. They have more sand in the upper part of the solum than Lamont and Fayette soils. Chelsea soils have more sand in the upper part of the solum than Backbone soils and are not underlain by limestone bedrock. They have a thinner, lighter colored A horizon than Sparta and Dickinson soils.

63C—Chelsea loamy fine sand, 2 to 9 percent slopes. This gently sloping to moderately sloping soil is on uplands and stream terraces. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that have a sandy loam surface layer. These soils are less droughty than this Chelsea soil.

This soil is poorly suited to cultivated crops. It is susceptible to severe droughtiness, and it is low in fertility. Crop yields depend on the amount and timeliness of rainfall. The organic matter content is very low. Capability unit IVs–1.

63E—Chelsea loamy fine sand, 14 to 25 percent slopes. This moderately steep to steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

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

Included with this soil in mapping are small areas of soils in which limestone bedrock is at a depth of 20 to 40 inches. These soils are more droughty than this Chelsea soil.

This soil is poorly suited to cultivated crops. It is better suited to woodland or wildlife habitat. It is susceptible to soil blowing, water erosion, and severe droughtiness. Because the slopes are steep, many pasture areas are difficult to renovate with regular farm machinery. The organic matter content is very low. Capability unit VIIs–1.

Clyde series

The Clyde series consists of dark colored, poorly drained soils. These nearly level to gently sloping soils are in drainageways and on lower concave positions on the uplands. Slopes are 1 to 3 percent. These soils formed in 30 to 50 inches of moderately fine textured material and in the underlying friable to firm glacial till or stratified valley fill. The native vegetation was prairie grasses and plants that were tolerant to wetness.

In a representative profile the surface layer is black, friable clay loam and silty clay loam high in sand and is about 20 inches thick. The subsoil extends to a depth of 52 inches. It is dark gray, friable silty clay loam in the upper part; gray, friable silty clay loam and mottled gray and olive gray, very friable sandy loam in the middle part; and mottled gray and strong brown, firm heavy loam in the lower part. The substratum is gray, firm heavy loam.

Available water capacity is high and permeability is moderate. Available phosphorus and available potassium are very low. These soils are generally neutral in the surface layer and do not require liming.

These soils are used mainly for cultivated crops. If not artificially drained, they are in permanent pasture or are idle. The major limitation for crops is wetness. Tile drainage is needed in Clyde soils for satisfactory crop yields. Much of the wetness is due to seepage and runoff from higher soils.

Representative profile of Clyde clay loam, 1 to 3 percent slopes, in permanent pasture, 1,250 feet east and 72 feet north of the northwest corner of SW¼SW¼ sec. 30, T. 91 N., R. 7 W.:

A11—0 to 9 inches; black (N 2/0) light clay loam; cloddy parting to weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—9 to 17 inches; black (N 2/0) clay loam; moderate medium, subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A3—17 to 20 inches; very dark gray (10YR 3/1) silty clay loam that is high in sand; black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

B21g—20 to 24 inches; dark gray (5Y 4/1) heavy silty clay loam that is high in sand; discontinuous black (10YR 2/1) coatings on peds; common fine distinct strong brown (7.5YR 5/8) mottles; moderate

medium subangular blocky structure; friable; common fine distinct dark brown (7.5YR 4/4) oxide concretions; neutral; clear smooth boundary.

B22tg—24 to 29 inches; gray (5Y 5/1) silty clay loam that is high in sand; common fine distinct strong brown (7.5YR 5/8) mottles; weak medium prismatic structure parting to strong fine subangular blocky; friable; few thin discontinuous dark gray (5Y 4/1) clay films; neutral; abrupt smooth boundary.

B31—29 to 36 inches; mottled gray (5Y 5/1) and olive gray (5Y 5/2) heavy sandy loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very friable; neutral; abrupt smooth boundary.

IIB32—36 to 52 inches; mottled strong brown (7.5YR 5/6) and gray (5Y 5/1) heavy loam; weak coarse prismatic structure; firm; neutral; clear smooth boundary.

IICg—52 to 60 inches; gray (N 5/0) heavy loam; massive; firm; neutral.

The solum is typically more than 3½ feet thick and ranges from 2½ to 5 feet or more in thickness. Depth to erosional sediment over glacial till is typically 3 to 3½ feet but ranges from 2½ to 5 feet. The profile is typically neutral throughout but ranges to slightly acid in the most acid part. The A horizon is silty clay loam high in sand to clay loam or heavy loam. It is 18 to 24 inches thick. The B horizon is silty clay loam, loam, or clay loam and, in places, has thin strata of sandy loam or loamy sand.

Clyde soils are associated with Kenyon, Floyd, Bassett, and Schley soils. They formed in parent material similar to that of Floyd and Schley soils. They are grayer in the upper part of the B horizon and are more poorly drained than Kenyon, Floyd, Bassett, and Schley soils. Clyde soils are more stratified and deeper to glacial till than Kenyon and Bassett soils.

84—Clyde clay loam, 1 to 3 percent slopes. This nearly level to gently sloping soil is in drainageways and on lower concave positions on the uplands. Areas are commonly 20 acres or more in size. These areas are elongated and commonly several miles in length. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of muck that are difficult to drain and that hinder farming.

This soil is well suited to cultivated crops if properly drained. It is subject to seepage and runoff from soils upslope. Tilth is generally good, although this soil will puddle if worked when wet. Stones and boulders need to be removed before this soil can be cropped. They also interfere with tile installation. A drainage system that intercepts laterally moving water protects against wetness caused by sidehill seepage. The organic matter content is high. Capability unit IIw–1.

391B—Clyde-Floyd complex, 1 to 4 percent slopes. This complex consists of dark, poorly drained and somewhat poorly drained soils. These nearly level to gently sloping soils are on uplands. They are in the small upland drainageways and are associated with Kenyon soils, which are better drained and more sloping than these soils. This complex is 60 percent Clyde soils and 40 percent Floyd soils. In most places the Clyde soil is in the lowest part of the drainageway, bordered by a band of Floyd soil. These soils are in such close association that it is impractical to map them separately.

These soils receive seepage and runoff from the more sloping soils upslope. Tile drains work well if a suitable outlet is available. Drainageways that have a high concentration of water should be in grass to prevent the formation of gullies. These soils are suited to row crops if properly drained, but many areas need to be left in grassed waterways to prevent gullies. In undrained areas large boulders need to be removed before the soils can be used for crops (fig. 9). Most areas of this complex are farmed with the surrounding soils, because individual areas are generally too small to be cropped separately. Capability IIw–1.

Coggon series

The Coggon series consists of light colored, moderately well drained soils. These gently sloping to moderately sloping soils are on ridges and side slopes on uplands. Slopes are 2 to 9 percent. These soils formed in 14 to 21 inches of loamy material and in the underlying glacial till.

In a representative profile the surface layer is very dark gray loam about 2 inches thick. The subsurface layer is dark grayish brown and brown loam about 9 inches thick. The subsoil extends to a depth of 52 inches. In the upper part it is dark yellowish brown, friable loam; in the middle part it is yellowish brown, firm heavy loam that has grayish brown mottles; and in the lower part it is dark yellowish brown, firm heavy loam that has strong brown and grayish brown mottles. The substratum is mottled strong brown and olive gray, firm heavy loam.

Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow in the underlying glacial till. The rate at which water moves through the friable loamy material differs considerably from the rate at which it moves through the underlying firm glacial till. Water moves more rapidly in the upper material and accumulates at the till contact, resulting in wet, seepy areas in some years. Available phosphorus is low, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The Coggon soils are used mainly for cultivated crops. The major limitation for crops is erosion. Providing adequate drainage and controlling erosion on these soils are difficult. The long, uniform slopes are well suited to contour cultivation and terracing, but these practices slow the movement of surface water, allowing more of it to soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of terracing and tile drainage helps overcome the wetness and erosion.

Representative profile of Coggon loam, 2 to 5 percent slopes, in permanent pasture at edge of wooded area, 42 feet north and 519 feet west of the southeast corner of the SW¼ sec. 28, T. 95 N., R. 10 W.:

Figure 9.—**Typical undrained area of Clyde-Floyd complex in permanent pasture.**

A1—0 to 2 inches; very dark gray (10YR 3/1) loam; weak medium platy structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A21–2 to 8 inches; dark grayish brown (10YR 4/2) loam, dark grayish brown (10YR 4/2) kneaded; some very dark grayish brown (10YR 3/2) coatings on peds; moderate thin platy structure; friable; thin discontinuous light gray (10YR 7/2), dry, silt coatings on peds; slightly acid; clear smooth boundary.

A22—8 to 11 inches; brown (10YR 4/3) loam, brown (10YR 4/3) kneaded; dark grayish brown (10YR 4/2) coatings on peds; moderate medium platy structure; friable; thin discontinuous light gray (10YR 7/2), dry, silt coatings on peds; very strongly acid; clear smooth boundary.

B1—11 to 16 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure parting to moderate medium angular blocky; friable; thin discontinuous light gray (10YR 7/2), dry, silt coatings on peds; very strongly acid; clear smooth boundary.

IIB21t—16 to 24 inches; yellowish brown (10YR 5/6) heavy loam; brown (10YR 5/3) coatings on peds; moderate medium subangular blocky and angular blocky structure; firm; stone line at top of horizon; thin nearly continuous dark yellowish brown (10YR 4/4) clay films; very strongly acid; clear smooth boundary.

IIB22t—24 to 32 inches; yellowish brown (10YR 5/6) heavy loam; brown (10YR 5/3) coatings on peds; strong medium subangular blocky and angular blocky structure; firm; thin discontinuous dark yellowish brown (10YR 4/4) clay films; very strongly acid; clear smooth boundary.

IIB23—32 to 38 inches; yellowish brown (10YR 5/4) heavy loam; brown (10YR 5/3) coatings on peds; common fine distinct grayish brown (10YR 5/2) mottles and few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky and angular blocky structure; firm; thin discontinuous white (10YR 8/1) silt coatings on peds; very strongly acid; clear smooth boundary.

IIB3—38 to 52 inches; dark yellowish brown (10YR 4/4) heavy loam; brown (10YR 5/3) coatings on peds; common fine distinct grayish brown (10YR 5/2) mottles and few fine distinct yellowish brown (10YR 5/6) mottles; strong coarse prismatic structure parting to strong medium angular blocky; firm; few soft dark oxide concretions; very strongly acid; clear smooth boundary.

IIC—52 to 60 inches; mottled strong brown (7.5YR 5/8) and olive gray (5Y 5/2) heavy loam; massive; firm; strongly acid.

The solum is 50 to 70 inches thick. The soils formed in 14 to 21 inches of loamy material and in the underlying glacial till. The A1 horizon is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). It is 1 inch to 4 inches thick. The Ap horizon is 6 to 8

inches thick and is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The A2 horizon is 4 to 10 inches thick, but in cultivated areas it may be partially incorporated into the Ap horizon. The IIB horizon is typically loam but ranges to light clay loam or sandy clay loam. It is medium acid to very strongly acid. Calcareous glacial till is at a depth of 60 to 80 inches.

Coggon soils are associated with Bassett, Schley, and Winneshick soils, and they formed in parent material similar to that of Bassett and Oran soils. They have a lighter colored Ap or A1 horizon than Schley, Bassett and Oran soils. They have a thicker IIB horizon than Winneshiek soils and are not underlain by limestone bedrock at a depth of less than 40 inches.

302B—Coggon loam, 2 to 5 percent slopes. This gently sloping soil is on convex ridges and side slopes on uplands. Areas are 20 to 40 acres or more in size and irregular in shape.

This soil has the profile described as representative of the series.

This soil is suited to occasional row crops, such as corn and soybeans. It is subject to slight erosion if cultivated. Because of the difference in permeability of the loamy material and the underlying glacial till at a depth of about 1½ feet, water accumulates at the contact of these materials and produces a temporary high water table, particularly early in spring. A combination of terracing and tile drainage helps to provide adequate erosion control and drainage. The organic matter content is very low. Capability unit IIe–1.

302C—Coggon loam, 5 to 9 percent slopes. This moderately sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

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

Included with this soil in mapping are a few areas of moderately eroded soils in which the depth to the glacial till is less than 14 inches. These soils are lower in fertility and organic matter content than this Coggon soil.

This soil is suited to occasional row crops such as corn and soybeans. It is subject to moderate or severe erosion if cultivated. It can have a seasonal perched water table because of water accumulation at the contact between the loamy material and the underlying glacial till. Because this soil is typically downslope from less sloping Coggon soils, water accumulates at a depth of 1½ to 2 feet and then moves downslope. The water may come to the surface part way down the slope and form a seepy spot, or it may make a large part of the slope wet. A combination of terracing and tile drainage helps to provide adequate erosion control and drainage. The organic matter content is very low. Capability unit IIIe–1.

Coland series

The Coland series consists of dark colored, poorly drained soils. These nearly level soils are on flood plains and on the lower parts of upland drainageways near the watercourse in areas of the Kenyon-Clyde-Floyd soil association. Slopes are 0 to 2 percent. These Coland soils formed in medium textured to moderately fine textured alluvium. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is about 49 inches thick. It is black, mottled, friable clay loam and loam. The substratum is gray loamy sand that has some gravel.

Available water capacity is high, and permeability is moderately slow. Available phosphorus is medium, and available potassium is very low. These soils are generally neutral to slightly acid and do not require lime.

These soils are used mainly for pasture and cultivated crops. The major limitations for crops are wetness and flooding. Areas which are flooded frequently or are cut up by old stream channels are generally in pasture.

Representative profile of Coland clay loam, channeled, 0 to 2 percent slopes, in permanent pasture, 69 feet north and 189 feet west of the southeast corner of sec. 33, T. 92 N., R. 9 W.:

A11—0 to 10 inches; black (N 2/0) clay loam; few fine distinct dark reddish brown (5Y 2/2) mottles; weak medium subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A12—10 to 25 inches; black (N 2/0) loam; common fine prominent yellowish red (5YR 4/8) mottles; moderate medium subangular blocky structure parting to moderate fine granular; friable; few fine dark red (2.5YR 3/6) oxide concretions; neutral; gradual smooth boundary.

A13—25 to 40 inches; black (N 2/0) loam; weak medium prismatic structure parting to moderate medium subangular blocky; friable; neutral; gradual smooth boundary.

A3—40 to 49 inches; black (N 2/0) light loam; weak coarse, prismatic structure; friable; neutral; abrupt wavy boundary.

IICg—49 to 60 inches; gray (5Y 5/1) loamy sand; single grained; loose; some 2-millimeter pebbles; many plant fibers; slightly acid.

The solum is 36 to 50 inches thick. It is neutral or slightly acid throughout. The A horizon is typically clay loam but ranges to silty clay loam and loam. The depth to a color that has value of 3 or higher is 36 to 40 inches or more. In some areas sandy loam or loamy sand is below a depth of 48 inches.

Coland soils are associated with Spillville and Hanlon soils, and they formed in parent material similar to that of those soils. They have a grayer C horizon and are more poorly drained than those soils. They have more clay and less sand in the A horizon than Hanlon soils.

135—Coland clay loam, 0 to 2 percent slopes. This nearly level soil is on flood plains. Areas are 20 acres or more in size.

Included with this soil in mapping are a few small areas of sandy soils that are somewhat droughty.

This soil is well suited to cultivated crops if drained and protected from flooding. It is subject to flooding, slow runoff, and a high water table. Areas that are

frequently flooded are used mainly for pasture. Plowing is difficult and can be delayed by excessive moisture. The soil puddles readily when wet and becomes cloddy and hard when dry. The organic matter content is very high. Capability unit IIw–3.

C135—Coland clay loam, channeled, 0 to 2 percent slopes. This nearly level soil is on the flood plains along the minor streams. Areas are long and narrow. Generally, they are about 100 to 200 feet wide and several miles long.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of sandy soils that are generally adjacent to streams or former stream channels. These soils are droughty.

This soil is poorly suited to cultivated crops because of flooding and the common channels, small oxbows, sloughs, and small ponds. Most areas of this soil are in permanent pasture. Capability unit Vw–1.

Cresco series

The Cresco series consists of dark colored, moderately well drained soils. These gently sloping to moderately sloping soils are on long, convex ridges and side slopes on uplands. Slopes are 2 to 9 percent. These soils formed in 14 to 21 inches of loamy material and in the underlying very firm glacial till. The native vegetation was prairie grasses. In most places, a layer of pebbles and stones is at the contact of the loamy material and the glacial till.

In a representative profile the surface layer is black and very dark grayish brown heavy loam about 13 inches thick. The subsoil extends to a depth of 47 inches. It is brown and dark yellowish brown, firm loam and light clay loam in the upper part and mottled strong brown and gray, very firm clay loam in the lower part. The substratum is mottled strong brown and gray, strongly effervescent clay loam.

Available water capacity is high. Permeability is moderate in the upper part of the soil and slow in the very firm glacial till. The rate at which water moves through the friable, loamy material differs considerably from the rate at which it moves through the underlying very firm glacial till. Water moves more rapidly in the upper material and accumulates at the till contact, resulting in wet, seepy areas in some years. The available phosphorus and available potassium are very low. Unless these soils have been limed in the last 5 years, they are generally acid in the surface layer.

The Cresco soils are used mainly for cultivated crops. The major limitation for crops is erosion. Providing adequate drainage and controlling erosion on these soils is difficult. The long, uniform slopes are well suited to contour cultivation and terracing, but these practices slow the movement of surface water, allowing more of it to soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of terracing and tile drainage helps to overcome these problems.

Representative profile of Cresco loam, 5 to 9 percent slopes, in a cultivated field, 125 feet north and 85 feet east of southwest corner of NW¼ sec. 27, T. 93 N., R. 10 W.:

Ap—0 to 7 inches; black (10YR 2/1) heavy loam; moderate very fine granular structure; friable; neutral; abrupt smooth boundary.

A3—7 to 13 inches; very dark grayish brown (10YR 3/2) heavy loam; very dark brown (10YR 2/2) coatings on peds; moderate fine granular structure; friable; medium acid; clear smooth boundary.

B1—13 to 17 inches; brown (10YR 4/3) heavy loam; dark brown (10YR 3/3) coatings on peds; weak very fine subangular blocky structure; firm; pebble band at lower boundary of horizon; strongly acid; clear smooth boundary.

IIB21—17 to 21 inches; dark yellowish brown (10YR 4/4) light clay loam; brown (10YR 5/3) coatings on peds; moderate fine subangular blocky structure; firm; medium acid; clear smooth boundary.

IIB22t—21 to 32 inches; mottled strong brown (7.5YR 5/6) and gray (5Y 5/1) clay loam; nearly continuous gray (5Y 5/1) coatings on faces of prisms; moderate fine prismatic structure parting to moderate medium subangular blocky; very firm; thin patchy dark gray (10YR 4/1) clay films; medium acid; gradual smooth boundary.

IIB3—32 to 47 inches; mottled strong brown (7.5YR 5/6) and gray (5Y 5/1) clay loam; discontinuous gray (5Y 5/1) coatings on prism faces; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; neutral; abrupt wavy boundary.

IIC—47 to 60 inches; mottled strong brown (7.5YR 5/6) and gray (5Y 5/1) light clay loam; massive; very firm; mildly alkaline; strong effervescence.

The solum is 40 to 55 inches thick. Carbonates are at a depth of 40 to 60 inches. The soils formed in 14 to 21 inches of loamy material and in the underlying clay loam glacial till. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). It is typically heavy loam but ranges to light clay loam. The A horizon is 10 to 15 inches thick. The abundance of gray coatings on the faces of peds in the IIB horizon decreases as depth increases. The IIB2 horizon is typically medium clay loam. It is 30 to 35 percent clay, but ranges to as much as 37 percent clay in some pedons. It ranges from medium acid to strongly acid in reaction.

Cresco soils are associated with Kenyon, Protivin, Floyd, and Clyde soils, and they formed in parent material similar to that of Protivin, Lourdes, and Riceville soils. They have grayer coatings on the faces of peds and have more clay in the IIB horizon than Kenyon, Floyd, and Clyde soils. Cresco soils are browner and less mottled in the upper part of the B horizon than Protivin and Riceville soils. They have a thicker and darker A horizon that contains more organic matter than Lourdes soils.

783B—Cresco loam, 2 to 5 percent slopes. This gently sloping soil is on long, convex ridges and side slopes on uplands. Areas are 40 acres or more in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the depth to clay loam till is greater.

Included with this soil in mapping are a few small spots of sandy soils that are more droughty than this Cresco soil.

This soil is well suited to corn and soybeans. It is subject to slight erosion if cultivated. Because of the difference in permeability between the loamy material and the underlying very firm glacial till, water accumulates at the contact of these materials, causing a temporary high water table, particularly early in spring. A combination of terracing and tile drainage helps to provide adequate erosion control and drainage. Careful placement and spacing of tile are important because of the slowly permeable subsoil. The organic matter content is moderate to high. Capability unit IIe–1.

783C—Cresco loam, 5 to 9 percent slopes. This moderately sloping soil is on long, convex side slopes on uplands. Areas are 5 to 10 acres in size and are elongated in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of moderately eroded soils in which the surface layer is less than 10 inches thick. These areas are lower in fertility than this Cresco soil. Also included are a few sandy areas that are more droughty.

This soil is suited to corn and soybeans. It is subject to moderate or severe erosion if cultivated. Because of the difference in permeability between the loamy material and the underlying very firm glacial till, water accumulates at the contact of these materials, causing a temporary high water table, particularly early in spring. A combination of terracing and tile drainage helps to provide adequate erosion control and drainage. Careful placement and spacing of tile are important because of the slowly permeable subsoil. The organic matter content is moderate. Capability unit IIIe–1.

Dickinson series

The Dickinson series consists of dark colored, well drained to somewhat excessively drained soils. These gently sloping to strongly sloping soils are on stream terraces and convex ridges and side slopes on uplands. Slopes are 2 to 14 percent. These soils formed in wind-deposited, moderately coarse textured sediment and the underlying coarse textured sediment, free of gravel, or in the underlying till. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable fine sandy loam and sandy loam about 20 inches thick. The subsoil extends to a depth of 35 inches. It is brown, very friable, light sandy loam and loamy sand. The substratum is dark yellowish brown fine sand.

Available water capacity is low. Permeability is moderately rapid in the moderately coarse textured sediment; and it is rapid in the underlying coarse textured substratum of some soils but moderately slow in the till substratum of other soils. Available phosphorus and available potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The Dickinson soils are used mainly for cultivated crops. The major limitations for crops are erosion and droughtiness. Conservation practices that control runoff and reduce moisture losses, such as minimum tillage that leaves residue on the surface, are beneficial.

Representative profile of Dickinson fine sandy loam, 2 to 5 percent slopes, in a cultivated field, 81 feet east and 171 feet south of the northwest corner of the NE¼NE¼ sec. 7, T. 91 N., R. 9 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) fine sandy loam; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A12—8 to 13 inches; very dark brown (10YR 2/2) fine sandy loam; moderate medium and fine granular structure; friable; medium acid; gradual smooth boundary.

A3—13 to 20 inches; very dark grayish brown (10YR 3/2) sandy loam; weak medium subangular blocky structure parting to moderate fine granular; friable; medium acid; clear smooth boundary.

B2—20 to 30 inches; brown (10YR 4/3) light sandy loam; dark brown (10YR 3/3) coatings on peds; weak medium subangular blocky structure; very friable; medium acid; gradual smooth boundary.

B3—30 to 35 inches; brown (10YR 4/3) loamy sand; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C—35 to 60 inches; dark yellowish brown (10YR 4/4) fine sand; single grained; loose; medium acid.

The solum is 24 to 40 inches thick. It is slightly acid to strongly acid in the most acid part. The soils formed in 24 to 36 inches of fine sandy loam sediment and in the underlying loamy sand and sand. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and is 10 to 20 inches thick. The B2 horizon is dark brown (10YR 3/3) or brown (10YR 4/3) to dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4). The C horizon is loamy sand or fine sand.

Dickinson soils are associated with Sparta, Flagler, Olin, Kenyon, and Ostrander soils, and they formed in parent material similar to that of Lamont and Sparta soils. They have less sand in the A horizon and the upper part of the B horizon than Sparta soils. They have a thicker, darker A horizon than Lamont soils. Dickinson soils are not underlain by glacial till at a depth less than 40 inches as are Olin, Kenyon and Ostrander soils. They have less gravel in the B and C horizons than Flagler soils.

175B—Dickinson fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is in convex areas on the uplands and on stream benches. Areas are generally about 5 acres in size.

This soil has a profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that have a loamy sand surface layer and are more droughty than this Dickinson soil.

This soil is suited to cultivated crops, and yields can be good if rainfall is normal and timely. The soil is subject to droughtiness and slight soil blowing and water erosion. The organic matter content is moderately low. Capability unit IIIe–3.

175C—Dickinson fine sandy loam, 5 to 9 percent slopes. This moderately sloping soil is on convex ridges and side slopes on uplands. Areas are about 5 acres in size and rounded in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner, only about 15 inches thick.

Included with this soil in mapping are a few areas of soils that are moderately eroded and lower in organic matter content and fertility than this Dickinson soil.

This soil is suited to cultivated crops and yields can be good if rainfall is normal and timely. The soil is subject to droughtiness and soil blowing and water erosion. The organic matter content is moderately low. Capability unit IIIe–3.

175D—Dickinson fine sandy loam, 9 to 14 percent slopes. This strongly sloping soil is on convex side slopes on uplands. Areas are less than 5 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is only 10 to 15 inches thick.

Included with this soil in mapping are areas of soils that are eroded and lower in fertility and organic matter content than this Dickinson soil.

This soil is poorly suited to cultivated crops. It is subject to drought, soil blowing, and water erosion. Yields depend on the amount and timeliness of rainfall. The organic matter content is low. Capability unit IVe–2.

409B—Dickinson fine sandy loam, till substratum, 2 to 5 percent slopes. This gently sloping soil is on convex side slopes on uplands. Areas are 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but this soil is underlain by loam glacial till at a depth of 40 to 50 inches.

Included with this soil in mapping are small areas of soils that are deeper than 50 inches to the underlying glacial till. Also included are small areas of soils that have a thinner, lighter colored surface layer and are lower in organic matter content and fertility than this Dickinson soil.

This soil is suited to row crops, and yields can be good if rainfall is normal and timely. The soil is subject to droughtiness during periods of below normal rainfall and to slight soil blowing and water erosion if cultivated. It is seepy at times in spring or after periods of heavy rainfall. The organic matter content is moderately low. Capability unit IIIe–3.

409C—Dickinson fine sandy loam, till substratum, 5 to 9 percent slopes. This moderately sloping soil is on convex areas adjacent to drainageways or on mounds on the uplands. Areas are about 5 to 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but loam glacial till is at a depth of more than 40 inches.

Included with this soil in mapping are small areas of soils in which the surface layer is thinner and lighter colored than in this Dickinson soil. These soils are lower in organic matter content and fertility. Also included are small areas of soils where the depth to glacial till is more than 50 inches.

This soil is suited to row crops, and yields can be good if rainfall is normal and timely. The soil is subject to droughtiness during periods of below normal rainfall and to soil blowing and water erosion if cultivated. It is seepy at times in spring or after periods of heavy rainfall. The organic matter content is moderately low. Capability unit IIIe–3.

Donnan series

The Donnan series consists of moderately dark colored, moderately well drained or somewhat poorly drained soils. These nearly level to moderately sloping soils are on convex ridges and convex to slightly concave side slopes on uplands. Slopes are 0 to 9 percent. These soils formed in 24 to 36 inches of loamy material and in the underlying, highly weathered older clayey material. The native vegetation was deciduous trees and prairie grasses.

In a representative profile the surface layer is very dark brown, friable loam about 8 inches thick. The subsoil extends to a depth of 48 inches. It is brown and dark yellowish brown, friable loam that grades to light clay loam in the upper part; dark gray, very firm silty clay in the middle part; and gray, very firm silty clay in the lower part. The substratum is mottled strong brown, grayish brown, and yellowish brown firm heavy loam.

Available water capacity is high. Permeability is moderate in the upper part and very slow in the clayey material. The rate at which water moves through the friable loamy material differs considerably from the rate at which it moves through the underlying extremely firm clayey material. Water moves more rapidly in the upper material and accumulates at the contact, which produces a seasonal perched water table and sidehill seeps in wet years. Available phosphorus and available potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The Donnan soils are mainly used for cultivated crops. The major limitations for cultivated crops are erosion and a seasonal perched water table. Providing adequate drainage and controlling erosion are difficult on these soils. Conservation practices slow the movement of surface water, allowing more water to soak into the soil. The extra water complicates drainage, especially in wet years. A combination of terracing or mulch tillage and tile drainage helps to control erosion and provide adequate drainage.

Representative profile of Donnan loam, 2 to 5 percent slopes, in a cultivated field, 275 feet west and 55 feet south of northeast corner of NE¼ sec. 3, T. 93 N., R. 9 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam; cloddy parting to weak fine gran-

ular structure; friable; neutral; abrupt smooth boundary.

B1—8 to 13 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21—13 to 18 inches; dark yellowish brown (10YR 4/4) heavy loam; brown (10YR 4/3) coatings on peds; moderate medium subangular blocky structure; friable; strongly acid; clear smooth boundary.

B22—18 to 24 inches; brown (10YR 4/3) light clay loam; common fine distinct dark grayish brown (10YR 4/2) mottles; moderate medium and fine subangular blocky structure; firm; strongly acid; abrupt smooth boundary.

IIB23t—24 to 34 inches; dark gray (5Y 4/1) silty clay; few fine distinct brown (7.5YR 4/4) mottles; moderate medium angular blocky and subangular blocky structure; very firm; thick continuous very dark grayish brown (10YR 3/2) clay films; thin patchy white (10YR 8/1) dry sand coatings on ped faces; strongly acid; clear smooth boundary.

IIB24t—34 to 48 inches; gray (5Y 5/1) silty clay; few fine distinct brown (7.5YR 4/4) mottles; strong medium prismatic structure parting to moderate fine subangular blocky; very firm; thick discontinuous very dark grayish brown (10YR 3/2) clay films; strongly acid; clear smooth boundary.

IIC1—48 to 57 inches; mottled strong brown (7.5YR 5/6) and grayish brown (2.5Y 5/2) heavy loam; massive; firm; strongly acid; clear smooth boundary.

IIC2—57 to 60 inches; yellowish brown (10YR 5/4) heavy loam; common fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; strongly acid.

The solum is 45 to 60 inches thick. The soils formed in 24 to 36 inches of loamy material and in the underlying extremely firm, clayey paleosol. In some pedons, a sandy loam or loamy sand horizon, less than 5 inches thick, is between the loamy material and the paleosol. These soils are medium acid to strongly acid in the most acid part. The A1 or Ap horizon is typically very dark gray (10YR 3/1), but ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The A horizon is typically loam but ranges to light loam and silt loam high in sand. The A1 horizon is 6 to 9 inches thick. The A2 horizon, when present, is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The IIB horizon is gray (5Y 5/1) or dark gray (5Y 4/1). It is clay or silty clay.

Donnan soils are associated with Kenyon, Bassett, Schley, and Floyd soils. They have a gray clay or silty clay IIB horizon, which Kenyon, Bassett, Schley, and Floyd soils do not have.

782—Donnan loam, 0 to 2 percent slopes. This nearly level soil is on the uplands. Areas are about 5 acres in size and are irregular in shape.

Included with this soil in mapping are a few areas of soils that have a sandy loam surface layer, have a high infiltration rate, and are very seepy in wet seasons.

This soil is suited to row crops. Most areas are cultivated, and use of this soil is commonly determined by the use of the surrounding soils. This soil is subject to wetness. Tile systems may not drain all areas satisfactorily. Careful placement of tile is very important because of the very slow permeability of the underlying subsoil. If the clayey subsoil is deep enough, tile placed above this layer helps drainage. The organic matter content is very low. Capability unit IIw–2.

782B—Donnan loam, 2 to 5 percent slopes. This gently sloping soil is on ridges and convex side slopes on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping, mostly in the southeastern part of the county, are a few small areas of soils that have a sandy surface layer. These soils are more seepy in spring than this Donnan soil.

This soil is suited to cultivated crops. It is subject to slight erosion if cultivated. Most areas are cultivated, but use of this soil is commonly determined by the use of the surrounding soils. Providing adequate drainage and controlling erosion are difficult. Erosion control practices slow the movement of surface water, letting more water soak in to the soil. The extra water entering the soil complicates drainage, especially in wet years. Because of this, a combination of terracing and tile drainage is needed. Careful placement of tile is very important because of the very slow permeability of the underlying subsoil. If the clayey subsoil is deep enough, tile may be placed above this layer to help drainage. Tile drainage may not drain all areas satisfactorily. The organic matter content is very low. Capability unit IIe–3.

782C—Donnan loam, 5 to 9 percent slopes. This moderately sloping soil is on ridges and convex side slopes on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

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

Included with this soil in mapping are areas of soils that are moderately eroded and are lower in organic matter content and fertility than this Donnan soil. Also included are areas of soils that have a sandy surface layer and have a high infiltration rate; they are very seepy in wet seasons and at other times are droughty.

This soil is suited to cultivated crops. It is subject to moderate to severe erosion if cultivated. Providing adequate drainage and controlling erosion are difficult. Erosion control practices slow the movement of surface water, letting more of it soak into the soil. The extra water complicates drainage. A combination of drainage and erosion control practices is most likely to be successful. Because of the very slow permeability of the subsoil, careful placement of tile is important. The difference in permeability of the loamy material and the underlying clay subsoil causes water to accumulate above the clay subsoil. This results in a perched

water table and seepy areas on the side slopes. If loamy materials above the clay subsoil are thick enough to provide adequate cover for tile, this soil should be tiled across the slopes to intercept the seepage. The organic matter content is very low. Capability unit IIIe–1.

Dorchester series

The Dorchester series consists of stratified, light colored and moderately dark colored, moderately well drained soils. These nearly level soils are on stream bottom lands associated with soils formed in thin loess over limestone on uplands. They are also in a complex with Volney soils along narrow upland drainageways. Slopes are 0 to 2 percent. These soils formed in 30 to 45 inches of recently deposited, mildly alkaline, stratified, silty alluvium over a dark medium textured buried soil. Because these soils are young, vegetation has not influenced the development of the profile.

In a representative profile the recently deposited material extends to a depth of 38 inches. It is dark grayish brown, friable, calcareous silt loam with thin strata of very dark grayish brown, dark brown, and yellowish brown, friable, calcareous silt loam. A black and very dark gray, friable, silt loam buried soil is below a depth of 38 inches.

Available water capacity is high, and permeability is moderate. Available phosphorus is low, and available potassium is very low. These soils are mildly alkaline in the surface layer and do not require lime.

The Dorchester soils are used mainly for cultivated crops and pasture. The major limitation for crops is flooding. If not protected from overflow, young plants on these soils can be covered by sediment.

Representative profile of Dorchester silt loam, channeled, 0 to 2 percent slopes, in permanent pasture, 60 feet west and 178 feet north of the southeast corner of the NE¼NE¼ sec. 1, T. 92 N., R. 7 W.:

C—0 to 38 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 7/2) dry; few fine distinct brown (7.5YR 4/4) mottles; thin strata of very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), and yellowish brown (10YR 5/4) silt loam; horizontal strata parting to weak medium platy structure; friable; mildly alkaline; slight effervescence; abrupt smooth boundary.

IIA11b—38 to 59 inches; black (10YR 2/1) silt loam; weak to moderate medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

IIA12b—59 to 70 inches; very dark gray (10YR 3/1) heavy silt loam; few fine distinct brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; neutral.

These soils formed in 30 to 45 inches of recent, stratified, silty alluvium and in the underlying dark buried soil. The C horizon is very dark grayish brown (10YR 3/2) to yellowish brown (10YR 5/4). It is typically silt loam, but includes thin layers of silt loam that is high in sand. It is mildly alkaline or moderately alkaline. The IIAb horizon is typically silt loam but ranges from loam to light silty clay loam. It is black (10YR 2/1) or very dark brown (10YR 2/2) and is mildly alkaline or neutral.

Dorchester soils are associated with Caneek, Ossian, Volney, and Spillville soils, and they formed in parent material similar to that of Caneek soils. They have a browner C horizon and are better drained than Caneek soils. They have a lighter colored solum and are more stratified than Ossian and Spillville soils. Dorchester soils are more stratified than Volney soils and do not have the coarse limestone fragments of Volney soils.

158—Dorchester silt loam, 0 to 2 percent slopes. This nearly level soil is on stream bottom lands associated with loess-covered uplands in the eastern part of the county. Areas are 20 to 40 acres in size and are irregular in shape.

Included with this soil in mapping are small areas of soils that have 6 to 15 inches of sandy overwash. Also included are a few areas of neutral soils where the surface layer does not have an excess of lime. These soils are less productive than this Dorchester soil.

This soil is well suited to intensive row crops. It is subject to flooding. Young plants on this soil can be covered by sediment if not protected from overflow. The organic matter content is low in the surface layer and moderate to high in the buried soil. Capability unit I–3.

C158—Dorchester silt loam, channeled, 0 to 2 percent slopes. This nearly level soil is on flood plains along small streams. Areas are long and narrow. Generally, they are about 100 to 200 feet wide and several miles long.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of soils that have 6 to 15 inches of sandy overwash. Also included are areas of soils that have many limestone fragments in the surface layer. These soils are droughty and less productive than this Dorchester soil.

This soil is poorly suited to cultivated crops. It is subject to frequent overflow and is dissected by small channels and oxbows. Most areas of this soil are in permanent pasture. The organic matter content is low in the surface layer. Capability unit Vw–1.

496B—Dorchester-Volney complex, 2 to 5 percent slopes. This complex consists of light colored to dark colored, moderately well drained to somewhat excessively drained soils. The complex generally is in small, elongated areas below areas of very steep Rock outcrop and Nordness soils.

These soils are closely intermingled on alluvial fans and in lower parts of narrow drainageways on steep uplands that have a thin cover of loess. The drainageways are generally 200 to 500 feet wide and can be 2 miles or more long. The drainageways are dry most of the year, but become high-velocity, short-duration streams during heavy rainfall. These soils are gently sloping, but they are associated with more sloping soils. This complex is about 60 percent Dorchester soils and about 40 percent Volney soils. The Volney soils have a dark surface layer. They have fragments of limestone on the surface and throughout the solum. Generally, the percentage of coarse fragments increases as depth increases, ranging from 15 to 20 per-

cent by volume in the surface layer to as much as 75 percent by volume in the lower part of the solum. These limestone fragments are numerous enough to make cultivation of this soil difficult. The soils are in such close association that it is impractical to map them separately.

Runoff from the sloping soils upslope deposits new sediment on the soils of this complex. This material generally contains limestone fragments. Some areas of these soils are slightly wet because of seepage from the soils upslope. Wetness is not a limitation, however, and tile drainage is not needed.

Most of this complex is in permanent pasture. It is poorly suited to cultivated crops. The small, elongated areas of this complex are difficult to reach with farm machinery, and because of their small size they generally remain in permanent pasture or woodland. Capability unit VIs–1.

Downs series

The Downs series consists of moderately dark colored, well drained soils. These gently sloping to moderately steep soils are on ridges and side slopes on uplands. Slopes are 2 to 18 percent. These soils formed in loess more than 40 inches thick. The native vegetation was prairie grasses and deciduous trees.

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

Available water capacity is high, and permeability is moderate. Available phosphorus is medium, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The less sloping Downs soils are used mainly for cultivated crops; the more sloping soils are in pasture. The major limitation for crops is erosion. The long upland slopes are well suited to contour cultivation and terraces. The subsoil exposed in terracing generally will respond to treatment more readily than many of the glacial till soils in the county.

Representative profile of Downs silt loam, 5 to 9 percent slopes, in a cultivated field, 900 feet north and 200 feet east of the center of the NE¼ sec. 15, T. 94 N., R. 8 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

A2—7 to 13 inches; dark grayish brown (10YR 4/2) silt loam; dark grayish brown (10YR 3/2) coatings on peds; weak medium platy structure parting to weak fine granular; friable; thin patchy light gray (10YR 7/1), dry, silt coatings on ped faces; slightly acid; clear smooth boundary.

B1—13 to 19 inches; brown (10YR 4/3) heavy silt loam; dark brown (10YR 3/3) coatings on peds; weak fine subangular blocky structure; friable; thin discontinuous light gray (10YR 7/1), dry, silt coatings on ped faces; slightly acid; clear smooth boundary.

B21t—19 to 24 inches; yellowish brown (10YR 5/4) light silty clay loam; brown (10YR 4/3) coatings on peds; moderate fine subangular blocky structure; friable; few thin discontinuous dark brown (10YR 3/3) clay films; discontinuous light gray (10YR 7/1), dry, silt coatings on ped faces; medium acid; clear smooth boundary.

B22t—24 to 30 inches; yellowish brown (10YR 5/4) light silty clay loam; brown (10YR 5/3) coatings on peds; weak medium subangular blocky structure; friable; few thin discontinuous dark brown (7.5YR 3/2) clay films; thin discontinuous light gray (10YR 7/1), dry silt coatings on ped faces; medium acid; clear smooth boundary.

B31t—30 to 44 inches; yellowish brown (10YR 5/4) silt loam; weak coarse prismatic structure parting to weak medium and fine subangular blocky; friable; few thin discontinuous dark brown (7.5YR 3/2) clay films; thin discontinuous light gray (10YR 7/1), dry, silt coatings on ped faces; medium acid; clear smooth boundary.

B32t—44 to 60 inches; yellowish brown (10YR 5/4) silt loam; weak coarse prismatic structure; friable; few thin discontinuous dark brown (7.5YR 3/2) clay films; thin discontinuous light gray (10YR 7/1), dry, silt coatings on ped faces; strongly acid.

The solum is 50 to 70 inches thick. The soils formed in loess more than 40 inches thick. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 5 to 8 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 4/3) or (10YR 5/3) and is 3 to 6 inches thick. In cultivated areas the A2 horizon may be incorporated in the Ap horizon. The B horizon is heavy silt loam to light silty clay loam. It is free of low chroma mottles to a depth of 30 inches or more. The B horizon is typically strongly acid but ranges from medium acid to very strongly acid in the most acid part.

Downs soils are associated with Exette, Fayette, and Port Byron soils, and they formed in parent material similar to that of Fayette and Port Byron soils. They have a thicker A horizon than Fayette soils. They have a thinner and lighter colored A1 horizon than Port Byron soils. Downs soils have browner B and C horizons and fewer mottles than Exette soils.

162B—Downs silt loam, 2 to 5 percent slopes. This gently sloping soil is on convex ridgetops on uplands above more sloping areas of Downs soils. Areas are several miles long and are irregular in shape.

This Downs soil is well suited to corn and soybeans. It is subject to slight erosion if cultivated. This soil is well adapted to contouring and terracing because of

the long, uniform slopes. The organic matter content is moderately low. Capability unit IIe–1.

162C—Downs silt loam, 5 to 9 percent slopes. This moderately sloping soil is on convex ridges and side slopes on uplands. Areas are several miles long and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils that have a darker, thicker surface layer and have a slightly higher organic matter content than this Downs soil.

This soil is suited to cultivated crops. It is subject to moderate or severe erosion if cultivated. Terraced areas can be used more frequently for row crops without excess soil loss than unterraced areas. The organic matter content is moderately low. Capability unit IIIe–1.

162C2—Downs silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on convex ridges and side slopes on uplands. Areas extend for several miles and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored. In some places the surface layer has been mixed with material from the subsoil. This soil has lower organic matter content than the uneroded Downs soils. It generally has good tilth but will puddle and become cloddy if worked when wet.

Included with this soil in mapping are a few areas of severely eroded soils that have a surface layer of brown or yellowish brown heavy silt loam and have lower fertility and poorer tilth than this Downs soil.

This soil is suited to cultivated crops. It is subject to severe erosion if cultivated. Terraced areas can be used more frequently for row crops without excessive soil loss than can unterraced areas. The organic matter content is moderately low to low. Capability unit IIIe–1.

162D—Downs silt loam, 9 to 14 percent slopes. This strongly sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This Downs soil is suited to cultivated crops grown occasionally in rotation with hay crops. It is subject to severe erosion if cultivated. Most areas of this soil are in permanent pasture or woodland. The organic matter content is moderately low. Capability unit IIIe–2.

162D2—Downs silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are about 10 to 20 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is lighter colored. The soil has a dark grayish brown plow layer because some of the subsoil has been mixed with the surface layer. It has lower organic matter content than uneroded Downs soils. It generally has good tilth but will puddle and become cloddy if worked when wet. This soil has a lower clay content, and the depth to the maximum content of clay is less.

Included with this soil in mapping are a few areas of severely eroded soils where the surface layer is brown or yellowish brown heavy silt loam. These soils have lower fertility and poorer tilth than this Downs soil.

This soil is suited to occasional row crops in rotation with meadow. It is subject to severe erosion if cultivated. The organic matter content is low. Capability unit IIIe–2.

162E2—Downs silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is lighter colored. This soil has a dark grayish brown surface layer. Erosion has removed part of the surface and subsurface layers. The plow layer is lower in fertility and organic matter than the uneroded Downs soils. This soil has a lower clay content, and the depth to the maximum content of clay is less.

Included with this soil in mapping are a few areas of severely eroded soils that have a brown or yellowish brown heavy silt loam surface layer. These soils are lower in fertility and have poorer tilth than this Downs soil. There are also a few areas which are in woodland or permanent pasture and are not eroded.

This soil is suited to cultivated crops grown occasionally in a rotation with hay crops. It is subject to severe erosion if cultivated. It generally has good tilth but will puddle and become cloddy if worked when wet. The organic matter content is low. Capability unit IVe–1.

Dubuque series

The Dubuque series consists of light colored, well drained soils. These moderately sloping to steep soils are on ridges and side slopes on uplands. Slopes are 5 to 25 percent. These soils formed in loess 20 to 30 inches thick and in a thin layer of residuum weathered from the underlying limestone bedrock. The native vegetation was deciduous trees.

In a representative profile the surface layer is very dark grayish brown, friable silt loam about 2 inches thick. The subsurface layer is brown, friable silt loam about 7 inches thick. The subsoil extends to a depth of 25 inches. It is yellowish brown, friable silt loam and light silty clay loam and strong brown, very firm clay. Limestone bedrock is at a depth of 25 inches. It is soft and fragmented in the upper 3 inches and hard and fractured below.

Available water capacity is low. Permeability is moderate in the loess and very rapid in the limestone bedrock. It is slow in the clayey residuum between the loess and limestone, but commonly the residuum is not a continuous layer. Available phosphorus is medium, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The less sloping Dubuque soils are used mainly for cultivated crops and pasture. The more sloping soils are used for pasture and woodland. The major limitations for crops are erosion and shallowness to limestone bedrock. The soils are subject to erosion, and any soil loss through erosion decreases the depth to limestone and affects the use of these soils. The roots of some crops grown on these soils develop to only a

limited extent because of the limestone bedrock near the surface. Lack of moisture is likely to damage crops if rains are not timely during the growing season.

Representative profile of Dubuque silt loam, 20 to 30 inches to limestone, 18 to 25 percent slopes, in permanent pasture, 216 feet north and 237 feet east of the southwest corner of NW¼SE¼ sec. 35, T. 95 N., R. 8 W.:

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) silt loam grayish brown (10YR 5/2) dry; some dark brown (10YR 2/2) coatings; moderate medium and fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A2—2 to 9 inches; brown (10YR 5/3) silt loam; common dark grayish brown (10YR 4/2) coatings on peds; weak medium platy structure; friable; thin nearly continuous light gray (10YR 7/1), dry, silt coatings on ped faces; slightly acid; clear smooth boundary.

B1—9 to 12 inches; yellowish brown (10YR 5/4) silt loam; dark yellowish brown (10YR 4/4) coatings on peds; weak medium and fine subangular blocky structure; friable; thin discontinuous light gray (10YR 7/1), dry, silt coatings on ped faces; medium acid; gradual smooth boundary.

B21t—12 to 20 inches; yellowish brown (10YR 5/6) light silty clay loam; few yellowish brown (10YR 5/4) coatings on peds; moderate medium and fine subangular blocky structure; friable; few thin discontinuous brown (7.5YR 4/4) clay films; medium acid; clear smooth boundary.

IIB22t—20 to 25 inches; strong brown (7.5YR 5/6) clay; strong medium and fine angular and subangular blocky structure; very firm; thick continuous brown (7.5YR 4/4) clay films; some pebbles mixed in with residuum; medium acid; abrupt wavy boundary.

IIR1—25 to 28 inches; level bedded limestone bedrock; interbedded flags of limestone and silty clay residuum; mildly alkaline; strong effervescence.

IIR2—28 inches; hard fractured limestone bedrock.

The loess over the residuum and limestone is 20 to 30 inches thick. The solum is medium acid or strongly acid in the most acid part. Carbonates are absent above the limestone bedrock. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 2 to 4 inches thick. The Ap horizon is dark grayish brown (10YR 4/2) to brown (10YR 4/3 or 5/3). The A2 horizon is typically dark grayish brown (10YR 4/2) but ranges to grayish brown (10YR 5/2) and brown (10YR 5/3). It is 4 to 8 inches thick. The B21t horizon is heavy silt loam or light silty clay loam. The IIB22t horizon is silty clay or clay and is 1 to 5 inches thick.

Dubuque soils are associated with Downs, Fayette, and Nordness soils, and they formed in parent material similar to that of Nordness soils. They have a thinner solum than Downs and Fayette soils. Dubuque soils are deeper to limestone bedrock than Nordness soils.

183C—Dubuque silt loam, 20 to 30 inches to limestone, 5 to 9 percent slopes. This moderately sloping soil is on convex ridges and side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but it has a higher clay content, and the depth to the maximum content of clay is greater.

Included with this soil in mapping are a few small areas of soils in which the depth to limestone bedrock is more than 30 inches. These soils are less droughty than this Dubuque soil.

Most areas of this soil are in permanent pasture or woodland. This soil is suited to occasional cultivated crops. It is subject to moderate or severe erosion if cultivated. Any soil loss through erosion decreases the depth to limestone and affects the use of this soil. Conservation practices should be used if row crops are grown. In places bedrock interferes with the construction of terraces. The organic matter content is very low. Capability unit IIIe–4.

183D2—Dubuque silt loam, 20 to 30 inches to limestone, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is lighter colored. Erosion has removed part of the surface and subsurface layers. The plow layer is lower in fertility and organic matter content than that of uneroded Dubuque soils.

Included with this soil in mapping are a few small areas of soils that are more than 30 inches deep over limestone bedrock and are less droughty than this Dubuque soil. Also included are some areas of soils that are in pasture or woodland and are not eroded.

This soil is suited to occasional cultivated crops. It is subject to severe erosion if cultivated. Any soil loss through erosion decreases the depth to limestone and affects the use of this soil. The organic matter content is very low. Capability unit IVe–2.

183E—Dubuque silt loam, 20 to 30 inches to limestone, 14 to 18 percent slopes. This moderately steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but maximum content of clay is higher and depth to the maximum content of clay is greater.

Included with this soil in mapping are a few areas of soils in which the depth to limestone bedrock is less than 20 inches. These soils are more droughty than this Dubuque soil.

This soil is in woodland and permanent pasture. It is poorly suited to cultivated crops. It is subject to severe erosion and should be protected by a cover of plants at all times. Any soil loss through erosion decreases the depth to limestone and affects the use of

this soil. It is suitable for permanent pasture, trees, or wildlife habitat. The organic matter content is very low. Capability unit VIe–1.

183E2—Dubuque silt loam, 20 to 30 inches to limestone, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored. Part of the surface and subsurface layers have been removed by erosion, which results in a plow layer that has lower organic matter content, lower fertility, and poorer tilth than is typical of the series.

Included with this soil in mapping are a few areas of soils that are less than 20 inches deep over limestone bedrock and are more droughty than this Dubuque soil.

This soil is poorly suited to cultivated crops. It is subject to severe erosion and should be protected by a plant cover at all times. Any soil loss through erosion decreases the depth to limestone and affects the use of this soil. It is suitable for permanent pasture, trees, or wildlife habitat. The organic matter content is very low. Capability unit VIe–1.

183F—Dubuque silt loam, 20 to 30 inches to limestone, 18 to 25 percent slopes. This steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil is in woodland and permanent pasture. It is poorly suited to cultivated crops. It is susceptible to severe erosion and should be protected by a plant cover at all times. It is suitable for permanent pasture, trees, or wildlife habitat. The organic matter content is very low. Capability unit VIIe–1.

Exette series

The Exette series consists of light colored, well drained soils. These moderately sloping to steep soils are in narrow bands on convex side slopes and in coves of drainageways on uplands. The side slopes are commonly dissected by many small waterways. Slopes are 9 to 25 percent. These soils formed in loess more than 40 inches thick. The native vegetation was deciduous trees.

In a representative profile the surface layer is dark grayish brown, friable silt loam about 6 inches thick. The subsoil extends to a depth of 41 inches. In the upper part it is brown, friable silt loam; in the middle part it is dark yellowish brown, friable silt loam that has grayish brown and strong brown mottles; and in the lower part it is mottled grayish brown and yellowish brown, friable silt loam that has yellowish red mottles. The substratum is grayish brown and light brownish gray, friable silt loam.

Available water capacity is high, and permeability is moderate. Available phosphorus is medium, and available potassium is very low. Unless limed within the past 5 years, these soils are acid in the surface layer.

The less sloping Exette soils are used mainly for cultivated crops in rotation with meadow. The steeper soils are in permanent pasture. The major limitation for crops is erosion.

Representative profile of Exette silt loam, 9 to 14 percent slopes, moderately eroded, in a cultivated field, 460 feet north and 9 feet west of the southeast corner of the NE¼NE¼ sec. 7, T. 93 N., R. 7 W.:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, few brown (10YR 4/3) mixings; cloddy parting to weak fine granular structure; friable; neutral; abrupt smooth boundary.

B1—6 to 11 inches; brown (10YR 4/3) silt loam; few dark grayish brown (10YR 4/2) coatings on peds; weak fine and very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21—11 to 24 inches; dark yellowish brown (10YR 4/4) heavy silt loam; brown (10YR 4/3) coatings on peds; few fine distinct grayish brown (10YR 5/2) mottles; weak to moderate medium subangular and angular blocky structure; friable; thin discontinuous light gray (10YR 7/2), dry, silt coatings on peds; medium acid; clear smooth boundary.

B22—24 to 33 inches; dark yellowish brown (10YR 4/4) silt loam; common fine distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; thin discontinuous light gray (10YR 7/2), dry, silt coatings on peds; slightly acid; clear smooth boundary.

B3—33 to 41 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silt loam; few fine distinct yellowish red (5YR 4/8) mottles; weak medium prismatic structure; friable; neutral; clear smooth boundary.

C1—41 to 54 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct yellowish brown (10YR 5/6) and yellowish red (5Y 5/6) mottles; massive; friable; neutral; abrupt wavy boundary.

C2—54 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; common fine distinct light olive brown (2.5Y 5/4) mottles; massive; friable; coarse yellowish red (5YR 4/6) iron segregations; mildly alkaline; weak effervescence.

The solum is 30 to 45 inches thick. The soils formed in a deoxidized and leached zone or in a thin, mottled, oxidized, and leached zone over a deoxidized and leached weathering zone. Carbonates are absent in the solum. The profile is neutral to medium acid in the most acid part. The Ap horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 1 to 4 inches thick. The B2 and B3 horizons have hue of 10YR to 2.5Y, value of 4 to 6, and chroma of 1 through 4. The Ap, B1 and B21 horizons are 22 to 26 percent clay. The B22, B3 and C horizons are 15 to 20 percent clay. Mottles are above a depth of 30 inches and have hue of 7.5YR to 2.5Y, value of 4 to 6, and chroma of 2 through 8.

Above a depth of 30 inches, the profile is at least 20 percent mottles that have chroma of 2. The grayness in the profile is a relict feature and not an indication of present drainage.

Exette soils are associated with the Fayette and Downs soils. They have grayer B and C horizons than those soils. Exette soils have a thinner A horizon than Downs soils.

763D2—Exette silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes that are dissected by many small waterways and in coves of upland drainageways. Areas are about 10 acres in size and are elongated in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few wooded areas of soils that are not eroded and a few areas of soils that have a darker surface layer and are higher in fertility. Also included are a few areas of soils that are severely eroded, are lower in fertility, have poorer tilth than this Exette soil and form a crust that restricts plant emergence.

This soil is suited to occasional row crops in a rotation with meadow. It is subject to severe erosion if cultivated. The organic matter content is very low. Capability unit IIIe–2.

763E2—Exette silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes that are dissected by many small waterways and in coves of upland drainageways. Areas are about 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but maximum clay content is lower and depth to the maximum content of clay is less.

Included with this soil in mapping are a few wooded areas of soils that are not eroded and a few areas of soils that have a darker surface layer and are higher in fertility. Also included are a few areas of soils that are severely eroded, are lower in fertility, and have poorer tilth than this Exette soil and form a crust that restricts plant emergence.

This soil is poorly suited to cultivated crops. It is subject to severe erosion if cultivated. It can be used occasionally for row crops in rotation with meadow. The organic matter content is very low. Capability unit IVe–1.

763E3—Exette silt loam, 14 to 18 percent slopes, severely eroded. This moderately steep soil is on short, convex side slopes that are dissected by many small waterways and in coves of upland drainageways. Areas are about 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but it is severely eroded and the plow layer is dominantly material from the subsoil. The plow layer has poorer tilth and is lower in fertility and organic matter content than the plow layer of the moderately eroded Exette soil. The plow layer is mainly brown silt loam. During intense rains it puddles easily, which results in more runoff, and when the surface is dry it develops a crust that restricts plant emergence.

Included with this soil in mapping are small areas of soils in which the grayish brown subsoil is on the surface. These areas are very low in organic matter content, are low in available phosphorus, and have very poor tilth.

This soil is poorly suited to cultivated crops. It is better suited to hay and permanent pasture than to most other uses. The organic matter content is very low. Capability unit VIe–1.

763F2—Exette silt loam, 18 to 25 percent slopes, moderately eroded. This steep soil is on convex side slopes that are dissected by many small waterways and in coves of upland drainageways. Areas are about 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but maximum clay content is lower and depth to maximum content of clay is less.

Included with this soil in mapping are a few areas of soils that are severely eroded, are lower in fertility, and have poorer tilth than this Exette soil. These soils develop a crust that restricts plant emergence.

This soil is poorly suited to cultivated crops. It is subject to severe erosion if cultivated. Regular farm machinery cannot be used in some places because of the steepness of slope. The soil is suitable for permanent pasture, trees, or wildlife habitat. The organic matter content is very low. Capability unit VIe–1.

763F3—Exette silt loam, 18 to 25 percent slopes, severely eroded. This steep soil is on short, convex side slopes that are dissected by many small waterways and in coves of upland drainageways. Areas are about 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but it has been severely eroded and part of the subsoil has been incorporated into the surface layer. The surface layer has poorer tilth and is lower in fertility and organic matter content than that of the moderately eroded Exette soils. In addition, maximum clay content is lower and depth to maximum content of clay is less. The plow layer is mainly brown silt loam. During intense rains it puddles easily, which results in more runoff and retarded plant growth. When they dry, these severely eroded soils develop a crust that restricts plant emergence.

Included with this soil in mapping are small areas of soils in which the grayish brown subsoil is on the surface. These soils are lower in organic matter content than this Exette soil and have very poor tilth.

This soil is poorly suited to cultivated crops. Regular farm machinery cannot be used in some places because of the steepness of slope. The soil is better suited to permanent pasture, trees, or wildlife habitat than to most other uses. The organic matter content is very low. Capability unit VIIe–1.

Fayette series

The Fayette series consists of light colored, well drained soils. These gently sloping to very steep soils are on upland ridges and side slopes. Slopes are 2 to 40 percent. These soils formed in loess more than 40 inches thick. The native vegetation was deciduous trees.

In a representative profile the surface layer is very dark gray silt loam about 3 inches thick. The subsurface layer is dark gray and dark grayish brown silt

loam about 8 inches thick. The subsoil extends to a depth of 47 inches; it is brown light silty clay loam in the upper part, brown and dark yellowish brown medium silty clay loam in the middle part, and yellowish brown light silty clay loam in the lower part. The substratum is yellowish brown, friable silt loam that has a few grayish mottles.

Available water capacity is high, and permeability is moderate. Available phosphorus is high, and available potassium is very low. Unless limed within the past 5 years, these soils are acid.

The less sloping Fayette soils are used mainly for cultivated crops, and the steeper soils are used for pasture or woodland. The major limitation for crops is erosion.

Representative profile of Fayette silt loam, 5 to 9 percent slopes, in wooded area, 235 feet south and 46 feet west of the northeast corner of the SW¼SW¼ sec. 35, T. 95 N., R. 8 W.:

A1—0 to 3 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; friable; thin patchy light gray (10YR 7/1) dry silt coatings on faces of peds; slightly acid; clear smooth boundary.

A21—3 to 5 inches; dark gray (10YR 4/1) silt loam, some dark grayish brown (10YR 4/2), light brownish gray (10YR 6/2) dry; moderate thin platy structure; friable; medium acid; clear smooth boundary.

A22—5 to 11 inches; dark grayish brown (10YR 4/2) silt loam, pale brown (10YR 6/3) dry; moderate thin platy structure; friable; medium acid; clear irregular boundary.

B1—11 to 14 inches; brown (10YR 4/3) light silty clay loam; moderate fine subangular blocky structure; friable; continuous light gray (10YR 7/1) dry silt coatings on faces of peds; strongly acid; gradual smooth boundary.

B21t—14 to 26 inches; brown (10YR 4/3) silty clay loam; strong fine and medium subangular and angular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) clay films; thin patchy light gray (10YR 7/1) dry silt coatings on faces of peds; very strongly acid; clear smooth boundary.

B22t—26 to 34 inches; dark yellowish brown (10YR 4/4) medium silty clay loam; moderate medium subangular and angular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) clay films; thin patchy light gray (10YR 7/1) dry silt coatings on faces of peds; strongly acid; gradual smooth boundary.

B3t—34 to 47 inches; yellowish brown (10YR 5/4) light silty clay loam; weak medium prismatic structure parting to weak medium angular blocky; friable; thin discontinuous dark brown (10YR 3/3) clay films in upper part of horizon grading to few or none in the lower part; few fine black (10YR 3/1) oxide concretions; strongly acid; gradual smooth boundary.

C—47 to 73 inches; yellowish brown (10YR 5/4) silt loam; few fine faint grayish brown (10YR 5/2) mottles; massive; some distinct vertical cleavage; friable; few dark brown (10YR 3/3) oxide concretions; strongly acid.

The solum is 40 to 60 inches thick. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 2 to 4 inches thick. The Ap horizon is dark grayish brown (10YR 4/2) to brown (10YR 4/3 or 5/3). The A2 horizon is typically dark grayish brown (10YR 4/2) but ranges from dark gray (10YR 4/1) to brown (10YR 5/3). The A2 horizon is 4 to 8 inches thick, but in eroded areas it may be incorporated into the Ap horizon. The B2t horizon is brown (10YR 4/3) to yellowish brown (10YR 5/4) It is light or medium silty clay loam, and has a maximum clay content of 28 to 34 percent.

Fayette soils are associated with Downs, Dubuque, Exette, and Nordness soils. They formed in parent material similar to that of Downs and Port Byron soils. Fayette soils have a thinner A horizon and a more distinct A2 horizon than Downs and Port Byron soils. They have a thicker solum than Dubuque and Nordness soils and are not underlain by limestone bedrock at a depth of less than 40 inches. They have browner B and C horizons and fewer mottles than Exette soils.

163B—Fayette silt loam, 2 to 5 percent slopes. This gently sloping soil is on convex ridgetops. Areas are about 10 to 20 acres in size and are irregular in shape.

This soil is well suited to cultivated crops. It is subject to slight to moderate erosion if cultivated. Most areas are suitable for terracing because of the uniform length and shape of slopes. The organic matter content is very low. Capability unit IIe–1.

163C—Fayette silt loam, 5 to 9 percent slopes. This moderately sloping soil is on narrow ridges and convex side slopes. Areas are several miles long and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of moderately eroded soils in which the surface layer is dark grayish brown or brown. These soils are lower in fertility and in organic matter content than this Fayette soil.

This soil is suited to row crops in rotation with alfalfa. It is subject to moderate to severe erosion if cultivated. Most areas are suitable for terracing because of the uniform length and shape of slope. The organic matter content is very low. Capability unit IIIe–1.

163C2—Fayette silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on narrow ridges and convex side slopes. Areas are several miles long and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but erosion has removed part of the surface and subsurface layers, and some of the subsoil has been mixed into the plow layer. This plow layer is lower in organic matter content and fertility than that of uneroded Fayette soils.

Included with this soil in mapping are a few small areas of severely eroded soils. These soils are lower in

fertility and have poorer tilth than this Fayette soil. They become cloddy if worked when wet. They puddle during intense rains, causing more than normal runoff and retarding growth.

This soil is suited to row crops and alfalfa. More fertilizer is needed to obtain the same yield on this soil than on uneroded Fayette soils. This soil is subject to erosion if cultivated. Most areas are suitable for terracing because of the uniform length and shape of slopes. (fig. 10). The organic matter content is very low. Capability unit IIIe–1.

163D—Fayette silt loam, 9 to 14 percent slopes. This strongly sloping soil is on convex side slopes. Areas are 10 to 20 acres in size and are elongated in shape.

Included with this soil in mapping are a few small areas of moderately eroded soils. The surface layer of these soils is dark grayish brown or brown and they are lower in organic matter content and fertility than this Fayette soil.

This soil is suited to occasional row crops. It is subject to moderate to severe erosion if cultivated. Most areas are in woodland and permanent pasture. The organic matter content is very low Capability unit IIIe–2.

163D2—Fayette silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes. Areas are about 10 to 20 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but erosion has removed part of the surface and subsurface layers. The plow layer is lower in fertility and organic matter content than that of uneroded Fayette soils. It becomes cloddy if worked when wet. It puddles during intense rains, causing more than normal runoff, poor seed emergence, and retarded plant growth. Maximum clay content is lower, and depth to the maximum content of clay is less than in the representative profile.

Included with this soil in mapping are a few areas of severely eroded soils that are lower in fertility and have poorer tilth than this Fayette soil.

This soil is suited to occasional row crops. The long and uniform slopes are well suited to conservation practices. This soil is susceptible to severe erosion if cultivated. Row crops can be grown frequently without excess soil loss if conservation is practiced. The organic matter content is very low. Capability unit IIIe–2.

Figure 10.—Typical grass-backslope, tile-outlet terrace in an area of Fayette soils.

163D3—Fayette silt loam, 9 to 14 percent slopes, severely eroded. This strongly sloping soil is on short convex side slopes on uplands. The slopes are dissected by many waterways. Areas are about 10 to 20 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but it is severely eroded and the subsurface layer and part of the subsoil has been incorporated into the surface layer. The present surface layer is lower in fertility and organic matter content and higher in clay than that of less eroded Fayette soils. The plow layer is mainly brown silt loam but is silty clay loam in some areas. It becomes cloddy if worked when wet. It puddles during intense rains, causing more than normal runoff, poor seed emergence, and retarded plant growth.

Included with this soil in mapping are a few areas in which loess is less than 40 inches thick and limestone or glacial till is at a depth of less than 40 inches. Soils in which limestone is at a depth of less than 40 inches are slightly droughty.

This soil is suited to occasional row crops. More fertilizer is needed to obtain the same yield on this soil than on less eroded Fayette soils. The organic matter content is very low. Capability unit IVe–1.

163E—Fayette silt loam, 14 to 18 percent slopes. This moderately steep soil is on convex side slopes on uplands. It is mostly in wooded areas and permanent pasture. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the maximum clay content is lower and depth to the maximum content of clay is less.

Included with this soil in mapping are a few small areas of moderately eroded soils. These soils have a dark grayish brown or brown surface layer and are lower in fertility than this Fayette soil.

This soil is poorly suited to row crops. It is subject to moderate to severe erosion if cultivated. It can be used occasionally for row crops in rotation with meadow. The organic matter content is very low. Capability unit IVe–1.

163E2—Fayette silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but parts of the surface and subsurface layers have been removed by erosion. The plow layer is lower in fertility and organic matter content than that of uneroded Fayette soils. It becomes cloddy if worked when wet. It puddles during intense rains, causing more than normal runoff, poor seed emergence, and retarded plant growth. Maximum clay content is lower and depth to the maximum content of clay is less than in the representative profile.

Included with this soil in mapping are a few small areas of wooded soils that are not eroded. Also included are a few areas in which loess is less than 40 inches thick and limestone or glacial till is at a depth of less than 40 inches. Soils in which limestone is at

a depth of less than 40 inches tend to be slightly droughty.

This soil is poorly suited to cultivated crops. It is subject to severe erosion if cultivated. It can be used occasionally for row crops in rotation with meadow. The organic matter content is very low. Capability unit IVe–1.

163E3—Fayette silt loam, 14 to 18 percent slopes, severely eroded. This moderately steep soil is on short, convex side slopes on uplands. The slopes have been dissected by many waterways. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but it is severely eroded and the subsurface layer and part of the subsoil have been incorporated into the plow layer. The present surface layer is lower in fertility and organic matter content and higher in clay than that of less eroded Fayette soils. The plow layer is mainly brown silt loam but is silty clay loam in some areas. It puddles easily during intense rains, causing more than normal runoff, poor seed emergence, and retarded plant growth.

Included with this soil in mapping are a few areas in which loess is less than 40 inches thick and limestone or glacial till is at a depth of less than 40 inches. These areas tend to be slightly droughty.

This soil is poorly suited to cultivated crops. It is subject to very severe erosion. It is better suited to hay and permanent pasture than to row crops. The organic matter content is very low. Capability unit VIe–1.

163F—Fayette silt loam, 18 to 25 percent slopes. This steep soil is on convex side slopes on uplands. It is mostly in wooded areas and permanent pasture. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the maximum clay content is lower and depth to the maximum content of clay is less.

Included with this soil in mapping are a few small areas of moderately eroded soils. These soils have a dark grayish brown or brown surface layer, and they are lower in fertility and organic matter content than this Fayette soil.

This soil is poorly suited to cultivated crops. It is subject to severe erosion if cultivated. Some areas are not safe for the use of regular farm machinery because of steepness. This soil is suitable for permanent pasture, trees, or wildlife habitat. The organic matter content is very low. Capability unit VIe–1.

163F2—Fayette silt loam, 18 to 25 percent slopes, moderately eroded. This steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is not so thick and is lighter in color. The subsurface layer has been incorporated into the plow layer. The maximum clay content is lower and depth to the maximum content of clay is less than in the representative profile.

Included in mapping are a few areas of severely eroded soils.

This soil is poorly suited to cultivated crops. It is subject to severe erosion if cultivated. Farm machinery cannot be used in some places because of the steepness of slope. This soil is suitable for permanent pasture, trees, or wildlife habitat. The organic matter content is very low. Capability unit VIe–1.

163F3—Fayette silt loam, 18 to 25 percent slopes, severely eroded. This steep soil is on short convex side slopes on uplands. The slopes have been dissected by many waterways. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is lighter in color. The subsurface layer and part of the subsoil have been incorporated into the plow layer. The present surface layer is lower in fertility and organic matter content than that of less eroded Fayette soils.

This soil is poorly suited to cultivated crops. It is subject to very severe erosion if cultivated. Farm machinery cannot be used in some places because of the steepness of slope. This soil is better suited to permanent pasture, trees, or wildlife habitat. The organic matter content is very low. Capability unit VIIe–1.

163G—Fayette silt loam, 25 to 40 percent slopes. This very steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the maximum clay content is less and depth to the maximum content of clay is less.

This soil is poorly suited to cultivated crops. It is subject to very severe erosion if cultivated. Farm machinery cannot be used safely on this soil because of the steepness of slope. This soil is suitable for trees or wildlife habitat, and it is suitable for permanent pasture if grazing is limited. Most areas of this soil are in woodland. The organic matter content is very low. Capability unit VIIe–1.

497F—Fayette-Dubuque-Jacwin complex, 14 to 25 percent slopes. This complex consists of light colored to dark colored, well drained to somewhat poorly drained soils. These steep soils are closely associated on uplands below Nordness soils and Rock outcrop and above the soils on benches and bottom lands. This complex is about 50 percent Fayette soils, 20 percent Dubuque soils, 20 percent Jacwin soils, and 10 percent Nordness soils and Rock outcrop. Fayette and Dubuque soils are on side slopes and Jacwin soils are at the base of slopes near waterways. These soils are in such close association that it is impractical to map them separately.

Limestone boulders that have rolled down from the higher Nordness soils and Rock outcrop are common on the surface of soils in this complex. These boulders range from 1 foot to 15 feet in diameter. In some areas, pasture renovation is feasible because the boulders can be removed. Other areas have so many boulders that removal is impractical.

Most areas of this complex are in permanent pasture or woodland. This complex is not suited to cultivated crops. It is subject to severe erosion if cultivated. The limestone boulders make cultivation impractical in most areas (fig. 11). Farm machinery cannot be used in some places because of steepness. Jacwin soils are

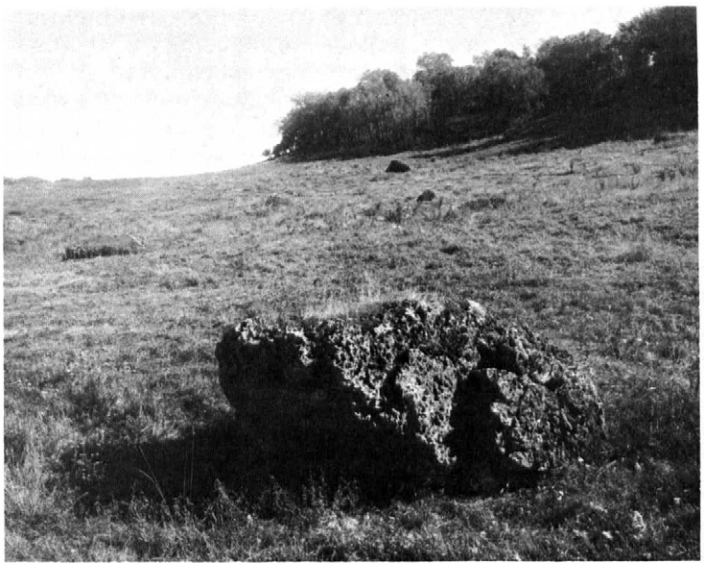

Figure 11.—Limestone boulders in an area of Fayette-Dubuque-Jacwin soils.

very slowly permeable and cause seepy areas. Springs develop in some areas, providing sources of water. Capability unit VIIe–1.

497G—Fayette-Dubuque-Jacwin complex, 25 to 40 percent slopes. This complex consists of light colored to dark colored, well drained to somewhat poorly drained soils. These very steep soils are closely associated on uplands below Nordness soils and Rock outcrop and above soils on benches and bottom lands. This complex is about 50 percent Fayette soils, about 20 percent Dubuque soils, about 20 percent Jacwin soils, and 10 percent Nordness soils and Rock outcrop. Fayette and Dubuque soils are on side slopes, and Jacwin soils are at the base of the slopes near waterways. The soils are in such close association that it is impractical to map them separately.

Limestone boulders that have rolled down from the more elevated Nordness soils and Rock outcrop are common on the surface of the soils in this complex. These boulders range from 1 foot to 15 feet in diameter.

This complex is not suited to cultivated crops. It is subject to severe erosion if cultivated. Farm machinery cannot be used safely on this soil because of steepness. This complex is suitable for trees or wildlife habitat, and it is suitable for permanent pasture if grazing is limited. Jacwin soils are very slowly permeable and cause seepy areas to form just above them. Springs develop in some areas, providing sources of water. Capability unit VIIe–1.

Festina series

The Festina series consists of moderately dark colored, well drained soils. These nearly level soils are on low stream benches. Slopes are 0 to 2 percent. These soils formed in medium textured silty alluvium. The native vegetation was prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark gray, friable silt loam about 8 inches thick. The subsurface layer is brown and dark grayish brown, friable silt loam about 6 inches thick. The subsoil extends to a depth of 48 inches. It is dark yellowish brown and yellowish brown, friable silt loam. The substratum is yellowish brown, friable silt loam.

Available water capacity is high, and permeability is moderate. Available phosphorus is low, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Festina soils are used mainly for cultivated crops. The major limitation for crops is occasional local runoff from the adjoining loess-covered soils upslope.

Representative profile of Festina silt loam, 0 to 2 percent slopes, in a cultivated field, 327 feet south and 123 feet east of northeast corner of NW¼NW¼ sec. 19, T. 95 N., R. 7 W.:

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam; cloddy parting to weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—8 to 14 inches; brown (10YR 4/3) silt loam; dark grayish brown (10YR 4/2) coatings; weak medium and thin platy structure; friable; slightly acid; gradual smooth boundary.

B1—14 to 21 inches; dark yellowish brown (10YR 4/4) silt loam; brown (10YR 4/3) coatings; moderate medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21t—21 to 29 inches; yellowish brown (10YR 5/4) heavy silt loam; strong medium and fine angular blocky and subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films in root channels; slightly acid; gradual smooth boundary.

B22t—29 to 39 inches; yellowish brown (10YR 5/4 and 5/6) heavy silt loam; moderate medium and fine angular blocky and subangular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) clay films; medium acid; gradual smooth boundary.

B3t—39 to 48 inches; yellowish brown (10YR 5/6) silt loam; weak medium prismatic structure; friable; few thin discontinuous brown (10YR 4/3) clay films; few discontinuous light gray (10YR 7/1), dry, silt coatings; medium acid; gradual smooth boundary.

C—48 to 60 inches; yellowish brown (10YR 5/6) silt loam; massive; friable; increase in sand in lower part; medium acid.

The solum is 40 to 60 inches thick. Sand strata are between depths of 40 and 60 inches in some places. Carbonates are absent at a depth of less than 60 inches. The solum ranges from neutral to medium acid but is typically medium acid in the most acid part. The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) and is 6 to 9 inches thick. The Ap horizon is very dark gray (10YR 3/1) or very dark

grayish brown (10YR 3/2). The A2 horizon is generally 4 to 12 inches thick, but in some places it may be partly incorporated into the Ap horizon. The B horizon is brown (10YR 4/3) to yellowish brown (10YR 5/4). It is medium silt loam to light silty clay loam.

Festina soils are associated with Richwood, Canoe, and Ossian soils. They formed in parent material similar to that of Richwood, Canoe, and Ossian soils. They have a thinner A horizon than Richwood soils. They have a thinner A horizon and a browner upper part of the B horizon than Ossian soils. Festina soils are browner in the upper part of the B horizon and are better drained than Canoe soils.

978—Festina silt loam, 0 to 2 percent slopes. This nearly level soil is on stream benches. Areas are about 10 acres in size and are irregular in shape.

Included with this soil in mapping are areas of soils that have a thinner and lighter colored surface layer and are lower in organic matter content and fertility than this Festina soil.

This soil is well suited to cultivated crops. It receives runoff and sediment from soils upslope. Diversion terraces upslope protect this soil from local runoff. The organic matter content is moderately low. Capability unit I–1.

Flagler series

The Flagler series consists of dark colored, somewhat excessively drained soils. These nearly level to moderately sloping soils are on alluvial benches along streams and on outwash areas on uplands. Slopes are 0 to 9 percent. These soils formed in 24 to 32 inches of stratified moderately coarse textured alluvium and in the underlying gravelly loamy sand and 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 sandy loam about 20 inches thick. The subsoil extends to a depth of 33 inches. It is dark yellowish brown gravelly sandy loam in the upper part and brown gravelly loamy sand in the lower part. The substratum is yellowish brown coarse sand with some gravel.

Available water capacity is low. Permeability is moderately rapid in the upper part of the soil and very rapid in the coarse textured substratum. Available phosphorus and available potassium are very low. Unless limed within the past 5 years, these soils are generally acid in the surface layer.

The Flagler soils are used mainly for cultivated crops and pasture. The major limitations for crops are droughtiness and erosion in the more sloping areas.

Representative profile of Flagler sandy loam, 0 to 2 percent slopes, in a cultivated field, 420 feet south and 258 feet west of northeast corner of SE¼NE¼ sec. 19, T. 93 N., R. 10 W.:

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

A12—9 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam; very dark brown (10YR 2/2) coatings on peds; moderate fine granular structure; very friable; few small gravel; medium acid; clear smooth boundary.

A3—14 to 20 inches; dark brown (10YR 3/3) sandy loam; weak medium subangular blocky structure; very friable; common 2-millimeter gravel; medium acid; gradual smooth boundary.

IIB2—20 to 28 inches; dark yellowish brown (10YR 4/4) gravelly sandy loam; weak coarse subangular blocky structure; very friable; medium acid; clear smooth boundary.

IIB3t—28 to 33 inches; brown (7.5YR 4/4) gravelly loamy sand; weak coarse subangular blocky structure; very friable; some clay bridging between sand grains; medium acid; clear smooth boundary.

IIC—33 to 60 inches; yellowish brown (10YR 5/6) coarse sand; some gravel; single grained; loose; medium acid.

The solum is 24 to 40 inches thick. Coarse textured material is at a depth of 20 to 36 inches. Carbonates are absent above a depth of 60 inches. The A1 or Ap horizon is black (10YR 2/1) to very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). It is sandy loam or fine sandy loam. The A horizon is 10 to 24 inches thick. The B2 horizon is brown (10YR 4/3) to dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6). The IIC horizon is loamy sand with some gravel to sand or gravelly sand. It is medium acid to neutral.

Flagler soils are associated with the Saude, Kenyon, and Burkhardt soils. They formed in parent material similar to that of Burkhardt soils. They have less clay and more sand in the A horizon and upper part of the B horizon than Saude and Kenyon soils. Flagler soils have more clay and less sand in the upper part of the solum than Burkhardt soils.

284—Flagler sandy loam, 0 to 2 percent slopes. This nearly level soil is on benches along streams. Areas are commonly 20 to 40 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils in which the depth to coarse textured material is more than 36 inches. These soils are less droughty than this Flagler soil.

This soil is suited to cultivated crops. It is subject to little runoff, but drainage is somewhat excessive. In most years, crop yields are depressed because of lack of moisture. The organic matter content is moderate. Capability unit IIIs–1.

284B—Flagler sandy loam, 2 to 5 percent slopes. This gently sloping soil is on outwash areas on uplands and on stream benches. Areas are generally about 5 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is only about 15 inches thick.

Included with this soil in mapping are a few areas of soils in which the depth to the coarse textured material is less than 20 inches. These soils are more droughty than this Flagler soil.

This soil is suited to cultivated crops, but it is droughty and productivity is low unless rainfall is normal or above normal and timely. It is subject to slight erosion if cultivated. Runoff is slow, but drainage is somewhat excessive. The organic matter content is moderate. Capability unit IIIe–3.

284C—Flagler sandy loam, 5 to 9 percent slopes. This moderately sloping soil is in outwash areas on uplands and on stream benches. Areas are small moundlike ridges, generally about 5 acres in size.

This soil has a profile similar to the one described as representative of the series, but the dark surface layer is about 12 inches thick.

Included with this soil in mapping are a few small areas of soils in which the depth to coarse textured material is less than 20 inches. These soils are more droughty than this Flagler soil. Also included are a few areas of moderately eroded soils in which the surface layer is about 8 inches thick. These soils are lower in fertility than this Flagler soil.

This soil is suited to cultivated crops, but yields are generally low and depend on the amount and timeliness of rainfall. This soil is subject to moderate to severe erosion if cultivated. Drainage is somewhat excessive. The organic matter content is moderate. Capability unit IIIe–3.

Floyd series

The Floyd series consists of dark colored, somewhat poorly drained soils. These nearly level to gently sloping soils are on concave side slopes and at the upper ends of drainageways on uplands. Slopes are 1 to 4 percent. These soils formed in loamy material 30 to 45 inches thick and in the underlying medium textured, stratified, friable glacial till. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish brown loam about 15 inches thick. The subsoil extends to a depth of 48 inches. It is dark grayish brown loam in the upper part; mottled yellowish brown and olive gray, friable sandy clay loam in the middle part; and mottled olive gray and yellowish brown friable, sandy clay loam in the lower part. The substratum is mottled olive gray and yellowish brown, firm loam that is mildly alkaline and strongly effervescent.

Available water capacity is high, and permeability is moderate. Available phosphorus and available potassium are low. These soils are generally neutral and do not require liming.

These soils are used mainly for cultivated crops. The major limitation for crops is wetness. The soils are wet, partly because they receive some seepage from adjoining soils upslope.

Representative profile of Floyd loam, 1 to 4 percent slopes, in a cultivated field, 27 feet west and 410 feet south of the northeast corner of the NW¼ sec. 14, T. 92 N., R. 8 W.:

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

A12—8 to 12 inches; black (10YR 2/1) loam; moderate fine granular structure; friable; neutral; clear smooth boundary.

A3—12 to 15 inches; very dark grayish brown (2.5Y 3/2) loam; black (10YR 2/1) coatings on peds; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.

B1—15 to 19 inches, dark grayish brown (2.5Y 4/2) loam; very dark grayish brown (2.5Y 3/2) coatings on peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

B21—19 to 27 inches; mottled yellowish brown (10YR 5/4) and olive gray (5Y 5/2) sandy clay loam; weak fine subangular blocky structure; friable; pebbles scattered throughout horizon; neutral; clear wavy boundary.

B22—27 to 32 inches; yellowish brown (10YR 5/6) loamy sand; very weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

IIB23—32 to 48 inches; mottled olive gray (5Y 5/2) and yellowish brown (10YR 5/6) sandy clay loam; moderate medium prismatic structure parting to weak fine subangular blocky; friable; common dark oxide concretions; neutral; clear wavy boundary.

IIC—48 to 60 inches; mottled olive gray (5Y 5/2) and yellowish brown (10YR 5/6) loam; massive; firm; mildly alkaline; strong effervescence.

The solum is 45 to 60 inches thick. It is neutral or slightly acid. Carbonates are at a depth of 45 to 70 inches. The soils formed in loamy material 30 to 45 inches thick and in the underlying medium textured, stratified, friable glacial till. The A3 horizon is very dark grayish brown (2.5Y 3/2) to very dark gray (10YR 3/1). The B horizon is light loam to sandy clay loam, but in places it contains loamy sand strata 6 inches or less thick.

Floyd soils are associated with Kenyon, Clyde, Ostrander, and Schley soils. They formed in parent material similar to that of Clyde, Schley, and Ostrander soils. They are grayer in the upper part of the B horizon than Kenyon and Ostrander soils, and are not so well drained. They have a more stratified B horizon than Kenyon soils. Floyd soils have a thicker A horizon than Schley soils. They are not so gray in the upper part of the B horizon as Clyde soils.

198B—Floyd loam, 1 to 4 percent slopes. This nearly level to gently sloping soil is on concave side slopes on uplands. Areas are about 10 to 20 acres in size and are elongated in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that have a sandy loam surface layer and are lower in fertility and organic matter content than this Floyd soil.

This soil is well suited to cultivated crops, if it is drained. It is susceptible to slight erosion on the more sloping areas; however, the major limitation is wetness. Because the wetness is partly due to hillside seepage, a drainage system that intercepts lateral

movement of water is needed. The organic matter content is high. Capability unit IIw–1.

Goss series

The Goss series consists of light colored, well drained to somewhat excessively drained soils. These strongly sloping to moderately steep soils are on ridges and side slopes on uplands. Slopes are 9 to 18 percent. These soils formed in 8 to 18 inches of loamy material and in the underlying residuum that was weathered from cherty limestone. The native vegetation was deciduous trees.

In a representative profile the surface layer is dark grayish brown, friable loam that is about 10 percent chert fragments and is about 6 inches thick. The subsurface layer is brown, friable cherty loam about 3 inches thick. The subsoil extends to a depth of 63 inches. It is dark yellowish brown, friable cherty loam in the upper part; red, firm cherty clay in the middle part; and dark red, firm cherty clay in the lower part. The substratum is red, firm cherty clay.

Available water capacity is low. Permeability is moderate in the loamy material and moderately rapid in the clayey residuum that has coarse chert fragments. Available phosphorus and available potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Goss soils are used mainly for permanent pasture, although a few areas are cultivated with the adjoining soils. A major limitation for crops is the coarse chert fragments, which make cultivation very difficult. Erosion is also a major limitation.

Representative profile of Goss loam, 9 to 18 percent slopes, in a cultivated field, 592 feet east and 6 feet north of southwest corner of NE¼NW¼ sec. 21, T. 93 N., R. 7 W.:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam; few very dark grayish brown (10YR 3/2) coatings; weak fine subangular blocky structure parting to weak fine granular; friable; about 10 percent chert fragments 5 to 60 millimeters in diameter; slightly acid; abrupt smooth boundary.

A2—6 to 9 inches; brown (10YR 4/3) cherty loam; weak thin platy structure parting to weak fine subangular blocky; friable; about 30 to 40 percent chert fragments 5 to 60 millimeters in diameter; slightly acid; clear smooth boundary.

B1—9 to 13 inches; dark yellowish brown (10YR 4/4) cherty loam; weak very fine subangular blocky structure; friable; about 40 percent chert fragments 5 to 60 millimeters in diameter; medium acid; clear smooth boundary.

IIB21t—13 to 32 inches; red (2.5YR 4/6) cherty clay; moderate fine and very fine subangular blocky structure; firm; about 70 percent chert fragments 5 to 80 millimeters in diameter; thin discontinuous dark reddish brown (2.5YR 3/4) clay films; medium acid; gradual smooth boundary.

IIB22—32 to 63 inches; dark red (10YR 3/6) cherty clay; moderate fine and very fine subangular and angular blocky structure; firm; about 60 percent chert fragments 5 to 80 millimeters in diameter; strongly acid; gradual smooth boundary.

IIC—63 to 70 inches; red (2.5YR 4/6) cherty clay; massive; firm; about 80 percent chert fragments 5 to 80 millimeters in diameter; medium acid.

The solum is 60 to 80 inches thick. The soils formed in 8 to 18 inches of loamy material and the underlying residuum weathered from cherty limestone. The A horizon is typically loam but ranges to silt loam high in sand and sandy loam. The A horizon is 10 to 30 percent chert fragments. The IIB horizon has hue of 10R to 7.5YR. The IIB and IIC horizons are 45 to 80 percent chert fragments.

Goss soils are associated with Marlean, Nordness, and Winneshiek soils. They formed in several feet of residuum weathered from cherty limestone, whereas Marlean, Nordness, and Winneshiek soils have a thin layer of limestone residuum.

215E—Goss loam, 9 to 18 percent slopes. This strongly sloping to moderately steep soil is on ridges and side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

Included with this soil in mapping are areas of soils where many coarse chert fragments are on the surface and cultivation is very difficult.

This soil is poorly suited to cultivated crops. It is subject to erosion, and cultivation is very difficult because of chert fragments that work up to the surface layer. Some areas of this soil have been cultivated, but most are now in pasture. Yields are generally low unless rainfall is above normal and timely. The organic matter content is very low. Capability unit VIs–1.

Hanlon series

The Hanlon series consists of dark colored, moderately well drained soils. These nearly level soils are on bottom lands along streams. Slopes are 0 to 2 percent. These soils formed in moderately coarse textured, loamy alluvium. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown, very friable and friable sandy loam 53 inches thick. The subsoil is very dark grayish brown, friable sandy loam 12 inches thick. The substratum is dark yellowish brown loamy sand.

Available water capacity is moderate, and permeability is moderately rapid. Available phosphorus and available potassium are very low. These soils are generally neutral in the surface layer and do not require lime.

Hanlon soils are used mainly for cultivated crops. The major limitations for crops are flooding of short duration and droughtiness. These soils can be quite productive if rainfall is timely throughout the growing season.

Representative profile of Hanlon fine sandy loam, 0 to 2 percent slopes, in permanent pasture, 182 feet

west and 726 feet south of the northeast corner of the NW¼ sec. 29, T. 93 N., R. 8 W.:

A11—0 to 18 inches; very dark brown (10YR 2/2) fine sandy loam; very weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

A12—18 to 47 inches; very dark brown (10YR 2/2) light sandy loam; very weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

A3—47 to 53 inches; very dark brown (10YR 2/2) sandy loam; very weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

B—53 to 65 inches; very dark grayish brown (10YR 3/2) heavy sandy loam; very weak medium and coarse subangular blocky structure; friable; neutral; gradual smooth boundary.

C—65 to 72 inches; dark yellowish brown (10YR 3/4) loamy sand; single grained; loose; neutral.

The solum is 40 to 72 inches thick. It is neutral or slightly acid. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) but in places ranges to very dark grayish brown (10YR 3/2). It is typically fine sandy loam but ranges to sandy loam. It is 40 to 60 inches thick. The B horizon has hue of 10YR, value of 3 or 4, and chroma of 1 or 2. It is commonly sandy loam but in places is fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 to 4. It is heavy sandy loam to loamy sand.

Hanlon soils are associated with Spillville, Dorchester, and Coland soils. They formed in parent material similar to that of Spillville soils. They have more sand and less clay throughout the solum than Spillville, Coland, and Dorchester soils. Hanlon soils do not have carbonates, whereas Dorchester soils do.

536—Hanlon fine sandy loam, 0 to 2 percent slopes. This nearly level soil is on flood plains and natural levees along rivers and large streams. Areas are 5 to 12 acres in size and are irregular in shape.

Included with this soil in mapping are small areas of soils that have a loamy sand surface layer and are more droughty and less productive than this Hanlon soil. Also included are areas of soils in which the dark surface layer is less than 36 inches thick. These soils are lower in organic matter content than this Hanlon soil.

This soil is suited to cultivated crops. It is subject to flooding of short duration, especially in spring. It is also subject to droughtiness when rainfall is below average or is not timely. The organic matter content is moderate. Capability unit IIs–3.

Hayfield series

The Hayfield series consists of moderately dark colored, somewhat poorly drained soils. These nearly level soils are on stream terraces on outwash areas on uplands. Slopes are 0 to 2 percent. These soils formed in 24 to 32 inches of loamy alluvial deposits and in the underlying coarse textured sediment. The native vegetation was prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark brown, friable loam about 8 inches thick. The subsurface layer is dark grayish brown, friable loam about 7 inches thick. The subsoil extends to a depth of 31 inches. It is brown, friable loam in the upper part; mottled grayish brown and brown, friable loam in the middle part; and mixed brown and strong brown loamy sand in the lower part. The substratum is mixed yellowish brown and light yellowish brown medium and coarse sand.

Available water capacity is moderate. Permeability is moderate in the upper part of the soil and rapid in the coarse textured substratum. Available phosphorus is low, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Hayfield soils are used mainly for cultivated crops. The major limitation for crops is slight wetness. Tile drainage is needed in some years to improve timeliness of field operations. Because of the coarse textured substratum, these soils can also be droughty if rainfall is not timely.

Representative profile of Hayfield loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, in permanent pasture, at edge of wooded area 417 feet south and 237 feet east of the northwest corner of the NW¼NW¼ sec. 32, T. 91 N., R. 10 W.:

A1—0 to 8 inches; very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak to moderate fine granular structure; friable; medium acid; clear smooth boundary.

A21—8 to 12 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) and few very dark brown (10YR 2/2) coatings on peds; weak fine subangular blocky structure; friable; few fine faint brown (7.5YR 4/4) mottles; medium acid; clear smooth boundary.

A22—12 to 15 inches; dark grayish brown (10YR 4/2) loam; weak medium and fine subangular blocky structure; friable; few fine faint brown (7.5YR 4/4) mottles; medium acid; clear smooth boundary.

B1—15 to 20 inches; brown (10YR 4/3) loam; some dark grayish brown (10YR 4/2) coatings on peds; weak medium and fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B2t—20 to 28 inches; mottled grayish brown (10YR 5/2) and brown (7.5YR 4/4) loam; weak medium and fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) clay films; medium acid; clear smooth boundary.

IIB3—28 to 31 inches; mixed brown (7.5YR 4/4) and strong brown (7.5YR 5/6) gravelly loamy sand; very weak fine subangular blocky structure; very friable; few fine distinct grayish brown (2.5Y 5/2) mottles; medium acid; clear smooth boundary.

IIC—31 to 60 inches; mixed yellowish brown (10YR 5/6) and light yellowish brown

(10YR 6/4) medium and coarse sand; single grained; loose; about 5 percent 2-millimeter gravel; medium acid.

The solum is 24 to 50 inches thick. Contrasting material is at a depth of about 24 to 40 inches. Carbonates are at a depth of less than 60 inches. The A1 or Ap horizon is 6 to 10 inches thick and has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The A2 horizon has matrix value of 4 or 5 and chroma of 2 or 3. It is 3 to 7 inches thick. The B horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 or 3. Where it has chroma of 3 there are mottles that have lower chroma. The B1 horizon is typically loam, silt loam that is high in sand, light clay loam, or sandy clay loam. In some places the lower part of the B1 horizon is sandy loam. The C horizon has a matrix with value of 4 to 6, chroma of 2 to 6, and hue of 10YR or 2.5Y. It is dominantly loamy sand, coarse sand, or sand and has some gravel. The C horizon is medium acid to very strongly acid in the most acid part.

Hayfield soils are associated with Wapsie, Marshan, and Lawler soils. They formed in parent material similar to that of Lawler and Wapsie soils. They have a thinner, lighter colored A horizon than Lawler and Marshan soils. Hayfield soils are grayer in the upper part of the B horizon than Wapsie soils.

725—Hayfield loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level soil is on stream benches and on a few outwash areas on uplands. Areas are about 10 acres in size and irregular in shape.

Included with this soil in mapping are a few areas of soils that have a sandy loam surface layer and are in places more droughty than this Hayfield soil.

If management is good, this soil is well suited to row crops. It is subject to droughtiness and wetness during the growing season, depending on the rainfall. The water table fluctuates rapidly, because the sandy substratum is close to the surface. During some seasons when the water table is high, this soil benefits from tile drainage; however, tile placement is difficult in places because of the loose, water-bearing sand and gravel. The organic matter content is moderately low. Capability unit IIs–2.

Huntsville series

The Huntsville series consists of dark, well drained soils. These nearly level to gently sloping soils are on bottom lands and on foot slopes at the base of loess-covered uplands. They are also in waterways associated with the loess-covered uplands. Slopes are 0 to 5 percent. These soils formed in silty alluvium. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown, friable silt loam about 30 inches thick. The subsoil extends to a depth of 47 inches. It is brown, friable silt loam in the upper part; dark yellowish brown, friable silt loam in the middle part; and yellowish brown, friable silt loam in the lower part. The substratum is yellowish brown, friable silt loam.

Available water capacity is high, and permeability is moderate. Available phosphorus is medium, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Huntsville soils are used mainly for cultivated crops. The major limitation for crops is runoff from soils upslope during periods of intense rainfall.

Representative profile of Huntsville silt loam, 0 to 2 percent slopes, in a cultivated field, 180 feet east of road at field gate at point very near center of W½ SE¼SW¼ sec. 18, T. 95 N., R. 7 W.:

Ap—0 to 6 inches; black (10YR 2/1) silt loam; cloddy parting to weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—6 to 20 inches; black (10YR 2/1) silt loam; moderate fine granular structure; friable; medium acid; clear smooth boundary.

A13—20 to 30 inches; very dark brown (10YR 2/2) silt loam; moderate very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—30 to 35 inches; brown (10YR 4/2) silt loam; dark brown (10YR 3/3) coatings on peds; moderate fine subangular blocky structure; friable; common fine very dark brown (10YR 2/2) oxide concretions; medium acid; clear smooth boundary.

B2—35 to 39 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B3—39 to 47 inches; yellowish brown (10YR 5/6) silt loam; weak coarse prismatic structure parting to moderate fine subangular blocky; friable; slightly acid; clear smooth boundary.

C—47 to 60 inches; yellowish brown (10YR 5/6) silt loam; massive; friable; slightly acid.

These soils formed in silty alluvium at least 40 inches thick. The solum is medium acid in the most acid part. In places thin strata of sandy loam material are at a depth of more than 40 inches. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). It is typically silt loam but ranges to light silty clay loam. It is 24 to 36 inches thick. The B horizon has value of 3 to 5 and chroma of 3 to 6. In some profiles few grayish brown mottles are at a depth of more than 36 inches.

Huntsville soils are associated with Otter, Ossian, and Dorchester soils, and they formed in parent material similar to that of Ossian soils. They have a thicker and darker A horizon than Dorchester soils. Huntsville soils are browner in the upper part of the B horizon and are better drained than Otter and Ossian soils.

98—Huntsville silt loam, 0 to 2 percent slopes. This nearly level soil is on bottom lands along streams. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils in which the dark surface layer is less than 24

inches thick. These soils are lower in organic matter content than this Huntsville soil.

This soil is well suited to intensive row crops. It is subject to seasonal flooding. The organic matter content is high. Capability unit I–3.

98B—Huntsville silt loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes, in upland drainageways, or on alluvial fans. Areas are about 5 to 10 acres in size and are elongated in shape.

Included with this soil in mapping are a few small areas of moderately sloping soils that are more subject to erosion than this Huntsville soil. Also included are some areas of soils that have 6 to 20 inches of lighter colored silt loam overwash.

This soil is well suited to cultivated crops. It is generally farmed with the adjoining soils. It is subject to slight erosion if cultivated. Some areas receive runoff from soils upslope during periods of intense rainfall. The organic matter content is high. Capability unit IIe–4.

Jacwin series

The Jacwin series consists of dark colored, somewhat poorly drained soils. These gently sloping to strongly sloping soils are on side slopes and foot slopes on structural benches below outcrops of limestone. Slopes are 2 to 14 percent. These soils formed in 24 to 36 inches of medium textured and moderately fine textured material and in the underlying very firm, silty clay shale. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish brown, friable loam about 16 inches thick. The subsoil extends to a depth of 38 inches. It is dark grayish brown, friable light clay loam in the upper part; brown, very friable light sandy loam in the middle part; and mottled greenish gray and light greenish gray, very firm, mildly alkaline silty clay in the lower part. The substratum is mottled greenish gray and yellowish brown, very firm, mildly alkaline silty clay shale.

Available water capacity is moderate. Permeability is moderate in the upper part of the soil and very slow in the silty clay shale. Available phosphorus and available potassium are low. These soils are generally neutral or slightly acid in the surface layer and generally do not require liming.

Jacwin soils are used mainly for cultivated crops and pasture. The major limitation for crops is wetness caused by a perched water table. Tiling is generally beneficial, but drain tile must not be placed too deeply in the clayey shale. This soil receives seepage water from soils upslope, and interceptor tile is needed in some places.

Representative profile of Jacwin loam, 2 to 5 percent slopes, in a cultivated field, 228 feet east and 284 feet south of the northwest corner of NW¼SW¼ sec. 26, T. 95 N., R. 9 W.:

Ap—0 to 6 inches; black (10YR 2/1) loam; cloddy parting to weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—6 to 10 inches; black (10YR 2/1) loam; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

A3—10 to 16 inches; very dark grayish brown (10YR 3/2) heavy loam; black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear smooth boundary.

B2—16 to 24 inches; dark grayish brown (10YR 4/2) light clay loam; discontinuous black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

B31—24 to 31 inches; brown (10YR 4/3) light sandy loam; weak fine subangular structure; very friable; neutral; abrupt wavy boundary.

IIB32—31 to 38 inches; mottled greenish gray (5GY 6/1) and light greenish gray (5GY 7/1) silty clay; few fine distinct yellowish red (5YR 4/8) mottles; moderate medium prismatic structure; very firm; carbonate filaments throughout; mildly alkaline; strong effervescence; clear smooth boundary.

IIC—38 to 60 inches; mottled greenish gray (5GY 6/1) and yellowish brown (10YR 5/6) silty clay shale; massive; very firm; mildly alkaline; strong effervescence.

The solum is generally more than 36 inches thick but ranges from 30 to 55 inches. It is neutral or slightly acid in the most acid part. Carbonates are generally present in the lower part of the solum at a depth of 24 to 42 inches. The A horizon is typically loam but ranges to silt loam that is high in sand and light clay loam. It is 15 to 24 inches thick. The B2 horizon is 8 to 12 inches thick and has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6. In places a thin stratum of sandy loam or loamy sand as much as 8 inches thick is between the loamy material and clayey shale. The shale is silty clay or clay and is mildly alkaline. In some places a small amount of fractured limestone is interbedded with the shale.

Jacwin soils are associated with the Rock outcrop-Nordness complex and with Calamine, Marlean, Nordness, Rockton, and Winneshiek soils. They are browner in the upper part of the B horizon and are better drained than Calamine soils. They are not underlain by limestone bedrock, as are Marlean, Nordness, Rockton, and Winneshiek soils.

444B—Jacwin loam, 2 to 5 percent slopes. This gently sloping soil is on slightly concave to slightly convex foot slopes on high structural benches on uplands. Areas are about 10 to 20 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils in which the depth to clayey shale is 4 feet or more. These soils commonly contain a sand lens as much as 2 feet thick and in places are more difficult to drain than this Jacwin soil.

If properly managed this soil is suited to cultivated

crops. It is subject to erosion if cultivated; however, wetness is the major limitation. Artificial drainage is difficult because the water that keeps this soil wet must be intercepted upslope before it seeps into the rooting zone. Drain tile must not be placed too deeply in the clayey shale and backfill should consist of porous material. Each area must be inspected before installing tile because the depth to clayey shale varies considerably. The organic matter content is high. Capability unit IIw–4.

444C—Jacwin loam, 5 to 9 percent slopes. This moderately sloping soil is on slightly concave to slightly convex side slopes on high structural benches on uplands. Areas are about 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the depth to clayey shale is generally less.

Included with this soil in mapping are a few, small areas of soils that are poorly drained and a few areas of soils in which the depth to shale is 3 to 4 feet.

If properly managed, this soil is suited to cultivated crops. It is subject to erosion if cultivated; however, wetness is the major limitation. This soil receives seepage from soils upslope. It is wet because of a perched water table. Drain tile must not be placed too deeply in the clayey shale and backfill should consist of porous material. Each area must be inspected before installing tile because the depth to clayey shale varies considerably. The organic matter content is high. Capability unit IIIe–5.

444D—Jacwin loam, 9 to 14 percent slopes. This strongly sloping soil is on slightly convex foot slopes and side slopes on high structural benches on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but depth to silty clay shale is generally about 24 inches.

Included with this soil in mapping are a few areas of soils in which the depth to clayey shale is less than 20 inches. These soils are better drained and have more lime in the surface layer than this Jacwin soil.

This soil is poorly suited to cultivated crops. It is subject to moderate or severe erosion if cultivated. It also receives seepage from soils upslope and is seasonally wet because of a perched water table. Most areas are in permanent pasture because they are small and better suited to that use. The organic matter content is high. Capability unit IVe–3.

Kenyon series

The Kenyon series consists of dark colored, moderately well drained soils. These gently sloping to moderately sloping soils are on ridges and convex side slopes on uplands. Slopes are 2 to 9 percent. These soils formed in 14 to 21 inches of loamy material and in the underlying glacial till. The native vegetation was prairie grasses. In most places, a layer of pebbles and stones is between the loamy material and the glacial till.

In a representative profile the surface layer is very dark brown and very dark grayish brown loam about 12 inches thick. The subsoil extends to a depth of 52 inches. It is brown, friable loam in the upper part; yellowish brown, firm heavy loam in the middle part; and mottled yellowish brown, strong brown, and light brownish gray, firm loam in the lower part. The substratum is mottled yellowish brown and light brownish gray, firm loam that is mildly alkaline and strongly effervescent.

Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow in the lower part. The rate at which water moves through the friable loamy material differs considerably from the rate at which it moves through the underlying firm glacial till. Water accumulates at the contact of the loamy material and the till, causing wet, seepy areas in some years. Available phosphorus and available potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Kenyon soils are used mainly for cultivated crops. The major limitation for crops is erosion. Providing adequate drainage and controlling erosion on these soils are difficult. The long, uniform, upland slopes are well suited to contour cultivation and terracing, which slow down movement of surface water and let more water soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of tile drainage and terracing helps to provide adequate drainage and to control erosion.

Representative profile of Kenyon loam, 2 to 5 percent slopes, in a cultivated field, 300 feet west and 175 feet north of the southeast corner of NE¼SE¼ sec. 5, T. 93 N., R. 10 W.:

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

A12—8 to 12 inches; very dark grayish brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate fine granular structure; friable; medium acid; gradual smooth boundary.

B1—12 to 17 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) coatings on peds; weak very fine subangular blocky structure; friable; stone line at base of horizon; strongly acid; clear smooth boundary.

IIB21—17 to 22 inches; yellowish brown (10YR 5/6) heavy loam; yellowish brown (10YR 5/4) coatings on peds; weak fine subangular blocky structure; firm; strongly acid; clear smooth boundary.

IIB22—22 to 31 inches; yellowish brown (10YR 5/6) heavy loam; discontinuous grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) coatings on prism faces; weak medium prismatic structure; firm; slightly acid; gradual smooth boundary.

IIB23—31 to 39 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) heavy loam; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; medium acid; clear smooth boundary.

IIB3—39 to 52 inches; mottled yellowish brown (10YR 5/6), strong brown (7.5YR 5/6), and light brownish gray (10YR 6/2) loam; moderate medium prismatic structure; firm; medium acid; abrupt smooth boundary.

IIC—52 to 60 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) loam; massive; firm; mildly alkaline; strong effervescence.

The solum is 45 to 60 inches thick. The soils formed in about 14 to 21 inches of loamy material and in the underlying glacial till. Carbonates are at a depth of 45 to 65 inches. The A1 horizon is 8 to 16 inches thick and is black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically loam but ranges to silt loam that is high in sand. The IIB horizon is typically heavy loam but ranges to light clay loam or sandy clay loam. It is medium acid to strongly acid.

Kenyon soils are associated with Floyd, Clyde, Schley, and Ostrander soils. They formed in parent material similar to that of Readlyn, Tripoli, Bassett, and Oran soils. They have a thicker A horizon than Bassett soils. Kenyon soils are browner in the upper part of the B horizon than Oran, Schley, Readlyn, Tripoli, Floyd, and Clyde soils and are better drained than those soils. They are shallower to firm till and grayish mottles than Ostrander soils.

83B—Kenyon loam, 2 to 5 percent slopes. This gently sloping soil is on ridgetops and long, convex side slopes on uplands. Areas are several miles long and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that have a sandy surface layer. These soils are more droughty than this Kenyon soil. Also included are a few patches of moderately eroded soils that are lower in fertility.

This soil is well suited to corn and soybeans. It is subject to slight erosion if cultivated. Because of the differences in permeability of the loamy material and the underlying glacial till at a depth of about 1½ feet, water tends to accumulate at this contact, causing a temporary water table, particularly early in spring. The organic matter content is high. Capability unit IIe–1.

83C—Kenyon loam, 5 to 9 percent slopes. This moderately sloping soil is on short, convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

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

Included with this soil in mapping are a few areas of sandy soils that are droughty and less productive than this Kenyon soil.

This soil is suited to corn and soybeans if properly managed. It is subject to moderate or severe erosion if cultivated. Contour farming and terracing help to control erosion. In a wet season, field work is delayed slightly. Because of the difficulty in providing adequate erosion control and drainage, a combination of terracing and tile drainage is needed. The organic matter content is moderate. Capability unit IIIe–1.

83C2—Kenyon loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on short, convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the dark surface layer is thinner, and some of the subsoil has been mixed into the plow layer. This soil has stones and pebbles on the surface that interfere with farming. It is lower in organic matter content and fertility than the slightly eroded Kenyon soils.

Included with this soil in mapping are areas of severely eroded soils that have little or no topsoil left and are lower in organic matter content and fertility than this Kenyon soil and areas of sandy soils that are more droughty and lower in fertility than this Kenyon soil.

This soil is suited to corn and soybeans if properly managed. It is subject to severe erosion if cultivated. Contour farming and terracing help to control erosion. In wet seasons, field work is delayed slightly. Because of the difficulty in providing adequate erosion control and drainage, a combination of terracing and tile drainage is needed. The organic matter content is moderately low. Capability unit IIIe–1.

Lamont series

The Lamont series consists of light colored, well drained to somewhat excessively drained soils. These nearly level to strongly sloping soils are on stream terraces, convex ridges, and side slopes on uplands. Slopes are 1 to 14 percent. These soils formed in moderately coarse textured wind-deposited sediment and the underlying coarse textured, gravel-free sediment. The native vegetation was deciduous trees.

In a representative profile the surface layer is very dark gray, friable fine sandy loam about 2 inches thick. The subsurface layer is brown and dark grayish brown, friable fine sandy loam about 6 inches thick. The subsoil extends to a depth of 30 inches. It is yellowish brown, very friable fine sandy loam in the upper part; yellowish brown, friable fine sandy loam and heavy fine sandy loam in the middle part; and yellowish brown, friable heavy sandy loam in the lower part. The substratum is light yellowish brown, brownish yellow, and yellowish brown fine sand that has thin brown sandy clay loam bands.

Available water capacity is low. Permeability is moderately rapid in the coarse textured sediments and rapid in the underlying coarse textured substratum. Available phosphorus is low, and available potassium is very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

The less sloping Lamont soils are used mainly for cultivated crops. The more sloping areas are in pasture and woodland. The major limitations for crops are erosion and droughtiness.

Representative profile of Lamont fine sandy loam, 1 to 5 percent slopes, in a wooded area, 173 feet north and 380 feet west of southeast corner of NW¼NE¼ sec. 30, T. 93 N., R. 8 W.:

A1—0 to 2 inches; very dark gray (10YR 3/1) fine sandy loam, gray (10YR 5/1) dry;

weak fine subangular blocky structure parting to weak fine granular; friable; neutral; abrupt smooth boundary.

A21—2 to 5 inches; brown (10YR 5/3) and some dark grayish brown (10YR 4/2) fine sandy loam; weak medium and thin platy structure; friable; slightly acid; gradual smooth boundary.

A22—5 to 8 inches; brown (10YR 5/3) fine sandy loam; weak medium platy structure; friable; strongly acid; gradual smooth boundary.

B1—8 to 12 inches; yellowish brown (10YR 5/4) fine sandy loam; weak medium and fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

B21—12 to 17 inches; yellowish brown (10YR 5/4) fine sandy loam; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B22t—17 to 22 inches; yellowish brown (10YR 5/4) heavy fine sandy loam; moderate medium subangular blocky structure; friable; few thin discontinuous brown (10YR 3/3) clay flows around sand grains; strongly acid; clear smooth boundary.

B3t—22 to 30 inches; yellowish brown (10YR 5/4) heavy sandy loam; moderate medium subangular blocky structure; friable; few thin discontinuous brown (10YR 3/3) clay flows around sand grains; few fine distinct brown (7.5YR 4/4) iron segregations; strongly acid; clear smooth boundary.

C1—30 to 36 inches; light yellowish brown (10YR 6/4) fine sand; single grained; loose; strongly acid; clear smooth boundary.

C2&B—36 to 60 inches; brownish yellow (10YR 6/6) fine sand; single grained; loose; 1- to 3-inch thick brown (7.5YR 4/4) sandy clay loam iron bands at depths of 37, 40, 48, and 57 inches; medium acid; clear smooth boundary.

C3—60 to 65 inches; mixed yellowish brown (10YR 5/6) and light yellowish brown (10YR 6/4) fine sand; single grained; loose; strongly acid.

The solum is 24 to 45 inches thick. The soils range from medium acid to very strongly acid in the most acid part. The soils formed in 24 to 36 inches of sandy loam sediment and the underlying loamy sand and sand. The A1 horizon is dark grayish brown (10YR 4/2) to dark gray (10YR 4/1) or very dark gray (10YR 3/1). In uneroded areas, the A2 horizon is dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) or brown (10YR 5/3). In some places, the A2 horizon may be wholly incorporated into the Ap horizon. The B2 horizon is sandy loam to light loam and light sandy clay loam. It has hue of 10YR to 7.5YR, value of 4 to 5, and chroma of 3 to 6.

Lamont soils are associated with Dickinson, Backbone, Chelsea, and Coggon soils. They formed in parent material similar to that of Dickinson and Sparta soils. They have less sand in the A horizon and upper part of the B horizon than Chelsea and Sparta soils. They are not underlain by limestone bedrock at a depth of less than 40 inches as are Backbone soils. Lamont soils have more sand and less clay in the solum than Coggon soils. They have a thinner, lighter colored A horizon than Dickinson soils.

110B—Lamont fine sandy loam, 1 to 5 percent slopes. This nearly level to gently sloping soil is on uplands and on stream benches. Areas are about 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils that have gravel at a depth of more than 2 feet and in places are more droughty than this Lamont soil.

This soil is suited to cultivated crops but it is droughty unless rainfall is very timely. It is also subject to soil blowing and water erosion if cultivated. The organic matter content is very low. Capability unit IIIe–3.

110C—Lamont fine sandy loam, 5 to 14 percent slopes. This moderately sloping to strongly sloping soil is on ridges and side slopes on stream benches on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but it is shallower to fine sand.

Included with this soil in mapping are small areas of soils that are shallower than 24 inches to loamy fine sand and fine sand and are more droughty than this Lamont soil.

This soil is suited to row crops, but it is droughty unless rainfall is very timely. It is subject to soil blowing and water erosion if cultivated. The organic matter content is very low. Capability unit IIIe–3.

Lawler series

The Lawler series consists of dark colored, somewhat poorly drained soils. These nearly level soils are on stream benches and in outwash areas on uplands. Slopes are 0 to 2 percent. These soils formed in 24 to 40 inches of loamy alluvial deposits and in the underlying thick layers of coarse textured sediment. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish brown loam about 20 inches thick. The subsoil extends to a depth of 30 inches. It is dark grayish brown heavy loam in the upper part and mottled yellowish brown, light olive brown, and grayish brown sandy clay loam in the lower part. The substratum is dominantly mottled yellowish brown, grayish brown and strong brown medium and coarse sand.

Available water capacity is moderate. Permeability is moderate in the loamy material and rapid in the coarser textured substratum. Available phosphorus and available potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Lawler soils are used mainly for cultivated crops. The major limitation for crops is wetness. Tile drain-

age is beneficial in some years. If rainfall is not timely these soils can be droughty because of the coarse textured substratum.

Representative profile of Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field, 24 feet south and 650 feet west of northeast corner of SW¼SW¼ sec. 29, T. 93 N., R. 10 W.:

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

A12—8 to 16 inches; black (10YR 2/1) loam; weak fine granular structure; friable; medium acid; clear smooth boundary.

A3—16 to 20 inches; very dark grayish brown (10YR 3/2) loam; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B2—20 to 26 inches; dark grayish brown (2.5Y 4/2) heavy loam; moderate medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

B3—26 to 30 inches; mottled yellowish brown (10YR 5/6), grayish brown (2.5Y 5/2), and light olive brown (2.5Y 5/6) sandy clay loam; very weak coarse subangular blocky structure; friable; medium acid; clear smooth boundary.

IIC1—30 to 44 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) medium and coarse sand; single grained; loose; few small pebbles about ½ inch in diameter; medium acid; gradual smooth boundary.

IIC2—44 to 60 inches; mottled strong brown (7.5YR 5/6), light brownish gray (2.5Y 6/2), and yellowish brown (10YR 5/6) coarse and medium sand; single grained; loose; few small pebbles about ½ inch in diameter; slightly acid.

Thickness of the solum and depth to coarse textured material are generally 24 to 40 inches. The A horizon is loam or silt loam that is high in sand. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1), and the A3 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A horizon is typically 12 to 18 inches thick. In some places it has value of 3 extending to a depth of 24 inches. The B2 horizon is typically dark grayish brown (2.5Y or 10YR 4/2) and has mottles of high chroma. It is mainly heavy loam but ranges from loam to light sandy clay loam. Where depth to sand and gravel is near the minimum for the series, a IIB3 horizon has developed in the coarse textured material. The IIB3 horizon or the upper part of the C horizon is typically loamy coarse sand to loamy medium gravel.

Lawler soils are associated with Hayfield, Marshan, Saude, and Waukee soils. They formed in parent material similar to that of Saude and Marshan soils. They have a thicker dark A horizon than Hayfield soils. They are not so well drained and have a grayer B horizon than Saude and Waukee soils. They are not so gray in the B horizon as Marshan soils and have better drainage.

225—Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level soil is on stream benches and in outwash areas on uplands. Areas are 10 to 20 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of sandy soils that are droughty and less productive than this Lawler soil.

This soil is well suited to row crops, and good yields can be expected if rainfall is timely. It is subject to wetness or droughtiness during the growing season, depending on the rainfall. It is somewhat poorly drained and benefits from tile drainage during wet seasons. Tile placement is difficult because of the loose, water-bearing sand and gravel. The organic matter content is high. Capability unit IIs–2.

226—Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This nearly level soil is on stream benches and in outwash areas on uplands. Areas are 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one 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 are a few areas of soils that have a silt loam surface layer.

This soil is well suited to row crops and can be used intensively for corn and soybeans. It is subject to wetness and will benefit from tile drainage during wet seasons. Tile placement is difficult in places because of the loose, water-bearing sand and gravel at a depth of about 3 feet. The organic matter content is high. Capability unit I–2.

Loamy alluvial land

315—Loamy alluvial land. These areas consist of nearly level, recently deposited highly stratified sediment. The sediment has not been in place long enough for soil to develop. The areas are frequently flooded, and each flood adds new sediment. The sediment varies in texture but is mainly loam, sandy loam, and silt loam.

Much of this unit is channeled and contains low natural levees, small ponds, sloughs, and small oxbows. It ranges from poorly drained in channels to well drained or excessively drained on natural levees. Some unchanneled areas are cropped even though they are frequently flooded. Because of the hazard of flooding and the oxbows and sloughs, these areas are poorly suited to crops. Much of this unit is in permanent pasture. Capability unit Vw–1.

Lourdes series

The Lourdes series consists of moderately dark colored, moderately well drained soils. These gently sloping soils are on long, convex ridges and short, convex side slopes on uplands. Slopes are 2 to 9 percent. These soils formed in 12 to 20 inches of loamy material and in the underlying very firm glacial till. The native

vegetation was deciduous trees and prairie grasses. In most places a layer of stones and pebbles is at the contact of the loamy material and the glacial till.

In a representative profile the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is brown loam about 3 inches thick. The subsoil extends to a depth of 44 inches. The upper part of the subsoil is dark yellowish brown, friable loam; the middle part is mottled strong brown, grayish brown, and olive gray, firm and very firm clay loam; and the lower part is strong brown, very firm clay loam with grayish mottles. The substratum is strong brown, firm clay loam with grayish mottles and is mildly alkaline and strongly effervescent.

Available water capacity is high. Permeability is moderate in the upper part of the soil and slow in the underlying glacial till. The rate at which water moves through the friable loamy material differs considerably from the rate at which it moves through the underlying very firm glacial till. Water accumulates at the till contact, causing wet, seepy areas in some years. Available phosphorus and available potassium are very low. Unless these soils have been limed within the past 5 years, they are generally acid in the surface layer.

Lourdes soils are used mainly for cultivated crops. The major limitation for crops is erosion. Providing adequate drainage and controlling erosion on these soils are difficult. The long, uniform slopes are well suited to contour farming and terracing, which slow the movement of surface water, allowing more of it to soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of terracing and tile drainage helps to provide adequate drainage and to control erosion.

Representative profile of Lourdes loam, 2 to 5 percent slopes, in a cultivated field, 760 feet north and 100 feet east of the southwest corner of NW¼ sec. 19, T. 93 N., R. 10 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam; cloddy parting to weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A2—8 to 11 inches; brown (10YR 4/3) loam; weak thin platy structure parting to weak very fine subangular blocky; friable; few very dark grayish brown (10YR 3/2) worm casts; discontinuous light brownish gray (10YR 6/2), dry, coatings on ped faces; strongly acid; clear smooth boundary.

B1—11 to 15 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; thin discontinuous light brownish gray (10YR 6/2), dry, silt and sand coatings on ped faces; strongly acid; clear smooth boundary.

IIB21—15 to 22 inches; mottled strong brown (7.5YR 5/8) and grayish brown (10YR 5/2) light clay loam; discontinuous grayish brown (10YR 5/2) coatings on prism faces; weak fine prismatic structure parting to moderate fine subangular blocky; firm; strongly acid; clear smooth boundary.

IIB22t—22 to 32 inches; mottled strong brown (7.5YR 5/6) and olive gray (5Y 5/2) clay loam; discontinuous gray (5Y 5/1) and olive gray (5Y 5/2) coatings on prism faces; weak medium prismatic structure parting to moderate fine subangular and angular blocky; very firm; thin patchy dark gray (10YR 4/1) clay films; thick dark gray (10YR 4/1) clay-filled root channels; strongly acid; clear smooth boundary.

IIB23—32 to 44 inches; strong brown (7.5YR 5/6) clay loam; many coarse prominent grayish brown (2.5YR 5/2) and gray (5Y 5/1) mottles; weak coarse prismatic structure parting to moderate coarse subangular blocky; very firm; thin very dark gray (10YR 3/1) and dark gray (10YR 4/1) clay flows in root channels; few black (10YR 2/1) oxide concretions; medium acid; abrupt wavy boundary.

IIC—44 to 60 inches; strong brown (7.5YR 5/6) light clay loam; many coarse prominent grayish brown (2.5Y 5/2) and gray (5Y 5/1) mottles; massive; firm; mildly alkaline; strong effervescence.

The solum is 40 to 55 inches thick. Carbonates are at a depth of 40 to 60 inches. These soils formed in 12 to 20 inches of loamy material and in the underlying very firm glacial till. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick. The A2 horizon is brown (10YR 4/3) to dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). It is 3 to 5 inches thick and is strongly acid or very strongly acid. In eroded areas the A2 horizon may be wholly incorporated into the Ap horizon. The IIB horizon is medium acid or strongly acid. The IIB22t horizon is typically medium clay loam and is 30 to 35 percent clay.

Lourdes soils are associated with Kenyon, Bassett, Riceville, Floyd, and Clyde soils. They formed in parent material similar to that of Cresco, Protivin, and Riceville soils. They have grayer coatings on ped faces and have more clay in the IIB horizon than Kenyon, Bassett, Floyd, and Clyde soils. Lourdes soils are browner, have less mottling in the upper part of the B horizon, and are better drained than Protivin and Riceville soils. They have a thinner, lighter colored A1 or Ap horizon than Cresco soils.

781B—Lourdes loam, 2 to 5 percent slopes. This gently sloping soil is on long, convex ridges and short, convex side slopes on uplands. Individual areas are about 20 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils that have a sandy surface layer and are more droughty than this Lourdes soil.

This soil is suited to corn and soybeans. It is subject to slight erosion if cultivated. Because of the difference

in permeability in the loamy material and the underlying very firm glacial till at a depth of about 1½ feet, water accumulates at this contact and produces a temporary high water table, especially early in spring. A combination of terracing and tile drainage helps to provide adequate erosion control and drainage. Careful placement and spacing of tile are important because of the slowly permeable subsoil. The organic matter content is moderately low. Capability unit IIe–1.

781C—Lourdes loam, 5 to 9 percent slopes. This moderately sloping soil is on short, convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 6 inches thick.

Included with this soil in mapping are a few moderately eroded areas of soils in which part of the subsurface layer has been incorporated into the plow layer. Also included are a few areas of soils that have a sandy surface layer and are more droughty than this Lourdes soil.

This soil is suited to corn and soybeans. It is subject to moderate or severe erosion if cultivated. It can have a seasonal perched water table because water accumulates at the contact between the loamy material and the underlying glacial till. Water tends to accumulate at a depth of 1 to 2 feet below the surface in soils upslope, and then moves downhill on these sloping soils. The water may surface part way down the slope as a seepy spot, or it may make a large part of the slope wet. A combination of terracing and tiling helps to provide adequate erosion control and drainage. The organic matter content is moderately low. Capability unit IIIe–1.

Marlean series

The Marlean series consists of dark colored, well drained to somewhat excessively drained soils. These gently sloping to strongly sloping soils are on ridges and side slopes on uplands. Slopes are 2 to 14 percent. These soils formed in 4 to 18 inches of loamy material over fragmented limestone bedrock. The native vegetation was mixed prairie grasses and some trees.

In a representative profile the surface layer is very dark brown and dark brown, friable loam about 15 inches thick. The substratum is fragmented limestone about 37 inches thick over hard limestone bedrock. Brown and dark yellowish brown loamy fillings are between the limestone fragments.

Available water capacity is low to very low. Permeability is moderate in the loamy material and rapid in the underlying fragmented limestone. The available phosphorus and the available potassium are very low. These soils are generally neutral or slightly acid and do not require lime.

Marlean soils are used mainly for permanent pasture. The major limitation for crops is droughtiness because of shallowness to limestone. These soils are subject to erosion if cultivated.

Representative profile of Marlean loam, 2 to 5 percent slopes, in permanent pasture, 740 feet south and 36 feet west of northeast corner of NE¼SW¼ sec. 2, T. 94 N., R. 7 W.:

A11—0 to 5 inches; very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—5 to 9 inches; very dark brown (10YR 2/2) loam; weak fine subangular blocky structure parting to moderate fine granular; friable; slightly acid; clear smooth boundary.

A3—9 to 15 inches; dark brown (10YR 3/3) loam; very dark grayish brown (10YR 3/2) coatings on peds; moderate medium subangular blocky structure; friable; slightly acid; abrupt wavy boundary.

IIC—15 to 52 inches; a bed of fragmented limestone with about 5 to 10 percent chert fragments; 60 to 80 percent is fragments of limestone ½ inch to 4 inches in diameter, with brown (10YR 4/3) and dark yellowish brown (10YR 4/4) loamy filling between fragments; fragments are moderately alkaline and strongly effervescent, and fillings are mildly alkaline.

IIR—52 inches; hard limestone bedrock.

The solum is 4 to 8 inches thick. Fragmented limestone is below this depth. The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2), but it is very dark grayish brown (10YR 3/2) where cultivated. The A horizon is loam or light clay loam to silt loam that is high in sand. It is 4 to 15 inches thick. The IIC horizon is typically soft, fragmented limestone with loamy fillings, but in some profiles it has as much as 80 percent hard fragments of limestone and chert. Generally no residuum is above the fragmented limestone.

Marlean soils are associated with Calamine, Jacwin, Rockton, and Winneshiek soils. They are underlain by limestone, whereas Calamine and Jacwin soils are underlain by shale. They are underlain by more fragmented limestone and are deeper to hard limestone than Rockton and Winneshiek soils.

512B—Marlean loam, 2 to 5 percent slopes. This gently sloping soil is on ridges and side slopes on uplands. Areas are about 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils in which shattered slabs of fragmented limestone are near the surface or are exposed.

This soil is poorly suited to cultivated crops. It is subject to droughtiness. Because of the shallow depth to fragmented limestone, tillage is very difficult. Some areas of this soil have been cultivated but are now in pasture. The organic matter content is moderately low. Capability unit IVs–1.

512D—Marlean loam, 5 to 14 percent slopes. This moderately to strongly sloping soil is mostly on side slopes on uplands; a few areas are small knobs high on the landscape. Areas are about 5 acres in size and are elongated in shape.

This soil has a profile similar to the one described as

representative of the series, but depth to fragmented limestone is about 8 inches.

Included with this soil in mapping are areas of soils in which shattered slabs of limestone are near the surface or are exposed.

This soil is poorly suited to cultivated crops. It is subject to droughtiness because of the very limited root zone. Because exposed limestone fragments are at the surface, tillage is very difficult. This soil is subject to moderate erosion if cultivated. Some areas of this soil have been cultivated but are now in pasture. The organic matter content is low. Capability unit IVs–1.

Marsh

354—Marsh. Marsh is mostly in depressions on bottom lands adjacent to the major streams; a few areas are in land-locked depressions on the uplands and are associated with Kenyon, Bassett, Sparta, and Chelsea soils. The native vegetation was mostly swampgrass, reeds, cattails, and other plants that were tolerant to wetness.

Marsh is covered by water most of the time. It has not formed soil layers; however, a layer of old plant residue can be seen on the surface when the water recedes. Marsh is not suited to cultivation and provides poor yield for pasture. These areas are better suited to wildlife habitat than to most other uses. Capability unit VIIw–1.

Marshan series

The Marshan series consists of dark colored, poorly drained soils. These nearly level soils are on stream benches and in a few outwash areas on uplands. Slopes are 0 to 2 percent. These soils formed in 24 to 40 inches of loamy alluvial deposits overlying thick layers of coarse textured sediment. The native vegetation was mixed prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black, friable clay loam about 18 inches thick. The subsoil extends to a depth of 30 inches. In the upper part it is olive gray, friable silty clay loam that has olive mottles; in the middle part it is dark gray, friable heavy loam; and in the lower part it is gray, very friable sandy loam. The substratum is mottled gray and olive medium and coarse sand.

Available water capacity is moderate. Permeability is moderate in the loamy material and rapid in the coarse textured substratum. Available phosphorus and available potassium are very low. These soils are generally neutral or slightly acid and do not require lime.

Marshan soils are used mainly for cultivated crops. The major limitation for crops is wetness. These soils have a seasonal high water table.

Representative profile of Marshan clay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, in a cultivated field, 396 feet west and 50 feet north of the southeast corner of NW¼ sec. 34, T. 92 N., R. 7 W.:

Ap—0 to 5 inches; black (N 2/0) light clay loam; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—5 to 11 inches; black (N 2/0) light clay loam; moderate medium granular structure; friable; slightly acid; clear smooth boundary.

A13—11 to 18 inches; black (10YR 2/1) heavy clay loam; black (N 2/0) coatings on peds; moderate medium subangular blocky structure parting to moderate medium granular; friable; neutral; clear smooth boundary.

B21g—18 to 24 inches; olive gray (5Y 5/2) silty clay loam; few fine distinct olive (5Y 5/6) mottles; very weak medium subangular blocky structure; friable; few fine distinct black (10YR 2/1) oxide concretions; neutral; clear smooth boundary.

B22g—24 to 27 inches; dark gray (5Y 4/1) heavy loam; very weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

B3—27 to 30 inches; gray (5Y 5/1) sandy loam; very weak coarse subangular blocky structure; very friable; neutral; abrupt wavy boundary.

IIC—30 to 60 inches; mottled gray (5Y 5/1) and olive (5Y 4/3) medium and coarse sand; single grained; loose, neutral.

The thickness of the solum and the depth to contrasting textures are 24 to 40 inches. The profile is slightly acid or neutral in the most acid part. The A horizon is 14 to 24 inches thick. It is black (N 2/0) to very dark gray (10YR 3/1). It is typically clay loam but ranges to include heavy loam and silty clay loam. The B horizon is loam to silty clay loam or clay loam. The IIC horizon can be loam or sandy loam in the upper part, but it is gravelly sand, coarse loamy sand, or medium and coarse sand between depths of 24 and 40 inches.

Marshan soils are associated with Lawler, Clyde, and Saude soils. They formed in parent material similar to that of Lawler and Saude soils. They are grayer in the upper part of the B horizon than Lawler and Saude soils. Marshan soils have a coarser textured C horizon than Clyde soils and are not underlain by glacial till at a depth of less than 60 inches as are Clyde soils.

151—Marshan clay loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level soil is on stream benches and in outwash areas on uplands where there is erosional sediment from glacial till. Areas are about 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of soils that have a sandy surface layer. These soils can be somewhat droughty.

This soil is well suited to row crops if properly drained. It is subject to little surface runoff. The water table is high, especially in the spring. Artificial drainage is needed for row crops. Tile placement can be difficult because of the loose, water-bearing sand and gravel. Tilth is generally good, but this soil puddles if worked when wet. The organic matter content is high. Capability unit IIw–1.

152—Marshan clay loam, 32 to 40 inches to sand

and gravel, 0 to 2 percent slopes. This nearly level soil is on stream benches and in outwash areas on uplands where there is erosional sediment from glacial till. Areas are about 10 acres in size and are irregular in shape.

This soil has a profile similar to the one 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 are small areas of soils that have a sandy surface layer. These soils can be somewhat droughty.

This soil is suited to row crops if properly drained. It is subject to little surface runoff. The water table is high, especially in spring. Artificial drainage is needed for row crops. Tilth is generally good, but this soil puddles if worked when wet. The organic matter content is high. Capability unit IIw–1.

Nordness series

The Nordness series consists of light colored, somewhat excessively drained soils. These gently sloping to steep soils are on narrow ridges and convex side slopes on uplands. Slopes are 2 to 25 percent. These soils formed in 5 to 18 inches of loamy or silty material and in the underlying thin layer of residuum weathered from limestone bedrock. The native vegetation was deciduous trees.

In a representative profile the surface layer is dark grayish brown, friable silt loam about 3 inches thick. The subsurface layer is brown, friable silt loam about 3 inches thick. The subsoil extends to a depth of 16 inches. It is yellowish brown and brown, friable silt loam in the upper part and dark brown, very firm clay in the lower part. Below this is shattered limestone over hard limestone bedrock.

Available water capacity is very low. Permeability is moderate in the loamy or silty material and rapid in the underlying limestone bedrock. Available phosphorus and the available potassium are very low. These soils are generally neutral or slightly acid in the surface layer, but limestone fragments are common on the surface and throughout the profile.

Nordness soils are used mainly for pasture or woodland. The limestone bedrock interferes with most farming practices. The major limitations for crops are erosion and droughtiness.

Representative profile of Nordness silt loam, 2 to 5 percent slopes, in permanent pasture, 456 feet east and 14 feet south of the northwest corner, SW¼SW¼ sec. 26, T. 95 N., R. 9 W.:

A1—0 to 3 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—3 to 6 inches; brown (10YR 4/3) silt loam; very weak thin platy structure; friable; neutral; clear smooth boundary.

B1t—6 to 11 inches; yellowish brown (10YR 5/4) heavy silt loam; brown (10YR 4/3) coatings on peds; strong medium subangular blocky structure; friable; thin discontinuous light gray (10YR 7/1), dry silt coatings on faces of peds; thin discontinuous very dark grayish brown (10YR 3/2) clay films; slightly acid; clear smooth boundary.

IIB2t—11 to 16 inches; dark brown (7.5YR 4/4) clay; strong medium subangular blocky structure; very firm; thick continuous dark brown (7.5YR 3/2) clay films; neutral; abrupt wavy boundary.

IIR1—16 to 18 inches; level bedded limestone bedrock; flags of limestone with silty clay residuum interbedded; mildly alkaline; strong effervescence.

IIR2—18 inches; hard fractured limestone bedrock.

The solum is 5 to 18 inches thick. It is neutral to medium acid in the most acid part. The A1 horizon is very dark gray (10YR 3/1) or dark grayish brown (10YR 4/2) and is 1 to 4 inches thick. The A1 and A2 horizons typically are silt loam but range to loam that is high in silt. The IIB2t horizon is heavy silty clay loam to silty clay or clay and is 1 to 6 inches thick. Carbonates are absent above the limestone bedrock. Limestone fragments are common on the surface and throughout the profile. Limestone bedrock is at a depth of 5 to 18 inches.

Nordness soils are associated with Fayette and Dubuque soils. They formed in parent material similar to that of Dubuque and Winneshiek soils. Depth to limestone bedrock is less in Nordness soils than in Dubuque and Winneshiek soils. Nordness soils are underlain by limestone at a depth of less than 40 inches, whereas Fayette soils are not underlain by limestone bedrock at this depth.

499B—Nordness silt loam, 2 to 5 percent slopes. This gently sloping soil is on ridges and side slopes on uplands. Areas are about 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of soils where shattered slabs of limestone bedrock are near the surface or are exposed.

This soil is poorly suited to cultivated crops. It is subject to droughtiness and erosion. It has a very limited root zone. Bedrock and limestone slabs on the surface make tillage difficult. Some areas of this soil have been cultivated but are now in permanent pasture or woodland. The organic matter content is very low. Capability unit IVs–1.

499D—Nordness silt loam, 5 to 14 percent slopes. This moderately sloping to strongly sloping soil is on convex side slopes on uplands. Areas are about 10 acres in size and are elongated in shape.

Included with this soil in mapping are small areas of soils where shattered slabs of limestone bedrock are near the surface or are exposed. Also included are areas of moderately eroded soils from which erosion has removed part of the surface and subsurface layers.

This soil is poorly suited to cultivated crops. It is better suited to pasture or woodland than to most other uses. It is subject to erosion and droughtiness if cultivated. It is shallow and has a very limited root zone. The organic matter content is very low. Capability unit VIs–1.

499F—Nordness silt loam, 14 to 25 percent slopes. This moderately steep to steep soil is on convex side

slopes on uplands. Areas are about 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but depth to limestone bedrock is typically less.

Included with this soil in mapping are areas of soils where shattered slabs of limestone are near the surface or are exposed. Also included are areas of moderately eroded soils where erosion has removed part of the surface and subsurface layers.

This soil is poorly suited to cultivated crops and pasture. It is better suited to woodland or to wildlife habitat than to most other uses. Because of the very shallow root zone it is subject to severe erosion and is droughty. The organic matter content is very low. Capability unit VIIs–1.

Olin series

The Olin series consists of dark colored, well drained soils. These gently to moderately sloping soils are on convex ridges and side slopes on uplands. Slopes are 2 to 9 percent. These soils formed in 20 to 36 inches of sandy loam material and in the underlying glacial till. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and dark brown, very friable fine sandy loam about 16 inches thick. The subsoil extends to a depth of 57 inches. It is brown and dark yellowish brown, very friable sandy loam and yellowish brown, firm heavy loam. The substratum is yellowish brown, firm loam that has grayish brown mottles.

Available water capacity is moderate. Permeability is moderately rapid in the upper part and moderately slow in the underlying glacial till. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Olin soils are used mainly for cultivated crops. The major limitations for crops are erosion and droughtiness. These soils may be droughty during periods of low rainfall. Soil blowing is a hazard if these soils are left bare. Because the permeability is greater in the sandy upper part of the subsoil than in the till lower part, water accumulates at the contact of the sandy material and the till, and seepy areas develop in periods of high rainfall.

Representative profile of Olin fine sandy loam, 2 to 5 percent slopes, in a cultivated field, 138 feet south and 570 feet west of the northeast corner of the SW¼SW¼ sec. 4, T. 91 N., R. 10 W.:

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

A3—9 to 16 inches; dark brown (10YR 3/3) fine sandy loam; very dark grayish brown (10YR 3/2) coatings on peds; very weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

B1—16 to 24 inches; brown (10YR 4/3) sandy loam; very weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

B21—24 to 33 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

IIB22—33 to 45 inches; yellowish brown (10YR 5/6) heavy loam; moderate medium subangular blocky structure; firm; pebble band at top of horizon; strongly acid; clear smooth boundary.

IIB3—45 to 57 inches; yellowish brown (10YR 5/6) heavy loam; few fine distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure; firm; strongly acid; gradual smooth boundary.

IIC—57 to 60 inches; yellowish brown (10YR 5/6) loam; few fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; medium acid.

The solum is 40 to 60 inches thick. It is medium acid to strongly acid in the most acid part. Carbonates are at a depth of 50 to 80 inches. The soils formed in 20 to 36 inches of very friable sandy loam material and in the underlying glacial till. The Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The A horizon is 12 to 21 inches thick. The part of the B2 horizon in sandy material is brown (10YR 4/3) to yellowish brown (10YR 5/4). It is mainly sandy loam, but layers of loamy sand 6 to 8 inches thick are in some pedons. The IIB horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6). It is commonly heavy loam but ranges to medium loam, light clay loam, or sandy clay loam.

Olin soils are associated with Kenyon, Dickinson, and Sparta soils. They formed in parent material similar to that of Dickinson, till substratum, soils. They have more sand in the A horizon and the upper part of the B horizon than Kenyon soils. They have less sand in the solum than Sparta soils. They are shallower to glacial till than Dickinson soils.

408B—Olin fine sandy loam, 2 to 5 percent slopes. This gently sloping soil is on glaciated uplands. Areas are small, moundlike ridges about 5 to 10 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils which have sandy loam less than 20 inches thick. These soils are not so droughty as this Olin soil. Also included are small, nearly level areas that are not so eroded.

This soil is well suited to row crops if it is well managed. The surface layer is easy to work and dries out quickly. Because of the difference in permeability between the upper and lower parts of the subsoil, this soil is subject to droughtiness in some years. Water accumulates above the till in periods of high rainfall and then moves laterally, resulting in seepy areas. The organic matter content is moderate. Capability unit IIe–2.

408C—Olin fine sandy loam, 5 to 9 percent slopes. This moderately sloping soil is on narrow ridges and side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the dark surface

layer is thinner and depth to the loam glacial till is typically less.

Included with this soil in mapping are areas of soils in which the dark surface layer is less than 10 inches thick. These soils are lower in organic matter content and fertility than this Olin soil.

This soil is suited to row crops if well managed. The surface layer is easy to work and dries out quickly. It is subject to soil blowing and water erosion. Because of the difference in permeability between the upper and lower parts of the subsoil, this soil can be droughty in some years. Water accumulates above the till in periods of high rainfall and then moves laterally, resulting in seepy, wet areas. The organic matter content is moderate. Capability unit IIIe–1.

Oran series

The Oran series consists of moderately dark colored, somewhat poorly drained soils. These nearly level to gently sloping soils are on broad upland ridges and on convex or slightly concave side slopes. Slopes are 1 to 3 percent. These soils formed in 14 to 24 inches of loamy material and in the underlying glacial till. The native vegetation was deciduous trees and mixed prairie grasses. In most places, a layer of pebbles and stones is at the contact of the loamy material and the glacial till.

In a representative profile the surface layer is black loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 5 inches thick. The subsoil extends to a depth of 58 inches. It is dark grayish brown, friable loam in the upper part and mottled grayish brown and yellowish brown, firm heavy loam in the lower part. The substratum is mottled grayish brown and light olive brown, firm loam that is mildly alkaline and strongly effervescent.

Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow in the underlying glacial till. The rate at which water moves through the friable loamy material differs considerably from the rate at which it moves through the underlying glacial till. Water moves more rapidly in the upper material and accumulates at the till contact, resulting in wet, seepy areas in some years. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Oran soils are used mainly for cultivated crops. The major limitation for crops is a seasonal high water table. These soils benefit from tile drainage in most years.

Representative profile of Oran loam, 1 to 3 percent slopes, in permanent pasture at edge of wooded area, 275 feet east and 130 feet south of northwest corner of SE¼NE¼ sec. 17, T. 91 N., R. 10 W.:

A1—0 to 7 inches; black (10YR 2/1) loam, grading to very dark gray (10YR 3/1) in lower part; cloddy parting to weak fine granular structure; friable; medium acid; clear smooth boundary.

A2—7 to 12 inches; dark grayish brown (10YR 4/2) light loam; some very dark gray (10YR 3/1) in root channels; weak medium platy structure; friable; very strongly acid; clear smooth boundary.

B1—12 to 18 inches; dark grayish brown (10YR 4/2) loam; few fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; very strongly acid; clear smooth boundary.

IIB21t—18 to 26 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) heavy loam; moderate medium subangular blocky structure; firm; few thin discontinuous dark gray (10YR 4/1) clay films in root channels; very strongly acid; clear smooth boundary.

IIB22t—26 to 40 inches; yellowish brown (10YR 5/6) heavy loam; many medium distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few thin discontinuous clay flows in root channels; strongly acid; clear smooth boundary.

IIB3t—40 to 58 inches; mottled yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) heavy loam; weak coarse prismatic structure parting to weak coarse subangular blocky; thin discontinuous grayish brown (10YR 5/2) coatings on prisms; firm; few thick dark gray (10YR 4/1) clay flows in root channels; medium acid; abrupt wavy boundary.

IIC—58 to 74 inches; mottled grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/6) loam; massive; firm; mildly alkaline; strong effervescence.

The solum is 40 to 60 inches thick. It is strongly acid or very strongly acid in the most acid part. Carbonates are at a depth of 40 to 60 inches. The soils formed in 14 to 24 inches of loamy material and in the underlying glacial till. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and is 6 to 9 inches thick. The A2 horizon is typically dark grayish brown (10YR 4/2) but ranges to brown (10YR 5/3) and grayish brown (10YR 5/2). It is 3 to 6 inches thick and is strongly acid or very strongly acid. The A1 and A2 horizons are typically loam, but they contain thin layers of light loam or heavy sandy loam in some pedons. The IIB horizon is typically heavy loam but ranges to light clay loam.

Oran soils are associated with Bassett, Schley, Floyd, and Clyde soils. They formed in parent material similar to that of Kenyon, Readlyn, and Bassett soils. They have a thinner A horizon than Readlyn, Floyd, and Clyde soils and are grayer in the upper part of the B horizon than Bassett and Kenyon soils. They are less stratified in the IIB horizon than Schley soils.

471—Oran loam, 1 to 3 percent slopes. This nearly level to gently sloping soil is on broad upland ridges and convex and slightly concave side slopes. Areas are large in size and are broad and irregular in shape.

This soil is well suited to corn and soybeans. It is subject to slight wetness. Because of the difference in permeability between the loamy material and the un-

derlying glacial till, water accumulates at the contact of these materials producing a seasonal high water table. This soil will benefit from tile drainage in some years. The organic matter content is moderate. Capability unit I–2.

Orwood series

The Orwood series consists of moderately dark colored, well drained soils. These gently sloping to moderately steep soils are on ridges and convex side slopes on uplands. Slopes are 5 to 18 percent. These soils formed in medium textured eolian materials more than 40 inches thick. The native vegetation was mixed prairie grasses and deciduous trees.

In a representative profile the surface layer, about 8 inches thick, is very dark grayish brown, friable silt loam that is high in sand. The subsoil extends to a depth of 45 inches. The upper part of the subsoil is brown, friable silt loam that is high in sand and the lower part is dark yellowish brown and yellowish brown, friable silt loam that is high in sand. The substratum is yellowish brown, friable silt loam that is high in sand and has grayish brown and light brownish gray mottles.

Available water capacity is high. Permeability is moderate. Available phosphorus is medium, and available potassium is very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Orwood soils are used mainly for cultivated crops. The major limitation for crops is erosion. These soils erode easily when planted to row crops.

Representative profile of Orwood silt loam, 5 to 9 percent slopes, in a cultivated field, 490 feet north and 85 feet west of the southeast corner of sec. 12, T. 94 N., R. 7 W.:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam high in sand; some very dark brown (10YR 2/2) coatings on peds; cloddy parting to moderate fine granular structure; friable; neutral; abrupt smooth boundary.

B1—8 to 12 inches; brown (10YR 4/3) silt loam high in sand; dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) coatings on peds; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21t—12 to 18 inches; dark yellowish brown (10YR 4/4) silt loam high in sand; moderate fine subangular blocky structure; friable; thin discontinuous dark brown (10YR 4/3) clay films; slightly acid; clear smooth boundary.

B22t—18 to 34 inches; yellowish brown (10YR 5/4 and 5/6) silt loam high in sand; moderate medium subangular blocky structure; friable; thin discontinuous brown (10YR 4/3) clay films; slightly acid; clear smooth boundary.

B3t—34 to 45 inches; yellowish brown (10YR 5/6) silt loam high in sand; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous dark yellowish brown (10YR 4/4) clay films; medium acid; gradual smooth boundary.

C—45 to 60 inches; yellowish brown (10YR 5/4 and 5/6) silt loam high in sand; few fine distinct grayish brown (2.5Y 5/2) and light brownish gray mottles; massive; friable; slightly acid.

The solum is 42 to 60 inches thick. It is medium acid or strongly acid in the most acid part. The A1 or Ap horizon is typically very dark gray (10YR 3/1) but ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). It is 6 to 9 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). In cultivated areas, it may be wholly incorporated into the Ap horizon. The A horizon is typically silt loam high in sand, but it ranges to loam. The B horizon is silt loam high in sand to silt loam or light silty clay loam. The B2 horizon has no low-chroma mottling, but the B3 and C horizons have fine faint mottles in some pedons.

Orwood soils are associated with Lamont, Fayette, and Downs soils, and they formed in similar parent material as Fayette and Downs soils. They have more sand in the A and B horizons than Fayette and Downs soils. They have less sand and more clay in the A and B horizons than Lamont soils.

480C—Orwood silt loam, 5 to 9 percent slopes. This moderately sloping soil is on convex ridges and side slopes on uplands. Areas are 10 to 20 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that are moderately eroded. These soils are lower in organic matter content and fertility than this Orwood soil.

This soil is suited to cultivated crops. It is subject to moderate or severe erosion if cultivated. Most areas are suitable for terracing because of the uniform length and shape of slope. The organic matter content is moderately low. Capability unit IIIe–1.

480D2—Orwood silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

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

Included with this soil in mapping are a few areas of soils that are in permanent pasture or woodland and are not eroded. These soils are higher in fertility and organic matter content than this Orwood soil.

This soil is suited to occasional row crops. It is subject to severe erosion if cultivated. It generally has good tilth but puddles and becomes cloddy if worked when wet. The organic matter content is low. Capability unit IIIe–2.

480E2—Orwood silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described

as representative of the series, but the surface layer is thinner and lighter colored.

Included with this soil in mapping are a few areas of uneroded soils that are wooded or in pasture. These soils are high in fertility and organic matter content. Also included are a few small areas of severely eroded soils. These soils are lower in fertility and organic matter content and have poorer tilth than this Orwood soil.

This soil is suited to cultivated crops if they are occasionally rotated with hay crops. It is subject to severe erosion if cultivated. It generally has good tilth but puddles and becomes cloddy if worked when wet. The organic matter content is low. Capability unit IVe–1.

Ossian series

The Ossian series consists of dark colored, poorly drained soils. These nearly level soils are on first bottoms along streams. Slopes are 0 to 2 percent. They formed in medium textured, silty alluvium mainly from loess soils on the uplands. The native vegetation was mixed prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black, friable heavy silt loam about 18 inches thick. The subsoil extends to a depth of 41 inches. It is dark gray, friable heavy silt loam in the upper part; mottled strong brown and olive gray, friable silt loam in the middle part; and olive gray, friable silt loam in the lower part. The substratum is olive gray and greenish gray, friable silt loam.

Available water capacity is high and permeability is moderate. Available phosphorus is low, and available potassium is very low. These soils are generally neutral and do not require lime.

Ossian soils are used mainly for cultivated crops. The major limitations for crops are flooding and wetness. Most areas benefit from tile drainage. Diversion terraces in places help protect these soils from local runoff.

Representative profile of Ossian silt loam, 0 to 2 percent slopes, in permanent pasture, 171 feet north and 207 feet east of the southwest corner of NW¼ SW¼ sec. 16, T. 94 N., R. 8 W.:

A11—0 to 10 inches; black (N 2/0) heavy silt loam; moderate; medium subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A12—10 to 15 inches; black (N 2/0) heavy silt loam; moderate medium subangular blocky structure parting to moderate very fine granular; friable; neutral; clear smooth boundary.

A13—15 to 18 inches; black (N 2/0) heavy silt loam; moderate medium subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

B1g—18 to 23 inches; dark gray (2.5Y 4/1) heavy silt loam; moderate medium subangular blocky structure; friable; few fine distinct strong brown (7.5YR 5/6) iron segregations in root channels; neutral; clear smooth boundary.

B2g—23 to 28 inches; mottled strong brown (7.5YR 5/8) and olive gray (5Y 5/2) silt loam; gray (5Y 5/1) coatings on peds; weak medium and coarse subangular blocky structure; friable; neutral; clear smooth boundary.

B31g—28 to 33 inches; olive gray (5Y 5/2) silt loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; friable; neutral; clear smooth boundary.

B32g—33 to 41 inches; olive (5Y 5/3) light silt loam; very weak coarse prismatic structure parting to massive; friable; few fine distinct yellowish brown (10YR 5/8) iron segregations; neutral; clear smooth boundary.

C1g—41 to 47 inches; olive gray (5Y 5/2) light silt loam; massive; friable; few fine distinct yellowish brown (10YR 5/8) iron segregations; neutral; abrupt smooth boundary.

C2g—47 to 60 inches, greenish gray (5BG 5/1) heavy silt loam; massive; friable; neutral.

The solum is 32 to 48 inches thick. It is slightly acid or neutral throughout. The A1 horizon is black (N 2/0, 10YR 2/1, or 5Y 2/1). The A horizon is 14 to 24 inches thick. The A1 horizon is typically heavy silt loam or light silty clay loam. The B2g horizon is heavy silt loam or light silty clay loam and is 25 to 30 percent clay. Sandy or gravelly horizons are in some pedons below a depth of 48 inches.

Ossian soils are associated with Otter, Caneek, and Huntsville soils. They formed in parent material similar to that of Huntsville and Otter soils. They have a thinner A horizon than Otter soils and a thicker, darker A horizon than Caneek soils. They are grayer in the upper part of the B horizon than Huntsville soils.

489—Ossian silt loam, 0 to 2 percent slopes. This nearly level soil is on bottom lands along streams. Areas are about 20 acres in size and are irregular in shape.

Included with this soil in mapping are some areas of soils that have 6 to 20 inches of light silt loam overwash. These soils are lower in fertility and organic matter content than this Ossian soil.

This soil is well suited to cultivated crops if drained and protected from flooding. It is subject to wetness because of flooding, slow runoff, or a high water table. Plowing is difficult and can be delayed by excessive moisture. The soil puddles easily when wet and becomes cloddy and hard when dry. Frequently flooded areas are used mainly for pasture. The organic matter content is high. Capability unit IIw–3.

Ostrander series

The Ostrander series consists of dark colored, well drained soils. These gently to moderately sloping soils are on ridges and convex side slopes on uplands. Slopes are 2 to 9 percent. They formed in 18 to 26

inches of loamy material and in the underlying friable to very friable, stratified loam, sandy loam and sandy clay loam glacial till. The native vegetation was mixed prairie grasses. A layer of pebbles or stones is at the contact of the loamy material and the glacial till in most places.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable loam about 15 inches thick. The subsoil extends to a depth of 65 inches. In the upper part it is dark yellowish brown and yellowish brown, friable sandy clay loam; in the middle part it is yellowish brown, friable light loam; and in the lower part it is yellowish brown, very friable sandy loam that has a few strong brown mottles. The substratum is yellowish brown, friable light loam with strong brown mottles.

Available water capacity is high, and permeability is moderate. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Ostrander soils are used mainly for cultivated crops. The major limitation for crops is erosion. Providing adequate drainage and controlling erosion on these soils is difficult. Conservation practices slow down the movement of surface water, letting more of it soak into the soil. The extra water complicates drainage. A combination of practices, such as terraces or mulch tillage and tile drainage is needed on this soil.

Representative profile of Ostrander loam, 2 to 5 percent slopes, in a cultivated field, 372 feet east and 378 feet south of the northwest corner of the SW¼ sec. 12, T. 94 N., R. 10 W.:

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam; cloddy parting to moderate medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A12—6 to 10 inches; very dark brown (10YR 2/2) loam; moderate medium subangular blocky structure parting to weak medium and fine granular; friable; neutral; clear smooth boundary.

A3—10 to 15 inches; very dark grayish brown (10YR 3/2) loam; moderate medium and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—15 to 19 inches; dark yellowish brown (10YR 4/4) sandy clay loam; moderate medium and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21—19 to 24 inches; yellowish brown (10YR 5/6) sandy clay loam; moderate medium and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

IIB22—24 to 37 inches; yellowish brown (10YR 5/6) light loam; moderate medium subangular blocky structure; friable; stone line at top of horizon; medium acid; gradual smooth boundary.

IIB23—37 to 53 inches; yellowish brown (10YR 5/6) light loam; common strong brown (7.5YR 5/6) coatings; moderate medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

IIB3—53 to 65 inches; yellowish brown (10YR 5/8) sandy loam; few fine distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

IIC1—65 to 86 inches; yellowish brown (10YR 5/8) light loam; few fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; thin 2-inch sandy loam zones at depths of 72, 77, and 83 inches; few fine distinct red (2.5YR 4/8) iron and manganese oxide concretions; slightly acid; gradual smooth boundary.

IIIC2—86 to 90 inches; yellowish brown (10YR 5/6) heavy loam; few fine distinct strong brown (7.5YR 5/6) mottles and common fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; slightly acid.

The solum is 45 to 70 inches thick. Carbonates are at a depth of 60 to 80 inches. The soils formed in 14 to 22 inches of loamy material and in the underlying glacial till. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon is typically loam but ranges to silt loam that is high in sand. It is 10 to 18 inches thick. The IIB horizon is sandy clay loam, heavy loam, or loam to sandy loam or loamy sand. It is medium acid to strongly acid. It has no mottles above a depth of 40 inches.

Ostrander soils are associated with Kenyon, Floyd, and Clyde soils. They formed in parent material similar to that of Floyd and Clyde soils. They are browner in the upper part of the B horizon and are better drained than Floyd and Clyde soils. They have less clay in the IIB horizon, are free of mottles to a greater depth, and are deeper to carbonates than Kenyon soils.

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

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of soils that have a sandy surface layer. These soils can be somewhat droughty.

This soil is well suited to cultivated crops. It is subject to slight erosion if cultivated. This soil does not need supplemental drainage, but erosion control practices are needed when this soil is in row crops. Conservation practices, however, slow the movement of surface water, letting more of it soak into the soil. The extra water complicates drainage. A combination of practices, such as terraces and tile drainage, is needed on this soil. The organic matter content is high. Capability unit IIe–1.

394C—Ostrander loam, 5 to 9 percent slopes. This moderately sloping soil is on short, convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as

representative of the series, but the dark surface layer is not so thick.

Included with this soil in mapping are a few areas of sandy soils. These soils are droughty and less productive than this Ostrander soil.

This soil is suited to corn and soybeans if properly managed. It is subject to moderate or severe erosion if cultivated. Erosion control practices are needed when this soil is in row crops. Conservation practices, however, slow the movement of surface water, letting more of it soak in to the soil. The extra water complicates drainage. A combination of practices, such as terraces and tile drainage, is needed on this soil. The organic matter content is moderate to high. Capability unit IIIe–1.

394C2—Ostrander loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on short, convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative for the series, but erosion has removed part of the surface layer. The surface layer is thinner and lower in organic matter content and fertility than the uneroded Ostrander soils.

This soil is suited to cultivated crops if properly managed. It is subject to severe erosion if cultivated. The organic matter content is moderately low. Capability unit IIIe–1.

Otter series

The Otter series consists of dark colored, poorly drained soils. These gently sloping soils are on the lower parts of narrow drainageways in the loess-covered uplands. Slopes are 2 to 5 percent. These soils formed in medium textured silty alluvium. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is about 51 inches thick. It is black, very dark gray, and very dark brown, friable silt loam that has dark red and dark reddish brown mottles. It contains thin strata of grayish brown, dark grayish brown, and very dark grayish brown, friable silt loam. The substratum, at a depth of 51 inches, is dark gray, friable silt loam.

Available water capacity is high, and permeability is moderate. Available phosphorus is medium and available potassium is low. These soils are generally neutral in the surface layer and do not require lime.

Otter soils are used mainly for pasture, although some areas are cropped with the adjoining soils upslope. The major limitation for crops is the high-velocity runoff water these soils receive from adjoining, more sloping upland soils. Maintaining many areas in grassed waterways helps to prevent gullying.

Representative profile of Otter silt loam in an area of Otter-Huntsville silt loams, 2 to 5 percent slopes, in a waterway, 460 feet west and 370 feet south of the northeast corner of SE¼ sec. 8, T. 94 N., R. 8 W.:

A11—0 to 11 inches; black (10YR 2/1) heavy silt loam, very dark brown (10YR 2/2) rubbed; moderate fine subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A12—11 to 16 inches; stratified thin grayish brown (10YR 5/2), very dark gray (10YR 3/1), dark grayish brown (10YR 4/2), and very dark grayish brown (10YR 3/2) silt loam, very dark grayish brown (10YR 3/2) kneaded; common, medium prominent red (2.5YR 4/6) and yellowish red (5YR 4/6) mottles associated with roots; moderate thin platy structure; friable; neutral; gradual smooth boundary.

A13—16 to 18 inches; very dark gray (10YR 3/1) silt loam, very dark brown (10YR 2/2) kneaded; common medium prominent dark red (2.5YR 3/6) mottles associated with roots; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A14—18 to 36 inches; very dark brown (10YR 2/2) silt loam; moderate fine subangular blocky structure parting to moderate fine granular; friable; neutral; gradual smooth boundary.

A15—36 to 45 inches; very dark gray (10YR 3/1) heavy silt loam, very dark brown (10YR 2/2) kneaded; common fine prominent dark red (2.5YR 3/6) mottles; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A16—45 to 51 inches; very dark gray (10YR 3/1) heavy silt loam; few fine distinct dark reddish brown (5YR 3/4) mottles; moderate fine angular blocky structure; friable; few dark reddish brown (5YR 2/2) oxide concretions; slightly acid; clear smooth boundary.

Cg—51 to 60 inches; dark gray (5Y 5/1) silt loam; massive; friable; neutral.

The solum is 36 to 60 inches thick. It is neutral or slightly acid throughout. Carbonates are absent above a depth of 60 inches. The A horizon is typically medium to heavy silt loam, but it commonly contains thin strata of light silty clay loam. Colors that have a value of 3 or higher are at a depth of 36 inches or more.

Otter soils are associated with Huntsville soils. They formed in parent material similar to that of Huntsville and Ossian soils and have a thicker A horizon than those soils. They have a grayer C horizon and are more poorly drained than Huntsville soils.

487B—Otter-Huntsville silt loams, 2 to 5 percent slopes. This complex consists of dark, poorly drained and well drained soils in narrow upland drainageways. The drainageways are U-shaped and are generally about 100 to 200 feet wide. The soils are gently sloping and are associated with more sloping upland soils that are loess-covered. The complex is 55 percent Otter soils and 45 percent Huntsville soils. The Otter soils are near stream channels or waterways and the Huntsville soils border the base of the upland slope. These soils are in such close association that it is impractical to map them separately.

Included with these soils in mapping are areas of soils where 6 to 20 inches of light colored silt loam overwash has been deposited.

These soils are generally wet because of overflow

and seepage from more sloping soils upslope. Drainageways that carry a high concentration of water need to be maintained in grass to help prevent gullying. Tile is needed on each side of some drainageways to remove the excess water.

Most of these soils are in permanent pasture or are cropped with the surrounding soils. Areas are generally too small and narrow and irregular in shape to be cropped separately. Capability unit IIw–1.

Palms series

The Palms series consists of dark colored, very poorly drained organic soils. These nearly level to gently sloping soils are on sidehill seeps or in drainageways on uplands. A few areas are on stream benches. Slopes are 1 to 4 percent. These soils formed in 18 to 50 inches of organic soil over alluvial sediment or glacial till. The native vegetation was grass, sedges, and other water-tolerant plants.

In a representative profile the surface layer is black, friable organic material about 28 inches thick. The substratum is very dark grayish brown silt loam in the upper part, olive gray coarse loamy sand in the middle part, and dark greenish gray loam in the lower part.

Available water capacity is high to very high. Permeability is moderately rapid in the organic material and moderate in the loamy material. Available phosphorus and available potassium are very low. These soils are neutral or slightly acid and do not require lime.

Palms soils are used mainly for permanent pasture or are left idle. The major limitation for crops is wetness. The soils have a very high water table and a hummocky surface. Drainage and leveling are needed before row crops can be grown. These soils settle considerably after they are drained.

Representative profile of Palms muck, 1 to 4 percent slopes, in a cultivated field, 162 feet north and 1,161 feet west of the southeast corner of sec. 8, T. 94 N., R. 10 W.:

Oap—0 to 7 inches; black (10YR 2/1), broken face and rubbed, sapric material; about 5 percent fiber, less than 5 percent rubbed; weak coarse subangular blocky structure parting to weak fine granular; friable; fibers are herbaceous; about 5 percent mineral matter; pH 6.0 in water; abrupt smooth boundary.

Oa2—7 to 28 inches; black (N 2/0), broken face and rubbed, sapric material; about 10 to 20 percent fiber, less than 5 percent rubbed; weak coarse subangular blocky structure; friable; fibers are herbaceous; about 10 to 15 percent mineral matter; pH 5.6 in water; clear smooth boundary.

IIC1—28 to 31 inches; very dark grayish brown (10YR 3/2) silt loam; massive; friable; strongly acid; clear smooth boundary.

IIC2g—31 to 38 inches; olive gray (5Y 4/2) coarse loamy sand; few fine distinct light olive brown (2.5Y 5/4) mottles; single grained; loose; about 5 percent fine gravel; neutral; clear smooth boundary.

IIC3g—38 to 60 inches; dark greenish gray (5GY 4/1) loam; massive; friable; neutral.

The sapric material is generally 18 to 40 inches thick, but it is as much as 50 inches thick in places. It is black (N 2/0 or 10YR 2/1) or very dark brown (10YR 2/2). The fiber is mainly derived from herbaceous plants. The IIC horizon has hue of 10YR, to 5Y, chroma of 1 or 2, and value of 1 to 3. It is variable in texture, but it is typically silty clay loam, loam, or silt loam and has sandy strata in places. It is typically neutral but ranges from slightly acid to mildly alkaline.

Palms soils are associated with Clyde, Coland, and Marshan soils. They have a surface layer of decomposed organic material more than 18 inches thick that those soils do not have. They are also more poorly drained than those soils.

221—Palms muck, 1 to 4 percent slopes. This nearly level to gently sloping soil generally occurs as sidehill seeps at the base of slopes or in upland drainageways. Some areas are also on stream benches.

Included with this soil in mapping are areas of soils that have 6 to 20 inches of lighter colored overwash. Also included are areas of soils that have as much as 72 inches of mucky peat and that have a higher percentage of partially decomposed organic material than this Palms soil.

This soil is suited to row crops if it is adequately drained. Where this soil is not drained, the water table is at or near the surface much of the year. Tile or surface drainage and leveling of hummocks are needed before row crops can be grown. Outlets for tile drainage are difficult to obtain in some areas. The organic matter content is very high. Capability unit IIIw–1.

Port Byron series

The Port Byron series consists of dark colored, well drained soils. These gently sloping soils are on ridges and convex side slopes on uplands. Slopes are 2 to 5 percent. These soils formed in loess more than 40 inches thick. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable silt loam about 15 inches thick. The subsoil extends to a depth of 48 inches. In the upper part it is brown, friable silt loam; in the middle part it is yellowish brown, friable heavy silt loam; and in the lower part it is yellowish brown, friable silt loam that has strong brown mottles. The substratum is yellowish brown, friable silt loam that has strong brown and grayish brown mottles.

Available water capacity is high, and permeability is moderate. Available phosphorus and available potassium are very low. These soils have good tilth and are easy to work. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Port Byron soils are used mainly for cultivated crops. The major limitation for crops is erosion.

Representative profile of Port Byron silt loam, 2 to 5 percent slopes, in a cultivated field, 27 feet south

and 108 feet west of the northeast corner of the western half of SW¼NW¼ sec. 6, T. 94 N., R. 8 W.:

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

A12—8 to 15 inches; very dark grayish brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) coatings on peds; moderate fine granular structure; friable; medium acid; clear smooth boundary.

B1t—15 to 22 inches; brown (10YR 4/3) silt loam; nearly continuous very dark grayish brown (10YR 3/2) coatings on peds; moderate fine subangular blocky structure; friable; thin discontinuous very dark gray (10YR 3/1) clay films; medium acid; gradual smooth boundary.

B21t—22 to 30 inches; yellowish brown (10YR 5/6) heavy silt loam; dark brown (10YR 3/3) coatings on peds; moderate medium subangular blocky structure; friable; few thin discontinuous light gray (10YR 7/1), dry, silt coatings on faces of peds; thin patchy dark brown (10YR 3/3) clay films; strongly acid; gradual smooth boundary.

B22t—30 to 38 inches; yellowish brown (10YR 5/6) heavy silt loam; brown (10YR 4/3) coatings on peds; moderate medium subangular blocky structure; friable; thin patchy brown (10YR 3/3) clay films; strongly acid; clear smooth boundary.

B3—38 to 48 inches; yellowish brown (10YR 5/6) heavy silt loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure; friable; medium acid; clear smooth boundary.

C—48 to 60 inches; yellowish brown (10YR 5/6) silt loam; few fine distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) mottles; massive; friable; slightly acid.

The solum is 40 to 60 inches thick. It is medium acid to strongly acid in the most acid part. Carbonates are absent above a depth of 60 inches. The A1 or Ap horizon is typically black (10YR 2/1) or very dark brown (10YR 2/2). The B horizon typically has hue of 10YR, value of 3 to 5, and chroma of 3 to 6. The A and B horizons are silt loam and are typically 22 to 26 percent clay, although they range from 18 to 27 percent clay. The B3 and C horizons have few or no mottles.

Port Byron soils are associated with Downs soils. They formed in parent material similar to that of Fayette and Downs soils. They have a thicker and darker A horizon than those soils.

620B—Port Byron silt loam, 2 to 5 percent slopes. This gently sloping soil is on ridges and convex side slopes on uplands. Areas are about 40 acres in size and are irregular in shape.

Included with this soil in mapping are areas of soils that have a thinner and lighter colored surface layer and that are lower in organic matter content and fertility than this Port Byron soil.

This soil is well suited to cultivated crops. It is subject to erosion if cultivated. It is well suited to terracing because slopes are generally long and smooth. The organic matter content is moderate to high. Capability unit IIe–1.

Protivin series

The Protivin series consists of dark colored, somewhat poorly drained soils. These nearly level to gently sloping soils are on slightly concave side slopes on uplands. Slopes are 1 to 4 percent. These soils formed in 14 to 24 inches of loamy material and in the underlying very firm glacial till. The native vegetation was mixed prairie grasses. A layer of pebbles and stones is at the contact of the loamy material and the glacial till in most places.

In a representative profile the surface layer is black and very dark grayish brown loam about 18 inches thick. The subsoil extends to a depth of 48 inches. It is dark grayish brown, firm light clay loam in the upper part and mottled gray and strong brown, very firm clay loam in the lower part. The substratum is mottled light gray and strong brown, firm light clay loam.

Available water capacity is high. Permeability is moderate in the upper part of the soil and slow in the very firm glacial till. The rate at which water moves through the friable loamy material differs considerably from the rate at which it moves through the underlying very firm glacial till. Water moves more rapidly in the upper material and accumulates at the till contact, resulting in wet, seepy areas in some years. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

The Protivin soils are used mainly for cultivated crops. The major limitation for crops is a seasonal high water table. Protivin soils benefit from tile drainage in most years.

Representative profile of Protivin loam, 1 to 4 percent slopes, in a cultivated field, 370 feet north and 265 feet east of southwest corner of NW¼ sec. 27, T. 93 N., R. 10 W.:

Ap—0 to 9 inches; black (10YR 2/1) loam; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—9 to 14 inches; black (10YR 2/1) heavy loam; moderate very fine granular structure; friable; medium acid; clear smooth boundary.

A3—14 to 18 inches; very dark grayish brown (2.5Y 3/2) heavy loam; very dark gray (10YR 3/1) coatings on peds; moderate fine granular structure; friable; medium acid; clear smooth boundary.

B1—18 to 28 inches; dark grayish brown (2.5Y 4/2) light clay loam; discontinuous very dark grayish brown (2.5Y 3/2) coatings on faces of peds; few fine distinct olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/6) mottles; weak fine and medium subangular blocky structure; firm; medium acid; clear smooth boundary.

IIB2t—28 to 40 inches; mottled gray (5Y 5/1)

and strong brown (7.5YR 5/6) medium clay loam; discontinuous gray (5Y 5/1) coatings on faces of prisms; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; pebble band at top of horizon; slightly acid; few thin discontinuous clay films on prisms; clear smooth boundary.

IIB3t—40 to 48 inches; mottled gray (5Y 5/1) and strong brown (7.5YR 5/6) medium clay loam; discontinuous gray (5Y 5/1) coatings on faces of prisms; weak medium prismatic structure parting to weak medium subangular blocky; very firm; neutral; clear smooth boundary.

IIC—48 to 64 inches; mottled light gray (5Y 6/1) and strong brown (7.5 5/6) light clay loam; massive; firm; neutral.

The solum is 40 to 60 inches thick. Carbonates are at a depth of 40 to 60 inches. The soils formed in 14 to 24 inches of loamy material and the underlying clay loam glacial till. The A horizon is typically heavy loam but ranges to light clay loam. It is 12 to 18 inches thick. The A3 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2 or 2.5Y 3/2). The IIB2 horizon is typically clay loam and is 30 to 35 percent clay, although in some pedons it is as much as 37 percent clay. Gray coatings on the faces of peds in this horizon decrease as depth increases.

Protivin soils are associated with Cresco, Kenyon, Floyd, and Clyde soils. They formed in parent material similar to that of the Riceville, Cresco, and Lourdes soils. They have grayer coatings on the faces of peds and have more clay in the IIB horizon than Kenyon, Floyd, and Clyde soils. Protivin soils have lower chroma and more mottling in the upper part of the B horizon than Cresco and Lourdes soils. They have a thicker and darker A horizon than Riceville soils.

798B—Protivin loam, 1 to 4 percent slopes. This nearly level to gently sloping soil is on convex and slightly concave side slopes on uplands. Areas are about 10 acres in size and are elongated in shape.

This soil is suited to corn and soybeans. It is subject to slight erosion if cultivated. Because of the difference in permeability between the loamy material and the underlying very firm glacial till, water accumulates at the contact of these materials and produces a temporary high water table, particularly early in spring. Because the subsoil is slowly permeable, careful placement and spacing of tile are important. The organic matter content is high. Capability unit IIw–2.

Readlyn series

The Readlyn series consists of dark colored, somewhat poorly drained soils. These nearly level to gently sloping soils are on broad, upland ridges and long, convex side slopes. Slopes are 0 to 5 percent. These soils formed in 14 to 21 inches of loamy material and in the underlying glacial till. The native vegetation was mixed prairie grasses. A layer of stones and pebbles is at the contact of the loamy material and the glacial till in most places.

In a representative profile the surface layer is black, very dark brown, and very dark grayish brown loam about 18 inches thick. The subsoil extends to a depth of 43 inches. It is mottled dark grayish brown and olive brown, friable loam in the upper part; mottled dark grayish brown and strong brown, firm heavy loam in the middle part; and mottled yellowish brown and grayish brown, firm loam in the lower part. The underlying material is mottled yellowish brown and grayish brown firm loam that is mildly alkaline and strongly effervescent.

Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow in the underlying glacial till. The rate at which water moves through the friable loam material differs considerably from the rate at which it moves through the underlying firm glacial till. Water moves more rapidly in the upper material and accumulates at the till contact, resulting in wet, seepy areas in some years. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Readlyn soils are used mainly for cultivated crops. The major limitation for crops is a seasonal high water table. Readlyn soils benefit from tile drainage in some years.

Representative profile of Readlyn loam, 0 to 2 percent slopes, in a cultivated field, 875 feet south and 55 feet east of northwest corner of SW¼ sec. 7, T. 91 N., R. 10 W.:

Ap—0 to 9 inches; black (10YR 2/1) loam; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—9 to 13 inches; very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; moderate fine granular structure; friable; neutral; clear smooth boundary.

A3—13 to 18 inches; very dark grayish brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate fine granular structure; friable; stone line at base of horizon; medium acid; clear smooth boundary.

IIB21—18 to 22 inches; mottled dark grayish brown (10YR 4/2) and olive brown (2.5Y 4/4) loam; few fine distinct strong brown (7.5YR 5/6) mottles; moderate very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

IIB22—22 to 31 inches; mottled dark grayish brown (10YR 4/2) and strong brown (7.5YR 5/6) heavy loam; discontinuous dark grayish brown (10YR 4/2) coatings on faces of prisms; weak fine prismatic structure parting to moderate fine subangular blocky; firm; few thick very dark gray (10YR 3/1) clay flows in root channels; medium acid; clear smooth boundary.

IIB3—31 to 43 inches; mottled yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; few thick very

dark gray (10YR 3/1) clay flows in root channels; neutral; abrupt wavy boundary.

IIC—43 to 60 inches; mottled yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) loam; massive; firm; mildly alkaline; strong effervescence.

The solum is 42 to 60 inches thick. It is medium acid to strongly acid in the most acid part. Depth to carbonates is generally the same as the solum thickness. The soils formed in about 14 to 21 inches of loamy material and in the underlying glacial till. The A horizon is black (10YR 2/1) to very dark grayish brown (2.5Y 3/2) and is 16 to 20 inches thick. The IIB horizon is loam to sandy clay loam in the upper part and light clay loam in the lower part. The B horizon has mottles throughout. It has hue of 10YR or 2.5Y, value of 4 to 5, and chroma of 2 to 8.

Readlyn soils are associated with Tripoli, Floyd, and Clyde soils. They formed in parent material similar to that of Oran, Kenyon, and Tripoli soils. They are more acid and less friable in the B horizon than Floyd and Clyde soils and are not so poorly drained as Clyde soils. They have a browner B horizon and are better drained than Tripoli soils. They are grayer in the upper part of the B horizon and less well drained than Kenyon soils.

399—Readlyn loam, 0 to 2 percent slopes. This nearly level soil is on broad upland ridges. Areas are large, they are broad and several miles long, and they are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that are browner in the upper part of the subsoil and are better drained than this Readlyn soil. A few spots of sandy soils that are somewhat droughty are also included.

This soil is well suited to corn and soybeans. It is subject to slight wetness. Because of the difference in permeability between the loamy material and the underlying glacial till, water accumulates at the contact of these materials and produces a seasonal high water table. This soil will benefit from tile drainage in some years. The organic matter content is high. Capability unit I–2.

399B—Readlyn loam, 2 to 5 percent slopes. This gently sloping soil is on long, slightly convex side slopes. In a few places, it is in concave positions below the side slopes. Areas are about 10 to 20 acres in size and are irregular in shape.

Included with this soil in mapping are a few small areas of soils that are browner in the upper part of the subsoil and are better drained than this Readlyn soil.

This soil is well suited to corn and soybeans. It is subject to slight erosion if cultivated. Providing adequate drainage and controlling erosion are difficult. The long, uniform slopes are well suited to conservation practices, such as terracing, but these practices slow the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of tiling and terracing helps overcome these problems. The organic matter content is high. Capability unit IIe–1.

Riceville series

The Riceville series consists of moderately dark colored, somewhat poorly drained soils. These nearly level to gently sloping soils are on low ridgetops and slightly concave side slopes on uplands. Slopes are 1 to 4 percent. These soils formed in 12 to 20 inches of loamy material and in the underlying very firm glacial till. The native vegetation was deciduous trees and tall prairie grasses. A layer of pebbles and stones is at the contact of the loamy material and the glacial till in most places.

In a representative profile the surface layer is very dark grayish brown loam about 7 inches thick. The subsurface layer is mottled grayish brown and yellowish brown heavy loam about 4 inches thick. The subsoil extends to a depth of 46 inches. It is mottled yellowish brown and grayish brown, friable light clay loam in the upper part; mottled strong brown, grayish brown, and gray, firm and very firm clay loam in the middle part; and mottled yellowish red, gray, and strong brown, very firm clay loam in the lower part. The substratum is mottled gray and strong brown, firm light clay loam that is mildly alkaline and strongly effervescent.

Available water capacity is high. Permeability is moderate in the upper part of the soil and slow in the underlying very firm glacial till. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Riceville soils are used mainly for cultivated crops. The major limitation for crops is a seasonal perched water table. Because of the difference in permeability of the loamy material and the underlying very firm glacial till at a depth of about 1½ feet, water accumulates at this contact and produces a temporary high water table, particularly early in spring. The more sloping Riceville soils are subject to slight erosion, but erosion control practices slow the movement of surface water, letting more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. A combination of terracing and tile drainage is needed. Because the subsoil is slowly permeable, careful placement and spacing of tile is important.

Representative profile of Riceville loam, 1 to 4 percent slopes, in a cultivated field, 65 feet south and 150 feet east of the southwest corner of NW¼NW¼ sec. 19, T. 93 N., R. 10 W.:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam; weak very fine granular structure; friable; slightly acid; abrupt smooth boundary.

A2—7 to 11 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) heavy loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium platy structure; friable; strongly acid; clear smooth boundary.

B1—11 to 14 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) light clay loam; few fine distinct strong brown (7.5YR 5/6) mot-

tles; moderate very fine subangular blocky structure; friable; stone line at base of horizon; very strongly acid; clear smooth boundary.

IIB21—14 to 18 inches; mottled strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) light clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; very strongly acid; clear smooth boundary.

IIB22—18 to 21 inches; mottled strong brown (7.5YR 5/6) and gray (5Y 5/1) clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; very strongly acid; clear smooth boundary.

IIB23t—21 to 36 inches; mottled yellowish red (5YR 5/6) and gray (5Y 5/1) clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; thick nearly continuous dark gray (10YR 4/1) clay films on faces of prisms; thick very dark gray (10YR 3/1) clay flows in coarse root channels; strongly acid; clear smooth boundary.

IIB3t—36 to 46 inches; mottled gray (5YR 5/1) and strong brown (7.5YR 5/6) clay loam; moderate medium prismatic structure parting to moderate medium subangular blocky; very firm; thick nearly continuous very dark gray (10YR 3/1) clay flows in thin root channels; medium acid; abrupt wavy boundary.

IIC—46 to 60 inches; mottled gray (5Y 5/1) and strong brown (7.5YR 5/6) light clay loam; nearly continuous light gray (5Y 6/1) coatings on faces of peds; massive; firm; mildly alkaline; strong effervescence.

The solum is typically about 45 inches thick but ranges from 40 to 60 inches in thickness. Carbonates are at a depth of 40 to 60 inches. These soils formed in 12 to 20 inches of loamy material and in the underlying very firm glacial till. The A1 or Ap horizon is very dark brown (10YR 2/2) or very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick. The A2 horizon is typically dark grayish brown (10YR 4/2) and ranges from very dark grayish brown (10YR 3/2) to grayish brown (10YR 5/2). It is 3 to 6 inches thick. In cultivated areas, the A2 horizon may be incorporated into the Ap horizon. The IIB2 horizon is typically light to medium clay loam and is 30 to 35 percent clay, although in some pedons this horizon is as much as 38 percent clay.

Riceville soils are associated with Bassett, Lourdes, Floyd, and Clyde soils. They formed in parent material similar to that of Lourdes, Cresco, and Protivin soils. They have grayer coatings on ped faces and more clay in the IIB horizon than Bassett, Floyd, and Clyde soils. They have grayer colors in the lower part of the A horizon and upper part of the B horizon than Lourdes and Cresco soils. They have a thinner and lighter colored A horizon than Protivin soils.

784B—Riceville loam, 1 to 4 percent slopes. This nearly level to gently sloping soil is on low, broad ridges and slightly concave side slopes on uplands. Areas are about 20 acres in size and are irregular in shape.

This soil is suited to corn and soybeans. It is subject to slight erosion on the more sloping areas if cultivated. Because of the difference in permeability between the loamy material and the underlying very firm glacial till at a depth of about 1½ feet, water accumulates at the contact of these materials and produces a temporary high water table, particularly early in spring. Because providing adequate erosion control and drainage is difficult on this soil, a combination of terracing and tile drainage is needed. Careful placement and spacing of tile is important because of the slowly permeable subsoil. The organic matter content is moderately low to low. Capability unit IIw–2.

Richwood series

The Richwood series consists of dark colored, well drained soils. These nearly level soils are on benches along streams. Slopes are 0 to 2 percent. These soils formed in silty alluvium. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable silt loam about 18 inches thick. The subsoil extends to a depth of 49 inches. It is brown, friable silt loam in the upper part and yellowish brown, friable silt loam in the lower part. The substratum is yellowish brown and grayish brown, friable silt loam that has brown and strong brown mottles.

Available water capacity is high and permeability is moderate. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Richwood soils are used mainly for cultivated crops. The major limitation for crops is occasional runoff and siltation from soils upslope.

Representative profile of Richwood silt loam, 0 to 2 percent slopes, in a cultivated field, 33 feet west and 262 feet north of road intersection on the southeast corner of SW¼NW¼ sec. 2, T. 95 N., R. 9 W.:

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam; cloddy parting to weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—8 to 13 inches; very dark brown (10YR 2/2) silt loam; moderate fine subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A3—13 to 18 inches; very dark grayish brown (10YR 3/2) silt loam; very dark brown (10YR 2/2) coatings on peds; moderate medium and fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

B21—18 to 24 inches; brown (10YR 4/3) silt loam; very dark grayish brown (10YR 3/2) coatings on peds; moderate medium and fine subangular blocky structure; friable; thin discontinuous light

gray (10YR 7/1) silt coatings on peds; neutral; clear smooth boundary.

B22—24 to 30 inches; brown (10YR 4/3) silt loam; moderate medium subangular blocky structure; friable; thin discontinuous light gray (10YR 7/1) silt coatings on peds; slightly acid; clear smooth boundary.

B31t—30 to 41 inches; yellowish brown (10YR 5/4) silt loam; moderate coarse prismatic structure; friable; very dark grayish brown (10YR 3/2) clay films in root channels; slightly acid; clear smooth boundary.

B32t—41 to 49 inches; yellowish brown (10YR 5/4) silt loam; weak coarse prismatic structure; friable; very dark grayish brown (10YR 3/2) clay films in root channels; medium acid; clear smooth boundary.

C1—49 to 51 inches; yellowish brown (10YR 5/4) silt loam; few fine distinct strong brown (7.5YR 5/6) and brown (10YR 5/3) mottles; massive; friable; medium acid; clear smooth boundary.

C2—51 to 66 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct brown (7.5YR 4/4) mottles; massive; friable; strongly acid.

The thickness of the solum is typically more than 40 inches, but ranges from 36 to 60 inches. The solum is typically slightly acid to medium acid in the most acid part. Carbonates are not present above a depth of 60 inches or more. The A horizon is 14 to 24 inches thick. The B horizon is typically silt loam but ranges to light silty clay loam.

Richwood soils are associated with Ossian soils. They formed in parent material similar to that of the Festina and Ossian soils. They are browner in the upper part of the B horizon and are better drained than Ossian soils. They have a thicker and darker A horizon than Festina soils.

977—Richwood silt loam, 0 to 2 percent slopes. This nearly level soil is on stream benches, mainly along the Turkey River where the upland soils are covered with loess. Areas are 5 to 10 acres in size and are irregular in shape.

Included with this soil in mapping are a few areas of soils on which lighter colored silty overwash has been deposited from adjoining loess-covered uplands. These soils are lower in organic matter content in the surface layer than this Richwood soil.

This soil is well suited to cultivated crops. It is subject to occasional local runoff from soils upslope. Diversion terraces on adjacent upland slopes help to protect this soil from overflow and silting. The organic matter content is high. Capability unit I–1.

Rock outcrop-Nordness complex

478G—Rock outcrop-Nordness complex, 25 to 60 percent slopes. This complex is on uplands above stream benches on bottom lands. A thin layer of silt loam covers most of the areas, but in other places the surface layer is loam. Outcrops of limestone bedrock and fragments are at the surface in many areas.

This complex is 50 percent Rock outcrop and 40 percent Nordness soils.

This complex is better suited to trees or wildlife habitat than to most other uses, but a few areas are in permanent pasture. The carrying capacity for pasture is very low. Because the slopes are steep, regular farm machinery cannot be used. Capability unit VIIs–1.

Rockton series

The Rockton series consists of dark colored, well drained soils. These nearly level to moderately sloping soils are on high benches and ridges and side slopes on uplands. Slopes are 0 to 9 percent. These soils formed in 20 to 40 inches of loamy material and a thin layer of residuum over limestone bedrock. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable loam about 17 inches thick. The subsoil extends to a depth of 33 inches. It is brown, friable loam in the upper part; dark yellowish brown, friable sandy clay loam in the middle part; and brown, very firm silty clay in the lower part. Below this is partially weathered, shattered limestone with thin rinds of clay residuum overlying hard, fractured limestone bedrock.

Available water capacity is moderate to low. Permeability is moderate in the loamy material and rapid in the underlying limestone bedrock. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Rockton soils are used mainly for cultivated crops. The major limitations for crops are droughtiness and erosion. These soils are suited to row crops but tend to be droughty unless rainfall is timely.

Representative profile of Rockton loam, 30 to 40 inches to limestone, 2 to 5 percent slopes, in a cultivated field, 54 feet south and 455 feet east of the northwest corner of SW¼SE¼ sec. 4, T. 94 N., R. 9 W.:

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam high in silt; moderate fine subangular blocky structure parting to weak fine granular; friable; neutral; abrupt smooth boundary.

A12—7 to 13 inches; very dark brown (10YR 2/2) loam high in silt; moderate fine subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A3—13 to 17 inches; very dark grayish brown (10YR 3/2) loam high in silt; very dark brown (10YR 2/2) coatings on peds; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21—17 to 27 inches; brown (10YR 4/3) loam; some very dark grayish brown (10YR 3/2) mixed from the A horizon; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B22t—27 to 31 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak coarse prismatic structure; thin discontinuous clay films on faces of peds; medium acid; clear wavy boundary.

IIB3t—31 to 33 inches; brown (10YR 4/3) silty clay; moderate medium prismatic structure parting to strong medium subangular blocky; very firm; thick discontinuous dark brown (7.5YR 4/4) clay films and clay bridges between sand grains; pebble band at top boundary of horizon; slightly acid; abrupt wavy boundary.

R1—33 to 36 inches; level bedded limestone bedrock; flags of limestone with silty clay residuum interbedded; mildly alkaline; strong effervescence.

R2—36 inches; hard fractured limestone bedrock.

The thickness of the solum and depth to limestone bedrock range from 20 to 40 inches. The solum is medium acid to strongly acid in the most acid part. The A horizon has value of 2 or 3, chroma of 1 or 2, and hue of 10YR. It is 10 to 18 inches thick. It is typically loam but ranges to silt loam. The B2 horizon has value of 4 to 5, chroma of 3 to 6, and hue of 10YR in the upper part and 7.5YR or 10YR in the lower part. The B horizon is about 25 to 35 percent clay. The IIB horizon or residuum may be absent or visible only as rinds around limestone flags. If present, it is heavy clay loam, clay, or silty clay and is as much as 6 inches thick.

Rockton soils are associated with Kenyon, Ostrander, and Marlean soils. They formed in parent material similar to that of Winneshiek soils. They are shallower to limestone bedrock than Kenyon and Ostrander soils, and are deeper to bedrock than Marlean soils. They have a thicker A horizon than Winneshiek soils.

213—Rockton loam, 30 to 40 inches to limestone, 0 to 2 percent slopes. This nearly level soil is in high benchlike areas. Areas are 10 to 20 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the typical loamy sediment over limestone is thicker.

Included with this soil in mapping are a few areas of soils in which the depth to limestone bedrock is more than 40 inches. These soils are less droughty than this Rockton soil.

This soil is well suited to cultivated crops. It is subject to droughtiness if rainfall is not timely. The organic matter content is moderate to high. Capability unit IIs–1.

213B—Rockton loam, 30 to 40 inches to limestone, 2 to 5 percent slopes. This gently sloping soil is on ridges and side slopes on uplands or in high parts of benchlike areas. Areas are 5 to 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils in which the depth to limestone bedrock is more than 40 inches. These soils are less droughty than this Rockton soil.

This soil is well suited to row crops. It is subject to erosion and is droughty if rainfall is not timely. The shallow depth to bedrock makes terrace construction difficult in some areas. The organic matter content is moderate. Capability unit IIe–2.

214—Rockton loam, 20 to 30 inches to limestone, 0 to 2 percent slopes. This nearly level soil is in high, benchlike areas. Areas are 10 to 20 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but limestone is generally at a depth of 20 to 30 inches.

Included with this soil in mapping are small areas of soils where limestone is near the surface or is exposed. These soils hinder farming operations.

This soil is suited to row crops, but the root zone is limited. This soil is subject to droughtiness when rainfall is average or below average. The organic matter content is moderate to high. Capability unit IIs–1.

214B—Rockton loam, 20 to 30 inches to limestone, 2 to 5 percent slopes. This gently sloping soil is on ridges and side slopes on uplands and in the high part of benchlike areas. Areas are 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but limestone is generally at a depth of 20 to 30 inches.

Included with this soil in mapping are small areas of soils where limestone is near the surface or is exposed. These soils hinder farming operations.

This soil is suited to row crops, but the root zone is limited. This soil is subject to erosion if cultivated, and it is droughty when rainfall is average or below average. This soil is not well suited to terraces because of the shallow depth to limestone. The organic matter content is moderate. Capability unit IIe–2.

214C—Rockton loam, 20 to 30 inches to limestone, 5 to 9 percent slopes. This moderately sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the dark surface layer is thinner and limestone is commonly at a depth of 20 and 30 inches.

Included with this soil in mapping are small areas of soils where limestone is near the surface or is exposed. These soils are more droughty than this Rockton soil, and the limestone hinders farming.

This soil is suited to cultivated crops, but the shallow depth to bedrock limits the root zone. It is subject to erosion. It is droughty when rainfall is average or below average. Because of the shallow depth to limestone bedrock, this soil is not well suited to terraces. The organic matter content is moderate. Capability unit IIIe–4.

Sandy escarpments

115F—Sandy escarpments, 14 to 30 percent slopes. These moderately steep to very steep soils are in areas between the stream benches or on uplands and bottom lands. They are mainly gravelly loamy sand, sand, or sandy loam and are commonly about 20 to 30 percent gravel. The surface layer ranges from dark to light in color.

Sandy escarpments are better suited to trees or wild-

life habitat than to most other uses, but there are some areas in permanent pasture. They are subject to severe gully erosion. Because they are underlain by sand or gravel, sandy escarpments are droughty. Fertility is variable but is generally very low. Capability unit VIIs–1.

Saude series

The Saude series consists of dark colored, well drained soils. These nearly level to moderately sloping soils are on stream terraces and in outwash areas on uplands. Slopes are 0 to 9 percent. These soils formed in 24 to 32 inches of loamy material and in the underlying sand and gravel. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark brown, friable loam about 18 inches thick. The subsoil extends to a depth of 32 inches. It is brown, friable loam in the upper part and dark yellowish brown, friable sandy loam in the lower part. The substratum is yellowish brown, gravelly coarse sand.

Available water capacity is moderate. Permeability is moderate in the upper part of the soil and very rapid in the coarse textured substratum. Available phosphorus and available potassium are low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Saude soils are used mainly for cultivated crops. The major limitations for crops are droughtiness on the nearly level soils, and erosion and droughtiness on the more sloping soils.

Representative profile of Saude loam, 0 to 2 percent slopes, in a cultivated field, 93 feet east and 87 feet north of the southwest corner of NE¼NE¼ sec. 33, T. 92 N., R. 10 W.:

Ap—0 to 9 inches; black (10YR 2/1) loam; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—9 to 15 inches; very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; clear smooth boundary.

A3—15 to 18 inches; very dark brown (10YR 2/2) loam; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21—18 to 23 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) coatings on peds; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B22—23 to 29 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; strongly acid; clear smooth boundary.

B3—29 to 32 inches; dark yellowish brown (10YR 4/4) sandy loam; very weak fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

IIC1—32 to 50 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grained; loose; strongly acid; gradual smooth boundary.

IIC2—50 to 60 inches; yellowish brown (10YR 5/6) gravelly coarse sand; single grained; loose; medium acid.

The solum is 24 to 40 inches thick. It is slightly acid to strongly acid in the most acid part. Carbonates are at a depth of more than 60 inches. Contrasting material is at a depth of 24 to 32 inches. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon is 10 to 18 inches thick. The B3 horizon is typically sandy loam but ranges to loamy sand. The C horizon is 5 to 15 percent gravel.

Saude soils are associated with Lawler, Marshan, Waukee, and Flagler soils. They formed in parent material similar to that of Waukee and Wapsie soils. Saude soils are browner in the upper part of the B horizon than Lawler and Marshan soils. They have more clay and less sand in the A horizon and the upper part of the B horizon than Flagler soils. Depth to coarse textured material is less in Saude soils than in Waukee soils. Saude soils have a thicker and darker A horizon than Wapsie soils.

177—Saude loam, 0 to 2 percent slopes. This nearly level soil is on stream benches and on uplands. Areas are 20 to 40 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of sandy soils. These soils are more droughty than this Saude soil.

This soil is well suited to row crops, but it is subject to droughtiness when rainfall is average or below average. If rainfall is above normal and timely this soil gives good yields. The organic matter content is moderate. Capability unit IIs–1.

177B—Saude loam, 2 to 5 percent slopes. This gently sloping soil is on stream benches and on uplands. Areas are about 10 to 20 acres in size and are irregular in shape.

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

Included with this soil in mapping are a few small areas of sandy soils. These soils are more droughty than this Saude soil.

This soil is suited to cultivated crops. It is subject to erosion and is droughty when rainfall is normal or below normal. If rainfall is above normal and timely, this soil gives good yields. The organic matter content is moderate. Capability unit IIe–2.

177C—Saude loam, 5 to 9 percent slopes. This moderately sloping soil is on stream benches and on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the depth to the sand and gravel substratum is less.

Included with this soil in mapping are small areas of soils that have a sandy and gravelly surface layer. These soils are more droughty and less productive than this Saude soil.

This soil is suited to cultivated crops if it is properly managed. It is subject to erosion and is droughty when

rainfall is normal or below normal. The organic matter content is moderate. Capability unit IIIe–3.

Schley series

The Schley series consists of moderately dark colored, somewhat poorly drained soils. These nearly level to gently sloping soils are on concave side slopes along drainageways and at the upper ends of drainageways on uplands. Slopes are 1 to 4 percent. These soils formed in 30 to 50 inches of loamy, stratified material and in the underlying glacial till. The native vegetation was mixed prairie grasses and deciduous trees.

In a representative profile the surface layer is black, friable loam about 8 inches thick. The subsurface layer is dark grayish brown, friable loam that has brown and strong brown mottles and is about 7 inches thick. The subsoil extends to a depth of 55 inches. In the upper part it is grayish brown, friable sandy clay loam and light sandy loam that has strong brown mottles; in the middle part it is brown, very friable loamy sand that has strong brown mottles; and in the lower part it is strong brown, firm heavy loam that has light brownish gray mottles. The substratum is strong brown, firm heavy loam that has many light brownish gray mottles.

Available water capacity is high. Permeability is moderate in the upper part of the soil and moderately slow in the underlying glacial till. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Schley soils are used mainly for cultivated crops. The major limitation for crops is wetness. The wetness is mainly caused by seepage from soils upslope. A drainage system that intercepts lateral water movement is likely to be successful on these soils.

Representative profile of Schley loam, 1 to 4 percent slopes, in a cultivated field, 360 feet south and 420 feet west of the northeast corner of the SE¼SW¼ sec. 9, T. 91 N., R. 10 W.:

Ap—0 to 8 inches; black (10YR 2/1) loam, gray (10YR 5/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—8 to 15 inches; dark grayish brown (10YR 4/2) loam; few fine distinct brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; weak thin platy structure; friable; few very dark brown (10YR 2/2) worm casts; strongly acid; clear smooth boundary.

B21—15 to 24 inches; grayish brown (10YR 5/2) sandy clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; brown (10YR 4/3) kneaded; moderate medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

B22—24 to 30 inches; grayish brown (2.5Y 5/2) light sandy loam; common medium distinct strong brown (7.5YR 5/8) mottles; very weak fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

B31t—30 to 45 inches; brown (10YR 5/3) loamy sand; few medium distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure; very friable; some clay bridging between sand grains; medium acid; abrupt smooth boundary.

IIB32t—45 to 55 inches; strong brown (7.5YR 5/6) heavy loam; common medium prominent light brownish gray (2.5Y 6/2) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; some clay bridging between sand grains; medium acid; gradual smooth boundary.

IIC—55 to 60 inches; strong brown (7.5YR 5/6) heavy loam; many medium prominent light brownish gray (2.5Y 6/2) mottles; massive; firm; slightly acid.

The solum is 45 to 60 inches thick. It is strongly acid or very strongly acid in the most acid part. Carbonates are at a depth of 60 inches or more. The soils formed in 30 to 50 inches of loamy, stratified material and the underlying glacial till. The Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2) to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is loam or silt loam that is high in sand. The A2 horizon is typically dark grayish brown (10YR 4/2) but ranges to brown (10YR 4/3 or 10YR 5/3) or grayish brown (10YR 5/2). It has mottles. The A2 horizon is typically loam but ranges to silt loam that is high in sand. It is 6 to 10 inches thick. The B horizon is typically loam but has strata of sandy loam or loamy sand. The IIB horizon is typically heavy loam but ranges to light clay loam or sandy clay loam.

Schley soils are associated with Bassett, Floyd, and Kenyon soils. They formed in parent material similar to that of Clyde and Floyd soils. They have a lighter colored A horizon than Clyde and Floyd soils. They are grayer in the upper part of the B horizon and are less well drained than Bassett and Kenyon soils.

407B—Schley loam, 1 to 4 percent slopes. This nearly level to gently sloping soil is on concave positions on uplands. Areas are about 10 to 20 acres in size and are irregular in shape.

Included with this soil in mapping are areas of soils in which the loamy stratified materials are underlain by grayish silt over glacial till. Also included are some soils that have a sandy loam surface layer and are more seepy and wet than the soils that have a loam surface layer.

This soil is well suited to cultivated crops if it is properly drained. It is subject to wetness. Although this soil can be farmed without artificial drainage, improving drainage will increase yields and allow earlier field operations. A drainage system that intercepts laterally moving water helps control wetness that results from sidehill seepage. A combination of terraces and tile will help to control soil loss. The organic matter content is moderately low. Capability unit IIw–1.

Sparta series

The Sparta series consists of dark colored, excessively drained soils. These nearly level to strongly

sloping soils are on ridges and side slopes on uplands and on stream terraces. Slopes are 0 to 14 percent. These soils formed in coarse-textured eolian material and in sandy alluvium that has been reworked by wind. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and brown, very friable loamy fine sand about 16 inches thick. The subsoil extends to a depth of 32 inches. It is brown, loose fine sand. The substratum is yellowish brown, loose fine sand.

Available water capacity is very low. Permeability is very rapid. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

The less sloping Sparta soils are used mainly for cultivated crops, and the more sloping soils are used for pasture or woodland. The major limitations for crops are droughtiness and erosion. These soils are droughty even in years of average rainfall. Even with good management, yields of all crops are below average unless rainfall is above average and very timely.

Representative profile of Sparta loamy fine sand, 2 to 5 percent slopes, in a cultivated field, 114 feet west and 225 feet north of the southeast corner of sec. 12, T. 91 N., R. 8 W.:

Ap—0 to 9 inches; very dark brown (10YR 2/2) loamy fine sand; cloddy parting to weak medium subangular blocky structure; very friable; neutral; abrupt smooth boundary.

A12—9 to 13 inches; very dark brown (10YR 2/2) loamy fine sand; very weak medium subangular blocky structure parting to single grained; very friable; neutral; clear smooth boundary.

A3—13 to 16 inches; brown (10YR 4/3) loamy fine sand; very weak medium subangular blocky structure parting to single grained; slightly acid; clear smooth boundary.

B2—16 to 32 inches; brown (10YR 4/3) fine sand; single grained; loose; medium acid; clear smooth boundary.

C1—32 to 37 inches; yellowish brown (10YR 5/4) fine sand, single grained; loose; medium acid; clear smooth boundary.

C2—37 to 60 inches; yellowish brown (10YR 5/6) fine sand; single grained; loose; dark yellowish brown (10YR 4/4) sandy loam band 2 inches thick at a depth of 47 inches; medium acid.

The solum is 24 to 40 inches thick. The soil is medium acid to very strongly acid in the most acid part. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The A horizon is loamy sand, loamy fine sand, or fine sand. It is 10 to 18 inches thick. The B horizon is loamy sand, loamy fine sand, or fine sand. It has hue of 10YR and value and chroma of 3 to 6.

Sparta soils are associated with Dickinson, Flagler, Burkhardt, Kenyon, and Olin soils. They formed in parent material similar to that of Dickinson and Chelsea soils. They have coarser texture in the solum than Kenyon soils and were not formed in glacial till as Kenyon soils were. They have more sand and less clay in the A horizon and the upper part of the B horizon than Dickinson and Olin soils. They are not underlain with glacial till at a depth of less than 60 inches as are Olin soils. Sparta soils have a thicker, darker A horizon than Chelsea soils. They have more sand in the upper part of the solum and are deeper to gravel than Flagler and Burkhardt soils.

41—Sparta loamy fine sand, 0 to 2 percent slopes. This nearly level soil is on uplands and on stream benches. Areas are about 5 to 10 acres in size on the uplands and about 20 acres or more on the benches.

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

Included with this soil in mapping are a few areas of soils in which the dark surface layer is thicker than 24 inches. These soils are higher in organic matter content and fertility than this Sparta soil.

This soil is suited to cultivated crops. It is subject to droughtiness and soil blowing. Yields are generally low but vary, depending on the amount and timeliness of rainfall. The organic matter content is low. Capability unit IVs–1.

41B—Sparta loamy fine sand, 2 to 5 percent slopes. This gently sloping soil is on convex side slopes on uplands. It is on dunelike positions in a few places. It is also on stream benches. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of soils that have a thinner and lighter colored surface layer. These soils are lower in organic matter content than this Sparta soil.

This soil is suited to cultivated crops, but it is subject to droughtiness, soil blowing, and water erosion. Yields are greatly reduced if rainfall is not above normal or timely. The organic matter content is low. Capability unit IVs–1.

41C—Sparta loamy fine sand, 5 to 9 percent slopes. This moderately sloping soil is on convex side slopes on uplands. A few moderately sloping areas are on stream benches. Areas are about 5 to 10 acres in size and irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 10 to 14 inches thick.

Included with this soil in mapping are a few areas of soils in which glacial till is at a depth of about 4 feet. These soils are somewhat less droughty than this Sparta soil.

This soil is poorly suited to cultivated crops. It is subject to droughtiness, soil blowing, and water erosion. Yields are greatly reduced if rainfall is not above normal or timely. The organic matter content is low. Capability unit IVs–1.

41D—Sparta loamy fine sand, 9 to 14 percent slopes. This strongly sloping soil is on convex side slopes on uplands, mostly along the major streams of drainageways. Areas are about 10 acres in size and are elongated in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 10 inches thick.

Included with this soil in mapping are a few areas of soils that are eroded and have a thinner and lighter colored surface layer. These soils are lower in organic matter content and fertility than this uneroded Sparta soil.

This soil is poorly suited to cultivated crops, and row crops are generally not grown. It is subject to droughtiness, soil blowing, and water erosion. It is better suited to pasture and woodland than to most other uses. Most areas are in woodland or in pasture. The organic matter content is low. Capability unit VIs–1.

Spillville series

The Spillville series consists of dark colored, moderately well drained to somewhat poorly drained soils. These nearly level soils are on bottom lands along streams. Slopes are 0 to 2 percent. These soils formed in loamy alluvium. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish brown, friable loam about 54 inches thick. The substratum is very dark grayish brown sandy loam that has a few brown and strong brown mottles.

Available water capacity is high. Permeability is moderate. Available phosphorus is low, and available potassium is very low. These soils are generally neutral in the surface layer and generally do not require lime.

Spillville soils are used mainly for cultivated crops. The major limitation for crops is short-duration flooding. In places some areas need diversion terraces as protection from local runoff.

Representative profile of Spillville loam, 0 to 2 percent slopes, in a cultivated field, 526 feet south and 360 feet east of northwest corner of SW¼SE¼ sec. 30, T. 95 N., R. 10 W.:

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

A12—8 to 23 inches; black (10YR 2/1) loam; moderate medium and fine granular structure; friable; neutral; gradual smooth boundary.

A13—23 to 34 inches; black (10YR 2/1) loam; moderate medium subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A14—34 to 43 inches; very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A15—43 to 54 inches; very dark grayish brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; weak medium and fine subangular blocky structure; friable; neutral; clear smooth boundary.

C—54 to 60 inches; very dark grayish brown (10YR 3/2) sandy loam; few fine distinct brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; massive; very friable; neutral.

The solum is 36 to 55 inches thick. The A horizon is black (10YR 2/1) very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). It is at least 36 inches thick, and it is typically loam but ranges from light loam to silt loam that is high in sand. The C horizon is typically loam, but ranges to sandy loam and light clay loam. In places strata of loamy sand are below a depth of 40 inches.

Spillville soils are associated with Coland, Dorchester, and Terril soils. They formed in parent material similar to that of Terril soils. They have a thicker A horizon than Terril soils. They have a browner C horizon and are better drained than Coland soils. They are darker, contain more sand, and are less stratified than Dorchester soils.

485—Spillville loam, 0 to 2 percent slopes. This nearly level soil is on the bottom lands along rivers and large streams. Areas are 20 to 40 acres in size and are irregular in shape.

Included with this soil in mapping are small areas of sandy soils. These soils are less productive than this Spillville soil. Also included are areas of soils where the dark surface layer is less than 36 inches thick. These soils are lower in organic matter content than this Spillville soil.

This soil is well suited to intensive row crops. It is subject to occasional flooding during periods of high rainfall, and flooding can reduce crop yields in some years. It can have a seasonal high water table. A few areas of this soil that have been cut by stream channels are in permanent pasture. The organic matter content is high. Capability unit I–3.

Terril series

The Terril series consists of dark colored, moderately well drained soils. These nearly level to gently sloping soils are on uplands on nearly straight to slightly convex foot slopes and on low stream benches. They are also in narrow upland drainageways associated with soils underlain by limestone. Slopes are 2 to 5 percent. These soils formed in local loamy alluvium. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable loam about 30 inches thick. The subsoil extends to a depth of 60 inches. It is dark brown and brown, friable loam and dark yellowish brown, friable light clay loam.

Available water capacity is high. Permeability is moderate. Available phosphorus and available potassium are very low. These soils are generally neutral or slightly acid and seldom need lime.

Terril soils are used mainly for cultivated crops. Some areas are in pasture along with the adjoining soils upslope. The major limitation for crops is runoff from the adjoining upland soils.

Representative profile of Terril loam, 2 to 5 percent slopes in a cultivated field, 355 feet east and 305 feet north of the southwest corner of NW¼NW¼ sec. 5, T. 94 N., R. 10 W.:

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; weak medium subangular blocky

structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.

A12—7 to 18 inches; very dark brown (10YR 2/2) loam; black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to moderate fine granular; friable; slightly acid; gradual smooth boundary.

A13—18 to 23 inches; very dark brown (10YR 2/2) loam; some black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to moderate fine granular; friable; neutral; gradual smooth boundary.

A3—23 to 30 inches; very dark grayish brown (10YR 3/2) loam; some very dark brown (10YR 2/2) coatings on peds; moderate medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B1—30 to 38 inches; dark brown (10YR 3/3) loam; few very dark grayish brown (10YR 3/2) coatings on peds; moderate medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B2—38 to 48 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on peds; moderate medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B3—48 to 60 inches; dark yellowish brown (10YR 4/4) light clay loam; moderate medium subangular blocky structure; friable; pebbles and stone fragments; slightly acid.

Depth to carbonates is commonly more than 60 inches. The A horizon is typically loam but ranges to light loam and silt loam high in sand. It is 24 to 36 inches thick and is neutral or slightly acid. The B horizon is typically loam but ranges to light clay loam and thin strata of sandy loam. In some pedons some faint mottles are present in the lower parts of the B and C horizons and thin strata of loamy sand are below a depth of 48 inches.

Terril soils are associated with Spillville, Waukee, Rockton, and Kenyon soils. They formed in parent material similar to that of Spillville soils. They have a thinner A horizon than Spillville soils. They are not underlain by sand and gravel at a depth of less than 40 inches as are Waukee soils, and they are not underlain by limestone at a depth of less than 40 inches as are Rockton soils. They did not form in glacial till as did Kenyon soils.

27B—Terril loam, 2 to 5 percent slopes. This gently sloping soil is on foot slopes at the base of uplands and in narrow upland drainageways that are associated with limestone bedrock. Areas are small in size and are long and narrow in shape.

Included with this soil in mapping are areas of soils that have sand and gravel below a depth of 40 inches. These soils can be somewhat droughty when rainfall is below average.

This soil is well suited to cultivated crops. It is generally farmed along with the adjacent soils. It is subject to slight erosion and to receiving runoff water and sediment from soils upslope. Diversion terraces help to control runoff from higher areas. The organic matter content is high. Capability unit IIe–4.

Tripoli series

The Tripoli series consists of dark colored, poorly drained soils. These nearly level soils are on broad, upland flats and at the upper end of broad, upland drainageways. Slopes are 0 to 2 percent. These soils formed in 18 to 25 inches of moderately fine textured loamy material and in the underlying glacial till. The native vegetation was mixed prairie grasses and water-tolerant plants. A layer of stones and pebbles is between the moderately fine textured loamy material and the underlying glacial till in most places.

In a representative profile the surface layer is black and very dark gray light clay loam about 17 inches thick. The subsoil extends to a depth of 36 inches. It is dark grayish brown and dark gray, friable light clay loam and mottled olive gray and yellowish brown, firm loam. The substratum is mottled yellowish brown and olive gray loam that is mildly alkaline and strongly effervescent.

Available water capacity is high. Permeability is moderate in the upper part and moderately slow in the underlying glacial till. Available phosphorus and available potassium are very low. These soils are typically neutral to mildly alkaline and do not require liming.

Tripoli soils are used mainly for cultivated crops. The major limitation for crops is a seasonal high water table. These soils are well suited to tile drainage if there is an adequate outlet.

Representative profile of Tripoli clay loam, 0 to 2 percent slopes, in a cultivated field, 135 feet south and 210 feet east of northwest corner of SW¼ sec. 7, T. 91 N., R. 10 W.:

Ap—0 to 8 inches; black (N 2/0) light clay loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A12—8 to 14 inches; black (N 2/0) light clay loam; moderate fine granular structure; friable; neutral; clear smooth boundary.

A3—14 to 17 inches; very dark gray (10YR 3/1) light clay loam; moderate fine granular structure; friable; few very fine black (10YR 2/1) oxide concretions; neutral; gradual smooth boundary.

B1g—17 to 21 inches; dark grayish brown (2.5Y 4/2) and dark gray (5Y 4/1) light clay loam; very dark grayish brown (2.5Y 3/2) coatings on peds; moderate very fine subangular blocky structure; weak stone line at base of horizon; neutral; clear smooth boundary.

IIB21—21 to 27 inches; yellowish brown (10YR 5/6) heavy loam; common medium distinct grayish brown (10YR 5/2) and brown (10YR 5/3) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; mildly alkaline; abrupt wavy boundary.

IIB22—27 to 36 inches; mottled olive gray (5Y

5/2) and yellowish brown (10YR 5/6) loam; weak medium prismatic structure; firm; mildly alkaline; abrupt wavy boundary.

IIC—36 to 60 inches; mottled yellowish brown (10YR 5/8) and olive gray (5Y 5/2) loam; massive; firm; few 1/8- to 1/4-inch accumulations of lime; mildly alkaline; strong effervescence.

The solum is 36 to 48 inches thick. Depth to carbonates ranges from 36 to 50 inches. The soil formed in 18 to 25 inches of moderately fine textured loamy material and in the underlying glacial till. The A horizon is black (N 2/0) in the upper part and very dark gray (10YR 3/1) or dark olive gray (5Y 3/2) in the lower part. It is light or medium clay loam, and is typically neutral or mildly alkaline. The IIB horizon is loam to light clay loam or sandy clay loam. It is neutral or mildly alkaline.

Tripoli soils are associated with Readlyn, Floyd, and Clyde soils. They formed in parent material similar to that of Oran, Kenyon, and Readlyn soils. They are less stratified in the solum and have carbonates at a shallower depth than Floyd and Clyde soils. They have lower chroma and more mottles in the lower part of the A horizon and in the upper part of the B horizon than Oran, Kenyon, and Readlyn soils.

398—Tripoli clay loam, 0 to 2 percent slopes. This nearly level soil is on broad, upland flats and at the upper end of broad, upland drainageways. Areas are large in size and are broad and irregular in shape.

Included with this soil in mapping are a few areas of soils in which the upper part of the subsoil is not so gray and that are not so poorly drained as this Tripoli soil.

This soil is well suited to corn and soybeans. It is subject to puddling if worked when wet. The major limitation to crops is wetness, and tile drainage is needed for maximum production. The organic matter content is high. Capability unit IIw–1.

Volney series

The Volney series consists of dark colored, well drained to somewhat excessively drained soils. These gently sloping soils are on narrow upland drainage ways and alluvial fans at the base of the thin, loess-covered uplands. They are mapped only in a complex with Dorchester soils. Slopes are 2 to 5 percent. These soils formed in medium textured alluvium containing variable amounts of limestone fragments. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark gray channery silt loam about 30 inches thick. It contains many limestone fragments. The substratum is dominantly limestone fragments interbedded with some very dark, grayish brown silt loam (fig. 12).

Available water capacity is low, and permeability is rapid. Available phosphorus and available potassium are very low. These soils are mildly alkaline in the surface layer and do not require lime.

Volney soils are used mainly for pasture. They are subject to occasional high-velocity, short-duration runoff from the more sloping soils upslope. The runoff deposits sediment and limestone fragments on the surface. These fragments can interfere with farming. The location of these soils below very steep areas of Nordness soils and Rock outcrop, which makes them difficult to reach with farm machinery, is the major limitation for crops.

Figure 12.—Representative profile of a Volney soil.

Representative profile of Volney channery silt loam in an area of Dorchester-Volney complex, 2 to 5 percent slopes, in permanent pasture, 72 feet east and 16 feet south of the northwest corner of SW1/4SE1/4 sec. 34, T. 95 N., R. 9 W.:

A1—0 to 30 inches; very dark gray (10YR 3/1) channery silt loam; weak fine granular structure; very friable; many fragments of limestone; mildly alkaline; strong effervescence.

IIC—30 to 50 inches; dominantly fragments of limestone with some very dark grayish brown (10YR 3/2) silt loam interbedded; massive; very friable; moderately alkaline; strong effervescence.

The solum is 24 to 36 inches thick. The soils formed in medium textured alluvium containing variable amounts of limestone fragments. The A1 horizon is black (10YR 2/1) to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 24 to 36 inches thick. The content of hard limestone fragments

varies within short distances. Generally the percentage of limestone fragments increases as depth increases, ranging from 15 to 20 percent in the surface layer to as much as 75 percent in the lower part of the solum.

Volney soils are associated with Dorchester soils. They have a dark surface layer, are less stratified, and have more limestone fragments in their solum than Dorchester soils.

Wapsie series

The Wapsie series consists of moderately dark colored, well drained soils. These nearly level to moderately sloping soils are on stream terraces and in outwash areas on uplands. Slopes are 0 to 9 percent. These soils formed in 20 to 30 inches of loamy alluvial deposits and in the underlying coarse textured sediment. The native vegetation was mixed prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark gray, friable loam about 7 inches thick. The subsoil extends to a depth of 29 inches. It is brown, friable loam in the upper part; dark yellowish brown, friable loam and heavy loam in the middle part; and brown, very friable gravelly loamy sand in the lower part. The substratum is yellowish brown medium and coarse sand with gravel.

Available water capacity is moderate to low. Permeability is moderate in the upper part of the soil and very rapid in the coarse textured substratum. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Wapsie soils are used mainly for cultivated crops. The major limitations for crops are droughtiness on the nearly level soils and erosion and droughtiness on the more sloping soils. These soils are droughty when rainfall is average or below average.

Representative profile of Wapsie loam, 0 to 2 percent slopes, in a cultivated field, 75 feet east and 525 feet south of the northwest corner of sec. 20, T. 91 N., R. 9 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam; weak fine and very fine granular structure; friable; slightly acid; abrupt smooth boundary.

B1—7 to 14 inches; brown (10YR 4/3) loam; some dark brown (10YR 3/3) and dark grayish brown (10YR 4/2) coatings on peds; moderate medium and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21—14 to 19 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; moderate medium subangular structure; friable; medium acid; clear smooth boundary.

B22t—19 to 23 inches; dark yellowish brown (10YR 4/4) heavy loam; brown (7.5YR 4/4) coatings on peds; moderate medium and fine subangular blocky structure; friable; a few thin discontinuous dark brown (7.5YR 3/2) clay films; strongly acid; clear smooth boundary.

IIB3—23 to 29 inches; brown (7.5YR 4/4) gravelly loamy sand; very weak fine subangular blocky structure parting to single grained; very friable; strongly acid; clear smooth boundary.

IIC—29 to 60 inches; yellowish brown (10YR 5/4 and 10YR 5/6) medium and coarse sand with gravel; some brown (7.5YR 4/4) mixings; loose; single grained; strongly acid.

The solum is 24 to 40 inches thick. It is medium acid or strongly acid in the most acid part. Carbonates are absent above a depth of 60 inches. Contrasting material is at a depth of 20 to 30 inches. The A1 or Ap horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1). It is 6 to 9 inches thick. The A2 horizon is brown (10YR 4/3) or dark grayish brown (10YR 4/2). The B2 horizon is typically medium loam but ranges to heavy loam, light clay loam, or sandy clay loam.

Wapsie soils are associated with Saude, Bixby, and Hayfield soils. They formed in parent material similar to that of Saude and Bixby soils. They have a thinner, lighter colored A horizon than Saude soils. Wapsie soils have a thicker A1 horizon or darker Ap horizon than Bixby soils. They are browner in the upper part of the B horizon than Hayfield soils.

777—Wapsie loam, 0 to 2 percent slopes. This nearly level soil is on stream benches. Areas are about 20 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of soils that have a sandy loam surface layer. Also included are a few areas of soils where the depth to sand and gravel is more than 30 inches. These soils are more droughty and less productive than this Wapsie soil.

This soil is suited to row crops, but it is subject to droughtiness in most seasons unless rainfall is above average or timely. The organic matter content is moderately low. Capability unit IIs–1.

777B—Wapsie loam, 2 to 5 percent slopes. This gently sloping soil is on stream benches or outwash areas on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the depth to sand is about 20 to 24 inches.

Included with this soil in mapping are a few areas of soils that have a sandy loam surface layer. These soils are more droughty and less productive than this Wapsie soil. Also included are a few areas of soils where the depth to sand and gravel is more than 30 inches.

This soil is suited to cultivated crops, but it is subject to droughtiness in most seasons unless rainfall is above normal or timely. This soil is also subject to erosion. The organic matter content is moderately low. Capability unit IIe–2.

777C—Wapsie loam, 5 to 9 percent slopes. This moderately sloping soil is on stream benches or in outwash areas on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but depth to the coarse textured material is generally about 20 to 24 inches.

Included with this soil in mapping are a few areas of soils that have coarse textured material at a depth of less than 20 inches. These soils are more droughty and less productive than this Wapsie soil.

This soil is suited to cultivated crops, but it is subject to droughtiness and moderate erosion. It is droughty in most seasons unless rainfall is above normal or very timely. The organic matter content is low. Capability unit IIIe–3.

Waukee series

The Waukee series consists of dark colored, well drained soils. These nearly level to gently sloping soils are on stream terraces and in outwash areas on uplands. Slopes are 0 to 5 percent. These soils formed in 32 to 40 inches of loamy alluvial deposits and in the underlying coarse textured sediment. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown, friable loam about 21 inches thick. The subsoil extends to a depth of 47 inches. It is brown, friable loam in the upper part; dark yellowish brown, friable loam and sandy clay loam in the middle part; and dark yellowish brown, and strong brown sandy loam and gravelly loamy sand in the lower part. The substratum is yellowish brown medium and coarse sand.

Available water capacity is moderate. Permeability is moderate in the upper part of the soil and rapid in the coarse textured substratum. Available phosphorus is low, and available potassium is very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

Waukee soils are used mainly for cultivated crops. The major limitation for crops is erosion on the more sloping areas. These soils are somewhat droughty when rainfall is below normal and in extended dry periods.

Representative profile of Waukee loam, 0 to 2 percent slopes, in a cultivated field, 150 feet west and 380 feet south of northwest corner of NE¼NE¼ sec. 27, T. 93 N., R. 7 W.:

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam high in silt; cloddy parting to moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—7 to 15 inches; very dark brown (10YR 2/2) loam high in silt; moderate medium subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A3—15 to 21 inches; very dark grayish brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate medium subangular blocky structure parting to moderate fine and very fine granular; friable; slightly acid; clear smooth boundary.

B1—21 to 26 inches; brown (10YR 4/3) loam; moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21—26 to 33 inches; dark yellowish brown subangular blocky structure; friable; strongly acid; clear smooth boundary.

B22—33 to 37 inches; dark yellowish brown (10YR 4/4) sandy clay loam; weak medium subangular blocky structure; friable; strongly acid; abrupt wavy boundary.

IIB31t—37 to 39 inches; dark yellowish brown (10YR 4/4) sandy loam; very weak fine subangular blocky structure; very friable; few thin brown (7.5YR 4/4) clay bridgings between sand grains; medium acid; clear smooth boundary.

IIB32t—39 to 47 inches; strong brown (7.5YR 5/6) gravelly loamy sand; very weak coarse subangular blocky structure; very friable; few thin brown (7.5YR 4/4) clay bridgings between sand grains; medium acid; clear smooth boundary.

IIC—47 to 60 inches; yellowish brown (10YR 5/6) medium and coarse sand; single grained; loose; 5 to 10 percent gravel; medium acid.

The solum is 35 to 48 inches thick. It is medium acid or strongly acid in the most acid part. Carbonates are absent above a depth of 60 inches. Contrasting material is at a depth of 32 to 40 inches. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is typically loam but ranges to silt loam that is high in sand. It is 10 to 21 inches thick. The B2 horizon is typically medium loam but ranges to heavy loam or sandy clay loam. The C horizon is coarse loamy sand, gravelly sand, or medium sand. It commonly is 10 to 20 percent gravel, but is as much as 50 percent in some places.

Waukee soils are associated with Saude, Lawler, and Marshan soils and formed in parent material similar to that of those soils. They are browner in the upper part of the B horizon than Lawler and Marshan soils and are deeper to coarse textured material than Saude soils.

178—Waukee loam, 0 to 2 percent slopes. This nearly level soil is on stream benches and in a few outwash areas on uplands. Areas are about 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of soils that have a sandy textured surface layer. These soils are droughty and less productive than this Waukee soil.

This soil is well suited to intensive row crops. It is subject to droughtiness when rainfall is below normal. It is easily tilled and has little or no runoff. The organic matter content is high. Capability unit I–1.

178B—Waukee loam, 2 to 5 percent slopes. This gently sloping soil is on stream benches and in a few outwash areas on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the dark surface layer is about 14 to 18 inches thick.

Included with this soil in mapping are small areas of soils that have sand at a depth of less than 32 inches.

These soils are more droughty and less productive than this Waukee soil.

This soil is well suited to row crops if properly managed. It is subject to slight erosion if cultivated and can be somewhat droughty when rainfall is below normal. The organic matter content is high. Capability unit IIe–1.

Winneshiek series

The Winneshiek series consists of moderately dark colored, well drained soils. These nearly level to strongly sloping soils are on ridges and side slopes on uplands. Slopes are 0 to 14 percent. These soils formed in 20 to 30 inches of loamy glacial material and in the underlying thin layer of residuum weathered from limestone bedrock. The native vegetation was mixed prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark brown, friable loam about 7 inches thick. The subsurface layer is brown, friable loam about 4 inches thick. The subsoil extends to a depth of 24 inches. It is brown, friable light clay loam in the upper part; dark yellowish brown, firm heavy clay loam in the middle part; and yellowish brown, very firm light clay in the lower part. Below this is partially weathered, shattered limestone with thin rinds of clay residuum overlying hard limestone bedrock.

Available water capacity is low. Permeability is moderate in the loamy glacial material and rapid in the underlying limestone bedrock. Available phosphorus and available potassium are very low. Unless they have been limed within the past 5 years, these soils are generally acid in the surface layer.

The less sloping Winneshiek soils are used mainly for cultivated crops. The more sloping areas are used for pasture or woodland. The major limitations for crops are erosion and droughtiness. Because limestone bedrock is at a shallow depth, roots of crops can develop only to a limited extent. These soils tend to be droughty unless rainfall is timely.

Representative profile of Winneshiek loam, 20 to 30 inches to limestone, 2 to 5 percent slopes, in a cultivated field, 42 feet east and 498 feet south of the northwest corner of the NE¼ sec. 28, T. 91 N., R. 10 W.:

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

A2—7 to 11 inches; brown (10YR 4/3) loam; dark grayish brown (10YR 4/2) coatings on peds; weak fine and very fine subangular blocky structure; friable; neutral; clear smooth boundary.

B1—11 to 15 inches; brown (10YR 4/3) light clay loam; a few dark grayish brown (10YR 4/2) coatings on peds; moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21t—15 to 18 inches; dark yellowish brown (10YR 4/4) heavy clay loam; strong fine subangular blocky structure; firm; thick discontinuous dark grayish brown (10YR 4/2) and brown (10YR 4/3) clay films; slightly acid; clear wavy boundary.

IIB22t—18 to 24 inches; yellowish brown (10YR 5/6) light clay; strong coarse prismatic structure parting to strong medium subangular blocky; very firm; thick continuous very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) clay films; neutral; abrupt wavy boundary.

IIR1—24 to 31 inches; limestone, soft, weathered along joints and partially fractured; flags of limestone with brown (7.5YR 4/2) clay residuum interbedded; mildly alkaline; strong effervescence.

IIR2—31 inches; hard limestone bedrock.

The solum is 20 to 30 inches thick. It is typically slightly acid or medium acid in the most acid part. Carbonates are absent above the limestone bedrock. The A1 or Ap horizon is very dark gray (10YR 3/1) to very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). In eroded areas, the A2 horizon may be wholly incorporated into the Ap horizon. The IIB horizon is typically silty clay or clay. The residuum is as much as 6 inches thick, or it may be thin rinds around limestone flags.

Winneshiek soils are associated with Bassett, Nordness, and Rockton soils. They formed in parent material similar to that of Rockton soils. They have a thinner dark A horizon than Rockton soils. They have limestone bedrock above a depth of 30 inches, whereas Bassett soils have no limestone at this depth. They have a thicker solum than Nordness soils.

714—Winneshiek loam, 20 to 30 inches to limestone, 0 to 2 percent slopes. This nearly level soil is on high, benchlike positions. Areas are 10 to 20 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but depth to limestone is generally about 26 to 30 inches.

Included with this soil in mapping are areas of soils where the depth to the limestone bedrock is less than 20 inches. These soils are more droughty than this Winneshiek soil.

This soil is suited to row crops, but the root zone is limited. It is subject to droughtiness when rainfall is average or below average. The organic matter content is moderately low. Capability unit IIs–1.

714B—Winneshiek loam, 20 to 30 inches to limestone, 2 to 5 percent slopes. This gently sloping soil is on ridges and side slopes on uplands and on the high part of benchlike positions. Areas are about 10 acres in size and are irregular in shape.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of soils where the depth to limestone is 30 to 40 inches. Also included are small areas of soils where the limestone bedrock is near the surface or is exposed. These soils hinder farming.

This soil is suited to row crops, but the root zone is limited. It is subject to erosion if cultivated, and it is droughty when rainfall is average or below average. This soil is not well suited to terraces because of the

shallow depth to limestone bedrock. The organic matter content is moderately low. Capability unit IIe–2.

714C—Winneshiek loam, 20 to 30 inches to limestone, 5 to 9 percent slopes. This moderately sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and depth to limestone is about 20 to 24 inches.

Included with this soil in mapping are small areas of soils where the limestone is near the surface or is exposed. These soils are more droughty and the limestone hinders farming operations.

This soil is suited to cultivated crops, but the root zone is limited because of the shallow depth to bedrock. It is subject to erosion if cultivated, and it is droughty when rainfall is average or below average. This soil is not well suited to terraces because of the shallow depth to limestone bedrock. The organic matter content is moderately low. Capability unit IIIe–4.

714D—Winneshiek loam, 20 to 30 inches to limestone, 9 to 14 percent slopes. This strongly sloping soil is on convex side slopes on uplands. Areas are about 5 to 10 acres in size and are irregular in shape.

This soil has a profile similar to the one described as representative of the series, but the surface layer is thinner and depth to limestone is generally about 20 to 24 inches.

Included with this soil in mapping are small areas of soils where the limestone bedrock is exposed. These areas are more droughty than this Winneshiek soil, and the limestone hinders farming.

This soil is poorly suited to cultivated crops. It is subject to erosion if cultivated. Because of the shallow depth to limestone bedrock, it is droughty when the rainfall is average or below average. The organic matter content is low. Capability unit IVe–2.

Planning the use and management of the soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area—the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment and to help avoid soil-related failures in uses of the land.

During a soil survey soil scientists, conservationists, and others keep extensive notes, not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating the kinds of soil and their productivity, potentials, and limitations under various uses and management. In this way field experience incorporated with measured data on soil properties and performance is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, woodland, and many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses may be determined, soil limitations to these land uses may be identified, and costly failures in homes and other structures, because of unfavorable soil properties, may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area, and on the environment. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees and shrubs, and most other uses of land are influenced by the nature of the soil.

Crops

Of the total 465,920 acres in Fayette County, 250,000 acres was in crops during 1971, 105,000 acres was in pasture, and 75,000 acres was other land in farms, according to the 1971 State of Iowa Annual Farm Census. Corn, soybeans, oats, and legume-grass are the principal crops. Most areas of permanent pasture are in bluegrass. Some areas have been renovated, and birdsfoot trefoil has been introduced. Grass-legume mixtures such as alfalfa-bromegrass are also in pasture. Most areas of permanent bluegrass pasture are not used for crops because the slopes are too steep for cultivation. Many areas, however, are not used for crops because they are wet and need tile drainage. Each year many acres are tile drained and converted to cropland. The Clyde, Floyd, Marshan, and Otter soils are the dominant soils in pasture that need tile drainage.

Many soils are subject to erosion. Erosion control practices are needed mainly on Bassett, Cresco, Coggon, Downs, Dubuque, Fayette, Kenyon, Lourdes, Olin, Orwood, and Port Byron soils. Controlling erosion and providing adequate drainage are difficult on Bassett, Cresco, Coggon, Kenyon, Lourdes, and Olin soils because the practices conflict to some extent. The permeability of the loamy superficial material differs greatly from the permeability of the glacial till in the subsoil. Water moves more rapidly in the loamy material and accumulates on top of the till, producing a seasonal perched water table and sidehill seepage in wet years. A combination of terracing and tiling is most likely to be successful on these soils. Gully control structures and grassed waterways are used to control gullying in watercourses. Downs, Fayette, and Port Byron soils

generally have long, uniform slopes and are well suited to erosion control practices.

Capability grouping

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on the limitations of the soils, the risk of damage when they are used for ordinary field crops or sown pastures, and the way they respond to treatment. The classification does not apply to horticultural crops, or to rice and other crops that have their own special requirements for economical production. The soils are classified according to degree and kind of permanent limitations, but without consideration of major and generally expensive land-forming that would change the slope, depth, or other characteristics of the soils, and without consideration of possible major reclamation projects.

In the capability system, all the soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have some limitations that reduce the choice of plants or 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 habitat.

Class VI soils have severe limitations that make them generally unsuitable for cultivation without major reclamation, and limit their use largely to pasture, range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuitable for cultivation without major reclamation and that restrict their use largely to range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plant production without major reclamation and restrict their use to recreation, wildlife, water supply, or esthetic purposes. (No class VIII soils in Fayette 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; *w* shows that water on or in the soil interferes with plant growth or cultivation; *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c* shows that the chief limitation is climate that is too cold or too dry. Subclass *c* is not in Fayette County.

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. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIs–1.

A complete explanation of the capability classification is in Agriculture Handbook No. 210, Land Capability Classification (*14*).

Management by capability units

In the following pages, the capability units of Fayette 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.

Capability unit I–1

This unit consists of nearly level soils of the Camden, Festina, Richwood, and Waukee series. These soils are well drained. They are mainly on stream benches, and a few areas of Waukee soils are also on uplands.

The surface layer and the subsoil are friable and medium textured. The subsoil is moderately permeable. Camden and Waukee soils are moderately rapidly to rapidly permeable in the coarse material in the substratum. Available water capacity is moderate to high. These soils are well aerated, warm up quickly in the spring, and can be worked soon after rains. Unless limed within the past 5 years, these soils are acid.

These soils are well suited to cultivated crops. They are not subject to erosion, and drainage is not a concern. Although these soils are nearly level and receive runoff from the adjoining soils upslope, water does not pond on the surface. Most of these soils are not droughty. Camden and Waukee soils are somewhat droughty when rainfall is below normal.

Corn, soybeans, oats, and hay are the main crops. Most areas are used for cultivated crops. Corn is the main crop. Soybeans are often substituted for corn in a rotation. These soils are also suited to pasture and woodland and to other less intensive uses.

Capability unit I–2

This unit consists of nearly level soils of the Canoe, Lawler (32 to 40 inches to sand and gravel), Oran, and Readlyn series. These soils are dark to moderately dark and are somewhat poorly drained. They are on uplands and stream benches.

The surface layer is friable and medium textured. The subsoil is friable to firm and medium textured. Available water capacity is mainly high, but in Lawler soils it is moderate. Permeability is mainly moderate to moderately slow, but Lawler soils are rapidly permeable in the coarse textured material. These soils have a seasonal high water table, and farm operations can be delayed by excess moisture in some years. Unless limed within the past 5 years, these soils are acid. Most of these soils are not droughty, but Lawler soils tend to be droughty when rainfall is below normal.

These soils are well suited to cultivated crops. Corn, soybeans, oats, and hay are grown on these soils. Most areas are used for cultivated crops; corn is the major crop. Soybeans are often grown instead of corn in a rotation. These soils are also suited to pasture and woodland and to other less intensive uses.

Water sometimes collects on the surface for short periods. Field operations can be more timely if these soils are tiled. Erosion is not a hazard.

Capability unit I–3

This unit consists of nearly level soils of the Dorchester, Huntsville, and Spillville series. These soils are mainly dark colored, but Dorchester soils are moderately dark to light colored. They are well drained to somewhat poorly drained. These soils are on flood plains and in narrow upland valleys.

The surface layer and subsoil are friable and medium textured. Available water capacity is high, and permeability is moderate. These soils are subject to short-duration, high-velocity flooding during spring runoff and after heavy rains. They have a moderately high but variable water table.

These soils are well suited to row crops. Because these soils are subject to occasional overflow, however, about half of the acreage is in permanent pasture. These soils are also suited to woodland and wildlife habitat and to other less intensive uses. Cropping patterns and yields vary from year to year because of the flooding hazard.

Erosion and droughtiness are not hazards on these soils. The Dorchester and Spillville soils need some artificial drainage in places when rainfall is above normal.

Capability unit IIe–1

This unit consists of gently sloping soils on the Bassett, Coggon, Cresco, Downs, Fayette, Kenyon, Lourdes, Ostrander, Port Byron, Readlyn, and Waukee series. These soils are dark to light colored. They are mainly moderately well drained to well drained; Readlyn soils are somewhat poorly drained. These soils are on uplands, and Waukee soils are also on stream benches.

The surface layer is friable and medium textured. The subsoil is mainly friable to firm and medium textured. Cresco and Lourdes soils have a very firm, moderately fine textured subsoil. Available water capacity is mainly high, but in Waukee soils it is moderate. Permeability ranges mainly from moderate to slow, but Waukee soils are rapidly permeable in the substratum. The surface layer of Fayette, Downs, and Port Byron soils tends to seal during rains, and a crust is likely to form as the surface layer dries. Unless limed within the past 5 years, these soils are acid. Most of these soils are not droughty. Waukee soils are somewhat droughty when rainfall is below normal.

These soils are suited to corn and soybeans. Most areas are used for corn, soybeans, small grain, and alfalfa. Bassett, Coggon, Downs, Fayette, Kenyon, Ostrander, and Port Byron soils typically have long, uniform slopes and are well suited to conservation practices.

Controlling erosion and providing adequate artificial drainage are difficult on Bassett, Coggon, Cresco, Kenyon, Lourdes, Ostrander, and Readlyn soils because erosion control and drainage conflict to some extent. Conservation practices tend to slow the movement of surface water and allow more water to soak into the soil. This increases the need for artificial drainage. A combination of practices, such as the use of terraces and tile drainage, can be the most successful management. Terrace cuts should be minimal to avoid exposing the less productive glacial till subsoil in Bassett, Coggon, Cresco, Kenyon, Lourdes, Ostrander, and Readlyn soils or the sandy substratum in Waukee soils.

Capability unit IIe–2

This unit consists of gently sloping soils of the Bixby, Olin, Rockton, Saude, Wapsie, and Winneshiek series. These soils are dark to light colored and are well drained. They are on the uplands or stream benches and are moderately deep to deep over bedrock, coarse textured material, or glacial till.

The surface layer and the subsoil are friable and moderately coarse textured or medium textured. Available water capacity is low to moderate. Permeability is mainly moderate to very rapid, but Olin soils are moderately slowly permeable in the glacial till subsoil. Unless limed within the past 2 to 5 years, these soils are acid.

These soils are used mainly for corn, small grain, and alfalfa and they are suited to these crops. These soils are also suited to pasture and woodland and to other less intensive uses.

Erosion is a hazard on these soils. They are somewhat droughty in most years. Unless rainfall is timely, yields are often reduced because of the lack of moisture. The soils are not well suited to terraces because of the shallowness to limestone or to sand and gravel. Olin soils have sandy texture to a depth of about 2 feet, thus making it difficult to maintain a terrace ridge. Terraces should be shallow to avoid exposing bedrock or coarse textured material in the terrace channels. The underlying limestone or sand and gravel may limit the rooting of some crops.

Capability unit IIe–3

Donnan loam, 2 to 5 percent slopes, is the only soil in this unit. This soil is moderately dark colored and moderately well drained to somewhat poorly drained. It is on uplands.

The surface layer is friable and medium textured. The subsoil is firm to very firm and moderately fine textured to fine textured. Available water capacity is high. Because of the high clay content, however, not all the moisture reaches the plants. This soil is sometimes wet because of the moderately high but variable water table. Farming is sometimes delayed by excess moisture. This soil is subject to erosion. Included in this unit are some areas of soils that have a sandy loam surface layer and a higher infiltration rate than this Donnan soil. These soils are very seepy in wet seasons; at other times, they can be droughty.

This soil is suited to corn, soybeans, small grain, and alfalfa. It is also suited to pasture and woodland and to other less intensive uses.

Field operations can be more timely if this soil is tiled. Tile placement is important because of the clayey, very slowly permeable subsoil. Terraces are not

well suited to this soil. Terrace construction may expose the less productive, very slowly permeable, clayey subsoil, and extra water entering the soil will increase wetness.

Capability unit IIe–4

This unit consists of gently sloping soils of the Huntsville, Chaseburg, and Terril series. These moderately well drained to well drained soils are dark to moderately dark. They are along upland drainageways and alluvial fans.

The surface layer and subsoil are friable and medium textured. Available water capacity is high, and permeability is moderate.

These soils are suited to row crops but are generally farmed with adjoining soils because areas are small and irregular. They are used mainly for corn, soybeans, small grain, and alfalfa. They are also suited to pasture and woodland and to other less intensive uses.

These soils are subject to gully and sheet erosion. They are flooded when they receive runoff from the higher-lying adjacent soils. Siltation is a hazard during heavy rains if soils upslope are not protected from erosion. Gullies form where water concentrates unless grass waterways are used to carry runoff from the hillsides to the main drainageways. In some places a combination of erosion control structures and grassed waterways are needed to control gullies. Diversions will help to control runoff from adjacent hillsides and prevent siltation. Tile drainage is needed in some areas of Chaseburg soils.

Capability unit IIw–1

This unit consists of nearly level and gently sloping soils of the Clyde, Floyd, Huntsville, Marshan, Otter, Schley, and Tripoli series. These soils are dark to moderately dark. They are mainly poorly drained or somewhat poorly drained, but Huntsville soils are well drained. These soils are on uplands and on stream benches. Complexes of Clyde and Floyd soils and of Otter and Huntsville soils are in narrow upland drainageways.

The surface layer is friable and medium textured or moderately fine textured. The subsoil is friable to firm and medium textured or moderately fine textured. Available water capacity is mainly high, but in Marshan soils it is moderate. Permeability is mainly moderate to moderately slow, but Marshan soils are moderately permeable in the upper part and rapidly permeable in the coarse substratum. These soils are mainly slightly acid to neutral and generally do not need lime. Unless limed within the past 5 years, Schley soils are acid.

These soils are well suited to row crops if drained. They are used mainly for corn and soybeans but are also suited to small grain, hay, pasture, and trees and to less intensive uses. Undrained areas are generally in permanent pasture.

The Clyde and Marshan soils are occasionally flooded for short periods, but damage is usually slight. Sheet erosion generally is not a hazard on these soils, but the complexes of Clyde and Floyd soils and of Otter and Huntsville soils are subject to gully erosion where water concentrates. These soils have a high water table or receive seepage from adjacent steeper soils. They dry somewhat slowly in spring and cannot be worked soon after rains. The complexes of Clyde and Floyd soils have some stones and boulders on the surface.

Capability unit IIw–2

This unit consists of nearly level soils of the Donnan series, and the nearly level to gently sloping soils of the Protivin and Riceville series. These soils are dark and moderately dark and are somewhat poorly drained. They are on uplands.

The surface layer is friable and medium textured. The subsoil is very firm and moderately fine textured to fine textured. Available water capacity is high. Permeability is slow to very slow. Unless limed within the past 5 years, these soils are acid.

These soils are suited to row crops. They are used mainly for corn, soybeans, small grain, and alfalfa. They are also suited to pasture and woodland and to other less intensive uses.

Artificial drainage improves timeliness of field operations on these soils. Tile drainage is not fully effective on these soils because of the slow permeability of the subsoil, but it is the most effective method of subsurface drainage currently available. The rate at which water moves through the loamy surface layer differs considerably from the rate at which it moves through the underlying glacial till. Water moves more rapidly in the loamy material and accumulates at the till contact, causing a seasonal perched water table and sidehill seeps, especially after heavy rains.

Capability unit IIw–3

This unit consists of nearly level soils of the Caneek, Coland, and Ossian series. These soils are mainly dark and poorly drained, but Caneek soils are moderately dark and are poorly drained to somewhat poorly drained. These soils are on flood plains.

The surface layer is friable and medium textured or moderately fine textured. The subsoil is friable and medium textured. Available water capacity is high. Permeability is mainly moderate, but Coland soils are moderately slowly permeable. These soils are mainly neutral, but Caneek soils are mildly alkaline.

These soils are suited to row crops. Tile drainage and flood protection measures are needed in most areas. These soils are subject to short-duration, high-velocity flooding in spring and after heavy rains. Tile functions well if properly installed with suitable outlets. Areas not drained by tile are generally in permanent pasture. Small, isolated areas are left idle in wet years or are used for wildlife habitat. These soils are wet in spring or after heavy rains because of the high water table, and some areas are subject to ponding for short periods. These soils puddle after heavy rains or if worked when wet.

Capability unit IIw–4

Jacwin loam, 2 to 5 percent slopes, is the only soil in this unit. This soil is dark and somewhat poorly drained. It is on concave foot slopes and high structural benches on uplands.

The surface layer is friable and medium textured. The subsoil is friable to very firm and moderately fine textured to fine textured. The substratum is very firm,

fine textured shale. Available water capacity is moderate, and permeability is very slow. This soil is generally neutral in the surface layer.

This soil is suited to cultivated crops if properly drained. Because permeability is very slow in the clayey shale, tile drainage is not fully effective. Drain tile must not be placed too deeply in the shale. Because it receives water from soils upslope, this soil is seepy. Water running into seepy areas must be intercepted upslope before it reaches the rooting zone. Many undrained areas are in permanent pasture. This soil is also suited to woodland and wildlife habitat and to other less intensive uses.

Capability unit IIs–1

This unit consists of nearly level soils of the Bixby, Rockton, Saude, Wapsie, and Winneshiek series. These soils are dark to light colored and are well drained. They are on stream benches and on uplands.

The surface layer is friable and medium textured. The subsoil is friable and medium textured. Available water capacity is low to moderate. Permeability is mainly moderate in the surface layer and subsoil and is rapid in the underlying coarse textured material. Rockton and Winneshiek soils are underlain by rapidly permeable limestone bedrock. Unless limed within the past 5 years, these soils are acid.

These soils are suited to cultivated crops. Droughtiness is a hazard in most years unless rainfall is very timely. Tilth is generally good, and these soils are easily tilled. They warm up quickly in spring and can generally be worked soon after rains. The main crops grown are corn, soybeans, small grain, and alfalfa. They are also suited to pasture and woodland and to other less intensive uses.

These nearly level soils are not subject to water erosion, but they are sometimes subject to soil blowing. Minimum tillage to help conserve moisture and prevent soil blowing is good management for these soils. Yields depend on the amount and timeliness of rainfall.

Capability unit IIs–2

This unit consists of nearly level Hayfield and Lawler soils that are 24 to 32 inches to sand and gravel. These soils are moderately dark or dark and are somewhat poorly drained. They are moderately deep to sand and gravel. They are dominantly on stream benches throughout the county.

The surface layer is friable and medium textured. The subsoil is friable and medium textured. Available water capacity is moderate. Permeability is moderate in the surface layer and subsoil, but is rapid in the underlying sand and gravel. Unless limed in the past 5 years, these soils are acid.

These soils are suited to cultivated crops. They are used mainly for corn, soybeans, small grain, and alfalfa, but they are also suited to pasture and woodland and to other less intensive uses. They have a fluctuating water table that is moderately high in the spring but which drops rapidly during the growing season. Droughtiness is a hazard, especially when rainfall is average or below average. These soils benefit from artificial drainage in wet seasons, but placing of tile may be difficult because of loose, water-bearing sand and gravel.

Capability unit IIs–3

Hanlon fine sandy loam, 0 to 2 percent slopes, is the only soil in this unit. This soil is dark and moderately well drained. It is on natural levees along streams.

The surface layer and the subsoil are friable to very friable and moderately coarse textured. The substratum is coarse textured. Available water capacity is moderate, and permeability is moderately rapid. This soil is generally neutral and does not require lime.

This soil is suited to row crops. It is subject to short-duration, high-velocity flooding, especially in spring and after heavy rains. It is droughty when rainfall is below average or not timely. This soil is used mainly for corn, oats, and hay. It is also suited to pasture and woodland and to other less intensive uses. Soil blowing is a hazard when the surface is unprotected, and blowing sand sometimes damages newly seeded crops. Minimum tillage and leaving crop residue on the surface help to control soil blowing and to conserve moisture.

Capability unit IIIe–1

This unit consists of moderately sloping soils of the Bassett, Coggon, Cresco, Donnan, Downs, Fayette, Kenyon, Lourdes, Olin, Orwood, and Ostrander series. These soils are dark to light colored. They are mainly moderately well drained to well drained, but Donnan soils are somewhat poorly drained to moderately well drained. They are on the uplands and are slightly or moderately eroded.

The surface layer is friable and moderately coarse textured or medium textured. The subsoil is friable to very firm, and moderately coarse textured to find textured. Available water capacity is moderate to high. Permeability is rapid to very slow. Unless limed within the past 5 years, these soils are acid.

These soils are suited to row crops if they are protected from erosion. Corn is the most common crop, but soybeans are sometimes grown, instead of corn in a rotation. The surface layer of the light colored Coggon, and Fayette soils tends to seal, and a crust is likely to form as the surface layer dries. Olin soils are somewhat droughty in some years unless rainfall is timely. Cresco, Donnan, Lourdes, and Olin soils have seepy areas, especially after periods of heavy rainfall. These soils are used mainly for corn, soybeans, small grain, and alfalfa. They are also suited to pasture and woodland and to other less intensive uses.

Contouring, stripcropping, or terracing on these soils helps to control erosion in cultivated fields. Minimum tillage is also beneficial. Downs, Fayette, Kenyon, and Orwood soils typically have long, uniform slopes and are well suited to terraces. Terrace cuts should be minimal to avoid exposing the less productive glacial till subsoil in the Bassett, Coggon, Cresco, Kenyon, and Lourdes soils. Terraces are not well suited to Donnan soils because terrace construction can expose the less productive, very slowly permeable, clayey subsoil and because extra water enters the soil, increasing wetness. Grassed waterways are needed to prevent the formation of gullies where water concentrates. Returning all crop residue to the soil helps to maintain good tilth, especially on the light colored soils.

Capability unit IIIe–2

This unit consists of strongly sloping soils of the Bassett, Downs, Exette, Fayette, and Orwood series. These soils are moderately dark colored to light colored and are moderately well drained to well drained. They are on uplands.

The surface layer is friable and medium textured. The subsoil is friable to firm and medium textured. Available water capacity is high. Permeability is mostly moderate, but in Bassett soils it is moderately slow. Unless limed within the past 5 years, these soils are acid.

These soils are suited to cultivated crops if erosion is controlled. They are used for corn, soybeans, small grain, and alfalfa. These soils are also suited to pasture and woodland and to other less intensive uses.

Management practices such as contouring, terracing, stripcropping, and minimum tillage are suited to these soils (fig. 13). Terrace cuts should be minimal to avoid exposing the less productive glacial till subsoil in Bassett soils. Grassed waterways prevent gullies from forming where water concentrates. All crop residues should be returned to the soil to help maintain tilth and organic matter content.

Capability unit IIIe–3

This unit consists of gently sloping to moderately sloping soils of the Dickinson, Flagler, Lamont, Saude, and Wapsie series. These soils are light colored to dark colored and are well drained to somewhat excessively drained. They are on uplands and on stream benches.

The surface layer and subsoil are friable to very friable and medium textured or moderately coarse textured. The substratum is mainly coarse textured, except for Dickinson till substratum soils. Available water capacity is low to moderate. Permeability is mainly moderate to very rapid. Dickinson till substratum soils are moderately slowly permeable in the till. The organic matter content is moderate to very low. Unless limed in the last 2 to 4 years, these soils are acid.

These soils are suited to corn, soybeans, oats, and hay. They are used mainly for these crops. These soils are also suited to pasture and woodland and to other less intensive uses. The slope and droughtiness of these soils limit their use. Blowing sand sometimes damages recently seeded crops.

Contour minimum tillage or contour stripcropping helps to control erosion and conserve moisture on the

Figure 13.—**Established stand of crown vetch on seeded-backslope, tile-inlet terraces on a strongly sloping Fayette soil.**

gently sloping to moderately sloping sandy soils. Terraces are difficult to construct and maintain in the sandy areas.

Capability unit IIIe–4

This unit consists of moderately sloping soils of the Dubuque, Rockton, and Winneshiek series that are underlain by limestone bedrock and gently sloping soils of the Backbone series. These soils are dark to light colored. They are mainly well drained, but Backbone soils are somewhat excessively drained.

The surface layer is friable and medium textured or moderately coarse textured. The subsoil is friable and moderately coarse to moderately fine textured. Limestone bedrock is at a depth of 20 to 40 inches in Backbone soils. Available water capacity is low to very low. Permeability is moderate to very rapid. Unless limed in the past 5 years, these soils are acid.

These soils are suited to cultivated crops. Because of the shallow depth to limestone bedrock, however, they are subject to erosion and droughtiness. They are used mainly for corn, oats, and alfalfa. These soils are also suited to pasture and woodland and to other less intensive uses. They are easily tilled, warm up quickly in the spring, and can be worked soon after rains. Most areas are poorly suited to terraces because of the shallow depth to bedrock.

Capability unit IIIe–5

Jacwin loam, 5 to 9 percent slopes, is the only soil in this unit. This soil is dark and somewhat poorly drained. It is on high, upland structural benches.

The surface layer is friable and medium textured. The subsoil is friable to very firm and moderately fine textured or fine textured. Available water capacity is moderate. Permeability is moderate in the loamy material and very slow in the clayey substratum. This soil is wet in some seasons because of the moderately high but variable water table, and farm operations are delayed by the excess moisture. Not all of the moisture is available to plants because of the high clay content. This soil is generally neutral or slightly acid and seldom requires lime.

This soil is suited to cultivated crops, but it is subject to erosion and is seasonally wet because of a perched water table. It is occasionally used for corn, oats, and alfalfa. It is also suited to pasture and woodland and to other less intensive uses.

Field operations on this soil are more timely if it is tiled. Tile placement is important because of the clayey, very slowly permeable substratum. Terraces are not well suited because terrace construction can expose the less productive, very slowly permeable clayey shale and because extra water enters the soil, increasing wetness.

Capability unit IIIw–1

Palms muck, 1 to 4 percent slopes, is the only soil in this unit. It is a nearly level to gently sloping organic soil. It is dark and very poorly drained. It is on uplands and occasionally on stream benches.

The surface layer is spongy and consists mainly of organic matter. It is 18 to 50 inches thick. Beneath the organic layer is very friable to friable, coarse textured to medium textured material. Available water capacity is very high. Permeability is moderately rapid in the organic layer and moderate in the underlying mineral material.

This soil is suited to row crops if it is well managed and artificially drained. It is suited to oats, but oats are subject to lodging. The use of early-maturing varieties of crops helps to alleviate the hazard of frost, which is more severe on this soil than on adjoining soils. The high water table and sidehill seepage make this soil wet. Undrained areas have a water table at or near the surface. Because the surface is irregular, water stands in places. When this soil is artificially drained, the organic material settles.

If tile is placed in the organic material, shrinkage will alter the tile alignment, causing it to function improperly. Tile drains function better if placed in the underlying mineral material. In some areas, outlets are difficult to obtain. Drained areas are used mainly for corn or soybeans. If undrained, they are poorly suited to pasture and are generally left idle. The spongy material will not withstand the traffic of grazing livestock.

Areas of muck in Fayette County are generally not very large, but some are large enough to be used for specialty vegetable crops, such as potatoes or onions.

Capability unit IIIw–2

Calamine silty clay loam, 1 to 3 percent slopes, is the only soil in this unit. This soil is dark and poorly drained. It is on foot slopes on high structural benches below limestone outcrops.

The surface layer is friable and moderately fine textured. The subsoil is friable to very firm and moderately fine textured or fine textured. The substratum is very firm, fine textured shale. Available water capacity is moderate. Permeability in the subsoil is very slow.

This soil is poorly suited to cultivated crops. The high water table and sidehill seepage makes this soil wet. Many areas receive water from springs. Artificial drainage is needed but is difficult because the water feeding these areas must be intercepted upslope before it reaches the rooting zone. This soil is suited to pasture and wildlife habitat, and to other less intensive uses.

Capability unit IIIs–1

Flagler sandy loam, 0 to 2 percent slopes, is the only soil in this unit. This soil is dark and somewhat excessively drained. It is on uplands or stream benches.

The surface layer and subsoil are friable and coarse textured or moderately coarse textured. The substratum is coarse textured. Available water capacity is low. Permeability is moderately rapid to very rapid. Unless limed in the last 2 to 5 years, this soil is acid.

This soil is suited to row crops, but yields depend on the amount and timeliness of rainfall. It is used mainly for corn or soybeans, oats, and alfalfa. It is also suited to pasture and woodland and to other less intensive uses. Droughtiness limits the use of this soil for crops, and soil blowing is a hazard when the surface is unprotected. Blowing sand sometimes damages newly seeded crops. On the nearly level areas of this sandy soil, minimum tillage and leaving crop residue on the surface help to control soil blowing and to conserve moisture.

Capability unit IVe–1

This unit consists of moderately steep, moderately eroded soils of the Bassett, Downs, Exette, and Orwood series; moderately steep, slightly eroded and moderately eroded soils of the Fayette series; and strongly sloping, severely eroded soils of the Fayette series. These soils are moderately dark to light colored and moderately well drained to well drained. They are on uplands.

The surface layer is friable and medium textured. The subsoil is friable to firm and medium textured or moderately fine textured. Available water capacity is high. Permeability is mainly moderate, but Bassett soils are moderately to moderately slowly permeable. Unless limed within the past 5 years, these soils are acid.

These soils are better suited to hay and pasture than to cultivated crops. Corn is generally grown only in rotation to reestablish the grass and legumes to hay and pasture. Soybeans are generally not substituted for corn in the rotation because they are more susceptible to erosion than corn. Cultivated areas should be tilled on the contour to prevent excess soil loss. The hazard of erosion is serious because runoff is rapid and the soils are highly erodible. The surface layer tends to seal during rains, and a crust forms when the soil dries, particularly on Fayette and Exette soils. Crop residue should be left on the surface. Gullies and drainageways need to be shaped and reseeded in places. Areas that are difficult to farm provide good habitat for wildlife or are suitable for growing trees.

Capability unit IVe–2

This unit consists of strongly sloping soils of the Backbone and Dickinson series and strongly sloping, moderately deep soils of the Dubuque and Winneshiek series. These soils are light colored to dark colored and well drained to somewhat excessively drained. These soils are mainly on uplands, and Dickinson soils are also on stream benches.

The surface layer is very friable to friable and moderately coarse textured or medium textured. The subsoil is very friable to friable and coarse textured to moderately fine textured. Dickinson soils have a coarse textured substratum. Backbone, Dubuque, and Winneshiek soils have limestone bedrock at a depth of about 2 to 3 feet. Available water capacity is low. Permeability is moderate to very rapid. Unless limed in the last 2 to 5 years, these soils are acid.

The soils of this unit are better suited to hay or pasture than to cultivated crops because these soils are subject to erosion and are droughty. These soils are used mainly for hay and pasture. Corn and oats are generally grown only in rotation to reestablish pasture. Yields vary, depending on the amount and timeliness of rainfall. Establishing new seeding can be difficult on the sandy soils. Crop residue left on the surface will help to prevent soil blowing and water erosion and help to conserve moisture. Terraces are not well suited to the sandy soils because they are difficult to construct and maintain. Terraces are generally not constructed on the Backbone, Dubuque, and Winneshiek soils because of the shallow depth to limestone bedrock. Contouring, stripcropping, and minimum tillage will reduce soil losses. Areas that are difficult to farm provide good habitat for wildlife or are suitable for trees.

Capability unit IVe–3

Jacwin loam, 9 to 14 percent slopes, is the only soil in this unit. This soil is dark and somewhat poorly drained. It is on high, upland structural benches.

The surface layer is friable and medium textured. The subsoil is friable to very firm and moderately fine textured or fine textured. The substratum is clayey shale. Available water capacity is moderate. Permeability is moderate in the loamy material and very slow in the clayey substratum. This soil is wet because of the moderately high but variable water table. Farm operations are delayed to some extent by the excess moisture. Because of the high clay content, not all the moisture is available to plants. This soil is generally neutral or slightly acid and seldom requires lime.

This soil is better suited to hay or pasture than to cultivated crops because it is subject to erosion and is seasonally wet. Terraces are not well suited because their construction can expose the less productive, very slowly permeable, clayey shale and they allow extra water to enter the soil, increasing wetness.

This soil is used mainly for hay and pasture. Corn and oats are generally grown only in rotation to reestablish pasture. Areas that are difficult to farm provide good habitat for wildlife or are suitable for trees.

Capability unit IVs–1

This unit consists of nearly level to moderately sloping soils of the Burkhardt and Sparta series, gently sloping to strongly sloping soils of the Marlean series, gently sloping to moderately sloping soils of the Chelsea series, and gently sloping soils of the Nordness series. These soils are dark to light colored and are somewhat excessively drained and excessively drained. These soils are mainly on uplands, and Burkhardt, Sparta, and Chelsea soils are also on stream benches.

The surface layer and subsoil are friable to very friable and coarse textured to medium textured. These soils have a coarse textured substratum, but Nordness and Marlean soils have limestone at a depth of less than 15 inches. Available water capacity is very low to low. Permeability is very rapid in Burkhardt, Chelsea, and Sparta soils and is moderate to rapid in Nordness and Marlean soils. Unless limed in the last 2 to 3 years, these soils are mainly acid; however, Nordness and Marlean soils generally do not require lime.

These soils are used for corn, oats, soybeans, hay, pasture, and woodland. They are better suited to permanent pasture, hay, woodland, or wildlife habitat than to most other uses. Droughtiness is the principal limitation on these soils, but erosion is also a hazard. Yields depend on the timeliness of rainfall during the growing season. Blowing sand may damage new seedlings on these soils and on adjacent soils.

These soils warm up quickly in spring and can be worked very soon after rains. They absorb moisture readily but lose much of it through deep percolation. Sloping areas are subject to sheet erosion. On the nearly level soils where water erosion is not a hazard, minimum tillage and leaving crop residue on the sur-

face help to control soil blowing and to conserve moisture.

Capability unit Vw–1

This unit consists of nearly level, channeled Coland and Dorchester soils and Loamy alluvial land. These soils are well drained to very poorly drained. They are on nearly level bottom lands and are commonly cut up by stream channels and oxbows.

The surface layer is dark to light colored and is coarse textured to moderately fine textured. Available water capacity and permeability are variable. Reaction is slightly acid to mildly alkaline.

These soils are frequently flooded. Flooding is the main hazard. Water is ponded in many places during part of the year, and the water table is high. Without major reclamation, the soils in this unit are better suited to pasture, woodland, or wildlife habitat than to most other uses. If cultivated crops are grown, land leveling, flood control, and surface drainage are needed in many places. Most of these soils are in permanent pasture or woodland, but a few areas are cultivated with areas of adjacent soils. If protected from flooding, these soils are suited to row crops; if not protected, they are poorly suited to cultivated crops.

Capability unit VIe–1

This unit consists of moderately steep, slightly eroded and moderately eroded soils of the Dubuque series; steep, moderately eroded and severely eroded soils of the Exette series; and steep, slightly eroded to severely eroded soils of the Fayette series. These soils are light colored and well drained. They are on uplands.

The surface layer is friable and medium textured. The subsoil is friable and medium textured or moderately fine textured. Available water capacity is mainly high, but it is low in Dubuque soils. Permeability is mainly moderate, but it is moderate to very rapid in Dubuque soils. Unless limed within the past 5 years, these soils are acid.

These soils are poorly suited to cultivated crops. They are better suited to permanent pasture or to woodland. Row crops are generally grown only in a rotation to reestablish hay and pasture. These soils are easily eroded by runoff if the surface is bare or if vegetation is sparse. Gullies have formed in some places. Tilth is poor in the eroded areas, and the surface tends to seal during heavy rains. Waterways and gullies can be shaped and seeded. Diversion terraces help to protect the soils downslope from runoff and siltation. These areas should be plowed only when meadows need reseeding.

Capability unit VIs–1

This unit consists of moderately sloping to strongly sloping soils of the Nordness series, strongly sloping to moderately steep soils of the Burkhardt and Goss series, strongly sloping soils of the Sparta series, and the gently sloping complex of Dorchester and Volney soils. These soils are light colored to dark colored and moderately well drained to excessively drained. They are mainly on uplands. The Dorchester and Volney soils are on alluvial fans and lower parts of upland waterways.

The surface layer is friable or very friable and coarse textured to medium textured. The subsoil is mainly very friable and coarse textured but Dorchester soils have a friable and medium textured subsoil. Limestone is at a depth of less than 15 inches in Nordness soils, and limestone outcrops are in many places. Sparta soils are sandy, and Volney soils have limestone fragments throughout the profile. Goss soils are dominantly chert fragments at a depth of less than 15 inches. Available water capacity is mainly low to very low; it is high in Dorchester soils. Permeability is moderate to rapid in Nordness, Goss, Dorchester, and Volney soils and very rapid in Sparta soils. Unless limed within the last 2 or 3 years, Dorchester and Volney soils are moderately alkaline, Nordness and Goss soils are generally neutral, and Sparta soils are acid.

Because they are droughty and susceptible to erosion, these soils are poorly suited to cultivated crops. Dorchester and Volney soils are subject to runoff from adjoining steep uplands. These soils absorb moisture readily but lose much of it through deep percolation. They are better suited to pasture, woodland, or wildlife habitat. Small areas that are left idle provide good wildlife habitat. Trees that are suited to these soils grow reasonably well in places. Areas should be protected from grazing. Establishing new seedings for pasture may be difficult on Sparta soils because of the sandy surface layer. Leaving crop residue on the surface helps to control erosion, protect seedlings from blowing sand, and conserve moisture. Controlled grazing helps to maintain good pasture.

Capability unit VIIe–1

This unit consists of very steep, severely eroded soils of the Fayette series; moderately steep and steep, severely eroded and slightly eroded soils of the Dubuque series; steep, severely eroded soils of the Exette series; and steep and very steep in complexes of Fayette-Dubuque-Jacwin soils. These soils are mainly light colored and well drained, but Jacwin soils are dark colored and somewhat poorly drained. These soils are on uplands.

The surface layer and subsoil are mainly friable and medium textured, but Jacwin soils have a firm to very firm and moderately fine textured or fine textured subsoil. Available water capacity is high in the Fayette soils, moderate in the Jacwin soils, and low in the Dubuque soils. Permeability is moderate in the Fayette soils, moderate to very rapid in the Dubuque soils, and moderate to very slow in the Jacwin soils. Unless limed within the last 5 years, Fayette and Dubuque soils are acid. Jacwin soils are generally neutral in reaction.

These soils are not suited to cultivated crops and are only poorly suited to pasture. Although some open areas are of limited use for pasture early in summer, the carrying capacity is low and grazing needs to be carefully controlled to insure a permanent plant cover. Renovating pasture is difficult because of the steep slopes. These soils provide excellent wildlife habitat.

Capability unit VIIw–1

Only Marsh is in this unit. It consists of areas that are covered by water most of the time. These areas

Figure 14.—Typical area of Rock outcrop-Nordness complex.

are not suited to most farming uses. They are suited to wildlife habitat and recreational areas. Waterfowl, muskrats, and upland game animals find food and nesting places in Marsh areas and around its edges. These areas can be improved as habitat by providing controls to maintain a more constant water level.

Capability unit VIIs–1

This unit consists of moderately steep to steep soils of the Chelsea and Nordness series. Sandy escarpments and the Rock outcrop-Nordness complex are also included. These soils are light colored and somewhat excessively drained to excessively drained.

Chelsea soils have a very friable, coarse textured surface layer and subsoil. Nordness soils have a thin, medium textured surface layer and are underlain by limestone bedrock at a depth of less than 18 inches. Sandy escarpments vary from medium textured to coarse textured. Rock outcrop-Nordness complex has a small amount of medium textured soil material in the surface layer. The soil material is between the fragments of limestone and in the fractures in the limestone. Available water capacity is very low (fig. 14). Permeability is very rapid in Chelsea soils and in Sandy escarpments and moderate to very rapid in Nordness soils and in the Rock outcrop-Nordness complex.

The farming uses of these soils are extremely limited. Most areas are presently in woodland or permanent pasture. Renovating pasture is difficult because slopes are usually too steep to use regular farm machinery. The carrying capacity of pasture is low, and grazing needs to be controlled to prevent erosion. Some limestone quarries are in the areas of Rock outcrop-Nordness complex. A few sand pits are in areas of the Chelsea soils. Rock outcrop-Nordness complex has scenic value.

Predicted yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 2. In any given year, yields may be higher or lower than those indicated in table 2 because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to or not commonly grown on the soil or that irrigation of a given crop is not commonly practiced on the soil.

The predicted yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The latest soil and crop management practices used by many farmers in the county are assumed in predicting the yields. Hay and pasture yields are predicted for varieties of grasses and legumes suited to the soil. A few farmers may be using more advanced practices and obtaining higher average yields than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends upon the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; using appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The predicted yields reflect the relative productive capacity of the soils for each of the principal crops. Yields are likely to increase in the future as new production technology is developed. The relative productivity of a given soil compared to other soils, however, is not likely to change.

Woodland

Trees formerly covered nearly all of the northeast-

TABLE 2.—*Yields per acre of crops and pasture*

[All yields were estimated for a high level of management in 1975. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Map symbol and soil name	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
27B: Terril	118	45	94	5.0	8.3	4.2
41, 41B: Sparta	63	24	47	2.5	4.3	2.0
41C: Sparta	61	23	45	2.5	4.3	2.0
41D: Sparta	56	21	42	2.3	3.8	1.8
63C: Chelsea	52	20	39	1.8	3.0	1.8
63E: Chelsea				1.0	1.6	1.0
83B: Kenyon	113	43	90	4.7	7.8	4.2
83C: Kenyon	108	41	86	4.5	7.5	4.0
83C2: Kenyon	105	40	84	4.4	7.3	3.8
84: Clyde	102	39	82	4.0	6.6	4.0
98: Huntsville	130	45	93	5.5	7.9	4.2
98B: Huntsville	130	45	91	5.5	7.9	4.2
109B: Backbone	65	25	45	2.2	3.6	1.6
109C: Backbone	50	19	35	2.2	3.6	1.6
109D: Backbone				2.0	3.3	1.6
110B: Lamont	69	26	52	2.5	4.1	2.3
110C: Lamont	55	21	41	1.8	3.0	1.8
115: Sandy escarpments				1.0	1.6	1.0
135: Coland	104	40	83	4.2	7.0	4.1
C135: Coland						3.0
142B: Chaseburg	104	40	82	4.3	7.0	4.1
151: Marshan	91	35	73	3.8	6.4	4.2
152: Marshan	101	38	81	4.0	6.6	3.5

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Map symbol and soil name	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
158: Dorchester	104	40	83	4.4	7.3	4.0
C158: Dorchester						3.0
162B: Downs	119	45	95	5.0	8.3	4.1
162C: Downs	114	43	91	4.8	8.1	4.0
162C2: Downs	111	42	89	4.7	7.8	3.8
162D: Downs	105	40	84	4.4	7.3	3.8
162D2: Downs	102	39	82	4.3	7.1	3.6
162E2: Downs	87	33	69	3.7	6.1	3.5
163B: Fayette	113	43	90	4.7	7.8	4.0
163C: Fayette	108	41	86	4.5	7.5	3.8
163C2: Fayette	105	40	84	4.4	7.3	3.7
163D: Fayette	99	38	80	4.2	7.0	3.6
163D2: Fayette	96	36	76	4.0	6.6	3.6
163D3: Fayette	90	34	72	3.8	6.3	3.5
163E: Fayette	84	32	67	3.5	5.8	3.3
163E2: Fayette	81	31	65	3.4	5.6	3.2
163E3: Fayette			62	3.2	5.3	3.0
163F: Fayette			60	3.4	5.6	3.1
163F2: Fayette			55	3.2	5.3	2.9
163F3: Fayette				3.0	5.0	2.5
163G: Fayette						3.0
171B: Bassett	107	40	85	4.5	7.5	4.0
171C: Bassett	102	39	81	4.3	7.0	4.0
171C2: Bassett	99	38	80	4.0	6.6	3.5

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Map symbol and soil name	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
171D2: Bassett	90	34	72	3.8	6.3	3.2
171E2: Bassett	75	28	60	3.1	5.5	3.0
175B: Dickinson	81	31	60	3.0	5.0	2.7
175C: Dickinson	76	29	57	2.8	4.6	2.5
175D: Dickinson	67	25	50	2.3	4.0	2.0
177: Saude	78	30	62	3.3	5.5	3.0
177B: Saude	76	29	61	3.2	5.3	3.0
177C: Saude	71	27	57	3.0	5.0	2.8
178: Waukee	98	37	78	4.1	6.8	4.0
178B: Waukee	96	36	77	4.0	6.6	4.0
183C: Dubuque	65	25	52	2.7	4.5	2.3
183D2: Dubuque	56	21	45	2.3	3.8	1.8
183E: Dubuque			40	2.1	3.4	1.4
183E2: Dubuque			38	1.9	3.1	1.4
183F: Dubuque				1.8	3.0	1.2
193: Camden	110	38	80	4.6	7.6	3.9
198B: Floyd	106	40	85	4.5	7.5	4.1
213: Rockton	100	38	80	4.2	7.0	3.7
213B: Rockton	96	36	77	4.0	6.6	3.5
214: Rockton	78	30	62	3.2	5.3	3.0
214B: Rockton	76	29	60	3.0	5.0	2.9
214C: Rockton	71	27	57	2.8	4.6	2.7
215E: Goss			20	1.2	2.0	1.3
221: Palms	79	30	61	3.1	5.1	3.0

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Map symbol and soil name	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
225: Lawler	85	32	68	3.6	6.0	3.7
226: Lawler	100	38	80	4.2	7.0	4.0
265: Bixby	70	26	65	3.5	4.0	3.0
265B: Bixby	65	24	60	3.0	4.0	3.0
284: Flagler	63	24	47	2.6	3.8	2.3
284B: Flagler	61	23	46	2.5	3.6	2.1
284C: Flagler	56	21	42	2.1	3.3	1.7
285: Burkhardt	43	16	36	1.6	2.8	1.6
285B: Burkhardt	41	16	34	1.5	2.6	1.5
285C2: Burkhardt	34	13	28	1.2	2.2	1.5
285E2: Burkhardt				0.5	1.2	1.0
302B: Coggon	101	38	80	4.3	7.1	3.8
302C: Coggon	96	36	77	4.0	6.6	3.6
315: Loamy alluvial land						2.5
354: Marsh						
391B: Clyde-Floyd	103	39	83	4.2	7.0	4.0
394B: Ostrander	105	40	84	4.5	7.3	3.9
394C: Ostrander	95	38	79	4.3	6.9	3.8
394C2: Ostrander	90	35	74	4.0	6.6	3.6
398: Tripoli	111	42	89	4.5	7.5	4.1
399: Readlyn	115	44	92	4.8	8.0	4.2
399B: Readlyn	113	43	90	4.7	7.8	4.1
407B: Schley	100	38	80	4.2	7.0	4.0
408B: Olin	97	37	73	4.1	6.8	3.4

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Map symbol and soil name	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
408C: Olin	92	35	70	3.9	6.5	3.2
409B: Dickinson	86	33	69	3.6	6.0	3.1
409C: Dickinson	81	31	65	3.4	5.6	3.0
444B: Jacwin	85	32	68	3.4	5.6	3.0
444C: Jacwin	70	30	56	2.8	4.6	2.6
444D: Jacwin	50	20	40	2.0	3.3	2.3
471: Oran	107	40	85	4.5	7.5	3.8
478G: Rock outcrop-Nordness						
480C: Orwood	100	38	80	4.2	7.0	3.7
480D2: Orwood	86	33	69	3.6	6.0	3.4
480E2: Orwood	70	27	57	2.9	4.8	3.2
485: Spillville	122	46	98	5.1	8.5	4.3
487B: Otter-Huntsville	102	39	76	4.0	6.6	3.8
489: Ossian	110	42	88	4.6	7.6	4.1
490: Caneek	96	38	80	4.0	6.6	3.8
496B: Dorchester-Volney				3.0	5.0	2.8
497F: Fayette-Dubuque-Jacwin					3.2	1.8
497G: Fayette-Dubuque-Jacwin						
499B: Nordness	36	14	29	1.5	2.5	1.5
499D: Nordness			20	1.2	2.0	1.0
499F: Nordness				0.5	0.8	0.7
512B: Marlean	46	17	37	2.0	3.3	1.8
512D: Marlean			32	1.5	2.6	1.5
536: Hanlon	90	34	72	3.0	5.0	3.3

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Map symbol and soil name	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
551: Calamine	75	29	60	3.0	5.0	3.0
620B: Port Byron	122	46	95	5.0	8.3	4.1
714: Winneshiek	72	27	58	3.0	5.0	2.6
714B: Winneshiek	70	27	56	2.9	4.8	2.6
714C: Winneshiek	65	25	52	2.7	4.5	2.5
714D: Winneshiek	56	21	45	2.3	3.8	2.0
725: Hayfield	79	30	63	3.0	5.0	3.0
763D2: Exette	92	35	73	3.9	6.6	3.6
763E2: Exette	75	26	60	3.4	5.6	3.2
763E3: Exette			58	3.2	5.3	3.0
763F2: Exette			52	3.2	5.3	2.9
763F3: Exette			48	3.0	5.0	2.5
777: Wapsie	72	27	57	3.0	5.0	2.7
777B: Wapsie	70	27	56	2.9	4.8	2.6
777C: Wapsie	65	25	52	2.7	4.5	2.3
781B: Lourdes	82	31	65	3.4	5.6	3.2
781C: Lourdes	77	29	62	3.2	5.3	3.0
782: Donnan	72	26	58	2.9	4.8	2.8
782B: Donnan	70	24	56	2.8	4.6	2.7
782C: Donnan	65	24	52	2.6	4.3	2.5
783B: Cresco	94	36	70	3.7	6.1	3.6
783C: Cresco	89	34	66	3.5	5.8	3.3
784B: Riceville	82	31	66	3.4	5.6	3.3
798B: Protivin	88	33	70	3.7	6.1	3.6

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Map symbol and soil name	Corn	Soybeans	Oats	Grass-legume hay	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
926: Canoe	120	46	96	5.0	8.3	4.2
977: Richwood	122	46	98	5.1	8.4	4.2
978: Festina	116	44	93	4.9	8.1	4.0

[1] Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

ern part of Fayette County. They also covered parts of the county that are mostly adjacent to streams. Early settlers highly valued the woodlands for building material and fuel. They harvested the best trees and left the less desirable. The less desirable trees gradually dominated the woodlands and reduced their economic value. Some of the wooded soils, such as Fayette, Bixby, Chelsea, Lamont, Coggon, and Dubuque soils were cleared for farming. Some of these soils are now eroded and should be replanted to adapted trees. About 9 percent of Fayette County is wooded.

The present pattern of tree cover is directly related to the seven soil associations in the county. The largest proportion of wooded areas is in the Fayette-Nordness-Rock outcrop and the Downs-Fayette associations. There are occasional woodlots in the other associations, and trees are scattered along the drainageways, in fence rows, and on farmsteads. In many places in the Fayette-Nordness-Rock outcrop and Downs-Fayette associations areas of woodland are steep and unsuitable for cultivation. Some areas are also shallow to limestone bedrock. Many areas that are now in crops are bordered by woods, and some trees grow in most pasture. Much of the steep land bordering the Turkey and Volga Rivers is not suited to crops and is only poorly suited to pasture. In these areas the present stands of timber are extremely important for controlling erosion.

Those native woodlands still in existence can be kept relatively productive by good management, including protection from livestock and fire; group selective cutting, thinning, and planting; and woodland weeding. The objective in woodland management is to attain sustained production by cutting the amount of wood that the stand is producing in yearly growth. This cutting can be done each year or periodically every 5 to 10 years. But some woodlands are of such poor quality in places that the best procedure is to convert them from hardwoods to the more valuable conifers. Before such conversion, competition from inferior species of trees and shrubs must be eliminated by mowing or by chemical spraying.

Except for walnut logs, the demand for trees for lumber is not great. Although several sawmills are in the county, they generally are operated part time. The logs for the sawmills are usually obtained from selected cuttings from a number of sites, rather than by harvesting the trees from an entire tract.

Several agencies in Iowa can assist woodland owners in improving and marketing their products. The Soil Conservation Service can help woodland owners determine which soils are suitable for trees, the best land use, yields, and conservation treatment needs. State foresters can assist in developing plans for managing new or old stands of trees. The type of woodland in the county and the suitability of soils for planting various kinds of trees are discussed in the following paragraphs and in table 3.

Factors affecting woodland management

Soils differ in their capabilites for use as woodland. The factors that influence such use are somewhat different and less restrictive than those that limit the use of soils for cultivated crops. This soil survey can help the owner of a wooded tract determine where he can get the best returns for his investment in woodland management. If the soils are suited to trees, the owner can afford to spend time and money in managing his woodland carefully. Little management, other than that needed to protect the soils, however, is justified on poor sites. Some factors that are important in woodland management are discussed in the following paragraphs.

Moisture. The growth of trees is directly related to the ability of a soil to supply moisture. The available moisture capacity of any soil depends largely on the slope, effective depth, texture, permeability, and internal drainage. Examples of soils that have only a limited supply of available moisture are Chelsea, Nordness, and Sparta soils and Rock outcrop-Nordness complex.

Aspect, or direction of exposure. Forest studies show a definite relationship between the exposure of a site and the rate of tree growth (*10*). Trees generally grow better and give better yields on north- and east-facing slopes and on gently sloping or nearly level valley flats and broad ridgetops than on south- or west-facing slopes. Long, steep slopes that have various exposures are typical for Fayette and Nordness soils and for Rock outcrop-Nordness complex.

Erosion. Eroded soils are generally not suitable for hardwoods, though pines may be planted on those sites. Natural reseeding of trees is greatly reduced by erosion. Examples of soils which have been eroded are some Bassett, Downs, Dubuque, and Fayette soils.

Soil reaction and soil fertility. Reaction and fertility have some influence on the adaptation and growth of different species of trees. For example, walnut and locust trees grow best on neutral or slightly calcareous soils. Pine trees need a slightly acid soil. Most species of pine, especially the native species, are poorly suited to soils that are high in lime. On the other hand, hardwoods commonly grow well on those soils. Eastern redcedar is also tolerant of lime. Dorchester soils contain excess lime in the upper 2 to 3 feet. Most of the other bottom land soils in Fayette County are neutral. Hardwoods should not be planted on eroded or depleted soils and generally are poorly suited to old formerly cultivated soils, whereas pine grows fairly well on these poorer sites.

Woodland management and productivity

Table 3 contains information useful to woodland owners or forest managers planning use of soils for wood crops. Those soils suitable for wood crops are listed alphabetically by soil name, and the ordination symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have about the same potential productivity.

The first part of the symbol, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates no significant limitations or restrictions. If a soil has more than one limitation, priority in placing the soil into a limitation class is in the order in which the letters are listed above—x, w, t, d, c, s, f, and r.

In table 3 the soils are also rated for a number of factors to be considered in management. The ratings of slight, moderate, and severe are used to indicate the degree of major soil limitations.

Ratings of the hazard of erosion indicate the risk of loss of soil in well-managed woodland. The risk is *slight* if the expected soil loss is small; *moderate* if some measures are needed to control erosion during logging and road construction; and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of equipment limitation reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or need for some modification in management or equipment; *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree that the soil affects expected mortality of planted tree seedlings when plant competition is not a limiting factor. The ratings are for seedlings from good planting stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality of the planted seedlings is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of plant competition indicate the degree to which undesirable plants are expected to invade or grow if openings are made in the tree canopy. The invading plants compete with native plants or planted seedlings by impeding or preventing their growth. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* means that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed for the control of undesirable plants.

The potential productivity of merchantable trees on a soil is expressed as a site index. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands (*11*).

Trees to plant are those that are suitable for commercial wood production and that are suited to the soils.

Wildlife [2]

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife will either be scarce or will not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 4 (see page 100) the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in—

1. Planning the use of parks, wildlife refuges, nature study areas, and other developments for wildlife.
2. Selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat.
3. Determining the intensity of management needed for each element of the habitat.

[2] This section was prepared by BILL D. WELKER, biologist, Soil Conservation Service.

TABLE 3.—*Woodland management and productivity*

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Map symbol and soil name	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
63C: Chelsea	3s	Slight	Slight	Moderate	Slight	White oak	55	Eastern white pine, Scotch pine, European larch, eastern redcedar, red pine, jack pine.
63E: Chelsea	3s	Moderate	Moderate	Moderate	Slight	White oak	55	Eastern white pine, Scotch pine, European larch, eastern redcedar, red pine, jack pine.
109B, 109C, 109D: Backbone	3o	Slight	Slight	Slight	Slight	Northern red oak White oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
110B, 110C: Lamont	3o	Slight	Slight	Slight	Moderate	Northern red oak White oak	55 55	Eastern white pine, Scotch pine, European larch, eastern redcedar.
142B: Chaseburg	2o	Slight	Slight	Slight	Moderate	Northern red oak Sugar maple American basswood	65 — —	Red pine, eastern white pine, white spruce.
158, C158: Dorchester	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	63 63	Ponderosa pine, Austrian pine, Scotch pine, hackberry, green ash, poplars.
162B, 162C, 162C2, 162D, 162D2: Downs	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.

TABLE 3.—*Woodland management and productivity*—Continued

Map symbol and soil name	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
162E2: Downs	2r	Moderate	Moderate	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
163B, 163C, 163C2, 163D, 163D2, 163D3: Fayette	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
163E, 163E2, 163E3, 163F, 163F2, 163F3: Fayette	2r	Moderate	Moderate	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
163G: Fayette	2r	Severe	Severe	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
171B, 171C, 171C2, 171D2: Bassett	3o	Slight	Slight	Slight	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
171E2: Bassett	3r	Moderate	Moderate	Slight	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.

TABLE 3.—*Woodland management and productivity*—Continued

Map symbol and soil name	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
183C, 183D2: Dubuque	2o	Slight	Slight	Slight	Moderate	Northern red oak White oak	65 65	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut.
183E, 183E2, 183F: Dubuque	2r	Moderate	Moderate	Slight	Moderate	Northern red oak White oak	65 65	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut.
193: Camden	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	White oak, black walnut, green ash, eastern white pine, red pine, yellow-poplar, black locust, white ash.
215E: Goss	3f	Slight	Moderate	Moderate	Slight	White oak Northern red oak	50 50	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, black walnut, sugar maple.
265, 265B: Bixby	3o	Slight	Slight	Slight	Moderate	Northern red oak White oak	50 50	Eastern white pine, white spruce, northern red oak, Scotch pine, black walnut, sugar maple.
302B, 302C: Coggon	3o	Slight	Slight	Slight	Moderate	Northern red oak White oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
407B: Schley	3w	Slight	Moderate	Slight	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.

TABLE 3.—*Woodland management and productivity*—Continued

Map symbol and soil name	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
471: Oran	3o	Slight	Slight	Slight	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
478G: Rock outcrop part								
Nordness part	4d	Moderate	Moderate	Severe	Moderate	Northern red oak White oak	45 45	Eastern white pine, red pine, Norway spruce, Scotch pine.
480C, 480D2: Orwood	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
480E2: Orwood	2r	Moderate	Moderate	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
496B: Dorchester part	3o	Slight	Slight	Moderate	Moderate	White oak Northern red oak	55 55	Ponderosa pine, Austrian pine, Scotch pine, hackberry, green ash, poplars.
Volney part	3o	Slight	Slight	Slight	Moderate	Northern red oak White oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
497F: Fayette part	2r	Moderate	Moderate	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.

TABLE 3.—*Woodland management and productivity*—Continued

Map symbol and soil name	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
497F con. Dubuque part	2r	Moderate	Moderate	Slight	Moderate	Northern red oak White oak	65 65	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut.
Jacwin part								
497G: Fayette part	2r	Severe	Severe	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
Dubuque part	2r	Moderate	Moderate	Slight	Moderate	Northern red oak White oak	65 65	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut.
Jacwin part								
499B, 499D, 499F: Nordness	4d	Moderate	Moderate	Severe	Moderate	Northern red oak White oak	45 45	
714, 714B, 714C, 714D: Winneshiek	2o	Slight	Slight	Slight	Moderate	Northern red oak White oak	65 65	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut.
725: Hayfield	3o	Slight	Slight	Slight	Moderate	Northern red oak White oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, black walnut, sugar maple.

TABLE 3.—*Woodland management and productivity*—Continued

Map symbol and soil name	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
763D2: Exette	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, black walnut, green ash, sugar maple.
763E2, 763E3, 763F2, 763F3: Exette	2r	Moderate	Moderate	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, black walnut, green ash, sugar maple.
777, 777B, 777C: Wapsie	3o	Slight	Slight	Slight	Moderate	Northern red oak White oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
781B, 781C: Lourdes	3o	Slight	Slight	Slight	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
782, 782B, 782C: Donnan	3o	Slight	Moderate	Moderate	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.

TABLE 3.—*Woodland management and productivity*—Continued

Map symbol and soil name	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
784B: Riceville	3o	Slight	Slight	Slight	Moderate	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
926: Canoe	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, sugar maple, Norway spruce, Scotch pine, white spruce, European larch, poplars.
978: Festina	2o	Slight	Slight	Slight	Moderate	White oak Northern red oak	65 65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.

4. Determining areas that are suitable for acquisition to manage for wildlife.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, oats, barley, soybeans, and rye. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are fescue, bluegrass, lovegrass, switchgrass, bromegrass, timothy, orchardgrass, clover, alfalfa, trefoil, and crownvetch. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, indiangrass, goldenrod, ragweed, sunflower, pigweed, and dock. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts or

TABLE 4.—*Wildlife*

[See text for definitions of "good," "fair," "poor," and "very

Map symbol and soil name	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
27B: Terril	Good	Good	Good	Good
41, 41B, 41C, 41D: Sparta	Poor	Fair	Fair	Fair
63C, 63E: Chelsea	Poor	Fair	Fair	Poor
83B: Kenyon	Good	Good	Good	Good
83C, 83C2: Kenyon	Fair	Good	Good	Good
84: Clyde	Good	Good	Good	Fair
98, 98B: Huntsville	Good	Good	Good	Good
109B: Backbone	Fair	Fair	Good	Fair
109C, 109D: Backbone	Poor	Fair	Fair	Fair
110B: Lamont	Good	Good	Good	Good
110C: Lamont	Fair	Good	Good	Good
115F: Sandy escarpments	Very poor	Fair	Fair	Fair
135, C135: Coland	Good	Good	Good	Fair
142B: Chaseburg	Good	Good	Good	Good
151, 152: Marshan	Good	Good	Good	Fair
158, C158: Dorchester	Fair	Fair	Fair	Fair
162B: Downs	Good	Good	Good	Good
162C, 162C2, 162D, 162D2: Downs	Fair	Good	Good	Good
162E2: Downs	Poor	Fair	Good	Good
163B: Fayette	Good	Good	Good	Good
163C, 163C2, 163D, 163D2, 163D3: Fayette	Fair	Good	Good	Good
163E, 163E2, 163E3, 163F, 163F2, 163F3, 163G: Fayette	Poor	Fair	Good	Good
171B: Bassett	Good	Good	Good	Good

habitat potentials

poor." Absence of an entry indicates the soil was not rated]

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Good	Poor	Poor	Good	Good	Poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Very poor	Very poor	Fair	Poor	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Fair	Good	Good	Fair.
Poor	Good	Good	Good	Fair	Good.
Good	Poor	Poor	Good	Good	Poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Fair	Very poor	Very poor	Very poor	Fair	Very poor.
Poor	Good	Good	Good	Fair	Good.
Fair	Poor	Poor	Good	Good	Poor.
Poor	Good	Good	Good	Fair	Good.
Poor	Fair	Poor	Fair	Poor	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Fair	Good	Good	Fair.

TABLE 4.—*Wildlife habitat*

Map symbol and soil name	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
171C, 171C2, 171D2: Bassett	Fair	Good	Good	Good
171E2: Bassett	Poor	Fair	Good	Good
175B: Dickinson	Fair	Fair	Fair	Fair
175C, 175D: Dickinson	Fair	Fair	Fair	Fair
177, 177B: Saude	Good	Good	Good	Good
177C: Saude	Fair	Good	Good	Good
178, 178B: Waukee	Good	Good	Good	Good
183C, 183D2: Dubuque	Fair	Fair	Good	Good
183E, 183E2, 183F: Dubuque	Poor	Fair	Fair	Fair
193: Camden	Good	Good	Good	Good
198B: Floyd	Good	Good	Good	Fair
213, 213B, 214, 214B, 214C: Rockton	Good	Good	Good	Good
215E: Goss	Very poor	Poor	Fair	Fair
221: Palms	Good	Poor	Poor	Poor
225, 226: Lawler	Good	Good	Good	Good
265, 265B: Bixby	Good	Good	Good	Good
284, 284B: Flagler	Fair	Fair	Fair	Fair
284C: Flagler	Poor	Fair	Fair	Fair
285, 285B, 285C2: Burkhardt	Poor	Fair	Fair	Fair
285E2: Burkhardt	Very poor	Fair	Fair	Fair
302B: Coggon	Good	Good	Good	Good
302C: Coggon	Fair	Good	Good	Good
315: Loamy alluvial land	Poor	Fair	Fair	Fair

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Good	Poor	Fair	Good	Good	Fair.
Good	Poor	Poor	Fair	Good	Poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Fair	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Fair	Good	Good	Good	Fair	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Good	Good	Fair	Poor	Good.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor
Fair	Very poor	Very poor	Poor	Fair	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Fair	Good	Good	Fair.
Poor	Good	Fair	Fair	Fair	Fair.

TABLE 4.—*Wildlife habitat*

Map symbol and soil name	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
354: Marsh	Very poor	Very poor	Very poor	Very poor
391B: Clyde part	Good	Good	Good	Fair
Floyd part	Good	Good	Good	Fair
394B: Ostrander	Good	Good	Good	Good
394C, 394C2: Ostrander	Fair	Good	Good	Good
398: Tripoli	Good	Good	Good	Fair
399, 399B: Readlyn	Good	Good	Good	Fair
407B: Schley	Good	Good	Good	Fair
408B: Olin	Good	Good	Good	Good
408C: Olin	Fair	Good	Good	Good
409B: Dickinson	Fair	Fair	Fair	Fair
409C: Dickinson	Fair	Fair	Fair	Fair
444B: Jacwin	Fair	Fair	Fair	Poor
444C, 444D: Jacwin	Poor	Poor	Fair	Poor
471: Oran	Good	Good	Good	Fair
478G: Rock outcrop part				
Nordness part	Very poor	Poor	Poor	Poor
480C, 480D2: Orwood	Fair	Good	Good	Good
480E2: Orwood	Poor	Fair	Good	Good
485: Spillville	Good	Good	Good	Good
487B: Otter part	Good	Good	Good	Fair
Huntsville part	Good	Good	Good	Good
489: Ossian	Good	Good	Good	Fair
490: Caneek	Fair	Fair	Fair	Fair
496B: Dorchester part	Fair	Fair	Fair	Fair
Volney part	Poor	Fair	Fair	Fair

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Very poor	Good	Good	Fair	Very poor	Good.
Poor	Good	Good	Good	Fair	Good.
Fair	Good	Good	Good	Fair	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good	Fair	Good.
Fair	Fair	Fair	Good	Fair	Fair.
Fair	Good	Good	Good	Fair	Good.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Poor	Good	Good	Poor.
Fair	Poor	Poor	Fair	Fair	Very poor.
Fair	Very poor	Poor	Fair	Fair	Very poor.
Poor	Good	Good	Fair	Poor	Good.
Poor	Fair	Fair	Poor	Poor	Fair.
Fair	Fair	Fair	Good	Good	Fair.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Poor	Good	Good	Good	Fair	Good.
Good	Poor	Poor	Good	Good	Poor.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Fair	Fair	Good.
Poor	Fair	Poor	Fair	Poor	Poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.

TABLE 4.—*Wildlife habitat*

Map symbol and soil name	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
497F:				
Fayette part	Poor	Fair	Good	Good
Dubuque part	Poor	Fair	Fair	Fair
Jacwin part	Very poor	Very poor	Fair	Poor
497G:				
Fayette part	Very poor	Fair	Good	Good
Dubuque part	Very poor	Fair	Fair	Fair
Jacwin part	Very poor	Very poor	Fair	Fair
499B:				
Nordness	Poor	Poor	Poor	Poor
499D:				
Nordness	Poor	Poor	Poor	Poor
499F:				
Nordness	Very poor	Poor	Poor	Poor
512B, 512D:				
Marlean	Poor	Poor	Fair	Fair
536:				
Hanlon	Good	Good	Good	Good
551:				
Calamine	Poor	Poor	Fair	Poor
620B:				
Port Byron	Good	Good	Good	Good
714, 714B:				
Winneshiek	Fair	Good	Good	Good
714C, 714D:				
Winneshiek	Fair	Fair	Good	Good
725:				
Hayfield	Good	Good	Good	Good
763D2:				
Exette	Fair	Good	Good	Good
763E2, 763E3, 763F2, 763F3:				
Exette	Poor	Fair	Good	Good
777, 777B:				
Wapsie	Good	Good	Good	Good
777C:				
Wapsie	Fair	Good	Good	Good
781B:				
Lourdes	Good	Good	Good	Good
781C:				
Lourdes	Fair	Good	Good	Good
782, 782B:				
Donnan	Good	Good	Good	Good
782C:				
Donnan	Fair	Good	Good	Good
783B:				
Cresco	Good	Good	Good	Good
783C:				
Cresco	Fair	Good	Good	Good

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Good	Very poor	Very poor	Fair	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Fair	Poor	Poor	Poor	Fair.
Good	Very poor	Very poor	Fair	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Poor	Poor	Poor	Fair	Poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Fair	Very poor	Very poor	Poor	Poor	Very poor.
Good	Poor	Fair	Good	Good	Poor.
Poor	Good	Good	Fair	Poor	Good.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Fair.

TABLE 4.—*Wildlife habitat*

Map symbol and soil name	Potential for habitat elements			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees
784B: Riceville	Fair	Fair	Good	Fair
798B: Protivin	Fair	Fair	Good	Fair
926: Canoe	Good	Good	Good	Good
977: Richwood	Good	Good	Good	Good
978: Festina	Good	Good	Good	Good

other fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Examples of native plants are oak, poplar, cherry, apple, hawthorn, hickory, black walnut, blackberry, grape, and briers. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated good are Russian-olive, autumn-olive, and crabapple. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness.

Coniferous plants are cone-bearing trees, shrubs, or ground cover that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Examples are pine, spruce, hemlock, fir, yew, cedar, and juniper. Major soil properties that affect the growth of coniferous plants are depth of the root zone, available water capacity, and wetness.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, rushes, sedges, reeds, arrowhead, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, red fox, and woodchuck.

Woodland habitat consists of hardwoods or conifers or a mixture of both, with associated grasses, legumes, and wild herbaceous plants. Examples of wildlife attracted to this habitat are woodpeckers, fox squirrels, fox, raccoon, and white-tailed deer.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, shore birds, kingfishers, muskrat, mink, and beaver.

Recreation

The soils of the survey area are rated in table 5 according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreational use by the duration of flooding and the season when it occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 5 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation,

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—		
Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Fair	Fair	Fair	Fair	Fair	Fair.
Fair	Fair	Fair	Fair	Fair	Fair.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Poor	Good	Good	Poor.

special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 5 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 10.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stablizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet nor subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and not wet nor subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

The design and layout of paths and trails for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the period of use. They should have moderate slopes and have few or no stones or boulders on the surface (fig. 15).

Engineering [3]

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community decision-makers and planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in tables in this section are based on

[3] VOLNEY H. SMITH, assistant state conservation engineer, Soil Conservation Service, assisted in preparation of this section.

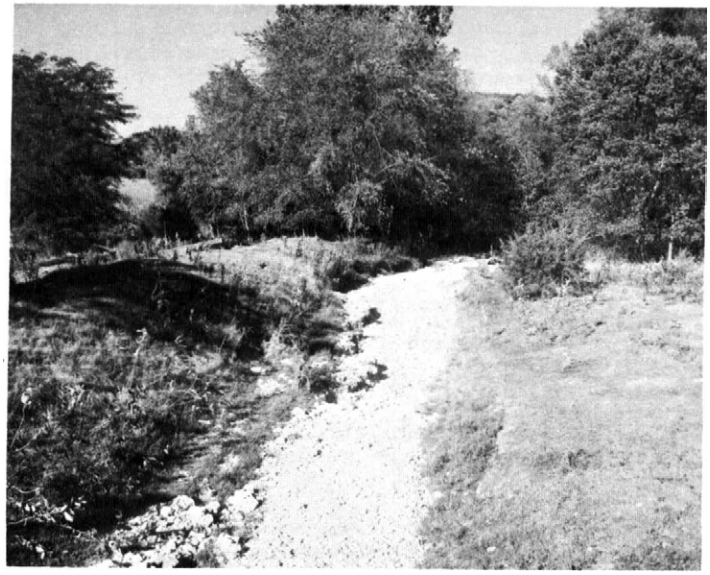

Figure 15.—Scenic area that is not suitable for campsites because of potential high-velocity flooding. Soils are in an area of Dorchester-Volney complex.

TABLE 5.—*Recreational development*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
27B: Terril	Slight	Slight	Moderate: slope	Slight.
41: Sparta	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
41B: Sparta	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy, slope.	Moderate: too sandy.
41C: Sparta	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
41D: Sparta	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope	Moderate: too sandy.
63C: Chelsea	Moderate: too sandy	Moderate: too sandy	Severe: too sandy, slope.	Moderate: too sandy.
63E: Chelsea	Severe: too sandy, slope.	Severe: slope	Severe: too sandy, slope.	Moderate: too sandy, slope.
83B: Kenyon	Moderate: percs slowly.	Slight	Moderate: slope	Slight.
83C, 83C2: Kenyon	Moderate: percs slowly, slope.	Slight	Severe: slope	Slight.
84: Clyde	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
98, 98B: Huntsville	Severe: floods	Moderate: floods	Moderate: floods	Slight.
109B: Backbone	Slight	Slight	Moderate: slope, depth to rock.	Slight.
109C: Backbone	Slight	Slight	Severe: slope	Slight.
109D: Backbone	Moderate: slope	Moderate: slope	Severe: slope	Slight.
110B: Lamont	Slight	Slight	Moderate: slope	Slight.
110C: Lamont	Moderate: slope	Moderate: slope	Severe: slope	Slight.
115F: Sandy escarpments	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
135, C135: Coland	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
142B: Chaseburg	Severe: floods	Moderate: floods, slope.	Severe: floods	Moderate: floods.
151, 152: Marshan	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.

TABLE 5.—*Recreational development*—Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
158, C158: Dorchester	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
162B: Downs	Slight	Slight	Moderate: slope	Slight.
162C, 162C2: Downs	Slight	Slight	Severe: slope	Slight.
162D, 162D2: Downs	Moderate: slope	Moderate: slope	Severe: slope	Slight.
162E2: Downs	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
163B: Fayette	Slight	Slight	Moderate: slope	Slight.
163C, 163C2: Fayette	Slight	Slight	Severe: slope	Slight.
163D, 163D2, 163D3: Fayette	Moderate: slope	Moderate: slope	Severe: slope	Slight.
163E, 163E2, 163E3, 163F, 163F2, 163F3: Fayette	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
163G: Fayette	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
171B: Bassett	Moderate: percs slowly.	Slight	Moderate: slope	Slight.
171C, 171C2: Bassett	Moderate: percs slowly.	Slight	Severe: slope	Slight.
171D2: Bassett	Moderate: slope, percs slowly.	Moderate: slope	Severe: slope	Slight.
171E2: Bassett	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
175B: Dickinson	Slight	Slight	Moderate: slope	Slight.
175C: Dickinson	Slight	Slight	Severe: slope	Slight.
175D: Dickinson	Moderate: slope	Moderate: slope	Severe: slope	Slight.
177: Saude	Slight	Slight	Slight	Slight.
177B: Saude	Slight	Slight	Moderate: slope	Slight.
177C: Saude	Slight	Slight	Severe: slope	Slight.
178: Waukee	Slight	Slight	Slight	Slight.
178B: Waukee	Slight	Slight	Moderate: slope	Slight.
183C: Dubuque	Slight	Slight	Severe: slope, depth to rock.	Slight.

TABLE 5.—*Recreational development*—Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
183D2: Dubuque	Moderate: slope	Moderate: slope	Severe: slope, depth to rock.	Slight.
183E, 183E2, 183F: Dubuque	Severe: slope	Severe: slope	Severe: slope, depth to rock.	Moderate: slope.
193: Camden	Slight	Slight	Slight	Slight.
198B: Floyd	Moderate: wetness	Moderate: wetness	Moderate: slope, wetness.	Moderate: wetness.
213: Rockton	Slight	Slight	Moderate: depth to rock.	Slight.
213B: Rockton	Slight	Slight	Moderate: depth to rock, slope.	Slight.
214: Rockton	Slight	Slight	Moderate: depth to rock.	Slight.
214B: Rockton	Slight	Slight	Moderate: depth to rock, slope.	Slight.
214C: Rockton	Slight	Slight	Severe: slope	Slight.
215E: Goss	Moderate: small stones, slope.	Moderate: small stones, slope.	Severe: small stones, slope.	Moderate: small stones.
221: Palms	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: wetness, excess humus.
225, 226: Lawler	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
265: Bixby	Slight	Slight	Slight	Slight.
265B: Bixby	Slight	Slight	Moderate: slope	Slight.
284: Flagler	Slight	Slight	Slight	Slight.
284B: Flagler	Slight	Slight	Moderate: slope	Slight.
284C: Flagler	Slight	Slight	Severe: slope	Slight.
285: Burkhardt	Slight	Slight	Slight	Slight.
285B: Burkhardt	Slight	Slight	Moderate: slope	Slight.
285C2: Burkhardt	Slight	Slight	Severe: slope	Slight.
285E2: Burkhardt	Moderate: slope	Moderate: slope	Severe: slope	Slight.

TABLE 5.—*Recreational development*—Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
302B: Coggon	Moderate: percs slowly.	Slight	Moderate: slope	Slight.
302C: Coggon	Moderate: percs slowly.	Slight	Severe: slope	Slight.
315: Loamy alluvial land	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
354: Marsh	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
391B: Clyde part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Floyd part	Moderate: wetness	Moderate: wetness	Moderate: slope, wetness.	Moderate: wetness.
394B: Ostrander	Slight	Slight	Moderate: slope	Slight.
394C, 394C2: Ostrander	Slight	Slight	Severe: slope	Slight.
398: Tripoli	Severe: wetness, percs slowly.	Severe: wetness	Severe: wetness	Severe: wetness.
399: Readlyn	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
399B: Readlyn	Moderate: wetness	Moderate: wetness	Moderate: wetness, slope.	Moderate: wetness.
407B: Schley	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
408B: Olin	Slight	Slight	Moderate: slope	Slight.
408C: Olin	Slight	Slight	Severe: slope	Slight.
409B: Dickinson	Slight	Slight	Moderate: slope	Slight.
409C: Dickinson	Slight	Slight	Severe: slope	Slight.
444B: Jacwin	Severe: percs slowly.	Moderate: wetness	Severe: percs slowly	Moderate: wetness.
444C: Jacwin	Severe: percs slowly.	Moderate: wetness	Severe: slope, percs slowly.	Moderate: wetness.
444D: Jacwin	Severe: percs slowly.	Moderate: slope, wetness.	Severe: slope, percs slowly.	Moderate: wetness.
471: Oran	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
478G: Rock outcrop part				
Nordness part	Severe: slope	Severe: slope	Severe: depth to rock.	Severe: slope.

TABLE 5.—*Recreational development*—Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
480C: Orwood	Slight	Slight	Severe: slope	Slight.
480D2: Orwood	Moderate: slope	Moderate: slope	Severe: slope	Slight.
480E2: Orwood	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
485: Spillville	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
487B: Otter part	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness.
Huntsville part	Severe: floods	Moderate: floods	Moderate: floods	Slight.
489: Ossian	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
490: Caneek	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
496B: Dorchester part	Severe: floods	Severe: floods	Severe: floods	Moderate: floods.
Volney part	Severe: floods	Severe: floods, small stones, large stones.	Severe: floods, large stones, depth to rock.	Moderate: floods, large stones, small stones.
497F: Fayette part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Dubuque part	Severe: slope	Severe: slope	Severe: slope, depth to rock.	Moderate: slope.
Jacwin part	Severe: percs slowly.	Severe: slope, wetness.	Severe: slope, percs slowly.	Moderate: wetness.
497G: Fayette part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Dubuque part	Severe: slope	Severe: slope	Severe: slope, depth to rock.	Severe: slope.
Jacwin part	Severe: percs slowly.	Severe: slope, wetness.	Severe: slope, percs slowly.	Severe: wetness, slope.
499B: Nordness	Slight	Slight	Severe: depth to rock.	Slight.
499D: Nordness	Moderate: slope	Moderate: slope	Severe: depth to rock.	Slight.
499F: Nordness	Severe: slope	Severe: slope	Severe: depth to rock.	Moderate: slope.
512B: Marlean	Slight	Slight	Moderate: slope, depth to rock.	Slight.
512D: Marlean	Moderate: slope	Moderate: slope	Severe: slope, depth to rock.	Slight.

TABLE 5.—*Recreational development*—Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
536: Hanlon	Severe: floods, soil blowing.	Moderate: floods	Moderate: floods	Slight.
551: Calamine	Severe: wetness, percs slowly.	Severe: wetness	Severe: wetness, percs slowly.	Severe: wetness.
620B: Port Byron	Slight	Slight	Moderate: slope	Slight.
714, 714B: Winneshiek	Slight	Slight	Moderate: depth to rock.	Slight.
714C: Winneshiek	Slight	Slight	Severe: slope	Slight.
714D: Winneshiek	Moderate: slope	Moderate: slope	Severe: slope	Slight.
725: Hayfield	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
763D2: Exette	Moderate: slope	Moderate: slope	Severe: slope	Slight.
763E2, 763E3, 763F2, 763F3: Exette	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
777: Wapsie	Slight	Slight	Slight	Slight.
777B: Wapsie	Slight	Slight	Moderate: slope	Slight.
777C: Wapsie	Slight	Slight	Severe: slope	Slight.
781B: Lourdes	Moderate: percs slowly.	Moderate: wetness	Moderate: slope, percs slowly.	Slight.
781C: Lourdes	Moderate: percs slowly.	Moderate: wetness	Severe: slope	Slight.
782, 782B: Donnan	Severe: percs slowly.	Moderate: wetness	Severe: percs slowly.	Moderate: wetness.
782C: Donnan	Severe: percs slowly.	Moderate: wetness	Severe: percs slowly, slope.	Moderate: wetness.
783B: Cresco	Moderate: percs slowly, wetness.	Moderate: wetness	Moderate: slope, percs slowly, wetness.	Slight.
783C: Cresco	Moderate: percs slowly, wetness.	Moderate: wetness	Severe: slope	Slight.
784B: Riceville	Moderate: wetness percs slowly.	Moderate: wetness	Moderate: slope, wetness, percs slowly.	Moderate: wetness.
798B: Protivin	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Moderate: wetness.

TABLE 5.—*Recreational development*—Continued

Map symbol and soil name	Camp areas	Picnic areas	Playgrounds	Paths and trails
926: Canoe	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.
977: Richwood	Slight	Slight	Slight	Slight.
978: Festina	Slight	Slight	Slight	Slight.

test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section are grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within a depth of 5 or 6 feet, soil wetness characteristics, depth to a seasonal water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

Based on the information assembled about soil properties, ranges of values may be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values may be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to—(1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 10 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 12, for water management. Table 11 shows the suitability of each kind of soil as a source of construction materials (See page 150).

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in the soil survey have different meanings in soil science than in engineering; the Glossary defines many of these terms.

Soil properties

Extensive data about soil properties collected during the soil survey are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses selected from representative soil profiles in the field.

When he makes soil borings during field mapping, the soil scientist can identify several important soil properties. He notes the seasonal soil moisture condition, or the presence of free water and its depth in the profile. For each horizon, he notes the thickness of the soil and its color; the texture, or the amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in-place under the existing soil moisture conditions. He records the root depth of existing plants, determines soil pH or reaction, and identifies any free carbonates.

Samples of soil material are analyzed in the lab-

oratory to verify the field estimates of soil properties and to characterize key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features, engineering test data, and data obtained from laboratory analyses, both physical and chemical, are presented.

Engineering properties

Table 6 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in value most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. Depth to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series in "Descriptions of the soils."

Texture is described in table 6 in standard terms used by the United States Department of Agriculture (USDA). These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms used by the USDA are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified soil classification system (*2*) and the American Association of State Highway and Transportation Officials soil classification system (AASHTO) (*1*). In table 6 soils in the survey area are classified according to both systems.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example CL–ML.

The AASHTO system is used to classify soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified as one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A–1 are coarse grained and low in content of fines. At the other extreme, in group A–7, are fine-grained soils. Highly organic soils are classified as A–8 on the basis of visual inspection.

When laboratory data are available, the A–1, A–2, and A–7 groups are further classified as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or more for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 13. The estimated classification, without group index numbers, is given in table 6.

Also in table 6 the percentage, by weight, of cobbles or the rock fragments more than 3 inches in diameter are estimated for each major horizon. These estimates are determined largely by observing volume percentage in the field and then converting it, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistency of soil material. These indexes are used in both the Unified and the AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior.

Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

Physical and chemical properties

Table 7 (See page 130) shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships between the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates are lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil

TABLE 6.—*Engineering properties*

[The symbol < means less than; > means greater than.

Map symbol and soil name	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
27B:				
Terril	0–38	Loam	OL, CL	A–4, A–6
	38–60	Loam, clay loam	CL	A–4, A–6
41, 41B, 41C, 41D:				
Sparta	0–16	Loamy fine sand	SM, SP–SM	A–2
	16–60	Sand	SP	A–3
63C, 63E:				
Chelsea	0–5	Loamy fine sand	SM	A–2–4
	5–60	Fine sand	SP, SM	A–3, A–2–4
83B, 83C, 83C2:				
Kenyon	0–17	Loam	CL	A–6
	17–52	Loam, clay loam	CL	A–6
	52–60	Loam	CL	A–6
84:				
Clyde	0–17	Clay loam	OL, MH, CL	A–7
	17–29	Silty clay loam, clay loam	CL	A–6, A–7
	29–36	Sandy loam	SM, SM–SC	A–2
	36–60	Loam	CL, SC	A–6
98, 98B:				
Huntsville	0–30	Silt loam	CL, ML	A–6, A–4
	30–60	Silt loam	CL, ML	A–4, A–6
109B, 109C, 109D:				
Backbone	0–9	Fine sandy loam	SM, SM–SC	A–2, A–4
	9–24	Sandy loam	SM, SC	A–2, A–4
	24–30	Clay loam	CL	A–6, A–7
	30–34	Clay	CH	A–7
	34	Unweathered bedrock		
110B, 110C:				
Lamont	0–8	Fine sandy loam	SM–SC, SC	A–2, A–4
	8–30	Fine sandy loam, loam	SM–SC, SC	A–2, A–4
	30–65	Fine sand	SM, SP–SM	A–2, A–3
115F:				
Sandy escarpments	0–60	Variable		
135, C135:				
Coland	0–10	Clay loam	OL, CL	A–6, A–7
	10–49	Loam	CL, SC	A–6, A–4
	49–60	Loamy sand	SM	A–2
142B:				
Chaseburg	0–60	Silt loam	ML	A–4
151, 152:				
Marshan	0–24	Clay loam	CL, CH	A–7
	24–30	Loam, sandy loam	CL, SC	A–4, A–6
	30–60	Coarse sand, gravelly coarse sand	SP, SW	A–1
158, C158:				
Dorchester	0–38	Silt loam	ML, CL–ML	A–4
	38–70	Silt loam	OL, ML, CL	A–6
162B, 162C, 162C2, 162D, 162D2, 162E2:				
Downs	0–13	Silt loam	CL, CL–ML	A–4, A–6
	13–30	Silty clay loam	CL	A–7, A–6
	30–60	Silt loam	CL	A–6

and classifications

Absence of an entry means data were not estimated]

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0–5	100	95–100	70–90	60–80	25–40	8–15
0–5	100	90–100	70–90	60–80	25–40	8–15
0	100	100	60–70	10–20	----------	[1] NP
0	100	100	65–75	1–5	----------	NP
0	100	100	65–80	10–35	----------	NP
0	100	100	65–80	3–15	----------	NP
0	100	95–100	85–95	65–75	30–40	10–20
0–5	90–95	85–95	80–90	50–65	30–40	10–20
0–5	90–95	85–95	80–90	50–65	25–35	10–20
0	100	100	80–90	55–75	45–60	15–25
0	95–100	90–95	75–90	50–75	30–50	10–20
0–5	80–95	75–90	50–80	15–35	15–20	NP–5
0–5	90–95	85–90	75–90	45–65	25–35	10–20
0	100	98–100	90–100	80–100	30–40	5–15
0	100	100	90–100	80–100	30–40	10–20
0	100	100	75–85	15–40	15–25	5–10
0–2	90–95	90–95	65–80	20–40	15–30	5–10
2–5	90–95	90–95	70–80	50–65	35–45	20–30
0–2	90–95	90–95	80–95	65–90	50–60	30–40
0	100	100	80–95	25–50	15–25	5–10
0	100	100	85–95	30–50	20–30	5–10
0	100	100	70–90	5–25	----------	NP
0	100	100	95–100	70–90	45–55	20–30
0	95–100	90–100	50–70	40–60	25–40	8–15
0	95–100	85–95	40–60	15–30	----------	NP
0	100	100	90–100	85–100	20–30	1–5
0	95–100	95–100	95–100	85–95	40–60	15–25
0	95–100	95–100	60–70	40–60	20–35	8–15
0–3	65–90	60–80	20–45	2–5	----------	NP
0	100	100	95–100	90–95	25–35	5–10
0	100	100	95–100	90–95	35–45	10–20
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	35–45	15–25
0	100	100	100	95–100	30–40	11–20

TABLE 6.—*Engineering properties*

Map symbol and soil name	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
163B, 163C, 163C2, 163D, 163D2, 163D3, 163E, 163E2, 163E3, 163F, 163F2, 163F3, 163G:				
Fayette	0–11	Silt loam	CL–ML, CL	A–4, A–6
	11–47	Silty clay loam	CL	A–7, A–6
	47–73	Silt loam	CL	A–6
171B, 171C, 171C2, 171D2, 171E2:				
Bassett	0–14	Loam	CL, CL–ML	A–4, A–6
	14–51	Loam, clay loam	CL	A–6
	51–60	Loam	CL	A–6
175B, 175C, 175D:				
Dickinson	0–20	Fine sandy loam	SM, SC	A–4
	20–35	Loamy sand	SM, SP	A–2
	35–60	Fine sand	SP, SM	A–3, A–2
177, 177B, 177C:				
Saude	0–18	Loam	CL	A–6
	18–32	Loam, sandy loam	CL, SC, CL–ML, SM–SC	A–4, A–6
	32–60	Loamy sand, gravelly coarse sand	SW, SM	A–1
178, 178B:				
Waukee	0–21	Loam	CL	A–4, A–6
	21–37	Loam, sandy clay loam	CL, SM–SC, SC, CL–ML	A–6, A–4
	37–60	Gravelly sand, loamy coarse sand	SW, SM	A–1, A–2
183C, 183D2, 183E, 183E2, 183F:				
Dubuque	0–12	Silt loam	ML, CL–ML	A–4, A–6
	12–20	Silt loam, silty clay loam	CL	A–6, A–7
	20–25	Clay	CH	A–7
	25	Unweathered bedrock		
193:				
Camden	0–15	Silt loam	ML, CL	A–4, A–6
	15–40	Silty clay loam, clay loam, silt loam	CL	A–6
	40–60	Sandy loam, sandy clay loam	SM, SM–SC	A–4, A–6
198B:				
Floyd	0–19	Loam	OL, MH	A–7
	19–27	Sandy clay loam	CL	A–6
	27–32	Loamy sand	SM	A–2
	32–60	Loam, sandy clay loam	CL, CL–ML	A–6
213, 213B, 214, 214B, 214C:				
Rockton	0–17	Loam	ML, CL–ML	A–4
	17–31	Loam, sandy clay loam, clay loam	CL, SC	A–6, A–7
	31–33	Clay, silty clay	CH, MH	A–7
	33	Weathered bedrock		
215E:				
Goss	0–6	Loam	CL, CL–ML	A–4, A–7
	6–13	Cherty loam	SC, SM	A–2
	13–70	Cherty clay	GC, GM, SC, SM	A–2
221:				
Palms	0–28	Sapric material	Pt	A–8
	28–60	Stratified loamy sand to silt loam	ML, CL, SM, SC	A–4, A–6, A–2
225, 226:				
Lawler	0–20	Loam	OL, CL	A–6, A–7
	20–30	Loam, sandy clay loam	CL, SC	A–6
	30–60	Sand	SP, SP–SM	A–1
265, 265B:				
Bixby	0–9	Loam	CL–ML, CL	A–4
	9–30	Loam, sandy clay loam, clay loam	CL–ML, CL, SC, SM–SC	A–4, A–6
	30–60	Stratified coarse sand to gravelly sand.	SP	A–1

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	35–45	15–25
0	100	100	100	95–100	30–40	10–20
0	100	95–100	85–95	65–85	20–30	5–15
2–5	90–95	85–95	80–90	50–65	30–40	10–20
2–5	90–95	85–95	80–90	50–65	30–40	10–20
0	100	100	85–95	35–50	15–30	NP–10
0	100	100	80–95	5–20	10–30	NP–5
0	100	100	70–90	5–20		NP
0	100	90–100	70–90	50–75	25–35	10–15
0–5	85–95	80–95	70–85	36–60	20–30	5–15
2–10	50–90	50–85	20–40	3–25		NP
0	100	90–100	70–90	50–75	30–40	10–20
0–5	85–95	80–95	65–85	40–60	20–35	5–15
2–10	60–90	60–85	20–40	3–25		NP
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	35–45	15–25
2–10	85–95	80–90	70–85	65–85	50–70	30–45
0	100	95–100	90–100	80–95	25–35	5–15
0	95–100	90–100	90–100	60–90	30–40	10–20
0	100	90–95	65–85	35–50	20–35	5–15
0	100	100	80–90	55–75	45–60	15–20
2–8	90–95	70–80	50–70	50–65	25–35	5–15
2–5	90–95	70–80	50–70	15–35		NP
2–5	90–95	85–95	70–85	50–65	25–35	5–20
0	90–100	90–100	65–85	50–75	25–35	5–15
0	90–100	90–100	75–90	45–70	30–45	10–20
0–2	90–100	90–100	90–95	70–90	50–60	30–40
0						
0–10	65–90	65–90	60–70	55–65	20–30	5–15
10–40	40–60	35–55	30–50	25–35	20–30	2–10
10–45	20–40	20–40	20–30	20–30	30–40	8–20
0	95–100	85–95	40–90	15–65	<40	NP–20
0	100	90–100	70–90	55–75	35–45	10–25
0–5	85–95	80–95	70–85	45–65	25–40	10–20
2–10	50–90	50–85	20–40	3–10		NP
0	98–100	95–100	80–95	50–65	25–40	5–10
0	95–100	90–100	75–95	45–70	30–40	8–15
0	80–95	60–90	25–50	2–5		NP

TABLE 6.—*Engineering properties*

Map symbol and soil name	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
284, 284B, 284C:				
Flagler	0–20	Sandy loam	SC, SM–SC	A–2, A–4
	20–28	Sandy loam, gravelly sandy loam	SC, SM–SC	A–2, A–4
	28–60	Sand, gravelly loamy sand	SP–SM, SW, SP, SW–SM	A–1, A–3
285, 285B, 285C2, 285E2:				
Burkhardt	0–15	Sandy loam	SM	A–2, A–4
	15–60	Sand and gravel	SP	A–1
302B, 302C:				
Coggon	0–16	Loam	CL, CL–ML	A–4, A–6
	16–38	Loam, clay loam	CL	A–6
	38–60	Loam	CL	A–6
315:				
Loamy alluvial land	0–60	Variable	----------	----------
354:				
Marsh	0–60	Variable	----------	----------
391B:				
Clyde part	0–17	Clay loam	OL, MH, CL	A–7
	17–29	Silty clay loam, clay loam	CL	A–6, A–7
	29–36	Sandy loam	SM, SM–SC	A–2
	30–60	Loam	CL, SC	A–6
Floyd part	0–19	Loam	OL, MH	A–7
	19–27	Sandy clay loam	CL	A–6
	27–32	Loamy sand	SM	A–2
	32–60	Loam, sandy clay loam	CL, CL–ML	A–6
394B, 394C, 394C2:				
Ostrander	0–15	Loam	CL–ML, CL	A–4, A–6
	15–24	Sandy clay loam, loam, sandy loam	CL, SC	A–6
	24–90	Loam	CL	A–6
398:				
Tripoli	0–21	Clay loam	CL	A–6, A–7
	21–27	Clay loam, loam	CL	A–6
	27–60	Loam	CL	A–6
399, 399B:				
Readlyn	0–18	Loam	CL	A–6
	18–43	Loam	CL	A–6
	43–60	Loam	CL	A–6
407B:				
Schley	0–15	Loam	CL, ML, CL–ML	A–4, A–6
	15–45	Sandy loam, sandy clay loam, loamy sand.	CL, SC, SM–SC, CL–ML	A–2, A–4
	45–60	Loam, sandy loam, sandy clay loam	CL	A–6
408B, 408C:				
Olin	0–33	Fine sandy loam	SM–SC, SC	A–2, A–4
	33–60	Loam	CL, SC	A–6
409B, 409C:				
Dickinson	0–40	Fine sandy loam	SM, SC, SM–SC	A–2, A–4
	40–60	Loam	CL	A–6
444B, 444C, 444D:				
Jacwin	0–24	Loam	OL, ML, OH	A–7
	24–31	Sandy loam	SC, SM–SC	A–6
	31–38	Silty clay, clay	CL, CH	A–7
	38	Weathered bedrock	----------	----------

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	95–100	90–95	60–70	25–40	15–25	5–10
0	95–100	90–95	50–70	25–40	15–25	5–10
0–5	70–90	70–85	20–40	3–12		NP
0	95–100	95–100	60–70	30–40	<26	NP–4
0	75–85	60–85	20–35	1–5		NP
0	100	95–100	90–95	65–85	20–30	5–15
2–5	90–95	85–95	80–90	50–65	30–40	10–20
2–5	90–95	85–95	80–90	50–65	30–40	10–20
0	100	100	80–90	55–75	45–60	15–25
0	95–100	90–95	75–90	50–75	30–50	10–20
0–5	80–95	75–90	50–80	15–35	15–20	NP–5
0–5	90–95	85–90	75–90	45–65	25–35	10–20
0	100	100	80–90	55–75	45–60	15–20
2–8	90–95	70–80	50–70	50–65	25–35	5–15
2–5	90–95	70–80	50–70	15–35		NP
2–5	90–95	85–95	70–85	50–65	25–35	5–20
0	100	98–100	90–95	70–90	25–40	5–15
0–2	95–100	75–98	65–90	45–65	25–35	10–20
0–1	95–100	90–98	80–95	50–75	25–40	10–20
0	100	100	85–95	55–75	35–45	15–25
2–5	90–95	85–90	75–85	55–65	30–40	11–20
2–5	90–95	85–90	75–85	55–65	30–40	11–20
0	100	100	85–95	55–75	30–40	15–25
2–5	90–95	85–90	75–85	55–65	30–40	10–20
2–5	90–95	85–90	75–85	55–65	25–35	10–20
0	100	95–100	80–90	55–75	25–40	5–15
2–8	90–95	70–80	50–70	20–60	20–30	5–10
2–5	90–95	85–95	70–85	50–65	25–40	10–20
0	100	95–100	85–95	30–50	20–30	5–10
2–5	90–95	85–95	80–90	45–65	25–35	10–20
0	100	100	80–95	35–50	15–30	5–10
2–5	90–95	85–95	80–90	55–65	25–35	11–20
0	100	100	90–95	50–65	40–55	10–15
2–5	95–100	90–95	55–75	35–50	15–25	5–10
0	100	100	95–100	80–95	40–55	20–30

TABLE 6.—*Engineering properties*

Map symbol and soil name	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
471:				
Oran	0–18	Loam	CL, CL–ML	A–4, A–6
	18–58	Loam, clay loam	CL	A–6
	58–74	Loam	CL	A–6
478G:				
Rock outcrop part				
Nordness part	0–11	Silt loam	CL, CL–ML	A–4
	11–16	Silty clay loam, clay, silty clay	CL, CH	A–7
	16	Unweathered bedrock		
480C, 480D2, 480E2:				
Orwood	0–8	Silt loam	ML, CL	A–4, A–6
	8–42	Silt loam, silty clay loam	CL	A–6
	42–60	Silt loam	CL	A–6
485:				
Spillville	0–54	Loam	CL, OL	A–6
	54–60	Sandy loam	SM	A–2
487B:				
Otter part	0–51	Silt loam	CL, ML	A–6, A–7
	51–60	Silt loam	CL, ML	A–7, A–6
Huntsville part	0–30	Silt loam	CL, ML	A–6, A–4, A–7
	30–60	Silt loam	CL	A–4, A–6
489:				
Ossian	0–18	Silt loam	OL, ML, CL	A–6, A–7
	18–60	Silt loam	CL	A–6
490:				
Caneek	0–23	Silt loam	ML, CL–ML	A–4
	23–60	Silt loam	OL, ML, CL	A–6, A–7
496B:				
Dorchester part	0–38	Silt loam	ML, CL–ML	A–4
	38–70	Silt loam	OL, ML, CL	A–6
Volney part	0–30	Channery silt loam	SM–SC, SC	A–2, A–4
	30–50	Fragmental material	GW–GC, GC	A–1, A–2
497F:				
Fayette part	0–11	Silt loam	CL–ML, CL	A–4, A–6
	11–47	Silty clay loam	CL	A–7, A–6
	47–73	Silt loam	CL	A–6
Dubuque part	0–12	Silt loam	ML, CL–ML	A–4, A–6
	12–20	Silt loam, silty clay loam	CL	A–6, A–7
	20–25	Clay	CH	A–7
	25	Unweathered bedrock		
Jacwin part	0–24	Loam	OL, ML, OH	A–7, A–6
	24–31	Loam, sandy loam	SC, SM–SC	A–4
	31–38	Silty clay, clay	CL, CH	A–7
	38–60	Weathered bedrock		
497G:				
Fayette part	0–11	Silt loam	CL–ML, CL	A–4, A–6
	11–47	Silty clay loam	CL	A–7, A–6
	47–73	Silt loam	CL	A–6
Dubuque part	0–12	Silt loam	ML, CL–ML	A–4, A–6
	12–20	Silt loam, silty clay loam	CL	A–6, A–7
	20–25	Clay	CH	A–7
	25	Unweathered bedrock		

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	85–95	55–75	25–35	5–15
2–5	90–95	85–90	75–85	55–65	30–40	10–20
2–5	90–95	85–90	75–85	55–65	30–40	10–20
0	100	100	90–100	70–90	20–30	5–10
2–10	85–95	80–90	70–85	65–85	45–65	30–40
0	100	100	90–100	80–90	30–40	8–15
0	100	100	85–95	60–80	30–40	10–20
0	100	100	85–95	70–90	30–40	10–20
0	100	95–100	85–95	60–80	25–40	10–20
0	95–100	85–95	40–60	15–30	NP	NP–20
0	100	98–100	90–100	80–100	30–50	10–20
0	100	95–100	90–100	80–100	30–50	10–20
0	100	98–100	90–100	80–100	36–50	10–25
0	100	100	90–100	80–100	20–40	10–20
0	100	100	100	95–100	35–50	11–25
0	100	100	100	95–100	30–40	11–20
0	100	100	95–100	90–95	25–35	5–10
0	100	100	95–100	90–95	35–45	10–20
0	100	100	95–100	90–95	25–35	5–10
0	100	100	95–100	90–95	35–45	10–20
20–30	50–60	40–60	30–50	25–50	15–25	5–15
60–90	10–40	10–30	10–20	3–12	<20	3–10
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	35–45	15–25
0	100	100	100	95–100	30–40	10–20
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	35–45	15–25
2–10	85–95	80–90	70–85	65–85	50–70	30–45
0	100	100	90–95	50–65	35–50	10–15
2–5	95–100	90–95	55–75	35–50	15–30	5–10
0	100	100	95–100	80–95	40–55	20–30
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	35–45	15–25
0	100	100	100	95–100	30–40	10–20
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	35–45	15–25
2–10	85–95	80–90	70–85	65–85	50–70	30–45

TABLE 6.—*Engineering properties*

Map symbol and soil name	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
497G—Con.				
Jacwin part	0–24	Loam	OL, ML, OH	A–7, A–6
	24–31	Loam, sandy loam	SC, SM–SC	A–4
	31–38	Silty clay, clay	CL, CH	A–7
	38	Weathered bedrock		
499B, 499D, 499F:				
Nordness	0–11	Silt loam	CL, CL–ML	A–4
	11–16	Silty clay loam, clay, silty clay	CH	A–7
	16	Unweathered bedrock		
512B, 512D:				
Marlean	0–15	Loam	CL, CL–ML	A–4, A–6
	15–52	Fragmental material	GP, GP–GM	A–1
	52	Unweathered bedrock		
536:				
Hanlon	0–65	Fine sandy loam	SM–SC, SC	A–4
	65–72	Loamy fine sand	SM, SM–SC	A–2, A–4
551:				
Calamine	0–17	Silty clay loam	CL	A–6
	17–29	Silty clay loam	CL	A–6
	29–40	Silty clay	CH	A–7
	40–60	Weathered bedrock	CH	A–7
620B:				
Port Byron	0–15	Silt loam	CL	A–4, A–6
	15–60	Silt loam	CL	A–4, A–6
714, 714B, 714C, 714D:				
Winneshiek	0–11	Loam	CL, CL–ML	A–4, A–6
	11–18	Clay loam	CL	A–6
	18–24	Clay, silty clay	CH	A–7
	24	Unweathered bedrock		
725:				
Hayfield	0–8	Loam	ML, CL	A–6
	8–28	Loam, silt loam	ML, CL	A–4, A–6
	28–60	Coarse sand, gravelly loamy sand, loamy sand.	SM, SP–SM	A–1, A–2
763D2, 763E2, 763E3, 763F2, 763F3:				
Exette	0–6	Silt loam	ML, CL–ML	A–4
	6–33	Silt loam	ML, CL	A–6
	33–60	Silt loam	CL, ML	A–4, A–6
777, 777B, 777C:				
Wapsie	0–7	Loam	CL	A–4
	7–23	Loam, sandy clay loam, clay loam	CL, SC, CL–ML	A–4, A–6
	23–60	Gravelly loamy sand, gravelly sand	SM, SP, SP–SM	A–1
781B, 781C:				
Lourdes	0–8	Loam	ML, CL	A–6, A–7
	8–15	Loam	CL	A–6
	15–44	Clay loam	CL	A–6
	44–60	Clay loam	CL	A–6
782, 782B, 782C:				
Donnan	0–13	Loam	CL–ML, CL, ML	A–4, A–6
	13–24	Clay loam	CL	A–6, A–7
	24–48	Clay	CH	A–7
	48–60	Clay loam	CL	A–6, A–7
783B, 783C:				
Cresco	0–17	Loam	CL, OL	A–6, A–7
	17–60	Clay loam	CL	A–6

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	90–95	50–65	35–50	10–15
2–5	95–100	90–95	55–75	35–50	15–30	5–10
0	100	100	95–100	80–95	40–55	20–30
0	100	100	90–100	70–90	20–30	5–10
2–10	85–95	80–90	70–85	65–85	45–65	30–40
5–15	75–85	70–80	60–70	50–65	20–30	5–15
20–50	15–30	5–25	5–15	3–5		NP
0	100	100	75–80	35–50	20–30	5–10
0	100	100	75–80	25–40	10–20	2–5
0	100	100	95–100	90–100	40–50	20–30
0	100	100	95–100	90–100	40–50	20–30
0	100	100	95–100	90–100	50–60	25–35
0	100	100	95–100	90–100	50–60	25–35
0	100	100	100	95–100	25–40	7–18
0	100	100	100	95–100	25–40	7–18
0	100	95–100	85–95	55–70	20–30	5–15
2–5	90–95	80–95	80–90	50–65	25–40	11–20
2–10	85–95	80–95	80–90	70–90	55–70	30–45
0	100	100	90–98	70–90	30–40	10–20
0	98–100	95–100	70–90	65–80	25–40	5–15
0–3	85–100	75–98	20–45	5–25		NP
0	100	100	100	95–100	25–35	5–10
0	100	100	100	95–100	30–40	11–15
0	100	100	100	95–100	30–40	8–15
0	100	90–100	70–90	50–75	25–35	5–10
0	85–95	80–95	70–85	40–60	20–35	5–15
0	60–90	60–85	20–40	3–25		NP
0	100	100	90–95	65–80	35–45	11–20
0	100	95–100	80–90	50–70	30–40	11–20
2–5	90–95	85–95	80–90	55–70	35–40	15–25
2–5	90–95	85–95	80–90	55–70	35–40	15–25
0	100	100	85–95	65–80	30–40	5–20
0–5	95–100	90–95	80–90	60–75	35–50	15–30
0–5	95–100	90–95	80–90	60–75	55–70	30–40
2–5	95–100	85–95	80–90	55–75	35–45	15–25
0	100	100	90–100	70–80	35–50	10–20
2–5	95–100	85–95	80–90	55–70	35–40	15–25

TABLE 6.—*Engineering properties*

Map symbol and soil name	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
784B:				
Riceville	0–7	Loam	OL, ML, CL	A–6, A–7
	7–14	Loam, clay loam	CL	A–6
	14–60	Clay loam	CL	A–6
798B:				
Protivin	0–18	Loam	MH, OL, CL	A–7
	18–28	Loam	CL	A–6
	28–60	Clay loam	CL	A–6
926:				
Canoe	0–8	Silt loam	CL–ML, CL	A–4, A–6
	8–17	Silt loam	CL–ML, CL	A–4
	17–60	Silt loam	CL	A–6
977:				
Richwood	0–18	Silt loam	ML, CL–ML	A–4
	18–60	Silt loam, silty clay loam	CL	A–4, A–6
978:				
Festina	0–14	Silt loam	CL–ML, CL	A–4, A–6
	14–60	Silt loam, silty clay loam	CL	A–6

[1] NP means nonplastic.

horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops and ornamental or other plants to be grown, in evaluating soil amendments for fertility and stabilization, and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is largely affected by the quality of the irrigation water and the irrigation practices. Hence, the salinity of individual fields can differ greatly from the value given in table 7. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A *high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 7, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to pre-

and classifications—Continued

Fragments >3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	85–95	60–75	35–45	15–20
2–5	90–95	85–90	75–85	55–65	30–40	15–20
2–5	90–95	85–90	75–85	55–65	35–40	15–25
0	100	100	85–95	60–75	45–55	15–20
2–5	90–95	85–90	75–85	55–65	35–40	15–20
2–5	90–95	85–90	75–85	55–65	35–40	15–25
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	20–30	5–10
0	100	100	100	95–100	30–40	10–20
0	100	100	90–100	85–95	25–35	5–15
0	100	100	90–100	85–95	30–40	10–20
0	100	100	100	95–100	25–35	5–15
0	100	100	100	95–100	30–40	10–20

dict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.
5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.
6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Features that relate to runoff or infiltration of water, to flooding, to grading and excavation, and to frost action of each soil are indicated in table 8 (See page 142). This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a high water table, by the presence of bedrock or a cemented pan in the upper 5 or 6 feet of the soil, or by frost action.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil after prolonged wetting are depth to a water table, water intake rate and permeability after prolonged wetting, and depth to layers of slowly or very slowly permeable soil.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when flooding is most likely. The ratings are based on evidences in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic matter content as depth increases; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape posi-

TABLE 7.—*Physical and chemical*

[Dashes indicate data were not available. The symbol < means less than; > means greater than. The

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
27B:				
Terril	0–38	0.6–2.0	0.20–0.22	6.1–7.3
	38–60	0.6–2.0	0.16–0.18	6.1–7.3
41, 41B, 41C, 41D:				
Sparta	0–16	6.0–20	0.06–0.08	5.6–6.0
	16–60	6.0–20	0.06–0.08	5.6–6.0
63C, 63E:				
Chelsea	0–5	6.0–20	0.10–0.15	6.1–6.5
	5–60	6.0–20	0.06–0.08	5.1–5.5
83B, 83C, 83C2:				
Kenyon	0–17	0.6–2.0	0.20–0.22	5.6–6.5
	17–52	0.2–0.6	0.17–0.19	5.1–7.3
	52–60	0.2–0.6	0.17–0.19	7.4–8.4
84:				
Clyde	0–17	0.6–2.0	0.21–0.23	6.6–7.3
	17–29	0.6–2.0	0.18–0.20	6.6–7.3
	29–36	2.0–6.0	0.11–0.13	6.6–7.3
	36–60	0.2–0.6	0.17–0.19	6.6–8.4
98, 98B:				
Huntsville	0–30	0.6–2.0	0.22–0.24	6.1–7.3
	30–60	0.6–2.0	0.20–0.22	6.1–7.8
109B, 109C, 109D:				
Backbone	0–9	2.0–6.0	0.12–0.14	6.6–7.3
	9–24	2.0–6.0	0.11–0.13	6.6–7.3
	24–30	0.2–0.6	0.14–0.16	5.1–7.3
	30–34	<0.06	0.11–0.14	5.1–5.5
	34			
110B, 110C:				
Lamont	0–8	2.0–6.0	0.16–0.18	5.1–7.3
	8–30	2.0–6.0	0.14–0.16	5.6–6.0
	30–65	>20	0.09–0.11	5.1–6.0
115F:				
Sandy escarpments	0–60			
135, C135:				
Coland	0–10	0.2–0.6	0.20–0.22	6.1–6.5
	10–49	0.2–0.6	0.20–0.22	6.1–6.5
	49–60	2.0–6.0	0.10–0.12	6.1–6.5
142B:				
Chaseburg	0–60	0.6–2.0	0.20–0.24	6.1–7.3
151, 152:				
Marshan	0–24	0.6–2.0	0.20–0.22	6.1–7.3
	24–30	0.6–2.0	0.20–0.22	6.1–7.3
	30–60	6.0–20	0.02–0.05	6.1–7.3
158, C158:				
Dorchester	0–38	0.6–2.0	0.20–0.22	7.9–8.4
	38–70	0.6–2.0	0.22–0.24	6.6–7.3
162B, 162C, 162C2, 162D, 162D2, 162E2:				
Downs	0–13	2.0–6.0	0.21–0.23	5.1–6.5
	13–30	0.6–2.0	0.18–0.20	5.1–5.5
	30–60	0.6–2.0	0.18–0.20	5.6–6.0

properties of soils

erosion tolerance factor (T) is for the entire profile. Absence of an entry means data were not estimated]

Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
		Uncoated steel	Concrete	K	T	
Mmhos/cm						
<2	Low	Moderate	Low	0.24	5	6
<2	Low	Moderate	Low	0.32		
<2	Low	Low	Low	0.17	5	2
<2	Low	Low	Low	0.17		
<2	Low	Low	Low	0.17	5	2
<2	Low	Low	Low	0.17		
<2	Low	Moderate	Moderate	0.28	5–4	6
<2	Low	Moderate	Moderate	0.28		
<2	Low	Moderate	Moderate	0.37		
<2	Moderate	High	Low			7
<2	Moderate	High	Low			
<2	Low	High	Low			
<2	Moderate	High	Low			
<2	Moderate	Low	Low			6
<2	Moderate	Low	Low			
<2	Low	Low	Low	0.24	4–3	3
<2	Low	Low	Low	0.24		
<2	Moderate	Low	Low	0.24		
	High	Low	Low	0.24		
<2	Very low	Low	Moderate	0.24	5–4	3
<2	Very low	Low	Moderate	0.24		
<2	Very low	Low	Moderate	0.17		
<2	High	High	Low			7
<2	High	High	Low			
<2	Low	High	Low			
<2	Low	Moderate	Low	0.37	5	5
<2	Moderate	High	Moderate			7
<2	Moderate	High	Moderate			
<2	Low	High	Low			
<2	Low	High	Low			6
<2	Moderate	High	Low			
<2	Low	Moderate	Moderate	0.32	5–4	6
<2	Moderate	Moderate	Moderate	0.43		
<2	Moderate	Moderate	Moderate	0.43		

TABLE 7.—*Physical and chemical*

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
163B, 163C, 163C2, 163D, 163D2, 163D3, 163E, 163E2, 163E3, 163F, 163F2, 163F3, 163G:				
Fayette	0–11	2.0–6.0	0.20–0.22	5.1–6.0
	11–47	0.6–2.0	0.18–0.20	4.5–5.5
	47–73	0.6–2.0	0.18–0.20	5.1–5.5
171B, 171C, 171C2, 171D2, 171E2:				
Bassett	0–14	0.6–2.0	0.19–0.21	5.1–6.5
	14–51	0.2–0.6	0.17–0.19	4.5–5.5
	51–60	0.2–0.6	0.17–0.19	5.1–7.8
175B, 175C, 175D:				
Dickinson	0–20	2.0–6.0	0.12–0.15	5.6–6.5
	20–35	6.0–20	0.08–0.10	5.6–6.5
	35–60	6.0–20	0.02–0.04	5.6–6.5
177, 177B, 177C:				
Saude	0–18	0.6–2.0	0.20–0.22	5.6–6.5
	18–32	0.6–6.0	0.15–0.19	5.6–6.0
	32–60	>20	0.02–0.06	5.1–6.0
178, 178B:				
Waukee	0–21	0.6–2.0	0.20–0.22	5.6–6.5
	21–37	0.6–2.0	0.15–0.19	5.6–6.0
	37–60	>20	0.02–0.06	5.6–6.0
183C, 183D2, 183E, 183E2, 183F:				
Dubuque	0–12	0.6–2.0	0.20–0.22	5.6–6.5
	12–20	0.6–2.0	0.18–0.20	5.6–6.0
	20–25	0.06–0.2	0.12–0.15	5.6–6.0
	25			
193:				
Camden	0–15	0.6–2.0	0.22–0.24	5.1–6.0
	15–40	0.6–2.0	0.16–0.20	5.1–6.0
	40–60	0.6–6.0	0.12–0.18	5.6–7.3
198B:				
Floyd	0–19	0.6–2.0	0.20–0.22	6.6–7.3
	19–27	0.6–2.0	0.11–0.18	6.6–7.3
	27–32	2.0–6.0	0.11–0.13	6.6–7.3
	32–60	0.2–0.6	0.16–0.18	6.6–7.8
213, 213B, 214, 214B, 214C:				
Rockton	0–17	0.6–2.0	0.20–0.22	5.1–6.5
	17–31	0.6–2.0	0.17–0.19	5.1–6.5
	31–33	0.06–0.2	0.10–0.14	5.6–7.3
	33			
215E:				
Goss	0–6	2.0–6.0	0.06–0.17	5.1–6.0
	6–13	2.0–6.0	0.06–0.10	5.1–6.0
	13–70	0.6–2.0	0.04–0.09	5.1–6.0
221:				
Palms	0–28	0.2–6.0	0.35–0.45	5.1–7.8
	28–60	0.2–6.0	0.05–0.19	6.1–8.4
225, 226:				
Lawler	0–20	0.6–2.0	0.20–0.22	5.6–6.0
	20–30	0.6–2.0	0.16–0.18	5.6–6.5
	30–60	6.0–20	0.02–0.04	6.1–6.5
265, 265B:				
Bixby	0–9	0.6–2.0	0.16–0.19	5.6–6.5
	9–30	0.6–2.0	0.14–0.18	4.5–6.0
	30–60	6.0–20	0.02–0.04	6.1–7.8

properties of soils—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
		Uncoated steel	Concrete	K	T	
Mmhos/cm						
<2	Low	Moderate	Moderate	0.37	5–4	6
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	Moderate	Moderate	0.37		
<2	Low	Moderate	Moderate	0.28	5–4	6
<2	Low	Moderate	Moderate	0.28		
<2	Low	Moderate	Moderate	0.37		
<2	Low	Low	Moderate	0.20	4–3	3
<2	Low	Low	Moderate	0.20		
<2	Low	Low	Moderate	0.15		
<2	Low	Low	Moderate	0.28	4–3	5
<2	Low	Low	Moderate	0.28		
<2	Very low	Low	Moderate	0.10		
<2	Low	Low	Moderate	0.24	4–3	6
<2	Low	Low	Moderate	0.32		
<2	Very low	Low	Moderate	0.10		
<2	Low	Moderate	Moderate	0.37	4–3	6
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	Moderate	Moderate	0.37		
<2	Low	Low	Moderate	0.37	5–4	6
<2	Moderate	Low	Moderate	0.37		
<2	Low	Low	Low	0.37		
<2	Moderate	High	Low	0.24	5	6
<2	Low	High	Low	0.32		
<2	Low	High	Low	0.32		
<2	Low	High	Low	0.32		
<2	Low	Low	Low	0.28	4–3	6
<2	Moderate	Low	Low	0.28		
<2	High	Low	Low	0.28		
<2	Low	Low	Moderate	0.24	2	7
<2	Low	Low	Moderate	0.24		
<2	Moderate	Low	Moderate	0.24		
<2		High	Moderate			3
<2	Low	High	Low			
<2	Low	High	Moderate	0.28	4	6
<2	Low	High	Moderate	0.28		
<2	Very low	High	Moderate	0.10		
<2	Low	Low	Moderate	0.32	4–3	6
<2	Moderate	Low	Moderate	0.32		
<2	Low	Low	Low	0.10		

TABLE 7.—*Physical and chemical*

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
284, 284B, 284C:				
Flagler	0–20	2.0–6.0	0.12–0.14	6.1–7.3
	20–28	2.0–6.0	0.11–0.13	5.1–6.5
	28–60	>20	0.02–0.04	5.1–7.3
285, 285B, 285C2, 285E2:				
Burkhardt	0–15	2.0–6.0	0.13–0.15	5.1–6.5
	15–60	6.0–20	0.02–0.04	5.6–6.0
302B, 302C:				
Coggon	0–16	0.6–2.0	0.18–0.20	5.1–6.5
	16–38	0.2–0.6	0.17–0.19	5.1–5.5
	38–60	0.2–0.6	0.17–0.19	5.1–7.8
315:				
Loamy alluvial land	0–60			
354:				
Marsh	0–60			
391B:				
Clyde part	0–17	0.6–2.0	0.21–0.23	6.6–7.3
	17–29	0.6–2.0	0.18–0.20	6.6–7.3
	29–36	2.0–6.0	0.11–0.13	6.6–7.3
	36–60	0.2–0.6	0.17–0.19	6.6–8.4
Floyd part	0–19	0.6–2.0	0.20–0.22	6.6–7.3
	19–27	0.6–2.0	0.11–0.18	6.6–7.3
	27–32	2.0–6.0	0.11–0.13	6.6–7.3
	32–60	0.2–0.6	0.16–0.18	6.6–7.8
394B, 394C, 394C2:				
Ostrander	0–15	0.6–2.0	0.20–0.24	5.6–7.3
	15–24	0.6–2.0	0.17–0.19	5.1–7.3
	24–90	0.6–2.0	0.17–0.19	6.6–7.8
398:				
Tripoli	0–21	0.6–2.0	0.19–0.21	6.6–7.3
	21–27	0.2–0.6	0.17–0.19	7.4–7.8
	27–60	0.2–0.6	0.17–0.19	7.4–8.4
399, 399B:				
Readlyn	0–18	0.6–2.0	0.20–0.22	5.1–6.0
	18–43	0.2–0.6	0.17–0.19	5.1–6.5
	43–60	0.2–0.6	0.17–0.19	6.6–7.8
407B:				
Schley	0–15	0.6–2.0	0.19–0.21	4.5–6.5
	15–45	2.0–6.0	0.12–0.16	4.5–5.5
	45–60	0.2–0.6	0.16–0.18	5.1–7.8
408B, 408C:				
Olin	0–33	2.0–6.0	0.13–0.15	5.6–6.5
	33–60	0.2–0.6	0.17–0.19	5.6–6.0
409B, 409C:				
Dickinson	0–40	2.0–6.0	0.12–0.15	5.6–6.5
	40–60	0.2–0.6	0.17–0.19	5.6–6.5
444B, 444C, 444D:				
Jacwin	0–24	0.6–2.0	0.20–0.22	6.6–7.3
	24–31	0.6–2.0	0.17–0.19	6.6–7.3
	31–38	<0.06	0.12–0.14	7.4–8.4
	38			
471:				
Oran	0–18	0.6–2.0	0.18–0.20	5.1–7.3
	18–58	0.2–0.6	0.17–0.19	5.1–6.5
	58–74	0.2–0.6	0.17–0.19	7.4–7.8

properties of soils—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
		Uncoated steel	Concrete	K	T	
Mmhos/cm						
<2	Low	Moderate	Low	0.20	4–3	3
<2	Low	Moderate	Low	0.20		
<2	Low	Moderate	Low	0.20		
<2	Low	Low	High	0.20	3–2	3
<2	Low	Moderate	Moderate	0.10		
<2	Low	Moderate	Moderate	0.32	5–4	6
<2	Low	Moderate	Moderate	0.32		
<2	Low	Moderate	Moderate	0.32		
<2	Moderate	High	Low			7
<2	Moderate	High	Low			
<2	Low	High	Low			
<2	Moderate	High	Low			
<2	Moderate	High	Low	0.24	5	6
<2	Low	High	Low	0.32		
<2	Low	High	Low	0.32		
<2	Low	High	Low	0.32		
<2	Low	Low	Low	0.28	5–4	6
<2	Low	Low	Low	0.28		
<2	Low	Low	Low	0.37		
<2	Moderate	High	Moderate			6
<2	Low	High	Moderate			
<2	Low	High	Moderate			
<2	Low	High	Moderate	0.24	5–4	6
<2	Low	High	Moderate	0.32		
<2	Low	High	Moderate	0.32		
<2	Moderate	High	High	0.32	5–4	6
<2	Low	High	High	0.32		
<2	Low	High	High	0.32		
<2	Very low	Moderate	Moderate	0.20	5–4	3
<2	Low	Moderate	Moderate	0.32		
<2	Low	Low	Moderate	0.20	4	3
<2	Low	Low	Moderate	0.37		
<2	Moderate	High	Low	0.28	5–4	6
<2	Low	High	Low	0.28		
<2	High	High	Low	0.28		
<2	Low	High	Moderate	0.28	5–4	6
<2	Low	High	Moderate	0.28		
<2	Low	High	Moderate	0.37		

TABLE 7.—*Physical and chemical*

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
478G:				
Rock outcrop part.				
Nordness part	0–11	0.6–2.0	0.20–0.22	5.6–7.3
	11–16	0.06–0.2	0.12–0.15	6.6–7.3
	16			
480C, 480D2, 480E2:				
Orwood	0–8	0.6–2.0	0.20–0.22	6.6–7.3
	8–42	0.6–2.0	0.18–0.22	5.1–7.3
	42–60	0.6–2.0	0.20–0.22	5.6–7.3
485:				
Spillville	0–54	0.6–2.0	0.19–0.21	6.1–7.3
	54–60	2.0–6.0	0.08–0.10	6.1–7.3
487B:				
Otter part	0–51	0.6–2.0	0.22–0.24	6.1–7.8
	51–60	0.6–2.0	0.12–0.21	6.6–8.4
Huntsville part	0–30	0.6–2.0	0.22–0.24	6.1–7.3
	30–60	0.6–2.0	0.20–0.22	6.1–7.8
489:				
Ossian	0–18	0.6–2.0	0.22–0.24	6.6–7.3
	18–60	0.6–2.0	0.20–0.22	6.6–7.8
490:				
Caneek	0–23	0.6–2.0	0.20–0.22	7.9–8.4
	23–60	0.6–2.0	0.22–0.24	6.6–7.3
496B:				
Dorchester part	0–38	0.6–2.0	0.20–0.22	7.9–8.4
	38–70	0.6–2.0	0.22–0.24	6.6–7.3
Volney part	0–30	2.0–6.0	0.20–0.22	7.9–8.4
	30–50	>20	0.02–0.04	7.9–8.4
497F:				
Fayette part	0–11	2.0–6.0	0.20–0.22	5.1–6.0
	11–47	0.6–2.0	0.18–0.20	4.5–5.5
	47–73	0.6–2.0	0.18–0.20	5.1–5.5
Dubuque part	0–12	0.6–2.0	0.20–0.22	5.6–6.5
	12–20	0.6–2.0	0.18–0.20	5.6–6.0
	20–25	0.06–0.2	0.12–0.15	5.6–6.0
	25			
Jacwin part	0–24	0.6–2.0	0.20–0.22	6.6–7.3
	24–31	0.6–2.0	0.17–0.19	6.6–7.3
	31–38	<0.06	0.12–0.14	7.4–8.4
	38			
497G:				
Fayette part	0–11	2.0–6.0	0.20–0.22	5.1–6.0
	11–47	0.6–2.0	0.18–0.20	4.5–5.5
	47–73	0.6–2.0	0.18–0.20	5.1–5.5
Dubuque part	0–12	0.6–2.0	0.20–0.22	5.6–6.5
	12–20	0.6–2.0	0.18–0.20	5.6–6.0
	20–25	0.06–0.2	0.12–0.15	5.6–6.0
	25			
Jacwin part	0–24	0.6–2.0	0.20–0.22	6.6–7.3
	24–31	0.6–2.0	0.17–0.19	6.6–7.3
	31–38	<0.06	0.12–0.14	7.4–8.4
	38			

properties of soils—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
		Uncoated steel	Concrete	K	T	
Mmhos/cm						
<2	Moderate	Low	Low	0.43	2–1	6
<2	High	Low	Low	0.43		
<2	Low	Low	Moderate	0.32	5–4	5
<2	Moderate	Low	Moderate	0.43		
<2	Moderate	Low	Moderate	0.43		
<2	Moderate	High	Moderate	0.28	5–4	6
<2	Low	High	Moderate	0.28		
<2	Low	High	Low			6
<2	Low	High	Low			
<2	Moderate	Low	Low			6
<2	Moderate	Low	Low			
<2	Moderate	High	Low			6
<2	Moderate	High	Low			
<2	Low	High	Low			6
<2	Moderate	High	Low			
<2	Low	High	Low			6
<2	Moderate	High	Low			
<2	Low	Low	Low	0.24	2	6
<2	Very low	Low	Low			
<2	Low	Moderate	Moderate	0.37	5–4	6
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	Moderate	Moderate	0.37		
<2	Low	Moderate	Moderate	0.37	4–3	6
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	High	Low	0.28	5–4	6
<2	Low	High	Low	0.28		
<2	High	High	Low	0.28		
<2	Low	Moderate	Moderate	0.37	5–4	6
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	Moderate	Moderate	0.37		
<2	Low	Moderate	Moderate	0.37	4–3	6
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	Moderate	Moderate	0.37		
<2	Moderate	High	Low	0.28	5–4	6
<2	Low	High	Low	0.28		
<2	High	High	Low	0.28		

TABLE 7.—*Physical and chemical*

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
499B, 499D, 499F:				
Nordness	0–11	0.6–2.0	0.20–0.22	5.6–7.3
	11–16	0.06–0.2	0.12–0.15	6.6–7.3
	16			
512B, 512D:				
Marlean	0–15	0.6–2.0	0.17–0.19	6.1–7.3
	15–52	>20.0	0.02–0.06	7.4–7.8
	52			
536:				
Hanlon	0–65	2.0–6.0	0.16–0.18	6.6–7.3
	65–72	2.0–20	0.09–0.13	6.6–7.3
551:				
Calamine	0–17	0.6–2.0	0.18–0.23	6.1–7.8
	17–29	0.06–0.6	0.18–0.20	7.4–8.4
	29–40	<0.06	0.08–0.12	7.4–8.4
	40–60			
620B:				
Port Byron	0–15	0.6–2.0	0.22–0.24	5.6–7.3
	15–60	0.6–2.0	0.20–0.22	5.6–8.4
714, 714B, 714C, 714D:				
Winneshiek	0–11	0.6–2.0	0.19–0.21	5.6–7.3
	11–18	0.6–2.0	0.17–0.19	5.6–7.3
	18–24	0.06–0.2	0.12–0.15	5.6–7.3
	24			
725:				
Hayfield	0–8	0.6–2.0	0.20–0.24	5.6–6.5
	8–28	0.6–2.0	0.17–0.22	5.1–6.0
	28–60	6.0–20	0.02–0.04	5.6–7.8
763D2, 763E2, 763E3, 763F2, 763F3:				
Exette	0–6	0.6–2.0	0.21–0.23	6.6–7.3
	6–33	0.6–2.0	0.20–0.22	5.6–6.5
	33–60	0.6–2.0	0.20–0.22	6.6–7.8
777, 777B, 777C:				
Wapsie	0–7	0.6–2.0	0.18–0.20	5.6–6.0
	7–23	0.6–2.0	0.15–0.17	5.6–6.0
	23–60	>20.0	0.02–0.06	5.1–6.0
781B, 781C:				
Lourdes	0–8	0.6–2.0	0.18–0.20	5.6–6.0
	8–15	0.6–2.0	0.16–0.18	4.5–5.5
	15–44	0.06–0.2	0.15–0.17	4.5–6.5
	44–60	0.06–0.2	0.15–0.17	7.4–7.8
782, 782B, 782C:				
Donnan	0–13	0.6–2.0	0.20–0.22	5.1–7.3
	13–24	0.6–2.0	0.17–0.19	5.1–5.5
	24–48	<0.06	0.11–0.14	5.6–6.5
	48–60	0.2–0.6	0.17–0.19	5.6–6.5
783B, 783C:				
Cresco	0–17	0.6–2.0	0.20–0.22	5.1–6.5
	17–60	0.06–0.2	0.17–0.19	5.1–7.8
784B:				
Riceville	0–7	0.6–2.0	0.18–0.20	4.5–5.5
	7–14	0.2–0.6	0.17–0.19	4.5–5.0
	14–60	0.06–0.2	0.15–0.17	4.5–7.8

properties of soils—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
		Uncoated steel	Concrete	K	T	
Mmhos/cm						
<2	Moderate	Low	Low	0.43	2–1	6
<2	High	Low	Low	0.43		
<2	Low	Low	Low	0.24	2–1	6
<2	Very low	Low	Low			
<2	Low	Moderate	Low			3
<2	Low	Moderate	Low			
<2	Moderate	High	Low			8
<2	High	High	Moderate			
<2	High	High	Moderate			
<2	Low	Low	Moderate	0.32	5–4	6
<2	Low	Low	Moderate	0.43		
<2	Low	Moderate	Moderate	0.28	4–3	6
<2	Low	Moderate	Moderate	0.28		
<2	High	Moderate	Moderate	0.28		
<2	Moderate	Low	Moderate			6
<2	Moderate	Low	Moderate			
<2	Low	Low	Moderate			
<2	Moderate	Low	Low	0.37	5–4	6
<2	Moderate	Low	Low	0.37		
<2	Moderate	Low	Low	0.37		
<2	Low	Low	High	0.28	4–3	6
<2	Low	Low	High	0.28		
<2	Very low	Low	High	0.10		
<2	Moderate	High	Moderate	0.37	3–2	6
<2	Low	High	Moderate	0.37		
<2	Moderate	High	Moderate	0.37		
<2	Moderate	High	Moderate	0.37		
<2	Low	High	Moderate	0.28	4–3	6
<2	Moderate	High	Moderate	0.28		
<2	High	High	Moderate	0.28		
<2	Moderate	High	Moderate	0.37		
<2	Moderate	High	Moderate	0.28	4–3	6
<2	Moderate	High	Moderate	0.37		
<2	Moderate	High	Moderate	0.32	4–3	6
<2	Moderate	High	Moderate	0.32		
<2	Moderate	High	Moderate	0.32		

TABLE 7.—*Physical and chemical*

Map symbol and soil name	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
798B:				
Protivin	0–18	0.6–2.0	0.18–0.20	5.1–5.5
	18–28	0.2–0.6	0.17–0.19	5.1–6.0
	28–60	0.06–0.2	0.15–0.17	6.1–7.8
926:				
Canoe	0–8	0.6–2.0	0.22–0.24	5.6–6.5
	8–17	0.6–2.0	0.20–0.22	5.1–6.0
	17–60	0.6–2.0	0.20–0.22	5.1–6.5
977:				
Richwood	0–18	0.6–2.0	0.22–0.24	5.6–7.3
	18–60	0.6–2.0	0.18–0.22	5.6–7.3
978:				
Festina	0–14	0.6–2.0	0.22–0.24	5.6–6.0
	14–60	0.6–2.0	0.20–0.22	5.6–6.0

tion of each soil to historic floods. Most soils in low positions on the landscape where flooding is likely to occur are classified as fluvents at the suborder level or as fluventic subgroups. See the section "Formation and classification of the soils."

The generalized description of flood hazards is of value in land use planning and provides a valid basis for land use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

A high water table is the highest level of a saturated zone more than 6 inches thick in soils for a continuous period of more than 2 weeks during most years. The depth to a high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed during the course of the soil survey. Indicated are the depth to the high water table; the kind of water table, whether perched, artesian, or the upper part of the ground water table; and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic tank absorption fields and other underground installations will function. Also, a high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at depths of 5 to 6 feet or less. For many soils, limited ranges in depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and other observations during the soil mapping. The kind of bedrock and its relative hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200 horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action is defined as freezing temperatures in the soil and movement of soil moisture into the freezing zone, which causes the formation of ice lenses. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or sandy soils are the least susceptible.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfills.

If the degree of soil limitation is indicated by the rating *slight,* soils are favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and, if *severe,*

properties of soils—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
		Uncoated steel	Concrete	K	T	
Mmhos/cm						
<2	Moderate	High	Moderate	0.28	3–2	6
<2	Moderate	High	Moderate	0.28		
<2	Moderate	High	Moderate	0.37		
<2	Low	High	Moderate			6
<2	Low	High	Moderate			
<2	Moderate	High	Moderate			
<2	Low	Moderate	Moderate	0.32	5–4	5
<2	Low	Moderate	Moderate	0.43		
<2	Low	Moderate	Moderate	0.32	5	6
<2	Moderate	Moderate	Moderate	0.43		

soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance are required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth less than 4 feet below the tile lines (fig. 16). In these soils the absorption field does not adequately filter the effluent, and, as a result ground water supplies in the area may be contaminated. Soils that have inadequate filtration are indicated by a footnote in table 9 (*16*).

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity (*3*).

In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table or to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while bacteria decompose the solid and liquid wastes. Lagoons have a nearly level flow area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. They generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil at least 4 feet thick for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic matter and those that have stones and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils

Figure 16.—Typical cut of fractured limestone that underlies many soils in Fayette County.

TABLE 8.—*Soil and*

[Absence of an entry indicates the feature is not a concern. See text for descriptions of symbols

Map symbol and soil name	Hydrologic group	Flooding		
		Frequency	Duration	Months
27B: Terril	B	None		
41, 41B, 41C, 41D: Sparta	A	None		
63C, 63E: Chelsea	A	None		
83B, 83C, 83C2: Kenyon	B	None		
84: Clyde	B/D	Frequent	Very brief	Feb-Nov
98, 98B: Huntsville	B	Occasional	Very brief	Feb-Nov
109B, 109C, 109D: Backbone	B	None		
110B, 110C: Lamont	B	None		
115F: Sandy escarpments	A	None		
135, C135: Coland	B/D	Common	Brief	Feb-Nov
142B: Chaseburg	B	Frequent	Very brief	Feb-Nov
151, 152: Marshan	B/D	Rare to occasional	Very brief	Feb-Nov
158, C158: Dorchester	B	Frequent	Very brief	Feb-Nov
162B, 162C, 162C2, 162D, 162D2, 162E2: Downs	B	None		
163B, 163C, 163C2, 163D, 163D2, 163D3, 163E, 163E2, 163E3, 163F, 163F2, 163F3, 163G: Fayette	B	None		
171B, 171C, 171C2, 171D2, 171E2: Bassett	B	None		
175B, 175C, 175D: Dickinson	B	None		
177, 177B, 177C: Saude	B	None		
178, 178B: Waukee	B	None		
183C, 183D2, 183E, 183E2, 183F: Dubuque	B	None		
193: Camden	B	None		
198B: Floyd	B	None		

water features

and such terms as "rare," "brief," and "perched." The symbol < means less than; > means greater than]

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Moderate.
1.0–3.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		High.
>6.0			20–40	Hard	Low.
>6.0			>60		Low.
>6.0			>60		Low.
1.0–3.0	Apparent	Nov-Jun	>60		High.
3.0–6.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		High.
>6.0			>60		High.
>6.0			>60		High.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			20–40	Hard	High.
>6.0			>60		High.
2.0–4.0	Apparent	Nov-Jun	>60		High.

TABLE 8.—*Soil and*

Map symbol and soil name	Hydrologic group	Flooding		
		Frequency	Duration	Months
213, 213B, 214, 214B, 214C: Rockton	B	None		
215E: Goss	B	None		
221: Palms	A/D	Rare		
225, 226: Lawler	B	None		
265, 265B: Bixby	B	None		
284, 284B, 284C: Flagler	B	None to rare		
285, 285B, 285C2, 285E2: Burkhardt	B	None		
302B, 302C: Coggon	B	None		
315: Loamy alluvial land	B	Frequent	Brief	Feb-Nov
354: Marsh		Frequent	Very long	Jan-Dec
391B: Clyde part	B/D	Frequent	Very brief	Feb-Nov
Floyd part	B	None		
394B, 394C, 394C2: Ostrander	B	None		
398: Tripoli	B/D	None		
399, 399B: Readlyn	B	None		
407B: Schley	B	None		
408B, 408C: Olin	B	None		
409B, 409C: Dickinson	A	None		
444B, 444C, 444D: Jacwin	B	None		
471: Oran	B	None		
478G: Rock outcrop part.				
Nordness part	B	None		
480C, 480D2, 480E2: Orwood	B	None		
485: Spillville	B	Common	Very brief	Feb-Nov

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			20–40	Hard	Low.
>6.0			>60		Moderate.
0–1.0	Apparent	Jan-Dec	>60		High.
3.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Moderate.
0–4.0	Apparent	Nov-Jun	>60		Moderate.
0–1.0	Apparent	Jan-Dec	>60		
1.0–3.0	Apparent	Nov-Jun	>60		High.
2.0–4.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Moderate.
2.0–4.0	Apparent	Nov-Jun	>60		High.
3.0–5.0	Apparent	Nov-Jun	>60		High.
2.0–4.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		Moderate.
>6.0			>60		Low.
2.0–4.0	Perched	Nov-Jun	36–60	Rippable	High.
3.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			8–20	Hard	Low.
>6.0			>60		Moderate.
3.0–5.0	Apparent	Nov-Jun	>60		Moderate.

TABLE 8.—*Soil and*

Map symbol and soil name	Hydrologic group	Flooding		
		Frequency	Duration	Months
487B:				
Otter part	B/D	Frequent	Very brief	Feb-Nov
Huntsville part	B	Occasional	Very brief	Feb-Nov
489:				
Ossian	B/D	Frequent	Very brief	Feb-Nov
490:				
Caneek	B	Frequent	Very brief	Feb-Nov
496B:				
Dorchester part	B	Frequent	Very brief	Feb-Nov
Volney part	B	Frequent	Very brief	Feb-Nov
497F:				
Fayette part	B	None		
Dubuque part	B	None		
Jacwin part	B	None		
497G:				
Fayette part	B	None		
Dubuque part	B	None		
Jacwin part	B	None		
499B, 499D, 499F:				
Nordness	B	None		
512B, 512D:				
Marlean	B	None		
536:				
Hanlon	B	Frequent	Very brief	Feb-Nov
551:				
Calamine	D	None		
620B:				
Port Byron	B	None		
714, 714B, 714C, 714D:				
Winneshiek	B	None		
725:				
Hayfield	B	None		
763D2, 763E2, 763E3, 763F2, 763F3:				
Exette	B	None		
777, 777B, 777C:				
Wapsie	B	None		
781B, 781C:				
Lourdes	C	None		
782, 782B, 782C:				
Donnan	C	None		
783B, 783C:				
Cresco	C	None		
784B:				
Riceville	C	None		

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
0–2.0	Apparent	Apr-Jun	>60		High.
>6.0			>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
1.0–3.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		High.
>6.0			48–72	Rippable	Low.
>6.0			>60		High.
>6.0			20–40	Hard	High.
2.0–4.0	Perched	Nov-Jun	36–60	Rippable	High.
>6.0			>60		High.
>6.0			20–40	Hard	High.
2.0–4.0	Perched	Nov-Jun	36–60	Rippable	High.
>6.0			8–20	Hard	Low.
>6.0			8–18	Rippable	Low.
3.0–5.0	Apparent	Nov-Jun	>60		Moderate.
0–1.0	Perched	Nov-Jun	30–50	Rippable	Moderate.
>6.0			>60		High.
>6.0			20–40	Hard	Moderate.
3.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		High.
>6.0			>60		Low.
>6.0	Perched	Nov-Jun	>60		High.
2.0–3.0	Perched	Nov-Jun	>60		High.
>6.0	Perched	Nov-Jun	>60		Moderate.
2.0–4.0	Apparent	Nov-Jun	>60		High.

TABLE 8.—*Soil and*

Map symbol and soil name	Hydrologic group	Flooding		
		Frequency	Duration	Months
798B: Protivin	C	None		
926: Canoe	B	Rare		
977: Richwood	B	None		
978: Festina	B	None		

where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread, compacted in layers, and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes difficulty in excavating and filling the trenches. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 9 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for sanitary landfills should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfills should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 10. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by the soil wetness of a high seasonal water table, the texture and consistence of soils, the tendency of soils to cave in or slough, and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
2.0–4.0	Apparent	Nov-Jun	>60		High.
3.0–5.0	Apparent	Nov-Jun	>60		High.
>6.0			>60		High.
>6.0			>60		High.

Dwellings and small commercial buildings referred to in table 10 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and the large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

Local roads and streets referred to in table 10 have an all-weather surface that can carry light to medium traffic all year. They consist of subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The AASHTO and Unified classifications of the soil and soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 11 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed and described as the survey is made, generally about 6 feet.

Roadfill is soil material used in embankments for roads. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about soil properties that determine such performance is given in the descriptions of soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 6 provide more specific information about the nature of each horizon that can help determine its suitability for roadfill.

Soils rated *good* have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as high shrink-swell potential, high potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor,* regardless of the quality of the suitable material.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 11 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of

TABLE 9.—*Sanitary facilities*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
27B: Terril	Slight	Moderate: seepage, excess humus.	Slight	Slight	Good.
41, 41B: Sparta	Slight[1]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: too sandy.
41C: Sparta	Slight[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: too sandy.
41D: Sparta	Moderate: slope.[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: too sandy, slope.
63C: Chelsea	Slight[1]	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
63E: Chelsea	Severe: slope.[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Poor: too sandy, slope.
83B: Kenyon	Severe: percs slowly.[2]	Moderate: slope, excess humus.	Slight	Slight	Good.
83C, 83C2: Kenyon	Severe: percs slowly.[2]	Severe: slope	Slight	Slight	Good.
84: Clyde	Severe: floods, wetness.	Severe: excess humus, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
98, 98B: Huntsville	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Good.
109B: Backbone	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Severe: seepage	Fair: thin layer.
109C: Backbone	Severe: depth to rock.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage.	Severe: seepage	Fair: thin layer.
109D: Backbone	Severe: depth to rock.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage.	Severe: seepage	Fair: slope, thin layer.
110B: Lamont	Slight[1]	Severe: seepage	Severe: seepage	Severe: seepage	Good.
110C: Lamont	Moderate: slope.[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: slope.
115F: Sandy escarpments	Severe: slope	Severe: slope	Severe: slope, seepage.	Severe: slope, seepage.	Poor: slope, too sandy.
135, C135: Coland	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
142B: Chaseburg	Severe: floods	Severe: wetness, floods.	Severe: floods, wetness.	Severe: floods	Good.

TABLE 9.—*Sanitary facilities*—Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
151, 152: Marshan	Severe: wetness, floods.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods.	Poor: wetness.
158, C158: Dorchester	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Good.
162B: Downs	Slight[3]	Moderate: slope, seepage.	Slight[3]	Slight[3]	Good.
162C, 162C2: Downs	Slight[3]	Severe: slope	Slight[3]	Slight[3]	Good.
162D, 162D2: Downs	Moderate: slope.[3]	Severe: slope	Slight[3]	Moderate: slope.[3]	Fair: slope.
162E2: Downs	Severe: slope[3]	Severe: slope	Moderate: slope.[3]	Severe: slope	Poor: slope.
163B: Fayette	Slight[3]	Moderate: slope, seepage.	Moderate: too clayey.[3]	Slight[3]	Fair: too clayey.
163C, 163C2: Fayette	Slight[3]	Severe: slope, seepage.	Moderate: too clayey.[3]	Slight[3]	Fair: too clayey.
163D, 163D2, 163D3: Fayette	Moderate: slope.[3]	Severe: slope, seepage.	Moderate: too clayey.[3]	Moderate: slope.[3]	Fair: slope, too clayey.
163E, 163E2, 163E3, 163F, 163F2, 163F3: Fayette	Severe: slope	Severe: slope, seepage.	Moderate: slope.[3]	Severe: slope	Poor: slope.
163G: Fayette	Severe: slope	Severe: slope, seepage.	Severe: slope	Severe: slope	Poor: slope.
171B: Bassett	Severe: percs slowly.[2]	Moderate: slope.	Slight	Slight	Good.
171C, 171C2: Bassett	Severe: percs slowly.[2]	Severe: slope	Slight	Slight	Good.
171D2: Bassett	Severe: percs slowly.[2]	Severe: slope	Slight	Moderate: slope.	Fair: slope.
171E2: Bassett	Severe: slope, percs slowly.	Severe: slope	Moderate: slope.	Severe: slope	Poor: Slope.
175B: Dickinson	Slight[1]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
175C: Dickinson	Slight[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: thin layer.
175D: Dickinson	Moderate: slope.[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: slope, thin layer.

TABLE 9.—*Sanitary facilities*—Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
177, 177B: Saude	Slight[4]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
177C: Saude	Slight[4]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: thin layer.
178, 178B: Waukee	Slight[4]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
183C, 183D2: Dubuque	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: seepage	Poor: area reclaim.
183E, 183E2, 183F: Dubuque	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: seepage, slope.	Poor: area reclaim, slope.
193: Camden	Slight	Severe: seepage	Severe: seepage	Slight	Good.
198B: Floyd	Severe: wetness	Moderate: slope, wetness, excess humus.	Severe: wetness	Moderate: wetness.	Good.
213, 213B, 214, 214B: Rockton	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage	Fair: thin layer.
214C: Rockton	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: seepage	Fair: thin layer.
215E: Goss	Moderate: slope.	Severe: slope	Slight	Moderate: slope.	Poor: small stones, area reclaim.
221: Palms	Severe: wetness	Severe: wetness, excess humus, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: excess humus, hard to pack.
225, 226: Lawler	Severe: wetness	Severe: seepage	Severe: seepage, wetness.	Severe: seepage	Fair: thin layer.
265, 265B: Bixby	Slight[4]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
284, 284B: Flagler	Slight[1]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
284C: Flagler	Slight[1]	Severe: slope, seepage.	Severe: seepage	Severe: seepage	Fair: thin layer.
285, 285B: Burkhardt	Slight[1]	Severe: seepage	Severe: seepage	Severe: seepage	Poor: thin layer.
285C2: Burkhardt	Slight[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Poor: thin layer.
285E2: Burkhardt	Moderate: slope.[1]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Poor: thin layer.
302B: Coggon	Severe: percs slowly.[3]	Moderate: slope.	Slight	Slight	Good.

TABLE 9.—*Sanitary facilities*—Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
302C: Coggon	Severe: percs slowly.[a]	Severe: slope	Slight	Slight	Good.
315: Loamy alluvial land	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Poor: wetness.
354: Marsh	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Poor: wetness.
391B: Clyde part	Severe: floods, wetness.	Severe: excess humus, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Floyd part	Severe: wetness	Moderate: slope, wetness, excess humus.	Severe: wetness	Moderate: wetness.	Good.
394B: Ostrander	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
394C, 394C2: Ostrander	Slight	Severe: seepage, slope.	Slight	Slight	Good.
398: Tripoli	Severe: wetness, percs slowly.	Moderate: excess humus.	Severe: wetness	Severe: wetness	Poor: wetness.
399: Readlyn	Severe: percs slowly, wetness.	Moderate: excess humus.	Severe: wetness	Moderate: wetness.	Good.
399B: Readlyn	Severe: percs slowly, wetness.	Moderate: slope, excess humus.	Severe: wetness	Moderate: wetness.	Good.
407B: Schley	Severe: wetness	Severe: wetness	Severe: wetness	Moderate: wetness.	Good.
408B: Olin	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Good.
408C: Olin	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
409B: Dickinson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
409C: Dickinson	Slight	Severe: slope	Slight	Slight	Good.
444B: Jacwin	Severe: wetness, percs slowly.	Moderate: slope, excess humus.	Severe: wetness, too clayey.	Severe: wetness	Poor: area reclaim.
444C, 444D: Jacwin	Severe: wetness, percs slowly.	Severe: slope	Severe: wetness, too clayey.	Severe: wetness	Poor: area reclaim.
471: Oran	Severe: percs slowly, wetness.	Moderate: slope, wetness.	Severe: wetness	Moderate: wetness.	Good.

TABLE 9.—*Sanitary facilities*—Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
478G: Rock outcrop part					
Nordness part	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: seepage, slope.	Poor: thin layer, area reclaim, slope.
480C: Orwood	Slight[3]	Severe: slope	Slight[3]	Slight[3]	Good.
480D2: Orwood	Moderate: slope.[3]	Severe: slope	Slight[3]	Moderate: slope.[3]	Fair: slope.
480E2: Orwood	Severe: slope[3]	Severe: slope	Moderate: slope.[3]	Severe: slope	Poor: slope.
485: Spillville	Severe: floods, wetness.	Severe: floods, wetness, excess humus.	Severe: floods, wetness.	Severe: floods, wetness.	Good.
487B: Otter part	Severe: wetness, floods.	Severe: floods	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Huntsville part	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Good.
489: Ossian	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
490: Caneek	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
496B: Dorchester part	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Good.
Volney part	Severe: floods, large stones.	Severe: floods, large stones, seepage.	Severe: floods, large stones, seepage.	Severe: floods, large stones.	Poor: large stones, area reclaim.
497F: Fayette part	Severe: slope	Severe: slope, seepage.	Moderate: slope.	Severe: slope	Poor: slope.
Dubuque part	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: seepage, slope.	Poor: area reclaim, slope.
Jacwin part	Severe: wetness, percs slowly.	Severe: slope	Severe: wetness, too clayey.	Severe: wetness	Poor: area reclaim.
497G: Fayette part	Severe: slope	Severe: slope, seepage.	Severe: slope	Severe: slope	Poor: slope.
Dubuque part	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: seepage, slope.	Poor: area reclaim, slope.
Jacwin part	Severe: wetness, percs slowly.	Severe: slope	Severe: wetness, too clayey.	Severe: wetness	Poor: area reclaim.
499B: Nordness	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage	Poor: thin layer, area reclaim.
499D: Nordness	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: seepage	Poor: thin layer, area reclaim.

TABLE 9.—*Sanitary facilities*—Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
499F: Nordness	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: seepage, slope.	Poor: thin layer, area reclaim, slope.
512B: Marlean	Severe: large stones.	Severe: seepage, large stones.	Severe: seepage, large stones.	Severe: seepage	Poor: thin layer, small stones.
512D: Marlean	Severe: large stones.	Severe: slope, seepage, large stones.	Severe: seepage, large stones.	Severe: seepage	Poor: thin layer, small stones.
536: Hanlon	Severe: floods	Severe: floods, seepage.	Severe: floods, seepage.	Severe: floods, seepage.	Good.
551: Calamine	Severe: wetness, percs slowly.	Severe: wetness, depth to rock.	Severe: wetness, depth to rock.	Severe: wetness	Poor: wetness.
620B: Port Byron	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
714, 714B: Winneshiek	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: seepage	Poor: area reclaim, thin layer.
714C: Winneshiek	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: seepage	Poor: area reclaim, thin layer.
714D: Winneshiek	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: seepage	Poor: area reclaim, thin layer.
725: Hayfield	Severe: wetness	Severe: seepage	Severe: seepage	Moderate: wetness, seepage.	Fair: thin layer.
763D2: Exette	Moderate: slope.	Severe: slope	Slight	Moderate: slope.	Fair: slope.
763E2, 763E3, 763F2, 763F3: Exette	Severe: slope	Severe: slope	Moderate: slope.	Severe: slope	Poor: slope.
777, 777B: Wapsie	Slight[4]	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
777C: Wapsie	Slight[4]	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: thin layer.
781B: Lourdes	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Fair: too clayey.
781C: Lourdes	Severe: percs slowly.	Severe: slope	Slight	Slight	Fair: too clayey.

TABLE 9.—*Sanitary facilities*—Continued

Map symbol and soil name	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
782: Donnan	Severe: percs slowly.	Slight	Severe: too clayey, wetness.	Moderate: wetness.	Poor: area reclaim, thin layer.
782B: Donnan	Severe: percs slowly.	Moderate: slope.	Severe: too clayey, wetness.	Moderate: wetness.	Poor: area reclaim, thin layer.
782C: Donnan	Severe: percs slowly.	Severe: slope	Severe: too clayey, wetness.	Moderate: wetness.	Poor: area reclaim, thin layer.
783B: Cresco	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Fair: thin layer.
783C: Cresco	Severe: percs slowly.	Severe: slope	Slight	Slight	Fair: thin layer.
784B: Riceville	Severe: percs slowly, wetness.	Moderate: slope.	Severe: wetness	Moderate: wetness.	Fair: too clayey.
798B: Protivin	Severe: percs slowly, wetness.	Moderate: slope.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey.
926: Canoe	Severe: wetness.[5]	Moderate: seepage, wetness.	Severe: wetness	Moderate: seepage, wetness.[5]	Good.
977: Richwood	Slight[5]	Severe: seepage	Severe: seepage	Slight[5]	Good.
978: Festina	Slight[5]	Moderate: seepage.	Slight	Slight[5]	Good.

[1] Excessive permeability may cause pollution of ground water.
[2] Perched water table is generally for short periods during extended wet periods and may not be continuous.
[3] Many areas are underlain by limestone bedrock at a depth of 6 to 10 feet. Seepage through fractures may cause pollution of ground water.
[4] Coarse material below a depth of 2 to 3 feet is poor filtering material and excessive permeability may cause pollution of ground water.
[5] Some areas may be underlain by sand and gravel at a depth below 6 feet.

the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 6.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones, are low in content of gravel and other coarse fragments, and have gentle slopes. They are low in soluble salts, which can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils; very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is much preferred for topsoil because of its organic mat-

TABLE 10.—*Building site development*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
27B: Terril	Moderate: wetness.[1]	Slight	Moderate: wetness.	Slight	Moderate: low strength, frost action.
41, 41B: Sparta	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
41C: Sparta	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
41D: Sparta	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
63C: Chelsea	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
63E: Chelsea	Severe: cutbanks cave, slope.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
83B: Kenyon	Moderate: wetness.[2]	Moderate: low strength.	Moderate: wetness.	Moderate: low strength.	Moderate: frost action, low strength.
83C, 83C2: Kenyon	Moderate: wetness.[2]	Moderate: low strength.	Moderate: wetness.	Moderate: slope, low strength.	Moderate: frost action, low strength.
84: Clyde	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: excess humus, floods, frost action.
98, 98B: Huntsville	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action.
109B, 109C: Backbone	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.
109D: Backbone	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope	Moderate: slope, depth to rock.
110B: Lamont	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
110C: Lamont	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
115F: Sandy escarpments	Severe: slope, cutbanks cave.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
135, C135: Coland	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, frost action.

TABLE 10.—*Building site development*—Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
142B: Chaseburg	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action.
151, 152: Marshan	Severe: wetness, cutbanks cave.	Severe: wetness	Severe: wetness, cutbanks cave.	Severe: wetness	Severe: wetness, frost action.
158, C158: Dorchester	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, low strength, frost action.
162B: Downs	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
162C, 162C2: Downs	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: slope, shrink-swell, low strength.	Severe: frost action, low strength.
162D, 162D2: Downs	Moderate: slope	Moderate: slope, low strength, shrink-swell.	Moderate: slope, low strength, shrink-swell.	Severe: slope	Severe: frost action, low strength.
162E2: Downs	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope, frost action, low strength.
163B: Fayette	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, low strength.	Severe: frost action, low strength.
163C, 163C2: Fayette	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: slope, shrink-swell, low strength.	Severe: frost action, low strength.
163D, 163D2, 163D3: Fayette	Moderate: slope	Moderate: slope, shrink-swell, low strength.	Moderate: slope, low strength, shrink-swell.	Severe: slope	Severe: frost action, low strength.
163E, 163E2, 163E3, 163F, 163F2, 163F3, 163G: Fayette	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: frost action, low strength, slope.
171B: Bassett	Moderate: wetness.[2]	Moderate: low strength.	Moderate: wetness.	Moderate: low strength.	Moderate: frost action, low strength.
171C, 171C2: Bassett	Moderate: wetness.[2]	Moderate: low strength.	Moderate: wetness.	Moderate: low strength.	Moderate: frost action, low strength.
171D2: Bassett	Moderate: slope, wetness.[2]	Moderate: slope, low strength.	Moderate: slope, wetness.	Severe: slope	Moderate: slope, frost action, low strength.

TABLE 10.—*Building site development*—Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
171E2: Bassett	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope, frost action, low strength.
175B: Dickinson	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
175C: Dickinson	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
175D: Dickinson	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
177, 177B: Saude	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
177C: Saude	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
178, 178B: Waukee	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
183C: Dubuque	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: low strength, frost action.
183D2: Dubuque	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: low strength, frost action.
183E, 183E2, 183F: Dubuque	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: low strength, frost action, slope.
193: Camden	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: frost action, low strength.
198B: Floyd	Severe: wetness	Moderate: wetness, low strength.	Severe: wetness	Moderate: wetness, low strength.	Severe: frost action, excess humus, low strength.
213, 213B, 214, 214B: Rockton	Severe: depth to rock.	Slight	Moderate: depth to rock.	Slight	Moderate: depth to rock.
214C: Rockton	Severe: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope	Moderate: depth to rock.
215E: Goss	Moderate: slope	Moderate: shrink-swell, slope.	Moderate: shrink-swell slope.	Severe: slope	Moderate: shrink-swell, frost action, slope.
221: Palms	Severe: wetness, excess humus, cutbanks cave.	Severe: wetness, frost action, excess humus.	Severe: wetness	Severe: wetness	Severe: wetness, frost action, low strength.

TABLE 10.—*Building site development*—Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
225, 226: Lawler	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness	Moderate: wetness.	Severe: frost action, low strength.
265: Bixby	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
265B: Bixby	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
284, 284B: Flagler	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
284C: Flagler	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
285, 285B: Burkhardt	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
285C2: Burkhardt	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
285E2: Burkhardt	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
302B: Coggon	Moderate: wetness.[2]	Moderate: frost action.	Moderate: wetness.	Moderate: frost action.	Moderate: frost action, low strength.
302C: Coggon	Moderate: wetness.[2]	Moderate: frost action.	Moderate: wetness.	Moderate: slope, frost action.	Moderate: frost action, low strength.
315: Loamy alluvial land	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
354: Marsh	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
391B: Clyde part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: excess humus, floods, frost action.
Floyd part	Severe: wetness	Moderate: wetness, low strength.	Severe: wetness	Moderate: wetness, low strength.	Severe: frost action, excess humus, low strength.
394B: Ostrander	Slight	Moderate: low strength.	Slight	Moderate: low strength.	Moderate: frost action.
394C, 394C2: Ostrander	Slight	Moderate: low strength.	Slight	Moderate: slope, low strength.	Moderate: frost action.
398: Tripoli	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness, frost action.

TABLE 10.—*Building site development*—Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
399, 399B: Readlyn	Moderate: wetness.	Moderate: wetness, low strength.	Severe: wetness	Moderate: wetness, low strength.	Severe: frost action.
407B: Schley	Severe: wetness, cutbanks cave.	Moderate: low strength.	Severe: wetness	Moderate: low strength.	Severe: frost action.
408B: Olin	Slight	Slight	Slight	Slight	Moderate: frost action, low strength.
408C: Olin	Slight	Slight	Slight	Moderate: slope	Moderate: frost action, low strength.
409B: Dickinson	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.
409C: Dickinson	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Moderate: frost action.
444B, 444C: Jacwin	Severe: wetness, too clayey.	Severe: shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, frost action, low strength.
444D: Jacwin	Severe: wetness, too clayey.	Severe: shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: shrink-swell, frost action, low strength.
471: Oran	Severe: wetness	Moderate: wetness.	Severe: wetness	Moderate: wetness.	Severe: frost action.
478G: Rock outcrop part					
Nordness part	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.
480C: Orwood	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Moderate: shrink-swell, low strength, frost action.
480D2: Orwood	Moderate: slope	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope	Moderate: shrink-swell, low strength, frost action.
480E2: Orwood	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
485: Spillville	Severe: floods, wetness.	Severe: floods	Severe: floods	Severe: floods	Severe: floods.

TABLE 10.—*Building site development*—Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
487B: Otter part	Severe: wetness, floods.	Severe: floods	Severe: floods	Severe: floods	Severe: wetness, floods, frost action.
Huntsville part	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action.
489: Ossian	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, frost action.
490: Caneek	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, frost action.
496B: Dorchester part	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, low strength, frost action.
Volney part	Severe: floods, large stones.	Severe: floods, large stones.	Severe: floods, large stones.	Severe: floods, large stones.	Severe: floods, large stones.
497F: Fayette part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: frost action, low strength, slope.
Dubuque part	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: low strength, frost action, slope.
Jacwin part	Severe: wetness, too clayey.	Severe: shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: slope, shrink-swell.	Severe: shrink-swell, frost action, low strength.
497G: Fayette part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: frost action, low strength, slope.
Dubuque part	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: low strength, frost action, slope.
Jacwin part	Severe: wetness, too clayey.	Severe: shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: slope, shrink-swell.	Severe: shrink-swell, frost action, low strength.
499B: Nordness	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
499D: Nordness	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
499F: Nordness	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.
512B: Marlean	Severe: small stones.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.
512D: Marlean	Severe: small stones.	Moderate: slope, depth to rock.	Moderate: slope, depth to rock.	Severe: slope	Moderate: slope, depth to rock.

TABLE 10.—*Building site development*—Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
536: Hanlon	Severe: floods, cutbanks cave.	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
551: Calamine	Severe: wetness, too clayey.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.
620B: Port Byron	Slight	Slight	Slight	Slight	Severe: frost action.
714, 714B: Winneshiek	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.
714C: Winneshiek	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Moderate: depth to rock.
714D: Winneshiek	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope	Moderate: slope, depth to rock.
725: Hayfield	Severe: cutbanks cave.	Severe: frost action.	Moderate: wetness.	Severe: frost action.	Severe: frost action.
763D2: Exette	Moderate: slope	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope	Severe: frost action.
763E2, 763E3, 763F2, 763F3: Exette	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: frost action, slope.
777, 777B: Wapsie	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
777C: Wapsie	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
781B: Lourdes	Moderate: too clayey, wetness.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell, low strength.	Severe: low strength, frost action.
781C: Lourdes	Moderate: too clayey, wetness.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, wetness.	Moderate: slope, shrink-swell, low strength.	Severe: low strength, frost action.
782, 782B, 782C: Donnan	Severe: wetness, too clayey.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, frost action.
783B: Cresco	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell, frost action.
783C: Cresco	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell, wetness.	Moderate: slope, shrink-swell.	Moderate: low strength, shrink-swell, frost action.

TABLE 10.—*Building site development*—Continued

Map symbol and soil name	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
784B: Riceville	Severe: wetness	Moderate: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.
798B: Protivin	Moderate: too clayey, wetness.	Moderate: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.
926: Canoe	Moderate: wetness.	Moderate: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Severe: wetness, low strength, frost action.
977: Richwood	Slight	Slight	Slight	Slight	Severe: frost action.
978: Festina	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.

[1] Subject to local runoff from upslope and occasional lateral movement of water from upslope in soil profile.
[2] Perched water table is generally for short periods during extended wet periods and may not be continuous.

ter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 12 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping, and that has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness, depth to bedrock or other unfavorable material, permeability, ease of establishing vegetation, and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff at nonerosive velocities to outlets. Features that affect the use of soils for waterways are slope, permeability, erodibility, and suitability for permanent vegetation.

Soil test data

Table 13 (See page 176) contains engineering test data for one soil series in Fayette County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum mois-*

TABLE 11.—*Construction materials*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry means soil was not rated]

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
27B: Terril	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
41, 41B, 41C, 41D: Sparta	Good	Good	Unsuited	Poor: too sandy.
63C: Chelsea	Good	Fair: excess fines	Unsuited	Poor: too sandy.
63E: Chelsea	Fair: slope	Fair: excess fines	Unsuited	Poor: too sandy, slope.
83B, 83C, 83C2: Kenyon	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
84: Clyde	Poor: excess humus, frost action, wetness.	Unsuited	Unsuited	Poor: wetness.[1]
98, 98B: Huntsville	Poor: frost action	Unsuited	Unsuited	Good.
109B, 109C: Backbone	Poor: thin layer[2]	Unsuited	Unsuited	Good.[3]
109D: Backbone	Poor: thin layer[2]	Unsuited	Unsuited	Fair: slope.
110B: Lamont	Fair: low strength	Fair: excess fines	Unsuited	Good.[4]
110C: Lamont	Fair: low strength	Fair: excess fines	Unsuited	Fair: slope.
115F: Sandy escarpments	Fair: slope	Good	Fair: excess fines	Poor: slope, too sandy.
135, C135: Coland	Poor: low strength, excess humus, frost action.	Unsuited	Unsuited	Poor: wetness.[1]
142B: Chaseburg	Poor: frost action	Unsuited	Unsuited	Good.[4]
151, 152: Marshan	Poor: wetness, frost action.	Fair: excess fines	Unsuited	Poor: wetness.
158, C158: Dorchester	Poor: low strength, frost action.	Unsuited	Unsuited	Fair: excess lime.
162B, 162C, 162C2: Downs	Poor: low strength	Unsuited	Unsuited	Good.[3]
162D, 162D2: Downs	Poor: low strength	Unsuited	Unsuited	Fair: slope.
162E2: Downs	Poor: low strength	Unsuited	Unsuited	Poor: slope.
163B, 163C, 163C2: Fayette	Poor: low strength	Unsuited	Unsuited	Good.[4]
163D, 163D2, 163D3: Fayette	Poor: low strength	Unsuited	Unsuited	Fair: slope.

TABLE 11.—*Construction materials*—Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
163E, 163E2, 163E3, 163F, 163F2, 163F3: Fayette	Poor: low strength	Unsuited	Unsuited	Poor: slope.
163G: Fayette	Poor: low strength, slope.	Unsuited	Unsuited	Poor: slope.
171B, 171C, 171C2: Bassett	Fair: low strength, frost action.	Unsuited	Unsuited	Good.[3]
171D2: Bassett	Fair: low strength, frost action.	Unsuited	Unsuited	Fair: slope.
171E2: Bassett	Fair: slope, frost action, low strength.	Unsuited	Unsuited	Poor: slope.
175B, 175C: Dickinson	Good	Fair: excess fines	Unsuited	Good.
175D: Dickinson	Good	Fair: excess fines	Unsuited	Fair: slope.
177, 177B, 177C: Saude	Good	Good	Fair: excess fines	Good.
178, 178B: Waukee	Good	Good	Fair: excess fines	Good.
183C, 183D2: Dubuque	Poor: low strength, area reclaim.[2]	Unsuited	Unsuited	Poor: area reclaim.
183E, 183E2, 183F: Dubuque	Poor: low strength, area reclaim.[2]	Unsuited	Unsuited	Poor: area reclaim, slope.
193: Camden	Poor: frost action, low strength.	Unsuited: excess fines.	Unsuited	Fair: thin layer.
198B: Floyd	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Good.
213, 213B, 214, 214B, 214C: Rockton	Fair: thin layer[2]	Unsuited	Unsuited	Poor: area reclaim.
215E: Goss	Fair: frost action, shrink-swell.	Unsuited	Unsuited: excess fines.	Poor: small stones, thin layer.
221: Palms	Poor: wetness, excess humus.	Unsuited	Unsuited	Poor: wetness.
225, 226: Lawler	Good	Good	Fair: excess fines	Good.
265, 265B: Bixby	Good	Good	Fair: excess fines	Good.[4]
284, 284B, 284C: Flagler	Good	Good	Fair: excess fines	Poor: area reclaim.
285, 285B, 285C2, 285E2: Burkhardt	Good	Good	Good	Poor: area reclaim.

TABLE 11.—*Construction materials*—Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
302B, 302C: Coggon	Fair: low strength, frost action.	Unsuited	Unsuited	Good.[2]
315: Loamy alluvial land	Poor: wetness, frost action.	Fair	Fair	Good.
354: Marsh	Poor: wetness	Unsuited	Unsuited	Poor: wetness.
391B: Clyde part	Poor: excess humus, frost action, wetness.	Unsuited	Unsuited	Poor: wetness.[1]
Floyd part	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Good.
394B, 394C, 394C2: Ostrander	Fair: frost action	Unsuited	Unsuited	Good.
398: Tripoli	Poor: wetness, frost action.	Unsuited	Unsuited	Poor: wetness.[1]
399, 399B: Readlyn	Poor: frost action	Unsuited	Unsuited	Good.
407B: Schley	Poor: frost action	Unsuited	Unsuited	Good.[3]
408B, 408C: Olin	Fair: low strength, frost action.	Poor: excess fines, thin layer.	Unsuited	Good.
409B, 409C: Dickinson	Good	Fair: excess fines	Unsuited	Good.
444B, 444C, 444D: Jacwin	Poor: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Poor: area reclaim.
471: Oran	Poor: frost action	Unsuited	Unsuited	Good.[3]
478G: Rock outcrop part				
Nordness part	Poor: area reclaim, thin layer, slope.[3]	Unsuited	Unsuited	Poor: thin layer, area reclaim, slope.
480C: Orwood	Fair: low strength, frost action, shrink-swell.	Unsuited	Unsuited	Good.[3]
480D2: Orwood	Fair: low strength, frost action, shrink-swell.	Unsuited	Unsuited	Fair: slope.
480E2: Orwood	Fair: low strength, frost action, shrink-swell.	Unsuited	Unsuited	Poor: slope.
485: Spillville	Fair: shrink-swell, frost action, wetness.	Unsuited	Unsuited	Good.

TABLE 11.—*Construction materials*—Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
487B: Otter part	Poor: frost action, wetness.	Unsuited	Unsuited	Poor: wetness.[1]
Huntsville part	Poor: frost action	Unsuited	Unsuited	Good.
489: Ossian	Poor: low strength, excess humus, frost action.	Unsuited	Unsuited	Good.
490: Caneek	Poor: low strength, frost action, wetness.	Unsuited	Unsuited	Poor: wetness, excess lime.
496B: Dorchester part	Poor: low strength, frost action.	Unsuited	Unsuited	Fair: excess lime.
Volney part	Poor: large stones, area reclaim.	Unsuited	Unsuited	Poor: area reclaim, small stones, large stones.
497F: Fayette part	Poor: low strength	Unsuited	Unsuited	Poor: slope.
Dubuque part	Poor: low strength, area reclaim.	Unsuited	Unsuited	Poor: area reclaim, slope.
Jacwin part	Poor: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Poor: area reclaim.
497G: Fayette part	Poor: low strength, slope.	Unsuited	Unsuited	Poor: slope.
Dubuque part	Poor: low strength, area reclaim.	Unsuited	Unsuited	Poor: area reclaim, slope.
Jacwin part	Poor: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Poor: area reclaim.
499B, 499D: Nordness	Poor: area reclaim, thin layer.[2]	Unsuited	Unsuited	Poor: thin layer, area reclaim.
499F: Nordness	Poor: area reclaim, thin layer.[2]	Unsuited	Unsuited	Poor: thin layer, area reclaim, slope.
512B, 512D: Marlean	Good	Unsuited	Good	Poor: area reclaim.
536: Hanlon	Fair: low strength	Unsuited	Unsuited	Good.
551: Calamine	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: wetness.
620B: Port Byron	Poor: frost action	Unsuited	Unsuited	Good.
714, 714B, 714C, 714D: Winneshiek	Poor: low strength, area reclaim.[2]	Unsuited	Unsuited	Poor: area reclaim.
725: Hayfield	Fair: wetness	Good	Poor: excess fines	Good.[3]

TABLE 11.—*Construction materials*—Continued

Map symbol and soil name	Roadfill	Sand	Gravel	Topsoil
763D2: Exette	Poor: frost action	Unsuited	Unsuited	Fair: slope.[4]
763E2, 763E3, 763F2, 763F3: Exette	Poor: frost action	Unsuited	Unsuited	Poor: slope.
777, 777B, 777C: Wapsie	Good	Good	Fair: excess fines	Good.[3]
781B, 781C: Lourdes	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer.
782, 782B, 782C: Donnan	Poor: wetness, shrink-swell, frost action.	Unsuited	Unsuited	Poor: area reclaim, thin layer, too clayey.
783B, 783C: Cresco	Fair: low strength, shrink-swell, frost action.	Unsuited	Unsuited	Fair: area reclaim.
784B: Riceville	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: thin layer, area reclaim.
798B: Protivin	Poor: frost action, low strength.	Unsuited	Unsuited	Fair: area reclaim.
926: Canoe	Poor: low strength, frost action.	Unsuited	Unsuited	Good.[3]
977: Richwood	Poor: frost action	Good	Unsuited	Good.
978: Festina	Poor: low strength, frost action.	Unsuited	Unsuited	Good.[3]

[1] The upper 2 feet is high in organic matter and a good source of topsoil when dry.

[2] Limestone rock good if crushed.

[3] Only thin layer with organic matter.

[4] Low in organic matter.

ture content is reached. After that, density decreases with increase in moisture content. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Tests to determine liquid limit and plastic limit measure the effect of water on the consistence of soil material as has been explained in the section "Engineering properties."

Shrinkage limit is the percentage of moisture at which shrinkage of the soil material stops.

Shrinkage ratio is the relation of change in volume of the soil material to the water content of the soil material when at the shrinkage limit. The change in volume is expressed as a percentage of the air-dry volume of the soil material, and the water content is expressed as a percentage of the weight of the soil material when oven-dry.

Linear shrinkage is the decrease in one dimension, expressed as a percentage of the original dimension, of the soil mass when the moisture content is reduced from the given value to the shrinkage limit.

Formation and classification of the soils

In this section factors that have affected the formation of the soils of Fayette County are discussed. Also discussed is the classification of the soils by higher categories. Detailed descriptions of profiles considered representative of the series are given in the section "Descriptions of the soils."

TABLE 12.—*Water management*

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Map symbol and soil name	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
27B: Terril	Seepage	Low strength, compressible.	Not needed	Slope	Favorable	Favorable.
41, 41B, 41C, 41D: Sparta	Seepage	Piping	Not needed	Seepage, droughty.	Too sandy	Droughty.
63C, 63E: Chelsea	Seepage	Piping, erodes easily, seepage.	Not needed	Droughty, erodes easily, seepage.	Complex slope, piping, too sandy.	Droughty, erodes easily, slope.
83B, 83C, 83C2: Kenyon	Favorable	Favorable	Not needed [1]	Slope	Favorable	Percs slowly, wetness.
84: Clyde	Favorable	Low strength, compressible, hard to pack.	Favorable	Wetness, floods.	Not needed	Wetness, large stones.
98, 98B: Huntsville	Seepage	Low strength, piping.	Not needed	Favorable	Not needed	Not needed.
109B, 109C, 109D: Backbone	Depth to rock, seepage.	Thin layer	Not needed	Seepage, fast intake, rooting depth.	Depth to rock	Droughty, rooting depth.
110B, 110C: Lamont	Seepage	Piping, erodes easily, seepage.	Not needed	Droughty, soil blowing, seepage.	Erodes easily, piping, too sandy.	Droughty, erodes easily.
115F: Sandy escarpments	Seepage	Seepage, erodes easily.	Not needed	Slope, seepage.	Slope, too sandy, piping.	Slope, rooting depth.
135, C135: Coland	Seepage	Compressible, low strength, excess humus.	Floods, wetness.	Wetness, floods.	Wetness	Wetness.
142B: Chaseburg	Seepage	Low strength, piping.	Not needed	Favorable	Erodes easily, piping.	Erodes easily.
151, 152: Marshan	Seepage	Unstable fill, seepage, erodes easily.	Wetness, cutbanks cave.	Wetness	Wetness	Wetness, erodes easily.
158, C158: Dorchester	Seepage	Compressible, low strength, piping.	Floods	Floods, excess lime.	Favorable	Erodes easily.
162B, 162C, 162C2, 162D, 162D2, 162E2: Downs	Seepage	Compressible, low strength, erodes easily.	Not needed	Erodes easily, slope.	Erodes easily, piping.	Favorable.

TABLE 12.—*Water management*—Continued

Map symbol and soil name	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
163B, 163C, 163C2, 163D, 163D2, 163D3, 163E, 163E2, 163E3, 163F, 163F2, 163F3, 163G: Fayette	Seepage, slope.	Compressible, low strength, erodes easily.	Not needed	Erodes easily, slope.	Complex slope, erodes easily, piping.	Favorable.
171B, 171C, 171C2, 171D2, 171E2: Bassett	Favorable	Low strength, compressible.	Not needed [1]	Slope	Percs slowly	Percs slowly, wetness.
175B, 175C, 175D: Dickinson	Seepage	Seepage, piping.	Not needed	Soil blowing, droughty, fast intake.	Too sandy, soil blowing, complex slope.	Droughty.
177, 177B, 177C: Saude	Seepage	Seepage, piping.	Not needed	Droughty	Complex slope, piping.	Droughty.
178, 178B: Waukee	Seepage	Piping, seepage.	Not needed	Favorable	Complex slope	Favorable.
183C, 183D2, 183E, 183E2, 183F: Dubuque	Depth to rock, slope.	Compressible, low strength.	Not needed	Erodes easily, slope, rooting depth.	Depth to rock, erodes easily, rooting depth.	Erodes easily, slope, rooting depth.
193: Camden	Seepage	Low strength, piping.	Not needed	Favorable	Favorable	Favorable.
198B: Floyd	Favorable	Low strength, piping.	Favorable	Wetness	Wetness, piping.	Wetness.
213, 213B, 214, 214B, 214C: Rockton	Depth to rock	Thin layer	Not needed	Rooting depth	Depth to rock	Depth to rock.
215E: Goss	Slope, seepage.	Compressible, hard to pack.	Not needed	Complex slope, droughty.	Complex slope	Droughty, slope.
221: Palms	Seepage	Compressible, hard to pack, low strength.	Wetness, cutbanks cave.	Wetness, fast intake, soil blowing.	Not needed	Not needed.
225, 226: Lawler	Seepage	Piping, seepage.	Cutbanks cave	Wetness	Wetness, rooting depth.	Rooting depth, wetness.
265, 265B: Bixby	Seepage	Seepage	Not needed	Favorable	Rooting depth	Rooting depth.
284, 284B, 284C: Flagler	Seepage	Seepage, piping.	Not needed	Droughty, fast intake.	Too sandy, piping.	Droughty.
285, 285B, 285C2, 285E2: Burkhardt	Seepage	Piping, seepage.	Not needed	Rooting depth, droughty, seepage.	Rooting depth, complex slope.	Rooting depth, droughty.
302B, 302C: Coggon	Favorable	Favorable	Not needed [1]	Slope	Favorable	Percs slowly, wetness.

TABLE 12.—*Water management*—Continued

Map symbol and soil name	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
315: Loamy alluvial land	Favorable	Piping, seepage.	Floods	Floods	Not needed	Not needed.
354: Marsh	Favorable	Unstable fill	Poor outlets	Floods, wetness.	Not needed	Wetness.
391B: Clyde part	Favorable	Low strength, compressible, hard to pack.	Favorable	Wetness, floods.	Not needed	Wetness, large stones.
Floyd part	Favorable	Low strength, piping.	Favorable	Wetness	Wetness, piping.	Wetness.
394B, 394C, 394C2: Ostrander	Favorable	Low strength	Not needed	Slope	Favorable	Favorable.
398: Tripoli	Favorable	Favorable	Favorable	Wetness	Not needed	Not needed.
399, 399B: Readlyn	Favorable	Favorable	Favorable	Wetness	Wetness	Not needed.
407B: Schley	Favorable	Low strength	Favorable	Wetness	Wetness	Wetness.
408B, 408C: Olin	Favorable	Low strength	Not needed	Fast intake, slope, soil blowing.	Soil blowing, piping.	Erodes easily, wetness.
409B, 409C: Dickinson	Seepage	Seepage, piping.	Not needed	Fast intake, soil blowing.	Piping, soil blowing.	Erodes easily.
444B, 444C, 444D: Jacwin	Favorable	Compressible, low strength, shrink-swell.	Depth to rock, percs slowly.	Wetness, percs slowly, rooting depth.	Complex slope, depth to rock, percs slowly.	Wetness, percs slowly.
471: Oran	Favorable	Low strength	Favorable	Wetness	Wetness	Not needed.
478G: Rock outcrop part						
Nordness part	Depth to rock, slope.	Thin layer	Not needed	Slope, rooting depth, droughty.	Depth to rock, rooting depth, complex slope.	Droughty, rooting depth, slope.
480C, 480D2, 480E2: Orwood	Seepage	Compressible, low strength, erodes easily.	Not needed	Erodes easily, complex slope.	Erodes easily, complex slope, piping.	Favorable.
485: Spillville	Seepage	Hard to pack, piping, excess humus.	Not needed	Favorable	Favorable	Favorable.
487B: Otter part	Favorable	Low strength	Floods, wetness.	Wetness	Not needed	Wetness.
Huntsville part	Seepage	Low strength, piping.	Not needed	Favorable	Not needed	Favorable.

TABLE 12.—*Water management*—Continued

Map symbol and soil name	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
489: Ossian	Seepage	Compressible, low strength, excess humus.	Floods, wetness.	Floods, wetness.	Not needed	Wetness.
490: Caneek	Seepage	Compressible, low strength, piping.	Floods, wetness.	Floods, wetness.	Wetness	Not needed.
496B: Dorchester part	Seepage	Compressible, low strength, piping.	Floods	Floods, excess lime.	Favorable	Erodes easily.
Volney part	Seepage	Large stones, thin layer, seepage.	Not needed	Floods, seepage.	Large stones, complex slope.	Large stones, erodes easily, rooting depth.
497F: Fayette part	Seepage, slope.	Compressible, low strength, erodes easily.	Not needed	Erodes easily, slope.	Complex slope, erodes easily, piping.	Favorable.
Dubuque part	Depth to rock, slope.	Compressible, low strength.	Not needed	Erodes easily, slope, rooting depth.	Depth to rock, erodes easily, rooting depth.	Erodes easily, slope, rooting depth.
Jacwin part	Favorable	Compressible, low strength, shrink-swell.	Depth to rock, percs slowly.	Wetness, percs slowly, rooting depth.	Complex slope, depth to rock, percs slowly.	Wetness, percs slowly.
497G: Fayette part	Seepage, slope.	Compressible, low strength, erodes easily.	Not needed	Erodes easily, slope.	Complex slope, erodes easily, piping.	Favorable.
Dubuque part	Depth to rock, slope.	Compressible, low strength.	Not needed	Erodes easily, slope, rooting depth.	Depth to rock, erodes easily, rooting depth,	Erodes easily, slope, rooting depth.
Jacwin part	Favorable	Compressible, low strength, shrink-swell.	Depth to rock, percs slowly.	Wetness, percs slowly, rooting depth.	Complex slope, depth to rock, percs slowly.	Wetness, percs slowly.
499B, 499D, 499F: Nordness	Depth to rock, slope.	Thin layer	Not needed	Slope, rooting depth, droughty.	Depth to rock, rooting depth, complex slope.	Droughty, rooting depth, slope.
512B, 512D: Marlean	Seepage, depth to rock.	Seepage	Not needed	Droughty, rooting depth, slope.	Depth to rock, complex slope, rooting depth.	Droughty, rooting depth, slope.
536: Hanlon	Seepage	Piping, low strength.	Floods, cutbanks cave.	Floods, fast intake, soil blowing.	Piping, soil blowing.	Not needed.
551: Calamine	Depth to rock	Shrink-swell, low strength.	Depth to rock, floods, percs slowly.	Wetness, floods, percs slowly.	Wetness, depth to rock.	Wetness.
620B: Port Byron	Seepage	Low strength	Not needed	Favorable	Favorable	Favorable.
714, 714B, 714C, 714D: Winneshiek	Depth to rock	Thin layer, low strength.	Not needed	Erodes easily, slope, rooting depth.	Depth to rock, erodes easily, rooting edpth.	Rooting depth, erodes easily, slope.

TABLE 12.—*Water management*—Continued

Map symbol and soil name	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
725: Hayfield	Seepage	Seepage	Not needed	Favorable	Favorable	Favorable.
763D2, 763E2, 763E3, 763F2, 763F3: Exette	Seepage, slope.	Compressible, low strength, erodes easily.	Not needed	Erodes easily, slope.	Complex slope, erodes easily, piping.	Erodes easily, slope.
777, 777B, 777C: Wapsie	Seepage	Seepage, piping.	Not needed	Droughty	Complex slope, piping.	Droughty.
781B, 781C: Lourdes	Favorable	Shrink-swell, low strength.	Percs slowly	Percs slowly, slope.	Percs slowly	Percs slowly, wetness.
782, 782B, 782C: Donnan	Favorable	Compressible, shrink-swell, low strength.	Percs slowly, complex slope.	Percs slowly, wetness, slope.	Percs slowly, wetness.	Percs slowly, wetness.
783B, 783C: Cresco	Favorable	Shrink-swell, low strength.	Percs slowly	Percs slowly	Percs slowly, slope.	Percs slowly.
784B: Riceville	Favorable	Shrink-swell, low strength.	Percs slowly	Percs slowly	Percs slowly, wetness.	Percs slowly, wetness.
798B: Protivin	Favorable	Shrink-swell, low strength.	Percs slowly	Percs slowly, wetness.	Percs slowly, wetness.	Percs slowly, wetness.
926: Canoe	Seepage	Compressible, low strength, piping.	Favorable	Favorable	Favorable	Not needed.
977: Richwood	Seepage	Low strength, piping.	Not needed	Favorable	Favorable	Favorable.
978: Festina	Seepage	Compressible, low strength, piping.	Not needed	Favorable	Favorable	Favorable.

[1] Artificial drainage not needed but in extended wet periods interceptor tile may be beneficial.

Factors of soil formation

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil 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 development have acted on the soil materials (*4*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material that has accumulated through the weathering of rock and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of parent material into a soil profile. It may be much or little, but some time is required for differentiation of soil horizons. A long period 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 and geology

The accumulation of parent material is the first step in the development of a soil. Some of the 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 Fayette County are glacial drift, loess, alluvium, and eolian or wind-deposited sand. Much less extensive parent materials are organic deposits and residuum.

Glacial drift is all rock material in transport by glacial ice, all deposits made by glacial ice, and all deposits of dominantly glacial origin made in the sea or in bodies of glacial melt water. It includes glacial till, which is unsorted sediment whose particles range in size from boulders to clay. Glacial drift is the most important parent material in the formation of the soils of Fayette County. At least twice during the glacial period, continental ice, or glaciers, moved over the land. The record of these ice invasions is contained in the unconsolidated rock material that was deposited by the melting ice and melt water streams. The older ice sheet, known as the Nebraskan, occurred some 750,000 years ago (*5, 6, 8*). It was followed by the Aftonian interglacial period. The Kansan glaciation is thought to have started about 500,000 years ago. A more recent glaciation was recognized by Leighton (*6*) as the Iowan substage of the Wisconsin glaciation, but recent studies of the presence and identification of Iowa's glacial till indicates that the conclusions formed from studies made before 1950 are questionable. Intensive, detailed geomorphic and stratigraphic work shows that the landscape is a multi-level sequence of erosion surfaces, and that many of the levels are cut into Kansan and Nebraskan till (*9*). Ruhe's study demonstrated that the Iowan till does not exist, but that an erosion-surface complex does exist in the Iowan region. The Iowan erosion surface is multi-level and is arranged in a series of steps from major drainageways toward bounding divides. The Iowan erosion surface is marked where it cuts Kansan and Nebraskan till by a stone line. The stone line occurs on all levels of the stepped surfaces where they occur, and it passes under the alluvium along the drainageways (fig. 17).

The soils formed in the glacial drift and glacial till on the Iowan erosion surface are Bassett, Clyde, Coggon, Cresco, Donnan, Floyd, Kenyon, Lourdes, Oran, Ostrander, Protivin, Readlyn, Riceville, Schley, and Tripoli soils. They have a loamy surface sediment about 1 to 2 feet thick over the glacial material. However, this is deeper in the lower concave slopes and waterways in such soils as the Clyde, Floyd, and Schley. A stone line or pebble band commonly separates the friable loamy surficial sediment from the firm loam or clay loam glacial till. Donnan soils formed in loamy material and clayey material derived from glacial till.

Loess is the second most important parent material in Fayette County. The loess is of Wisconsin age, and it consists of accumulated particles of silt and clay that have been deposited by wind. The base of the Wisconsin Loess in Iowa ranges in age from 16,500 to 29,000 years (*10*). The thickness of loess varies from about 16 feet on the more stable divides to a very thin mantle over limestone on the steep side slopes along the Turkey and Volga Rivers and their tributaries. The loess is in the northeastern part of the county. In the remainder of the county there is no loess mantling the glacial till. There is a sharp break from the thickly loess-covered areas to the less sloping areas formed in glacial till.

Soils that formed in loess more than 40 inches thick are the Downs, Exette, Fayette, and Port Byron series. Dubuque and Nordness soils developed in areas where the loess is less than 30 inches thick over limestone.

Alluvium consists of sediment that has been transported and laid down by water. Alluvial deposits of Late Wisconsin age occur under the flood plains and terraces of water courses in Fayette County. These materials occur as lenses and layers of sand, gravel, silt, and clay. The thickness of alluvial materials varies. These materials are as much as 95 feet thick along major streams; along small streams they are less than 5 feet thick. Waukee soils formed in loamy alluvium

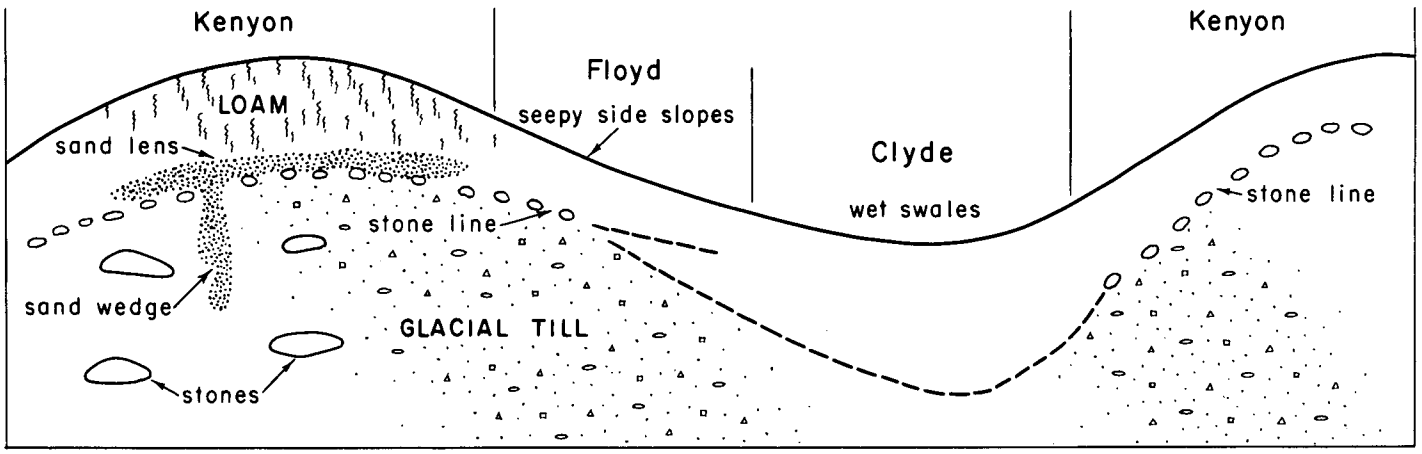

Figure 17.—**Parent materials of soils in the Kenyon-Floyd-Clyde association.**

TABLE 13.—*Engineering*

Soil name and location	Parent material	Report number AAD4—	Depth	Moisture density[1]	
				Maximum dry density	Optimum moisture
			In	*lb/ft³*	*Pct*
Exette silt loam: 460 feet north and 79 feet west of SE corner of NE¼NE¼, sec. 7, T. 93 N., R. 7 W. (Modal)	Deoxidized, leached Wisconsin loess.	3166	0–6	102	20
		3167	24–33	107	18
		3168	41–54	109	17

[1] Based on AASHTO Designation T99, Method A.

[2] Mechanical analyses according to the AASHTO Designation T88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

over sand and gravel, whereas Camden soils formed in silty material with some stratified sands at a depth of about 4 feet.

Some of the alluvial material has been transported only a short distance and has accumulated at the foot of the slope on which it originated. This material is called "local" alluvium and retains many characteristics of the soils in the areas from which it has eroded. Huntsville soil is an example. It is at the foot of the slopes directly below loess-derived soils.

When the streams overflow their channels and the water spreads over the flood plains, the coarse-textured materials are deposited first. While the floodwater continues to spread, it moves more slowly, and such fine-textured sediment as silt is deposited. When the flood has passed, the finest particles, or clay, settle from the water that is left standing in the lowest part of the flood plain. The Chaseburg and Dorchester soils developed from silty material, whereas Spillville soils formed from coarser textured, loamy material.

Eolian sand or wind-deposited sand occurs in the uplands and on benches. In the glacial till uplands the sand occurs as low mounds or dunes and is underlain by till at various depths. The wind-deposited sand consists largely of quartz that is very fine and fine in size and is highly resistant to weathering. It has not been altered appreciably since it was deposited. The soils in Fayette County that developed mainly from wind-deposited sand are Chelsea, Dickinson, Lamont, and Sparta soils.

Organic deposits consist of plant material that has accumulated in old lakebeds or swamps that supported a thick growth of water-loving plants. The organic soils occupy small, wet areas in the county where poor drainage has retarded the decay of plant remains, which have accumulated over a period of time. In Fayette County the organic material is about 10 to 60 inches thick, but in a few areas it is more than 60 inches thick. Palms muck soils formed in this organic material.

Residuum, the material derived from the weathering of sedimentary rock in place, is a minor source of parent material in this county. Limestone and shale are the types of sedimentary rock in Fayette County. In most places a deposit of loess or glacial drift covers the residuum, and in only a few areas does residuum make up the entire solum. Residuum makes up nearly all of the solum, however, in some Jacwin soils. In this county, the layer of residuum is generally less than 6 inches thick over bedrock. In the Dubuque soils, a deposit of loess covers the thin layer of residuum from limestone. In soils such as Calamine and Jacwin, part of the solum is made up of residuum from shale. Generally, however, less than 6 inches of the solum consists of residuum from shale. The residuum commonly has a texture of silty clay or clay. Residuum from limestone commonly has a more reddish hue than the yellowish residuum from shale.

Climate

The soils of Fayette County have been developing under the influence of a midcontinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to the growth of forest vegetation (*7*). The morphology of most of the soils in the county indicates that the climate 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.

Steep soils generally have weaker soil development than soils that are less sloping. Most of the water that falls on their surfaces runs off. Nordness soils are an example.

Soils that formed in alluvium, such as Coland, Spillville, and Dorchester soils, are on bottom lands. Even though they are on nearly level areas, their microrelief affects runoff, depth to water table, and the amount of new sediment. Coland soils are on the low elevations, have a high water table, and impound water for short periods. Spillville soils are on slightly higher elevations, but they are somewhat poorly drained to moderately well drained.

test data

Percentage passing sieve—[3]			Percentage smaller than—[3]				Liquid limit	Plasticity index	Classification	
No. 10	No. 40	No. 200	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO [3]	Unified [4]
							Pct			
---	---	99	79	46	27	22	39	14	A-6(10)	CL
---	---	99	82	48	23	20	34	11	A-6(8)	CL
---	---	99	76	40	22	18	30	10	A-4(8)	CL

[3] Based on AASHTO Designation M 145-49.
[4] Based on the Unified soil classification system.

Climate is a major factor in determining which soils develop from the various parent materials. The rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by climate. Temperature, rainfall, relative humidity, and length of the frost-free period are important in determining the vegetation.

The influence of the general climate of the region is somewhat modified by the local conditions in or near the developing soil. For example, south-facing, dry, sandy soils have a local climate or microclimate that is warmer and less humid than the average climate of nearby areas. Low-lying, poorly drained areas are wetter and colder than most areas around them. These contrasts account for some of the differences in soils within the same general climatic regions.

Plant and animal life

All living organisms are important to soil formation. These include plants, animals, bacteria, and fungi. The plants are responsible for the amount of organic matter, color of the surface layer, and the amount of nutrients. Animals, such as earthworms and burrowing animals, help to keep the soil open and porous. Bacteria and fungi decompose the plants, thus releasing nutrients for plant food.

Most of the soils in Fayette County developed under prairie grasses or a mixture of prairie grasses and water-tolerant plants. Because the grasses have many roots and tops that have decayed on or in the soils, the soils developed under these conditions have a thick, dark surface layer. Kenyon and Floyd soils are examples.

The soils which developed under timber vegetation have a thinner, lighter colored surface layer. The organic matter, derived mainly from leaves, was deposited only on the surface of the soil. Fayette and Coggon soils are examples of these light colored soils.

In many areas soils first developed under prairie grasses and then under forest vegetation. These soils are intermediate between soils formed entirely under grasses and those under forest. Downs and Bassett soils are examples.

The Fort Byron, Downs, and Fayette soils are members of a group of soils that formed from the same parent material and under comparable environment except for native vegetation. Differences in native vegetation account for the main differences in morphology in the soils of this group.

Relief

Relief, or topography, influences soil development mainly through its effect on drainage, runoff, and erosion. In Fayette County the relief ranges from nearly level to very steep. Water soaks into the nearly level areas that are not flooded. Where the slope is steeper, more water runs off the surface and less penetrates into the soil. Tripoli, Readlyn, and Kenyon soils are examples of soils that formed in the same kind of parent material under similar vegetation but differ because of topographic position. Tripoli soils are on broad, level or nearly level, high upland flats. Readlyn soils are on nearly level ridges and long, gentle, concave slopes. Kenyon soils are on the gently sloping to moderately sloping uplands.

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 nearly level to strongly sloping, because they have moderately rapid to rapid permeability.

Time

The length of time that the soil material remains in place and is acted on by the soil-forming processes affects the kind of soil that develops. Older or more strongly developed soils show well defined genetic horizons. Downs and Fayette soils are examples. A less well developed soil shows only weakly developed

horizons. Some of the soils that developed in alluvium show little or no profile development because fresh material is deposited periodically. The materials have not been in place long enough for the climate and vegetation to develop well defined genetic horizons in the profile. Dorchester soil is an example of a very young soil. In steep areas, soil material is removed before it has had time to develop into a deep soil profile. Nordness soil is an example.

Another factor that may modify the effect of time is the resistant materials. Soils that formed in material resistant to weathering, such as quartz sand, do not change much with time. Examples of this are the Chelsea and Sparta soils.

Where organic materials, such as trees, have been buried by later depositions through the action of ice, water, or wind, the age of a landscape can be determined by radiocarbon dating (*8*).

The loess that covered Fayette County and in which Port Byron, Downs, and Fayette soils formed is probably 14,000 to 29,000 years old (*9*). The Iowan erosion surface formed during loess-deposition time. Where the Iowan surface is covered by loam surficial sediments, it is younger than 14,000 years (*9*), and soils on the slopes are probably much younger. Such soils as Bassett, Kenyon, Readlyn, and Tripoli are on this surface. Floyd, Clyde, and Schley soils are cut in and below these higher-lying soils and are younger.

Man's influence on the soil

Important changes took place when man settled Fayette County. Some changes had little effect on soil productivity, and others had drastic effects.

Changes caused by water erosion are the most apparent. Cultivation changes the soil by making the sloping areas more susceptible to erosion, which removes the topsoil, organic matter, and plant nutrients. Sheet erosion, which is the most prevalent type in this county, removes a few inches of topsoil at a time, but cultivation usually destroys all evidence of this loss. In other places, shallow and deep gullies have formed, depositing the eroded materials on the lower slopes.

When man cultivates the soil, he leaves it susceptible to soil blowing. The light textured soils blow, especially when the land is left bare and the topsoil is dry. On the nearly level fields that have been fall-plowed, dark topsoil can be seen mixed with the snow, or piled along the fence rows and road ditches.

In fields that have been cultivated continuously, the well developed granular structure of the surface layer, so apparent in virgin grassland, begins to break down. The surface soil bakes and becomes hard when dry. The fine-textured soils that have been plowed continuously when wet tend to puddle and are less permeable than similar soils in undisturbed areas. In some fields of finer textured soils, a compact layer that hardens on drying and is less permeable than the subsoil, has formed below the plowed layer. The layer is called a plowsole or plowpan.

Man has also done much to increase productivity and to reclaim areas not suitable for crops. He has established drainage ditches and diversions at the foot of slopes to prevent flooding of the lowlands and to make them useable for cultivated crops. He has also added commercial fertilizers to counteract deficiencies in plant nutrients and to make the soil more productive than the virgin soil. In many places dark colored, low lying soils have received lighter colored deposition.

In Fayette County a soil developed in recent alluvium that shows the influence of man is Dorchester silt loam. There are strata of light and dark colored materials washed from the hillsides and deposited by floods. This erosion has taken place since man began cultivating the hillsides.

Classification of the soils

This section defines the current system of classifying soils and classifies the soils of the area according to that system.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*12, 13*).

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 the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 14 the soils of the survey area are classified according to the system. Classes of the system are briefly discussed in the following paragraphs.

ORDERS. Ten soil orders are recognized. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol.* An example is Mollisol.

SUBORDERS. Each order is divided into suborders based primarily on properties that influence soil genesis and that are important to plant growth or that were selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu,* meaning water, plus *oll,* from Mollisol).

GREAT GROUPS. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. The name of a great group ends with the name of a suborder. A prefix added to the name suggests something about the properties of the soil. An example is Haplaquoll (*Hapl,* meaning simple horizons, plus *aquoll,* the suborder of Mollisols that have an aquic moisture regime).

SUBGROUPS. Each great group is divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades that have some properties that are representative of the great groups but do not indicate transition to any other known kind of soil. The names

TABLE 14.—*Classification of the soils*

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Backbone	Coarse-loamy, mixed, mesic Mollic Hapludalfs
Bassett	Fine-loamy, mixed, mesic Mollic Hapludalfs
Bixby	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludalfs
Burkhardt	Sandy, mixed, mesic Typic Hapludolls
*Calamine	Fine, mixed, mesic Typic Argiaquolls
Camden	Fine-silty, mixed, mesic Typic Hapludalfs
Caneek	Fine-silty, mixed (calcareous), mesic Typic Fluvaquents
Canoe	Fine-silty, mixed, mesic Udollic Ochraqualfs
Chaseburg	Coarse-silty, mixed, nonacid, mesic Typic Udifluvents
Chelsea	Mixed, mesic Alfic Udipsamments
Clyde	Fine-loamy, mixed, mesic Typic Haplaquolls
Coggon	Fine-loamy, mixed, mesic Typic Hapludalfs
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Cresco	Fine-loamy, mixed, mesic Typic Argiudolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Donnan	Fine-loamy over clayey, mixed, mesic Aquollic Hapludalfs
Dorchester	Fine-silty, mixed (calcareous), mesic Typic Udifluvents
Downs	Fine-silty, mixed, mesic Mollic Hapludalfs
Dubuque	Fine-silty, mixed, mesic Typic Hapludalfs
Exette	Fine-silty, mixed, mesic Dystric Eutrochrepts
Fayette	Fine-silty, mixed, mesic Typic Hapludalfs
Festina	Fine-silty, mixed, mesic Mollic Hapludalfs
Flagler	Coarse-loamy, mixed, mesic Typic Hapludolls
Floyd	Fine-loamy, mixed, mesic Aquic Hapludolls
Goss	Clayey-skeletal, mixed, mesic Typic Paleudalfs
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Hayfield	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquollic Hapludalfs
Huntsville	Fine-silty, mixed, mesic Cumulic Hapludolls
Jacwin	Fine-loamy over clayey, mixed, mesic Aquic Hapludolls
Kenyon	Fine-loamy, mixed, mesic Typic Hapludolls
Lamont	Coarse-loamy, mixed, mesic Typic Hapludalfs
Lawler	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Loamy alluvial land	Loamy, mixed, mesic Typic Udifluvents
Lourdes	Fine-loamy, mixed, mesic Aquollic Hapludalfs
Marlean	Loamy-skeletal, mixed, mesic Typic Hapludolls
Marsh	Aquolls
Marshan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Nordness	Loamy, mixed, mesic Lithic Hapludalfs
Olin	Coarse-loamy, mixed, mesic Typic Hapludolls
Oran	Fine-loamy, mixed, mesic Udollic Ochraqualfs
Orwood	Fine-loamy, mixed, mesic Mollic Hapludalfs
Ossian	Fine-silty, mixed, mesic Typic Haplaquolls
Ostrander	Fine-loamy, mixed, mesic Typic Hapludolls
Otter	Fine-silty, mixed, mesic Cumulic Haplaquolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Port Byron	Fine-silty, mixed, mesic Typic Hapludolls
Protivin	Fine-loamy, mixed, mesic Aquic Argiudolls
Readlyn	Fine-loamy, mixed, mesic Aquic Hapludolls
Riceville	Fine-loamy, mixed, mesic Udollic Ochraqualfs
Richwood	Fine-silty, mixed, mesic Typic Argiudolls
Rockton	Fine-loamy, mixed, mesic Typic Argiudolls
Sandy escarpments	Coarse-loamy, mixed, mesic Udolls And Udalfs
Saude	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Schley	Fine-loamy, mixed, mesic Udollic Ochraqualfs
Sparta	Sandy, mixed, mesic Entic Hapludolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Tripoli	Fine-loamy, mixed, mesic Typic Haplaquolls
Volney	Loamy-skeletal, mixed, mesic Cumulic Hapludolls
Wapsie	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Mollic Hapludalfs
Waukee	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Winneshiek	Fine-loamy, mixed, mesic Mollic Hapludalfs

of subgroups are derived by placing one or more adjectives before the name of the great group. The adjective *Typic* is used for the subgroup that is thought to typify the great group. An example is Typic Haplaquolls.

FAMILIES. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-loamy, mixed, mesic, Typic Haplaquolls.

SERIES. The series consists of a group of soils that are formed from a particular kind of parent material and have horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Environmental factors affecting soil use

This section is for those who are not familiar with Fayette County or who need some general information on the county. It briefly discusses the history; climate; relief and drainage; farming; and transportation, industries, and markets of Fayette County.

History

The land that became Fayette County was acquired by the United States as part of the Louisiana Purchase in 1803. The land that now makes up Fayette County was purchased by treaty from the Sac and Fox Indians in 1832 and 1837. The area was named in honor of Marquis de La Fayette, a French statesman and general. The first settling and farming was by Franklin Wilcox in 1840 in section 32 of Westfield Township.

Fayette County was formally organized and the first election was held in 1850. The census at this time was 835 people. The county seat of West Union was founded in 1851. The first tasks of the newly created government were building county roads and instituting mail service. The first court was held in West Union in July, 1852. The first railroad in the county, the Burlington, Cedar Rapids and Minnesota Railroad Company, brought railway service through the county in September, 1873. The population of Fayette County increased until 1900 to 29,845; since then it has decreased to 26,898 in 1970.

Climate [4]

The climate of the central part of Fayette County is quite representative of the climate throughout Fayette County. However, minimum temperatures vary considerably on calm clear nights, when the rural lowlands have temperatures that are usually a few degrees colder than temperatures in other parts of the county. Rainfall also tends to vary somewhat in quantity over the county, particularly during the warm season.

About 70 percent of the annual precipitation falls during the warm part of the year, April through September. On the average, Fayette County receives a trace or more of precipitation on 185 days per year. Measurable precipitation, 0.01 inch or more, falls on an average of 100 to 105 days per year; 0.10 inch on 60 days per year; 0.50 inch on 20 days per year; and about 2.00 inches on 1 day per year. Most of the showers fall in spring and early in summer, which is the time when newly tilled fields are most likely to erode.

The seasonal snowfall in Fayette County totals about 40 inches. Snowfalls of 1 inch or more normally begin in the latter part of November and continue into March; during this period the snow cover is 1 inch thick or more on 70 to 80 days.

Ideally, during the crop season the subsoil should have abundant moisture. The variations from the ideal, however, are frequent and on occasion are extreme, as during drought or flood. Showers normally are most frequent during May and June and are followed by somewhat drier weather during July and August.

Temperatures have varied at Fayette from −35° F on February 1, 1918 to 110° on July 14, 1936. Temperatures of 90° or higher occur on about 11 days in summer, and temperatures of 32° or colder occur on 169 days per year. The average date of the last freeze date in spring is May 10, and the average date of the first freeze in fall is September 29. The growing season averages 142 days.

Additional temperature and precipitation data are given in tables 15 and 16.

Relief and drainage

Fayette County is drained by two main streams and the heads of a number of smaller streams. The northern third of the county is drained from west to east by the Turkey River and some of its small tributaries. The middle third of the county is drained, also from west to east, by the Volga River. The southern third of the county is drained, toward the south, by the upper reaches of the Maquoketa River and the Little Wapsipinicon River. Two small creeks that drain southward are Buffalo Creek and Otter Creek.

The topography of the western and southern two-thirds of the county is characterized by nearly level to gently undulating topography. Typical upland features are the generally flat horizon and low relief. Topography along the rivers is more sloping, and limestone frequently outcrops in these areas.

In contrast to this area, the northern and eastern one-third of the county is characterized by a gently rolling to hilly or steep relief. Typical upland features are high relief, frequent limestone outcrops on the steeper slopes, and steep slopes. A rough estimate of the slopes in this area shows that over 50 percent of the soils have slopes of more than 9 percent. In this area topography along the rivers is generally rough and is hilly to steep.

[4] Prepared by PAUL J. WAITE, climatologist for Iowa and director, Iowa Weather Service.

TABLE 15.—*Temperature and precipitation*

[Data from Fayette, near the center of Fayette County, 1915–72]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average monthly highest maximum	Average monthly lowest minimum	Average	1 year in 10 will have—		Number of days with snow of 1 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	In	In	In		In
January	28	8	44	−21	1.2	0.2	2.3	23	6
February	31	12	47	−14	1.1	.1	2.2	18	6
March	42	22	64	−2	2.4	1.2	4.4	12	7
April	59	35	80	19	2.6	1.4	4.7	6	4
May	71	47	87	29	3.8	1.8	7.4		
June	80	57	91	40	4.9	2.2	7.7		
July	85	61	94	47	3.6	1.5	8.0		
August	83	59	93	42	3.7	1.0	5.2		
September	74	50	88	30	3.4	1.4	6.8		
October	63	39	81	21	2.3	.4	4.4		
November	44	25	65	6	2.0	.4	2.9	3	3
December	31	14	50	−14	1.2	.4	2.2	16	4
Year	58	36			32.2			78	6

TABLE 16.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data from Fayette, near the center of Fayette County]

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	Apr 10	Apr 20	May 2	May 12	May 25
2 years in 10 later than	Apr 4	Apr 14	Apr 27	May 7	May 20
5 years in 10 later than	Mar 25	Apr 3	Apr 16	Apr 27	May 10
Fall:					
1 year in 10 earlier than	Oct 23	Oct 13	Oct 5	Sept 21	Sept 14
2 years in 10 earlier than	Oct 28	Oct 18	Oct 11	Sept 26	Sept 19
5 years in 10 earlier than	Nov 8	Oct 29	Oct 22	Oct 7	Sept 29

In some areas, rivers have defined terraces that are as much as a mile wide. The highest point in the county is about 1,250 feet in the southeastern part near Arlington; the lowest point, about 950 feet, is along the river north of Fairbank in the southwest corner.

Farming

Farms in Fayette County have been increasing in size and decreasing in number. The number of farms in Fayette County decreased from 2,770 in 1959 to 2,038 in 1970. The average farm increased during this time from 163 to 216 acres. The State average in 1970 was 249 acres per farm. The percentage of owner-operated farms in Fayette County was 68.2 in 1970, slightly above the State average of 52.8 in the same year.

Farm production in the county generally consists of livestock and grain crops. However, the south-central part of the county, around Oelwein, mainly produces cash grain, but seed corn is a significant part of the total output. The northeastern part of the county, which includes Fayette and Downs loess soils, derives a greater proportion of its income from livestock production than parts of the county that are gently undulating Kenyon, Floyd, and Clyde soils.

The principal crop grown in Fayette County is corn. Soybeans and hay are next in importance. In 1971,

Fayette County had 136,685 acres in corn, 28,625 acres in oats, 45,321 acres in soybeans, 46,122 acres in hay, and 102,381 acres in pasture.

The principal livestock produced in Fayette County is hogs, but beef cow and fed cattle production is also important. In Fayette County in 1971, 26,395 fed cattle were marketed, 223,633 hogs were marketed, and 1,427 fed lambs were marketed. There were 13,165 beef cows and 19,140 milk cows. Also, there were 149,754 hens and pullets of laying age.

Transportation, industries, and markets

Federal, State, and county highways through the county provide routes for automobile traffic and for transportation of farm products to market. U.S. Highway 18 crosses the county from west to northeast, and Iowa Highway 3 crosses the southern part of the county from west to east. Iowa Highway 150 crosses the county from north to south. Bus transportation is available daily on a north-south route. Motor freight lines serve every trading center in the county. Rail service is available to Oelwein and the surrounding area.

Businesses in Fayette County are predominantly small, mostly retail stores. Examples of small industries in the county are packing plants, dairy products, plastic tile, feed concentrate, and a railroad car repair center.

Farm livestock markets are scattered throughout the county, which is some distance from large centrally located markets in Waterloo, Cedar Rapids, and Dubuque, Iowa.

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Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom, first. The normal flood plain of a stream; land along a stream subject to flooding.

Bottom, second. An old alluvial plain, generally flat or smooth, that borders a stream but is seldom flooded.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.
A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.
A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.
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 a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.
R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Interfluve. Area between adjacent streams flowing in same direction.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Profile, soil. A vertical section of the soil extending through all its horizons and 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 described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	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

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stone line. A concentration of coarse fragments in soils that generally marks an old weathering surface. In a cross section, the line may be one fragment or more thick. The line generally overlies material that weathered in place and marks the top of a paleosol. It is ordinarily overlain by recent sediment of variable thickness.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

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 can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, 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."

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

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