Soil Survey of

Benton County, Iowa

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

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

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

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

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

Symbols
- 27C
- 56B
- 131B
- 134A
- 148B
- 151C
THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.

6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.

Consult "Contents" for parts of the publication that will meet your specific needs.

This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.
This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1969-74. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1974. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Benton County Soil and Water Conservation District. Funds appropriated by Benton County were used to defray part of the cost of this survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Typical landscape in the Fayette-Downs association. Fayette soils are on the upper part of slopes, and Lindley soils are on the lower part.
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* Corn, Soybeans, Oats, Grass-legume hay, Smooth bromegrass, Bromegrass-alfalfa, Kentucky bluegrass.

* Trees having predicted 20-year average heights.

* Camp areas, Picnic areas, Playgrounds, Paths and trails.

* Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife.


* Septic tank absorption fields, Sewage lagoon areas, Trench sanitary landfill, Area sanitary landfill, Daily cover for landfill.

* Roadfill, Sand, Gravel, Topsoil.

* Pond reservoir areas; Embankments, dikes, and levees; Drainage; Irrigation; Terraces and diversions; Grassed waterways.

* Depth, USDA texture, Classification—Unified, AASHTO, Fragments greater than 3 inches. Percent- age passing sieve—4, 10, 40, 200. Liquid limit, Plasticity index.

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Preface

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

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.
Soil Survey of **Benton County, Iowa**

United States Department of Agriculture
Soil Conservation Service

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

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Soil Conservation Service

**BENTON COUNTY** is in east-central Iowa (fig. 1). It is rectangular and is about 30 miles from north to south and 24 miles from east to west. It has a total area of 459,520 acres, or 720 square miles.

The county is about 67 percent cropland, 15 percent pastureland, 15 percent woodland, wasteland, and idle land, and 5 percent urban land. Corn for grain and seed, soybeans, cattle, and hogs are the principal farm products.

The area that became Benton County was acquired by the United States as a part of the Louisiana Purchase in 1803. The area was settled in 1839 and was organized as Benton County in 1846. In 1865 the population was 11,245. By 1900 it was 25,177. In 1970 the population of the county was 22,885, and the population of Vinton, the county seat, was 4,845.

Benton County is on a loess-covered glacial till plain. The soils in the dominantly gently sloping and moderately sloping areas formed in loess and till under prairie vegetation. The soils in the steeper areas and on the pahas formed in loess and till under trees.

**General nature of the survey area**

On the pages that follow is general information on natural resources, farming, drainage, relief, and transportation of the county.

**Natural resources**

Soil is the most important natural resource in the county. Crops and hogs and cattle for slaughter are marketable products derived from the soil.

Limestone is also an important natural resource. Several limestone quarries are in the northern part of the county.

In most of the county, the water supply is adequate for domestic use and livestock. Many flowing artesian wells are in the area around Belle Plaine. "Big Jumbo," a well known artesian well dug in Belle Plaine in 1886, flowed out of control for over a year before the flow could be stopped and the well sealed.

**Farming**

Because of the capability of the soils in Benton County and the climatic conditions, both crops and livestock are important to the economy. This has been true since the first years of settlement when grain was grown largely for subsistence and cattle were herded on the open range.
Wheat was important in those early years but declined in importance because of insect pests and inadequate profits. Corn, which was also grown in the first years of settlement, gradually increased in importance to become the most important crop. Soybeans is the second most important crop.

Some steeper areas still have a forest cover. The others are used for pastureland and cropland.

In 1970 about 150,000 acres was in corn; 30,000 acres in oats; 76,000 acres in soybeans; 30,000 acres in hay; 78,000 acres in pasture; and about 79,000 acres in woodland, farmsteads, and wasteland.

**Climate**

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

Table 1 gives data on temperature and precipitation for the survey area as recorded at Vinton in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 22 degrees F, and the average daily minimum temperature is 14 degrees. The lowest temperature on record, which occurred at Vinton on March 1, 1962, is -34 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at Vinton on July 30, 1955, is 105 degrees.

Growing degree days are shown in Table 1. They are equivalent to “heat units.” During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 32.38 inches. Of this, 23 inches, or 72 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 19 inches. The heaviest 1-day rainfall during the period of record was 5.80 inches at Vinton on August 5, 1968. Thunderstorms occur on about 41 days each year, and most occur in summer.

Average seasonal snowfall is 32 inches. The greatest snow depth at any one time during the period of record was 21 inches. On an average of 24 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 84 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average wind-speed is highest, 13 miles per hour, in April.

**Drainage**

Two major drainage systems, the Iowa River and the Cedar River, receive runoff. The Cedar River and its tributaries drain nearly 90 percent of the county. Prairie Creek, a major tributary of the Cedar River, drains much of the southern part of the county. The Iowa River, which flows across the southwest corner, drains about 10 percent of the county.

**Relief**

The highest areas in the county are located in Polk and Jackson townships and are 1,050 feet to 1,100 feet above sea level. The lowest areas are on bottom land along the Cedar River at the Benton-Linn County line and on the Iowa River bottom. The elevation of these areas is 700 feet to 750 feet above sea level.

The relief is stronger along the Cedar River and in the southern part of the county. It is less pronounced in the west-central part of the county.

**Transportation**

Two major highways extend across the county. U.S. Highway No. 30 traverses the southern half of the county. U.S. Highway No. 218 extends east and north across the county. Several state highways and hard surfaced county roads connect these major highways to the smaller communities. Most other roads are hard surfaced or are surfaced with crushed limestone or gravel.

Many towns are served by railroad lines that generally traverse the county in an east-west direction.

**How this survey was made**

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study 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, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some
are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each soil association on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one soil association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Association descriptions

1. Dinsdale-Kenyon-Tama association

Nearly level to strongly sloping, well drained and moderately well drained loamy and silty soils; on uplands

The characteristic landscape of this association is wide, gently sloping convex ridgetops and moderately sloping to strongly sloping side slopes. A well-developed network of drainageways is also characteristic.

The soils of this association formed in loess, glacial till, and loamy material or loess overlying glacial till (fig. 2).

This association occupies about 53 percent of the county. It is about 40 percent Dinsdale soils, 14 percent Kenyon soils, 8 percent Tama soils, and 38 percent soils of minor extent.

Dinsdale soils are gently sloping and moderately sloping. They are moderately well drained. Typically, the surface layer is very dark brown silty clay loam and is about 7 inches thick, except where eroded. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 33 inches thick. It is brown, friable silty clay loam in the upper part and brown and yellowish brown, firm loam in the lower part. The substratum is yellowish brown loam.

Kenyon soils are gently sloping to strongly sloping. They are moderately well drained. Typically, the surface layer is very dark brown loam and is about 11 inches thick, except where eroded. The subsurface layer is very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is about 36 inches thick. It is brown, friable loam in the upper part, dark yellowish brown and yellowish brown, firm loam in the middle part, and mottled yellowish brown and grayish brown, firm loam in the lower part. The substratum is mottled grayish brown and yellowish brown, calcareous loam.

Tama soils are nearly level to moderately sloping. They are well drained. Typically, the surface layer is black silty clay loam and is about 8 inches thick, except where eroded. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 29 inches thick. The upper few inches is brown, and the rest is dark yellowish brown with some mottles. The substratum is yellowish brown silty loam in the upper part and yellowish brown sandy loam and loam in the lower part.

Of minor extent are the well drained Aredale soils and moderately well drained Bassett soils on site slopes, the poorly drained Colo soils in drainageways, the somewhat poorly drained Ely soils on alluvial fans on foot slopes, the somewhat poorly drained Klinger soils at the heads of upland drainageways and on foot slopes, and the somewhat poorly drained Muscatine soils on upland divides and slightly concave foot slopes.

Most of the association is cultivated. Poorly drained swales and waterways are used for permanent pasture. Most trees are in groves or windbreaks near farm buildings.

These soils are suited to all cultivated crops commonly grown in the county. The main enterprises are growing corn and soybeans for cash crops and feeding hogs and beef cattle. The main concerns of management are controlling erosion, improving drainage along waterways, and maintaining tilth and fertility.

2. Muscatine-Garwin-Tama association

Nearly level to moderately sloping, well drained to poorly drained silty soils; on uplands

The characteristic landscape of this association is broad upland flats, long gentle slopes, slightly rounded
Figure 2.—Relationship of slope and parent material to the soils of the Dinsdale-Kenyon-Tama association and the Muscatine-Garwin-Tama association.

hills, and a well developed network of drainageways (fig. 2). In some areas hillsides are moderately sloping and have short slopes.

The soils of this association formed in loess (fig. 2). This association occupies about 7 percent of the county. It is about 54 percent Muscatine soils, 16 percent Garwin soils, 14 percent Tama soils, and 16 percent soils of minor extent.

Muscatine soils are nearly level and gently sloping and are somewhat poorly drained. The surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 12 inches thick. The subsoil is about 26 inches thick. It is dark grayish brown, friable silty clay loam with grayish brown and yellowish brown mottles. The substratum is olive gray silt loam.

Garwin soils are nearly level and are poorly drained. The surface layer is black silty clay loam about 7 inches thick. The subsurface layer is black and very dark gray silty clay loam about 15 inches thick. The subsoil is olive gray, friable silty clay loam about 26 inches thick. The substratum is light brownish gray silt loam.

Tama soils are nearly level to moderately sloping and are well drained. The surface layer is black silty clay loam and is about 8 inches thick, except where eroded. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is dark yellowish brown friable silty clay loam about 29 inches thick with some mottles in the lower part. The substratum is dark yellowish brown and yellowish brown silt loam from about 44 to 56 inches. Yellowish brown sandy loam and loam layers begin at about 56 inches.

Of minor extent are the poorly drained Colo soils in drainageways, the somewhat poorly drained Ely soils on alluvial fans or foot slopes, and the moderately well drained Dinsdale soils on ridgetops and side slopes.
Most of the association is cultivated. Areas of permanent pasture, which are fenced, are generally along small drainageways. Most trees are in groves or windbreaks near farm buildings.

These soils are well suited to all cultivated crops commonly grown in the county. The main enterprises are growing corn and soybeans for cash crops and feeding hogs and beef cattle. The principal management concerns are improving drainage and controlling erosion. Tile drains are needed for maximum yields on the Garwin soils, on the nearly level areas of Muscatine soils, and along drainageways. On the gently sloping Tama soils, contouring is generally adequate to control erosion. On the moderately sloping soils, a combination of terracing and contouring is generally needed.

3. Kenyon-Clyde-Floyd association

Nearly level to strongly sloping, moderately well drained to poorly drained loamy and silty soils; on uplands

The characteristic landscape of this association is long, gentle slopes, slightly rounded hills, and many drainageways and small streams. In some areas the hillsides are moderately sloping and strongly sloping, and the slopes are shorter.

The soils of this association formed in loamy overburden and the underlying glacial till (fig. 3). In the Clyde and Floyd soils, a stratified valley fill material is between the overburden and the glacial till. Water moves more rapidly in the loamy overburden and stratified valley fill material than in the till, accumulates at the contact surface between these materials, and moves downslope along the line of contact. It may emerge part way down the slope as a seepy spot, or it may wet a large part of the slope.

This association occupies about 7 percent of the county. It is about 28 percent Kenyon soils, 24 percent Clyde soils, 18 percent Floyd soils, and 30 percent soils of minor extent (fig. 4).

Kenyon soils are gently sloping to strongly sloping and are moderately well drained. The surface layer is very dark brown loam that is about 11 inches thick, except where eroded. The subsurface layer is dark brown, very dark brown, and very dark grayish brown loam about 7 inches thick. The subsoil is loam about 36 inches thick. It

Figure 3.—Relationship of slope and parent material to the soils of the Kenyon-Clyde-Floyd association.
is brown in the upper part, dark yellowish brown and yellowish brown in the middle part, and mottled yellowish brown and grayish brown in the lower part. The substratum is mottled grayish brown and yellowish brown calcareous loam.

Clyde soils are nearly level and are poorly drained. The surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark gray silty clay loam about 14 inches thick. The subsoil is about 22 inches thick. It is dark grayish brown, olive gray, and dark gray, friable silty clay loam and loam in the upper part, olive gray, very friable sandy loam and loamy sand in the middle part, and mottled gray and yellowish brown, firm loam in the lower part. The substratum is mottled gray and yellowish brown loam. Clyde soils are adjacent to drainageways and intermittent streams and on the lower slopes of some ridges. Some Clyde soils, which are undrained, are permanent pasture or are sloughs. Stones and boulders that interfere with cultivation and tile installation are in many of these unimproved pastures.

Floyd soils are gently sloping and are somewhat poorly drained. The surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 15 inches thick. The subsoil is about 38 inches thick. It is dark grayish brown and grayish brown, friable loam and sandy clay loam in the upper part, grayish brown, friable sandy loam in the middle part, and mottled yellowish brown and grayish brown, firm loam in the lower part. The substratum is mottled yellowish brown and grayish brown loam.

Of minor extent are the well drained Aredale soils and somewhat poorly drained and moderately well drained Donnan soils on ridgetops and side slopes; the well drained and somewhat excessively drained Dickinson soils, well drained and somewhat excessively drained Olin soils, and excessively drained Sparta soils on convex ridgetops and side slopes; the somewhat poorly drained Readlyn soils on ridgetops; and the poorly drained Tripoli soils on broad, flat ridgetops.

A large part of this association is cultivated. Unimproved drainageways, where boulders and large rocks interfere with cultivation, are generally used for permanent pasture. Most trees are in groves or windbreaks near farm buildings.

These soils are suited to all cultivated crops commonly grown in the county. The main enterprises are growing
corn and soybeans for cash crop and feeding hogs and beef cattle. The principal management concerns are improving drainage, controlling erosion, and improving fertility. Because wetness in Clyde and Floyd soils is caused partly by hillside seepage, interceptor tile are needed upslope from wet areas. Terracing is generally needed with the tile to control the risk of erosion.

4. Colo-Ely-Waukegan association

Nearly level to moderately sloping, well drained to poorly drained silty soils; on bottom lands, stream benches, and foot slopes

This association is dominantly nearly level and gently sloping but is moderately sloping in some areas and is strongly sloping in a few areas along the bench escarpments. The soils on bottom lands and the soils on benches form two distinct associations, but mapping them separately is impractical because of their close association in the generally narrow stream valleys. Many soils on bottom lands are subject to frequent flooding; those on benches are commonly free of flooding.

This association makes up about 13 percent of the county. It is about 30 percent Colo soils, 10 percent Ely soils, 6 percent Waukegan soils, and 54 percent soils of minor extent.

Colo soils are on bottom lands and in narrow drainageways in uplands. They are poorly drained. Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 31 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is olive gray, friable silty clay loam about 13 inches thick. The substratum is also olive gray silty clay loam.

Ely soils are on foot slopes and alluvial fans. They are somewhat poorly drained. Typically, the surface layer is black silty loam about 8 inches thick. The subsurface layer is black, very dark gray, and very dark grayish brown silty clay loam about 26 inches thick. The subsoil is dark grayish brown, friable silty clay loam about 24 inches thick. The substratum is yellowish brown sandy loam and dark yellowish brown loam.

Waukegan soils are on stream benches along rivers and major streams. They are well drained. Typically, the surface layer is very dark brown silty loam about 8 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is about 36 inches thick. It is brown and dark yellowish brown, friable silty clay loam in the upper part, dark yellowish brown, friable silt loam and loam in the middle part, and yellowish brown, loose loamy sand in the lower part. The substratum is yellowish brown sand.

The soils of minor extent are the poorly drained Bremer soils and somewhat poorly drained Nevin soils on low stream benches, the well drained Tama soils on high stream benches, and the poorly drained and very poorly drained Walford soils and well drained Waukee soils on stream benches.

Most of this association is cultivated. Some areas along the major streams are permanent pasture or woodland. Trees are along fence lines and in groves around farmsteads.

The soils of this association are well suited to all cultivated crops commonly grown in the county. A farm seldom lies wholly within the association. The main enterprises are growing corn and soybeans for cash crops and feeding hogs and beef cattle. The major concerns of management are controlling flooding, improving drainage, and maintaining tilth and fertility.

5. Fayette-Downs association

Gently sloping to very steep, well drained silty soils; on uplands

The characteristic landscape of this association is gently sloping and moderately sloping ridgetops, moderately sloping to very steep side slopes, and narrow valleys. The association is more rolling and hilly than most of the county. It includes a series of gently sloping to very steep, dome-shaped hills called "pahas," which tend to be oriented northwest to southeast. These hills are rather prominent because the surrounding topography is nearly level to gently sloping.

The soils in this association formed in deep loess (fig. 5). Because erosion is greater in areas of more sloping soils and because the native vegetation was trees rather than grass, the surface layer of the Fayette and Downs soils is relatively thinner and lighter colored than that of many soils in the county.

This association makes up about 11 percent of the county. It is about 75 percent Fayette soils, 15 percent Downs soils, and 10 percent soils of minor extent.

Fayette soils are gently sloping to very steep. They are well drained. Typically, the surface layer is very dark grayish brown silt loam that is about 5 inches thick unless eroded. The subsurface layer is brown and dark grayish brown silt loam about 5 inches thick. The subsoil is about 36 inches thick. It is brown, friable silt loam in the upper few inches, brown and dark yellowish brown, friable silty clay loam in the middle part, and yellowish brown, friable silty clay loam in the lower part. The substratum is yellowish brown silt loam.

Downs soils are gently sloping to strongly sloping. They are well drained. Typically, the surface layer is very dark grayish brown silt loam that is about 7 inches thick unless eroded. The subsurface layer is brown silt loam about 3 inches thick. The subsoil is 42 inches thick. It is brown and dark yellowish brown, friable silty clay loam in the upper and middle part and mottled brown and yellowish brown, friable silt loam in the lower part. The substratum is mottled brown and yellowish brown silt loam.

The soils of minor extent are the somewhat poorly drained Atterberry soils on flat ridgetops, the well drained Lindley soils on the lower part of side slopes, and the moderately well drained Nodaway and somewhat poorly drained Radford soils along the narrow drainageways.
This association is mostly used for permanent pasture where slopes are too steep to be cultivated. Soils on the nearly level to moderately sloping ridgetops are well suited to all cultivated crops commonly grown in the county. Patches of oak-hickory forest remain from the native vegetation; a few are large. Trees are also along roads, fence lines, and drainageways, in groves, and around farmsteads. The areas of woodland and the wide distribution of trees are distinctive features of the association.

Most farmsteads are on ridgetops, but a few are in small valleys. Fields are commonly small and irregular in shape. The main enterprises are raising beef cattle and hogs and some dairying. The principal concern of management is controlling erosion in cultivated areas. Gully erosion is a greater problem in this association than in the other associations. General improvement of fertility is also needed.

6. **Dickinson-Sparta-Chelsea association**

*Nearly level to very steep, well drained or somewhat excessively drained sandy and loamy soils; on uplands*

The characteristic landscape of this association is gently sloping ridgetops to very steep side slopes dissected by many waterways. Limestone crops out at the surface in many places, especially along major streams. The soils of this association formed in wind deposited or wind reworked alluvial sand, loamy sand, or sandy loam.

This association occupies about 5 percent of the county. It is about 25 percent Dickinson soils, 20 percent Sparta soils, 15 percent Chelsea soils, and 40 percent soils of minor extent.
Dickinson soils are nearly level to moderately sloping. They are well drained or somewhat excessively drained. The surface layer is very dark brown fine sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 9 inches thick. The subsoil is 15 inches thick. It is dark yellowish brown and brown, very friable fine sandy loam in the upper part and dark yellowish brown, very friable loamy sand in the lower few inches. The substratum is yellowish brown and brown loamy sand and sand.

Sparta soils are nearly level to strongly sloping and are excessively drained. The surface layer is very dark brown loamy fine sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 12 inches thick. The subsoil is brown, very friable loamy fine sand about 8 inches thick. The substratum is yellowish brown sand.

Chelsea soils are gently sloping to very steep and are excessively drained. The surface layer is dark brown loamy fine sand about 4 inches thick. The subsurface layer is brown, yellowish brown, and dark yellowish brown loamy fine sand and fine sand about 37 inches thick. The next layer is similar to the subsurface layer but has thin bands of brown loamy fine sand beginning at a depth of about 42 inches.

Of minor extent are the well drained Aredeale soils and somewhat excessively drained Sogn soils on side slopes, the somewhat excessively drained Backbone soils on convex, rounded ridgetops and side slopes, the poorly drained Clyde soils and somewhat poorly drained Floyd soils in upland swales and drainageways, the well drained Lamont soils on convex rounded ridges and side slopes, and the well drained Whalan soils on ridgetops and side slopes.

The soils of this association are mostly used for hay and pasture and for row crops in rotation with oats and hay. Some areas are permanent pasture. Small to large areas of oak-hickory woodland remain from the native vegetation. Other trees are along roads, fence lines, and drainageways, in groves, and around farmsteads.

Fields in this association are commonly small. Many of the soils are not well suited to cultivated crops. The soils on the steeper slopes are not suited to cultivated crops because of the erosion hazard and the difficulty of cultivation. They tend to be dry and subject to erosion.

7. Fluvaquents-Spillville-Flagler association

Level to gently sloping, excessively drained to very poorly drained loamy and sandy soils; on bottom lands and stream benches

This association is dominantly level. Some areas, however, are gently sloping, and a few bench escarpments are strongly sloping to steep. The soils on bottom lands and the soils on benches form two distinct patterns, but mapping them separately is impractical because of their close association in the generally narrow stream valleys (fig. 6). Many of the soils on bottom lands are subject to frequent flooding, but those on benches are generally free of flooding.

The soils of this association formed in dominantly loamy and sandy alluvial material.

This association occupies about 4 percent of the county. It is about 33 percent Fluvaquents, 14 percent Spillville soils, 10 percent Flagler soils, and 43 percent soils of minor extent.

Fluvaquents are nearly level, stratified sandy and loamy soils that are frequently flooded. They are very poorly drained to excessively drained. They are channeled and contain little natural levees, small ponds, sloughs, and small oxbows. Water often remains ponded in the oxbows.

Spillville soils are nearly level. They are moderately well drained and somewhat poorly drained and are subject to flooding. The surface layer is very dark brown loam about 21 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 31 inches thick. The substratum is dark brown fine sand.

Flagler soils are nearly level to gently sloping and are somewhat excessively drained. The surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown sandy loam about 15 inches thick. The subsoil is about 13 inches thick. It is dark yellowish brown; very friable sandy loam in the upper part and brown, loose gravelly sand in the lower part. The substratum is brown sand.

Of minor extent are the excessively drained Chelsea soils on high stream benches, the excessively drained Finchford soils on high flood plains, the moderately well drained Hanlon soils on low benches and alluvial fans, and the somewhat poorly drained Lawler soils and well drained Saude and Waukee soils on stream benches.

Much of this association is used for pasture and woodland because it is frequently flooded. The soils on benches, which are seldom flooded, are cultivated.

Farm enterprises are determined by surrounding associations because an entire farm seldom lies wholly within this association. The concerns of management are controlling flooding, improving drainage, and maintaining tillage and fertility.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes
general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

Soils that have profiles that are almost alike make up a soil series. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into soil phases. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Dinsdale silty clay loam, 2 to 5 percent slopes, is one of several phases in the Dinsdale series.

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

A soil complex consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Colo-Ely complex, 2 to 5 percent slopes, is an example.

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

This survey includes miscellaneous areas. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables")
give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil descriptions

11B—Colo-Ely complex, 2 to 5 percent slopes. This map unit consists of gently sloping, somewhat poorly drained and poorly drained soils in narrow upland drainageways along small streams and waterways. Individual areas range from 20 acres to 200 acres or more.

This unit is about 60 percent Colo soil and 40 percent Ely soil. The Colo soil is along the stream or waterway, and the Ely soil is along the outer edge of the map unit. The Colo soil is subject to flooding, but the Ely soil is not. Areas of these soils are so intricately mixed that it is not practical to map them separately.

Typically, the surface layer of the Colo soil is black silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 31 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is olive gray, friable silty clay loam about 13 inches thick. The substratum is olive gray silty clay loam.

Typically, the surface layer of the Ely soil is black silt loam about 8 inches thick. The subsurface layer is silty clay loam about 26 inches thick. The upper part is black, the middle part very dark gray, and the lower part very dark grayish brown. The subsoil is dark grayish brown, friable silty clay loam about 24 inches thick. The substratum is yellowish brown sandy loam and dark yellowish brown loam.

Included with these soils in mapping are areas where 6 to 10 inches of lighter colored overwash lower in organic matter has been deposited. These areas are on gently sloping fans at the mouth of small drainageways. They make up less than 5 percent of the map unit. Permeability is moderate in Colo and Ely soils. Surface runoff is medium, but overwash is received from adjacent soils. The available water capacity is high. The organic matter content in the plow layer is about 5.0 to 7.0 percent. Reaction in the surface layer is neutral or slightly acid. Tilth is fair to good.

Most areas are cropland. Some are pasture or hayland. Most of this unit is cropped with the surrounding soils because individual areas are generally too narrow to be cropped separately. The unit is moderately suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This unit is moderately suited to corn, soybeans, and small grain. Because seepage from the uplands keeps this unit wet, tile drains are generally needed. The unit is subject to overwash and siltation from upslope. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This unit is moderately suited to grasses and legumes for hay and pasture. Overwash and siltation from adjacent soils may damage hay and pasture. Artificial drain-
age is needed to maintain a good stand. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stock- ing, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is I1w.

41—Sparta loamy fine sand, 0 to 2 percent slopes. This nearly level, excessively drained soil is on benches or in uplands. Individual areas are irregular in shape and range from 20 to 200 acres.

Typically, the surface layer is very dark brown loamy fine sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 14 inches thick. The subsoil is brown, very friable loamy fine sand about 12 inches thick. The substratum is yellowish brown, loose fine sand which, in most areas, is underlain by coarser sand and gravel below 4 feet. In some areas the combined thickness of the surface layer and subsurface layer is more than 24 inches. In some areas the surface layer is fine sand or fine sandy loam.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Runoff is slow. The available water capacity is low. The organic matter content of the plow layer is 1.0 to 1.5 percent. Reaction in the subsoil is generally medium acid or strongly acid. The subsoil is very low in available phosphorus and available potassium. Tilth generally is good.

Most areas are cultivated. Some are pasture or hayland. This soil is poorly suited to cultivated crops and is moderately suited to hay, pasture, and trees. It is suited to many engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Wind erosion is a hazard in cultivated areas. Yields for all crops are below average, even under good management, unless rainfall is above average and timely. Conservation tillage and winter cover crops reduce wind erosion. Returning crop residue or adding other organic material helps to maintain fertility and reduce wind ero-

This soil is moderately suited to grasses and legumes for hay and pasture. If it is used for hayland or pasture, however, there is little hazard of wind erosion. The carry-

41B—Sparta loamy fine sand, 2 to 5 percent slopes. This gently sloping, excessively drained soil is in uplands, in some dune-like areas, and on benches along the Cedar River. Individual areas are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is very dark brown loamy fine sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 12 inches thick. The subsoil is brown, very friable loamy fine sand about 8 inches thick. The substratum is yellowish brown
fine sand. On benches, this soil generally is underlain by coarse sand and gravel. In a few areas the surface texture is fine sand or fine sandy loam.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Surface runoff is slow. The available water capacity is low. The organic matter content in the plow layer is 1.0 to 1.5 percent. Reaction is generally medium acid or strongly acid in the surface layer and the upper part of the subsoil unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is generally good.

Many areas are cultivated. Some are pastureland or hayland. This soil is poorly suited to cultivated crops and is moderately suited to hay, pasture, and trees. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. It is subject to wind and water erosion if cultivated. Yields for all crops are below average, even under good management, unless rainfall is above average and timely. Conservation tillage, winter cover crops, and grassed waterways reduce erosion by wind and water. Terraces are difficult to construct and maintain because of poor stability. Returning crop residue or adding other organic material helps to maintain fertility and to reduce erosion.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion if it is used for hayland or pasture. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

41C—Sparta loamy fine sand, 5 to 9 percent slopes. This moderately sloping, excessively drained soil is in uplands and on stream benches. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 8 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 10 inches thick. The substratum is yellowish brown fine sand. In a few areas the surface layer is fine sand or fine sandy loam.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Surface runoff is medium. The available water capacity is low. The organic matter content in the plow layer is about 0.5 to 1.0 percent. Reaction is generally medium acid or strongly acid in the surface and the upper part of the subsoil, unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth generally is good.

Many areas are pastureland. Some are cultivated. This soil is poorly suited to crops and moderately suited to hay and pasture and trees. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. It is subject to wind and water erosion if cultivated. Yields for all crops are below average, even under good management, unless rainfall is above average and timely. Conservation tillage, winter cover crops, and grassed waterways reduce erosion by wind and water. Terraces are difficult to construct and maintain because of poor stability. Returning crop residue or adding other organic material helps to maintain fertility and to reduce erosion.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion if it is used for hayland or pasture. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

41D—Sparta loamy fine sand, 9 to 14 percent slopes. This strongly sloping, excessively drained soil is on convex side slopes along major streams or drainageways and in some places on narrow convex ridges. Individual areas are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is very dark grayish brown loamy fine sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy fine sand about 5 inches thick. The subsoil is dark yellowish brown, very friable loamy fine sand about 10 inches thick. The substratum is yellowish brown fine sand. In a few areas the surface layer is fine sand or fine sandy loam.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Surface runoff is moderately rapid. The available water capacity is low. The organic matter content in the plow layer is less than 0.5 percent. Reaction is generally medium acid or strongly acid in the surface layer and the upper part of the subsoil. The subsoil is generally very low in available phosphorus and available potassium. Tilth is generally good.

Most areas are in pasture. This soil is poorly suited to cultivated crops and to hay, pasture, and trees. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. It is subject to wind and water erosion if cultivated. Yields are very low.

This soil is poorly suited to grasses and legumes for hay and pasture. There is little hazard of erosion if it is used for pasture or hay. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

51—Vesper silt loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained or poorly drained soil is in level or slightly depressed areas on flood plains or low stream benches. It is subject to occasional flooding. Individual areas are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is very dark brown silt loam about 7 inches thick. The subsurface layer is very dark
gray silt loam about 12 inches thick. The subsoil is about 41 inches thick. The upper part is black, firm silty clay loam; the middle part is dark gray and gray, firm silty clay loam; and the lower part is light gray, friable silty clay loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction in the surface layer is generally medium acid unless the soil has been limed in the last 5 years. The subsoil is medium in available phosphorus and low in available potassium. Tilth is generally good.

Nearly all areas are cropland. This soil is moderately suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. It is somewhat poorly drained or poorly drained and is subject to ponding. Surface drainage and tile drainage are needed. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is llw.

63B—Chelsea loamy fine sand, 1 to 5 percent slopes. This gently sloping, excessively drained soil is in uplands. A few areas are on benches along the Cedar River. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is dark brown loamy fine sand about 4 inches thick. The subsurface layer is yellowish brown fine sand about 37 inches thick. The next layer to a depth of 60 inches or more is similar to the subsurface layer but has bands of brown, very friable loamy fine sand 1/4 inch to 2 inches thick. In some small areas, the surface layer is fine sandy loam.

Permeability is rapid. Surface runoff is slow. The available water capacity is low. The organic matter content in the plow layer is about 0.5 to 1.0 percent. Reaction is generally medium acid or strongly acid in the surface layer. Lower layers are generally very low in available phosphorus and available potassium.

Most areas are pastureland or woodland. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture and trees. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. It is subject to wind and water erosion if cultivated. Yields for all crops are below average, even under good management, unless rainfall is above average and timely. Conservation tillage, contouring, winter cover crops, and grassed waterways reduce erosion by wind and water. Terraces are difficult to construct and maintain because of poor stability. Returning crop residue or adding other organic material helps to maintain fertility and reduce erosion.

This soil is moderately suited to hay and pasture. There is little hazard of erosion on hayland or pasture. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

63C—Chelsea loamy fine sand, 5 to 9 percent slopes. This moderately sloping, excessively drained soil is in uplands on mound-like ridges and side slopes. A few areas are on high stream benches. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is dark brown loamy fine sand about 4 inches thick. The subsurface layer is brown, yellowish brown, and dark yellowish brown fine sand about 37 inches thick. The next layer to a depth of 60 inches or more is similar to the subsurface layer but has bands of brown, very friable loamy fine sand 1/4 inch to 2 inches thick. In some small areas the surface layer is fine sandy loam.

Permeability is rapid. Surface runoff is medium. The available water capacity is low. The organic matter con-
tent in the plow layer is less than 0.5 percent. Reaction is generally medium acid or strongly acid in the surface layer. Lower layers are generally very low in available phosphorus and available potassium.

Most areas are pastureland or woodland. This soil is poorly suited to cultivated crops. It is moderately suited to hay and pasture and trees. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. It is subject to wind and water erosion if cultivated. Yields for all crops are below average, even under good management, unless rainfall is above average and timely. Conservation tillage, contouring, winter cover crops, and grassed waterways reduce erosion by wind and water. Terraces are difficult to construct and maintain because of low stability. Returning crop residue or adding other organic material helps to maintain fertility and reduce erosion.

This soil is moderately suited to hay and pasture. There is little hazard of erosion on hayland or pasture. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

63D—Chelsea loamy fine sand, 9 to 18 percent slopes. This strongly sloping and moderately steep, excessively drained soil is on upland ridges and side slopes. Individual areas are irregular in shape and generally range from 5 to 50 acres.

Typically, the surface layer is brown loamy fine sand about 2 inches thick. The subsurface layer is yellowish brown fine sand about 30 inches thick. The next layer to a depth of 60 inches or more is similar to the subsurface layer but has bands of brown, very friable loamy fine sand 1/4 inch to 2 inches thick.

Permeability is rapid. Surface runoff is moderately rapid. The available water capacity is low. The organic matter content in the plow layer is less than 0.5 percent. Reaction is generally medium acid or strongly acid in the surface layer. Lower layers are generally very low in available phosphorus and available potassium.

Most areas are pastureland or woodland. This soil is poorly suited to cultivated crops, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. It is subject to severe wind and water erosion if cultivated. Yields are very low.

This soil is poorly suited to hay and pasture. If it is used for pasture or hayland, however, there is little hazard of erosion. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is VIb.

65E2—Lindley loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is on convex side slopes and nose slopes in uplands. Individual areas are irregular in shape and range from 20 to 100 acres.

Typically, the surface layer is dark brown loam with some mixing of yellowish brown clay loam and is about 6 inches thick. The subsoil is yellowish brown, firm clay loam about 44 inches thick. The substratum is yellowish brown clay loam.

Included with this soil in mapping are soils that formed in 14 to 24 inches of friable loam over firm clay loam. Also included are areas where the subsoil is reddish brown silty clay. These areas are in a narrow band around the heads of some drainageways. They are wetter than this Lindley soil. They make up less than 4 percent of the map unit.

Permeability is moderately slow, and surface runoff is rapid. The available water capacity is high. The organic matter content of the plow layer is less than 0.5 percent. Reaction is generally strongly acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is medium in available phosphorus and very low in available potassium. Lith is generally poor. The soil becomes cloudy when worked when too wet.

Most areas are permanent pasture. A few are woodland. Many areas were cropped in the past. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. There is a severe hazard of erosion in cultivated areas. Conservation tillage, winter cover crops, and contouring reduce soil loss. Returning crop residue or adding other organic material helps to improve fertility and tilth.
This soil is moderately suited to grasses and legumes. There is little hazard of erosion on pastureland. Harvesting hay is somewhat difficult because of the steepness of the slopes. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and may cause gullying along livestock trails. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep pasture and soil in good condition. This soil is moderately suited to trees. There is little hazard of erosion in woodland. Proper management is needed to maintain good stands. The capability subclass is Vle.

65F—Lindley loam, 18 to 25 percent slopes. This steep, well drained soil is on convex side slopes and nose slopes in uplands. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is brown and dark brown loam about 5 inches thick. The subsurface layer is brown loam about 2 inches thick. The subsoil is yellowish brown, firm clay loam about 42 inches thick. The subsoil is yellowish brown clay loam.

Included with this soil in mapping are small areas where the subsoil is reddish brown silty clay. These areas are in a narrow band around the heads of some drainageways. They are wetter than this Lindley loam. They make up less than 3 percent of the map unit.

Permeability is moderately slow. Surface runoff is rapid. The available water capacity is high. The organic matter content in the plow layer is less than 0.5 percent. Reaction is generally strongly acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is medium in available phosphorus and very low in available potassium. Tilth is generally fair, but the soil becomes cloudy if worked when too wet.

Most areas are permanent pasture. Some are woodland. This soil is poorly suited to cultivated crops and moderately suited to pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. The hazard of erosion is very severe in cultivated areas. The steep slope makes use of machinery hazardous.

This soil is moderately suited to grasses and legumes and pasture. There is little hazard of erosion if it is used for pasture. Harvesting hay is somewhat difficult because of the steepness of the slopes. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and may cause gullying along livestock trails. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

This soil is moderately suited to trees. There is little hazard of erosion in woodland. Proper management is needed to maintain good stands. The capability subclass is Vle.

65F3—Lindley clay loam, 18 to 25 percent slopes, severely eroded. This steep, well drained soil is on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is mixed brown and yellowish brown clay loam about 2 inches thick. The subsoil is yellowish brown, firm clay loam about 38 inches thick. The substratum is yellowish brown clay loam.

Included with this soil in mapping are small areas where the subsoil is reddish brown silty clay. These areas are in a narrow band around the heads of some drainageways and are wetter than this Lindley soil. They make up less than 3 percent of the map unit.

Permeability is moderately slow. Surface runoff is rapid. The available water capacity is high. The organic matter content in the plow layer is less than 0.5 percent. Reaction is usually strongly acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is medium in available phosphorus and very low in available potassium. Tilth is poor. The surface layer is generally cloudy.

Most areas are permanent pasture. This soil is poorly suited to cultivated crops and hay. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. The hazard of erosion is very severe in cultivated areas. Yields may be very low. The steep slope makes use of machinery hazardous.

This soil is poorly suited to grasses and legumes. Pastureland, however, is one of the best uses for this soil. There is little hazard of erosion on well managed areas. Reseeding may be difficult because of the clay loam texture, firm consistency, and low fertility in the surface layer. Fertilizer, lime, and a seeding method that leaves intact as much of the old vegetation as possible are needed. Harvesting hay is somewhat difficult because of the steepness of the slope. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and may cause gullying along livestock trails. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

This soil is moderately suited to trees. Production is low on timberland, but the hazard of erosion is also low. Seedling mortality is high unless suitable species are selected. Proper management is needed to maintain good stands.

The capability subclass is Vle.

83B—Kenyon loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape. They range from 5 to several hundred acres and may extend across several farms.

Typically, the surface layer is very dark brown loam about 11 inches thick. The subsurface layer is very dark grayish brown, brown, and dark brown loam about 7 inches thick. The subsoil is about 36 inches thick. The upper part is brown, friable loam; the middle part is yellowish brown and dark yellowish brown, firm loam;
and the lower part is mottled grayish brown and yellowish brown, firm loam. The substratum is mottled grayish brown and yellowish brown loam. In some areas the surface layer is sandy loam.

Permeability is moderate, but the soil is more permeable in the upper part than in the lower part. Because of the difference in permeability, water tends to move laterally. In wet seasons seepy areas may develop for short periods. Runoff is medium. The available water capacity is high. The organic matter content of the plow layer is 3.0 to 4.0 percent. Reaction in the surface layer is generally medium acid or slightly acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tillth generally is good.

Nearly all areas are cropland. Some are pasture or hayland. This soil is well suited to cultivated crops and to hay and pasture. It is well suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, are needed. If this soil is contoured or terraced, tile drains are needed to prevent seepy spots. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pasture. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

83C—Kenyon loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape. They range from 10 to several hundred acres and may extend across several farms.

Typically, the surface layer is very dark brown loam about 11 inches thick. The subsurface layer is very dark brown loam about 4 inches thick. The subsoil is about 39 inches thick. The upper part is brown, friable loam; the middle part is dark yellowish brown, firm loam; and the lower part is yellowish brown, firm loam. The substratum is mottled grayish brown and yellowish brown loam. In some areas, the surface layer is sandy loam.

Included with this soil in mapping are areas where the surface layer is thinner and lower in organic matter. These areas are on the steepest part of the side slopes and on the convex nose slopes. They make up less than 10 percent of the map unit.

Permeability is moderate, but the soil is more permeable in the upper part than in the lower part. Because of the difference in permeability, water tends to move laterally. In wet seasons seepy areas may develop for short periods. Surface runoff is medium. The available water capacity is high. The organic matter content of the plow layer is 3.0 to 4.0 percent. Reaction in the surface layer is generally medium acid or slightly acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tillth generally is good.

Many areas are cropland. Many are hayland or pasture. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, may be needed. If this soil is contoured or terraced, tile drains are needed to prevent seepy spots. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pasture. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

83C2—Kenyon loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape and range from 10 to 200 acres or more.

Typically, the surface layer is very dark grayish brown loam with some mixing of brown loam and is about 8 inches thick. The subsoil is about 38 inches thick. The upper part is brown, friable loam; the middle part is dark yellowish brown, firm loam; and the lower part is yellowish brown, firm loam. The substratum is mottled grayish brown and yellowish brown loam. In some areas the surface layer is sandy loam.

Included in mapping are areas where most of the topsoil has been removed by erosion. In these areas the organic matter content is lower in this Kenyon soil. These areas are on the steepest part of side slopes and on convex nose slopes. They make up less than 10 percent of the map unit.

Permeability is moderate, but the soil is more permeable in the upper part than in the lower part. Because of the difference in permeability, water tends to move laterally, and in wet seasons seepy areas may develop for short periods. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is 2.0 to 3.0 percent. Reaction in the surface layer is generally medium acid or slightly acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potas-
sium. Tillth is commonly poor, and the soil is commonly cloddy.

Most areas are cropland or were cropped in the past. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Because material from the subsoil, which is very low in available phosphorus, available potassium, and organic matter, has been mixed into the plow layer, more fertilizer is needed to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in less eroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some areas causes severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways are needed to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, may be needed. If this soil is contoured or terraced, tile drains are needed to prevent seepy spots. Returning crop residue or adding other organic materials helps to improve fertility and tillth.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing help to keep the pasture and soil in good condition.

The capability subclass is Ile.

83D2—Kenyon loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained soil is on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark grayish brown loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 2 inches thick. The subsoil is about 37 inches thick. The upper part is brown, friable loam; the middle part is dark yellowish brown, firm loam; and the lower part is yellowish brown, firm loam. The substratum is mottled grayish brown and yellowish brown loam. In some areas the surface layer is sandy loam.

Included with this soil in mapping are areas where the surface layer is thinner and lower in organic matter. These areas are on the steepest part of side slopes and on convex nose slopes. They make up less than 10 percent of the map unit.

Permeability is moderate, but the soil is more permeable in the upper part than in the lower part. Because of the difference in permeability, water tends to move laterally and seepy areas may develop for short periods in wet seasons. Runoff is moderately rapid. The available water capacity is high. The organic matter content in the plow layer is 2.0 to 3.0 percent. Reaction in the surface layer is generally medium acid or slightly acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tillth generally is good.

Many areas are cropland. Many are hayland or pastureland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, may be needed. If this soil is contoured or terraced, tile drains are needed to prevent seepy spots. Returning crop residue or adding other organic materials helps to improve fertility and maintain tillth.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.
and to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Some material from the subsoil, which is very low in phosphorus, potassium, and organic matter, has been mixed into the plow layer. As a result, more fertilizer is needed to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in uneroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some cases causes severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, may be needed. If this soil is contoured or terraced, tile drains are needed to prevent seepy spots. Returning crop residue or adding other organic matter helps to improve fertility and tilth.

This soil is moderately suited to legumes and grasses for hay and pasture. If it is used for hay or pasture, there is little hazard of erosion. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is I1e.

84—Clyde silty clay loam, 0 to 2 percent slopes.

This nearly level, poorly drained soil is along drainageways and in lower concave areas in uplands. It is subject to frequent flooding. Individual areas are irregular or long and range from 20 to 200 acres or more.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark gray silty clay loam about 14 inches thick. The subsoil is about 22 inches thick. The upper part is dark grayish brown, olive gray, and dark gray, friable silty clay loam and loam; the middle part is olive gray, very friable sandy loam and loamy sand; and the lower part is mottled gray and yellowish brown, firm loam. The substratum is gray and yellowish brown loam.

Permeability is moderate, but the soil is more permeable in the upper part than in the lower part. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 9.0 to 11.0 percent. Reaction is generally neutral or slightly acid in the surface layer. The subsoil is very low in available phosphorus and available potassium. Tilth is generally fair unless the soil has been worked when too wet.

Many areas are cropland. Many are pastureland. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately or poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Yields are below average unless rainfall is above average and timely. Both wind and water erosion are hazards in cultivated areas. Conservation tillage, contouring, winter cover crops, and grassed waterways reduce erosion. Terraces are difficult to construct because of shallowness over limestone. Returning crop residue or adding other organic material helps to maintain fertility and reduce erosion.

This soil is poorly suited to grasses and legumes for hay and pasture. There is little hazard of erosion, however, on hayland or pasture. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

109C—Backbone fine sandy loam, 4 to 12 percent slopes.

This moderately sloping and strongly sloping, somewhat excessively drained soil is on ridges and convex side slopes in uplands. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically, the surface layer is dark brown with some brown fine sandy loam about 9 inches thick. The subsurface layer is dark yellowish brown fine sandy loam about 2 inches thick. The subsoil is about 23 inches thick. It is dominantly dark yellowish brown, friable fine sandy loam. Fractured limestone bedrock is at 34 inches. In some areas the surface layer is lighter colored and thinner. Permeability is moderately rapid in the upper part of the soil and moderately slow in the lower part. Surface runoff is medium. The available water capacity is very low to low. Organic matter content in the plow layer is about 0.5 to 1.0 percent. Reaction in the surface and subsurface layers is generally neutral or slightly acid but is strongly acid in some areas. The subsoil is generally low in available phosphorus and very low in available potassium. Tilth is fair.

Many areas are cropland or pastureland. Some are woodland. This soil is poorly suited to cultivated crops, hay and pasture, and trees. It is moderately or poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Yields are below average unless rainfall is above average and timely. Both wind and water erosion are hazards in cultivated areas. Conservation tillage, contouring, winter cover crops, and grassed waterways reduce erosion. Terraces are difficult to construct because of shallowness over limestone. Returning crop residue or adding other organic material helps to maintain fertility and reduce erosion.

This soil is poorly suited to grasses and legumes for hay and pasture. There is little hazard of erosion, however, on hayland or pasture. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

110B—Lamont fine sandy loam, 2 to 5 percent slopes.

This gently sloping, well drained soil is on upland ridges or high stream benches. Individual areas are irregular in shape and range from 5 to 100 acres.
Typically, the surface layer is very dark gray fine sandy loam about 4 inches thick. The subsurface layer is brown fine sandy loam about 6 inches thick. The subsoil is about 30 inches thick. The upper part is dark yellowish brown and dark brown, friable and very friable sandy loam, and the lower part is yellowish brown, very friable loamy sand. The substratum is yellowish brown loamy sand.

Permeability is moderately rapid in the upper part of the soil and very rapid in the lower part. Surface runoff is slow. The available water capacity is low. The organic matter content in the plow layer is about 0.5 to 1.0 percent. Reaction in the surface and subsurface layers is medium acid or strongly acid. The subsoil is generally medium in available phosphorus and very low in available potassium. Lith is fair.

Most areas are pastureland or woodland. A few are cropland. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture and trees. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Yields tend to be below average unless rainfall is above average and timely. If this soil is cultivated, there is a hazard of both wind and water erosion. Conservation tillage, contouring, winter cover crops, and grassed waterways reduce soil loss by wind and water. Terraces may be difficult to construct and maintain because of poor stability. Returning crop residue or adding other organic material helps to maintain fertility and reduce erosion.

This soil is moderately suited to hay and pasture. It is used for pasture or hay, however, there is little hazard of erosion. The carrying capacity for pasture is slightly limited during midsummer because of droughtiness. The capability subclass is Ili.

**11B—Garwin silty clay loam, 0 to 2 percent slopes.** This nearly level, poorly drained soil is in uplands at the heads of concave drainageways. Individual areas are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is black and very dark gray silty clay loam about 15 inches thick. The subsoil is about 26 inches thick. It is olive gray, friable silty clay loam. The substratum is light brownish gray silt loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 5.5 to 6.5 percent. Reaction is typically neutral or slightly acid in the surface layer. The subsoil is generally very low in available phosphorus and very low in available potassium. Lith is fair unless the soil is worked when too wet.

Almost all areas are cropland. This soil is well suited to cultivated crops and hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Artificial drainage, however, is needed to use the soil to its full potential. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition. The capability subclass is I1w.

**119—Muscatine silty clay loam, 0 to 2 percent slopes.** This nearly level, somewhat poorly drained soil is on broad upland divides. Individual areas are irregular in shape. They range from 10 to several hundred acres and may extend across several farms.
Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 12 inches thick. The subsoil is friable silty clay loam about 26 inches thick. The upper and middle part is dark grayish brown, and the lower part is dark grayish brown with grayish brown and yellowish brown mottles. The substratum is olive gray silt loam with yellowish brown mottles.

Included in mapping are small areas of Garwin soils, which are more poorly drained than Muscatine soils. Garwin soils are in small drainageways. They make up about 5 percent of the map unit.

Permeability is moderate. Surface runoff is slow. The available water capacity is very low. The organic matter content in the plow layer is about 5.0 to 6.0 percent. Reaction in the surface layer is generally medium acid or strongly acid unless the soil has been limed in the past 5 years. The subsoil is generally low in available phosphorus and very low in available potassium. Tillth is generally fair or good unless the soil has been worked when too wet.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately or poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of erosion in cultivated areas. The soil is subject to overflow from upslope and may be wet or seepy during periods of high rainfall. Terracing or contouring this soil and the area upslope reduces erosion. Tile drains may be needed to reduce wetness. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tillth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is I.

119B—Muscatine silty clay loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on loess covered uplands around the heads of drainageways and on foot slopes. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 12 inches thick. The subsoil is friable silty clay loam about 24 inches thick. The upper and middle part is dark grayish brown, and the lower part is dark grayish brown with yellowish brown mottles. The substratum is olive gray silt loam with yellowish brown mottles.

Permeability is moderate. Surface runoff is medium. The available water capacity is very high. The organic matter content in the plow layer is about 4.5 to 5.5 percent. Reaction in the surface layer is generally medium acid unless the soil has been limed in the past 5 years. The subsoil is generally low in available phosphorus and very low in available potassium. Tillth is generally fair or good unless the soil has been worked when too wet.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately or poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of erosion in cultivated areas. The soil is subject to overflow from upslope and may be wet or seepy during periods of high rainfall. Terracing or contouring this soil and the area upslope reduces erosion. Tile drains may be needed to reduce wetness. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tillth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.

120—Tama silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on narrow upland ridgetops. Individual areas are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark brown silty clay loam about 10 inches thick. The subsoil is friable silty clay loam about 32 inches thick. The upper part is dark brown and brown, and the lower part is dark yellowish brown. The substratum to a depth of 60 inches is dark yellowish brown silt loam. Below that, it is yellowish brown loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 3.5 to 4.5 percent. Reaction is typically medium acid or slightly acid in the surface layer and the upper part of the subsoil. The subsoil is generally medium in available phosphorus and very low in available potassium. Tillth is good.

Nearly all areas are cropland. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of soil blowing in cultivated areas. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tillth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.

120B—Tama silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on upland ridges
above the moderately sloping Tama soils. Individual areas are irregular in shape and range from 5 to 100 acres or more.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 29 inches thick. The upper few inches are brown, friable silty clay loam. The rest is dark yellowish brown, friable silty clay loam. Some mottles are in the lower part. The substratum to a depth of 56 inches is dark yellowish brown silt loam. Next is a layer of yellowish brown sandy loam 8 inches thick. Below that is yellowish brown loam. In some areas loam is at a depth as shallow as 36 inches.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 3.0 to 4.0 percent. Reaction is typically medium acid or slightly acid in the surface layer and the upper part of the subsoil. The subsoil is generally medium in available phosphorus and very low in available potassium. Tillth is generally good.

Most areas are cropland. Some are permanent pasture or hayland. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places, contouring and terracing, is difficult because of irregular contours, but in most places these practices are suitable. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pasture. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poor tillth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIIe.

120C—Tama silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in uplands below the less sloping Tama soils. Individual areas are long and irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is dark brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 26 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The substratum to a depth of 48 inches is yellowish brown silt loam. Next is a layer of yellowish brown sandy loam. Below that is yellowish brown loam. In some areas loam is at a depth as shallow as 36 inches.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 3.0 to 4.0 percent. Reaction is typically medium acid or slightly acid in the surface layer and the upper part of the subsoil. The subsoil is generally medium in available phosphorus and very low in available potassium. Tillth is generally good.

Most areas are cropland. Some are permanent pasture or hayland. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places, contouring and terracing, is difficult because of irregular contours, but in most places these practices are suitable. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pasture. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poor tillth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIIe.
to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in the adjacent uneroded Tama soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some cases causes severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places contouring and terracing are difficult because of irregular contours, but in most places these practices are suitable. Returning crop residue or adding other organic material helps to improve fertility and tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in even poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIIe.

127—Wlota silt loam, loamy substratum, 1 to 3 percent slopes. This nearly level, poorly drained or very poorly drained soil is in level or slightly depressional areas on the broad, loess covered flat ridgetops in uplands. It is subject to frequent ponding. Individual areas are irregular in shape and range from 5 to 15 acres.

Typically, the surface layer is black silt loam about 9 inches thick. The subsurface layer is very dark gray and dark gray silt loam about 13 inches thick. The subsoil is about 24 inches thick. The upper part is black, firm silty clay; the middle part is very dark gray, firm silty clay loam; and the lower part is dark gray, firm silty clay loam. The substratum is dark gray silty clay loam.

Permeability is slow and very slow. Surface runoff is very slow. The available water capacity is high. The organic matter content in the plow layer is about 3.0 to 4.0 percent. Reaction in the surface layer and the upper part of the subsoil is slightly acid or medium acid unless the soil has been limed within the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is fair unless the soil has been worked too wet.

Almost all areas are cropland. This soil is moderately suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. It is poorly drained or very poorly drained and may be ponded at times. Both surface drainage and tile drainage are needed. Tile drains function slowly because of the slow and very slow permeability of the soil. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIW.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on alluvial flood plains and in narrow drainageways in uplands. It is subject to occasional flooding (fig. 7). Individual areas are irregular or long and range from 20 to several hundred acres.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 31 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is olive gray, friable silty clay loam about 13 inches thick. The substratum is olive gray silt loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 5.0 to 7.0 percent. Reaction is typically neutral or slightly acid in the surface layer. The subsurface layer is medium in available phosphorus and very low in available potassium. Tilth is generally fair unless the soil is worked when too wet.
Many areas are cropland. Some are pastureland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. It is poorly drained, however, and is subject to frequent flooding. Artificial drainage is needed. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ilw.

159—Finchford loamy sand, 0 to 2 percent slopes.
This nearly level, excessively drained soil is on high alluvial flood plains along the major rivers. It is subject to rare flooding. Individual areas are irregular in shape and range from 20 to several hundred acres.

Typically, the surface layer is very dark brown loamy sand about 8 inches thick. The subsurface layer is very dark grayish brown loamy sand about 11 inches thick. The subsoil is dark brown, loose sand about 18 inches thick. The substratum is very dark grayish brown loamy sand.

Permeability is very rapid. Surface runoff is slow. The available water capacity is low. The organic matter content in the plow layer is 1.0 to 1.5 percent. Reaction in the surface layer is generally medium acid or slightly acid unless the soil has been limed in the last 5 years. The subsoil is generally very low in available phosphorus and available potassium. Tilth is generally good.

Most areas are pastureland. A few are cultivated. This soil is poorly suited to cultivated crops and to hay and pasture. It is poorly or moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Yields for all crops are low, even under good management, unless rainfall is above average and timely. This soil is subject to infrequent flooding. Wind erosion is a hazard in cultivated areas. Conservation tillage and winter cover crops reduce wind erosion. Returning crop residue or adding other organic material helps to maintain fertility and reduce soil loss caused by wind erosion.

This soil is poorly suited to grasses and legumes for hay and pasture. If it is used for hayland or pastureland,
however, there is little hazard of wind erosion. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is IVs.

162B—Downs silt loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on moderately wide ridgetops in loess covered uplands. Individual areas are irregular in shape and range from 20 to 200 acres or more.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is brown silt loam about 3 inches thick. The subsoil is friable silty clay loam about 42 inches thick. The upper and middle parts are brown and dark yellowish brown, and the lower part is mottled brown and yellowish brown. The substrate is mottled brown and yellowish brown silt loam.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is 2.0 to 3.0 percent. Reaction is generally medium acid or strongly acid in the surface layer unless the soil has been limed in the last 5 years. The subsoil is generally medium in available phosphorus and very low in available potassium. The soil is generally good, but the soil puddles readily.

Many areas are pasture or hayland. Some are cultivated. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion is a hazard, however, in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places, the use of contouring and terracing to control erosion is difficult because of the irregular contour. In most places, however, these practices are suited. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IIe.

162C—Downs silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on narrow ridgetops and convex side slopes in uplands. Individual areas are generally long and irregular in shape and range from 5 to 75 acres.

Typically, the surface layer is very dark grayish brown silt loam mixed with some dark brown silt loam. It is about 7 inches thick. The subsoil is friable silty clay loam about 37 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The subsurface layer is brown and yellowish brown silt loam.

Included with this soil in mapping are small areas where most of the surface layer has been removed by erosion. In these areas the organic matter content is lower and tilth is generally poorer than in this Downs soil. These areas are on convex nose slopes and steeper side slopes. They make up about 8 to 10 percent of the unit.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 1.0 to 2.0 percent. Reaction is generally medium acid or strongly acid in the surface layer unless the soil has been limed in the last 5 years. The subsoil is generally medium in available phosphorus and very low in available potassium. The soil is generally fair, but the soil puddles readily.
Most areas are cultivated. Some are pastureland. This soil is moderately suited to cultivated crops and well suited to hay, pasture, and trees. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Because material from the subsoil, which is very low in available potassium and organic matter, has been mixed into the plow layer, more fertilizer is needed to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in less eroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some areas causes severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places the use of contouring and terracing to control erosion is difficult because of the irregular contour. In most places, however, these practices are suited. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is I12.

162D2—Downs silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes in loess covered uplands. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is brown silt loam about 2 inches thick. The subsoil is friable silty clay loam about 38 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam. In some areas the surface layer is thinner and lighter colored because of erosion.

Permeability is moderate. Surface runoff is moderately rapid. The available water capacity is high. The organic matter content in the plow layer is about 1.5 to 2.0 percent. Reaction is typically medium acid or strongly acid in the surface layer unless the soil has been limed in the last 5 years. The subsoil is generally medium in available phosphorus and very low in available potassium. Tilth is generally good, but the soil puddles readily.

Many areas are pastureland or hayland. Some are cultivated. This soil is moderately suited to cultivated crops and well suited to hay, pasture, and trees. It is moderately or poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a severe hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways reduce soil loss. Limiting the amount of intertilled crops in a rotation system also reduces soil loss. In places the use of contouring or terracing to control erosion is difficult because of the irregular contour. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is I12.
crops in a rotation system also reduces soil loss. In places contouring or terracing to control erosion is difficult because of the irregular contour. Returning crop residue or the adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IIIe.

163B—Fayette silt loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on moderately wide ridgetops in loess covered uplands. Individual areas are long and irregular in shape and range from 5 to 100 acres or more.

Typically, the surface layer is very dark grayish brown silt loam about 5 inches thick. The subsurface layer is brown and dark grayish brown silt loam about 5 inches thick. The subsoil is about 36 inches thick. The upper part is brown, friable silt loam; the middle part is brown and dark yellowish brown, friable silty clay loam; and the lower part is yellowish brown, friable, silty clay loam. The substratum is yellowish brown silt loam. In some areas part of the surface layer has been removed by erosion.

Included with this soil in mapping are some nearly level areas on ridgetops that are not so susceptible to erosion. They make up less than 2 percent of the map unit.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 1.5 to 2.5 percent. Reaction is generally medium acid or strongly acid in the surface layer unless the soil has been limed in the last 5 years. The subsoil is generally high in available phosphorus and very low in available potassium. Tilth generally is good, but the soil puddles readily.

Many areas are cultivated. Many are pasture and hayland. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places the use of contouring and terracing to control erosion is difficult because of the irregular contour. In most places, however, these practices are suited. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IIIe.

163C—Fayette silt loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on narrow ridgetops and convex side slopes in uplands (fig. 8). Individual areas are generally elongated and irregular in shape and range from 5 to 100 acres or more.

Typically, the surface layer is very dark grayish brown silt loam about 4 inches thick. The subsurface layer is brown and grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 35 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam. In some small areas part of the surface layer has been removed by erosion.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 1.5 to 2.5 percent. Reaction is typically medium acid or strongly acid in the surface layer unless the soil has been limed in the last 5 years. The subsoil is generally high in available phosphorus and very low in available potassium. Tilth generally is good, but the soil puddles readily.

Most areas are pastureland and woodland. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately or poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places the use of contouring and terracing to control erosion is difficult because of the irregular contour. In most places, however, these practices are suited. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pasture or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IIIe.

163C2—Fayette silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on narrow ridgetops and convex side slopes in loess covered uplands. Individual areas are generally long and irregular in shape and range from 5 to 100 acres or more.

Typically, the surface layer is brown silt loam with some mixing of dark yellowish brown silty clay loam and is about 8 inches thick. The subsoil is friable silty clay loam about 32 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.
Included with this soil in mapping are small areas where most of the surface layer has been removed by erosion. In those areas, the organic matter content is lower and tillth is generally poorer than in this Fayette soil. Those areas are on the steeper parts of side slopes and on convex nose slopes. They make up about 8 to 12 percent of the map unit.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 0.5 to 1.0 percent. Reaction is typically medium acid or strongly acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is generally high in available phosphorus and very low in available potassium. Tillth generally is poor, and the soil puddles readily.

Most areas are cultivated or were cultivated in the past. This soil is moderately suited to cultivated crops and well suited to hay, pasture, and trees. It is moderately or poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Because material from the subsoil, which is very low in available potassium and organic matter, has been mixed into the plow layer, more fertilizer is needed to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in less eroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some cases causes severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places the use of contouring and terracing to control erosion is difficult because of the irregular contour. In most places, however, these practices are suited. Returning crop residue or adding other organic material helps to improve fertility and tillth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tillth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.
The capability subclass is Ille.

163D—Fayette silt loam, 9 to 14 percent slopes. This strongly sloping, well drained soil is on narrow ridgetops and convex side slopes in loess covered uplands. Individual areas are long and irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is very dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 33 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Permeability is moderate. Surface runoff is moderately rapid. The available water capacity is high. The organic matter content in the plow layer is about 1.0 to 1.5 percent. Reaction is typically medium acid or strongly acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is generally high in available phosphorus and very low in available potassium. Tilth generally is good, but the soil puddles readily.

Most areas are in pastureland and woodland. This soil is moderately suited to cultivated crops and well suited to hay and pasture and to trees. It is moderately or poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. If this soil is cultivated, erosion is a severe hazard. Conservation tillage, winter cover crops, and grassed waterways reduce soil loss. Limiting the amount of intertilled crops in a rotation system also reduces soil loss. In places the use of contouring or terracing to control erosion is difficult because of the irregular contour. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ille.

163D2—Fayette silt loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on narrow ridgetops and convex side slopes in loess covered uplands (fig. 9). Individual areas are long and irregular in shape and range from 20 to 200 acres.

Typically, the surface layer is brown silt loam with some mixing of dark yellowish brown silty clay loam and is about 8 inches thick. The subsoil is friable silty clay loam about 30 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Included with this soil in mapping are small areas where most of the surface layer has been removed by erosion. In those areas organic matter content is lower and tilth is generally poorer than in this Fayette soil.

Those areas are on the steeper parts of side slopes and on convex nose slopes. They make up about 5 to 8 percent of the map unit.

Permeability is moderate. Surface runoff is moderately rapid. The available water capacity is high. The organic matter content in the plow layer is about 0.5 to 1.0 percent. Reaction is typically medium acid or strongly acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is generally high in available phosphorus and very low in available potassium. Tilth generally is poor, and the soil puddles readily.

Most areas are cultivated or were cultivated in the past and are now used for pasture or hayland. This soil is moderately suited to cultivated crops and well suited to hay and pasture and trees. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Because material from the subsoil, which is very low in available potassium and organic matter, has been mixed into the plow layer, more fertilizer is needed to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in uneroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some cases causes severe loss of plant population. If this soil is cultivated, erosion is a severe hazard. Conservation tillage, winter cover crops, and grassed waterways reduce soil loss. Limiting the amount of intertilled crops in a rotation system also reduces soil loss. In places the use of contouring or terracing to control erosion is difficult because of the irregular contour. Returning crop residue or adding other organic material helps to improve fertility and tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ille.

163E—Fayette silt loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on long, convex side slopes in loess covered uplands. Individual areas are irregular in shape and generally range from 20 to 200 acres or more.

Typically, the surface layer is very dark grayish brown silt loam about 3 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 31 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Permeability is moderate. Surface runoff is rapid. The available water capacity is high. The organic matter content in the plow layer is less than 1.0 percent. Reaction
is typically medium acid or strongly acid in the surface layer and subsoil. The subsoil is generally high in available phosphorus and very low in available potassium. Tilth generally is good, but the soil puddles readily.

Most areas are pastureland and woodland. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture and trees. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. There is a severe hazard of erosion in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways reduce soil loss. Limiting the amount of intertilled crops in a rotation system also reduces soil loss. In places the use of contouring or terracing to control erosion is difficult because of irregular contour. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IVe.

163E2—Fayette silt loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is on long, convex side slopes in loess covered uplands. Individual areas are irregular in shape and generally range from 20 to 200 acres.

Typically, the surface layer is brown silt loam with some mixing of dark yellowish brown silty clay loam and is about 8 inches thick. The subsoil is friable silty clay loam about 28 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Included with this soil in mapping are small areas where most of the surface layer has been removed by erosion. In those areas organic matter content is lower and tilth is generally poorer than in this Fayette soil. Those areas are on the steeper parts of side slopes and on convex nose slopes. They make up about 5 to 8 percent of the map unit.

Permeability is moderate. Surface runoff is rapid. The available water capacity is high. The organic matter con-
tent in the plow layer is less than 0.5 percent. Reaction is typically medium acid or strongly acid in the surface layer and upper part of the subsoil. The subsoil is generally high in available phosphorus and very low in available potassium. Tillth commonly is poor, and the soil puddles readily.

Most areas have been cultivated but are now pasture or hayland. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture and trees. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. If this soil is cultivated, there is a very severe hazard of erosion. This soil is moderately suited to grasses and legumes for pasture but is poorly suited to hay. Slope makes harvesting hay difficult. If this soil is used for pastureland or woodland, there is little hazard of erosion. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tillth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IVe.

163F2—Fayette silt loam, 18 to 25 percent slopes, moderately eroded. This steep, well drained soil is on long, convex side slopes in loess covered uplands. Individual areas are irregular in shape and generally range from 20 to 200 acres.

Typically, the surface layer is brown silt loam with some mixing of dark yellowish brown silty clay loam and is about 6 inches thick. The subsoil is friable silty clay loam about 28 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Included with this soil in mapping are small areas where most of the surface layer has been removed by erosion. In those areas the organic matter content is lower and tillth is commonly poorer than in this Fayette soil. Those areas are on the steeper parts of side slopes and on convex nose slopes. They make up about 5 to 8 percent of the map unit.

Permeability is moderate. Surface runoff is rapid. The available water capacity is high. The organic matter content in the plow layer is less than 0.5 percent. Reaction is typically medium acid or strongly acid in the surface layer and upper part of the subsoil. The subsoil is generally high in available phosphorus and very low in available potassium. Tillth generally is poor, and the soil puddles readily.

Most areas have been cultivated but nearly all are now pastureland. This soil is poorly suited to cultivated crops and to hay and is moderately suited to pasture and trees. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. If this soil is cultivated, there is a very severe hazard of erosion. This soil is moderately suited to grasses and legumes for pasture but is poorly suited to hay. Slope makes harvesting hay difficult. If this soil is used for pastureland or woodland, there is little hazard of erosion. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tillth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IVe.

163F—Fayette silt loam, 18 to 25 percent slopes. This steep, well drained soil is on long, convex side slopes in loess covered uplands. Individual areas are irregular in shape and generally range from 30 to 300 acres.

Typically, the surface layer is very dark grayish brown silt loam about 3 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 29 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Permeability is moderate. Surface runoff is rapid. The available water capacity is high. The organic matter content in the plow layer is less than 1.0 percent. Reaction is typically medium acid or strongly acid in the surface layer and subsoil. The subsoil is generally high in available phosphorus and very low in available potassium. Tillth generally is good, but the soil puddles readily.

Most areas are pastureland and woodland. This soil is poorly suited to cultivated crops and to hay and is moderately suited to pasture and trees. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. If this soil is cultivated, there is a very severe hazard of erosion. This soil is moderately suited to grasses and legumes for pasture but is poorly suited to hay. Slope makes harvesting hay difficult. If this soil is used for pastureland or woodland, there is little hazard of erosion. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tillth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is IVe.
in uneroded soils, preparing a suitable seedbed is more
difficult. Overgrazing or grazing when the soil is too wet
compacts the surface, increases runoff, and results in
poorer tilth. Proper stocking, pasture rotation, and de-
ferred grazing help to keep the pasture and soil in good
condition.

This soil is moderately suited to trees. If it is used for
trees, there is little hazard of erosion.
The capability subclass is Vle.

163G—Fayette silt loam, 25 to 40 percent slopes.
This very steep, well drained soil is on long, convex side
slopes in loess covered uplands. Individual areas are
irregular in shape and range from 10 to 50 acres.
Typically, the surface layer is very dark grayish brown
silt loam about 3 inches thick. The subsurface layer is
dark grayish brown silt loam about 5 inches thick. The
subsoil is friable silty clay loam about 28 inches thick.
The upper part is dark yellowish brown, and the lower
part is yellowish brown. The substratum is yellowish
brown silt loam.

Permeability is moderate. Surface runoff is very rapid.
The available water capacity is high. The organic matter
content in the surface layer is less than 0.5 percent.
Reaction is typically medium acid or strongly acid in the
surface layer and upper part of the subsoil. The subsoil
is generally high in available phosphorus and very low in
available potassium. Tilth generally is good, but the soil
puddles readily.

Most areas are woodland or pastureland. This soil is
poorly suited to cultivated crops and to hay and is mod-
erately suited to pasture and trees. It is poorly suited to
most engineering uses.

This soil is poorly suited to corn, soybeans, and small
grain. If it is cultivated, there is a very severe hazard of
erosion.

This soil is moderately suited to grasses and legumes
for pasture but is poorly suited to hay. Harvesting hay is
difficult because of the slope. If the soil is used for
pastureland or woodland, there is little hazard of erosion.
Overgrazing or grazing when the soil is too wet com-
acts the surface, increases runoff, and results in poorer
tilth. Proper stocking, pasture rotation, and deferred graz-
ing are needed to keep the pasture and soil in good
condition.
The capability subclass is Vle.

171B—Bassett loam, 2 to 5 percent slopes. This
gently sloping, moderately well drained soil is on convex
ridgetops and side slopes in uplands. Individual areas are
irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is very dark grayish brown
loam about 8 inches thick. The subsurface layer is brown
loam about 3 inches thick. The subsoil is about 37
inches thick. The upper part is brown, friable loam; the
middle part is dark yellowish brown and yellowish brown,
firm loam; and the lower part is mottled grayish brown
and yellowish brown, firm loam. The substratum is mot-
tled grayish brown and yellowish brown loam. In some
areas the surface layer is sandy loam.

Permeability is moderate, but the soil is more perme-
able in the upper part than in the lower part. Because of
this difference in permeability, water tends to move later-
ally, and seepy areas may develop for short periods in
wet seasons. Runoff is medium. The available water
capacity is high. The organic matter content in the plow
layer is about 2.0 to 3.0 percent. Reaction of the surface
layer is medium acid to very strongly acid unless the soil
has been limed in the past 5 years. The subsoil is very
low in available phosphorus and available potassium.
Tilth generally is good.

Many areas are cropland. Some are hayland, pasture-
land, and woodland. This soil is well suited to crops and
to hay and pasture. It is moderately suited to most en-
gineering uses.

This soil is well suited to legumes and grasses for hay
and pasture. There is little hazard of erosion on hayland
or pastureland. Overgrazing or grazing when the soil is
too wet compacts the surface and increases runoff.
Proper stocking, pasture rotation, and deferred grazing
are needed to keep the pasture and soil in good condi-
tion.
The capability subclass is Ile.

171C—Bassett loam, 5 to 9 percent slopes. This
moderately sloping, moderately well drained soil is on
convex ridgetops and side slopes in uplands. Individual
areas are irregular in shape and range from 10 to 100
acres.

Typically, the surface layer is very dark grayish brown
loam about 8 inches thick. The subsurface layer is dark
brown loam about 3 inches thick. The subsoil is about 35
inches thick. The upper part is dark yellowish brown,
friable loam, and the lower part is yellowish brown, firm
loam. The substratum is mottled yellowish brown loam.
In some areas the surface layer is sandy loam.

Included with this soil in mapping are areas where the
surface layer is thinner and the organic matter content is
lower than in this Bassett soil. Those areas are on the
steepest part of slopes and on convex nose slopes.
They make up less than 10 percent of the map unit.

Permeability is moderate, but the soil is more perme-
able in the upper part than in the lower part. Because of
this difference in permeability, water tends to move later-
ally, and seepy areas may develop for short periods in
wet seasons. Surface runoff is medium. The available
water capacity is high. The organic matter content in the
plow layer is 2.0 to 2.5 percent. Reaction in the surface
class layer is medium acid to very strongly acid unless the soil
has been limed in the past 5 years. The subsoil is very
low in available phosphorus and very low in available
potassium. Tilth generally is good.

Many areas are cropland. Some are hayland, pasture-
land, and woodland. This soil is moderately suited to
cultivated crops and well suited to hay and pasture. It is
moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and
small grain. Erosion is a hazard in cultivated areas. Con-
servation tillage, winter cover crops, and grassed water-
ways help to prevent excessive soil loss. Erosion control
practices, such as contouring or terracing, may be
needed. If this soil is contoured or terraced, seepy spots
may develop unless tile drains are installed. Returning
crop residue or adding other organic material helps to
improve fertility and maintain tilth.

This soil is well suited to legumes and grasses for hay
and pasture. There is little hazard of erosion on hayland
and pastureland. Overgrazing or grazing when the soil is
too wet compacts the surface and increases runoff.
Proper stocking, pasture rotation, and deferred grazing
are needed to keep the pasture and soil in good condi-
tion.

The capability subclass is IIe.

171C2—Bassett loam, 5 to 9 percent slopes, mod-
ately eroded. This moderately sloping, moderately well
drained soil is on convex ridgetops and side slopes
in uplands. Individual areas are irregular in shape and
range from 10 to 100 acres.

Typically, the surface layer is very dark grayish brown
loam with some mixing of brown loam and is about 8
inches thick. The subsoil is about 32 inches thick. The
upper part is brown, friable loam, and the lower part is
yellowish brown, firm loam. The substratum is motted
grayish brown and yellowish brown loam. In some areas
the surface layer is sandy loam.

Included with this soil in mapping are small areas
where most or all of the original surface layer has been
lost through erosion. In those areas the organic matter
content is lower than in this Bassett soil. Those areas
are on the steepest part of side slopes and on convex
nose slopes. They make up less than 10 percent of the map
unit.

Permeability is moderate but the soil is more perme-
able in the upper part than in the lower part. Because
of the difference in permeability, water tends to move later-
ally, and seepy areas may develop for short periods in
wet seasons. Runoff is medium. The available water
capacity is high. The organic matter content in the plow
layer is 1.5 to 2.0 percent. Reaction in the surface layer
is generally medium acid to very strongly acid unless the
soil has been limed in the past 5 years. The subsoil is
very low in available phosphorus and very low in availa-
ble potassium. Tilth generally is poor.

Most areas are cropland. This soil is moderately suited
to row crops and well suited to hay and pasture. It is
moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and
small grain. Because material from the subsoil, which is
very low in available phosphorus and available potas-
sium and in organic matter, has been mixed into the
plow layer, more fertilizer is needed to maintain high
yields. Because the organic matter content of the plow
layer is lower in this soil than in less eroded adjacent
soils, less herbicide is needed. Failure to adjust the rates
of herbicides, particularly those that are very sensitive to
organic matter levels, lowers yields and in some cases
causes severe loss of plant population. Erosion is a
hazard in cultivated areas. Conservation tillage, winter
cover crops, and grassed waterways help to prevent
excessive soil loss. Erosion control practices, such as
contouring or terracing, may be needed. If this soil is
contoured or terraced, seepy spots may develop unless
tile drains are installed. Returning crop residue or adding
other organic material helps to improve fertility and tilth.

This soil is well suited to legumes and grasses for hay
and pasture. There is little hazard of erosion on hayland
or pastureland. Overgrazing or grazing when the soil is
too wet compacts the surface and increases runoff.
Proper stocking, pasture rotation, and deferred grazing
are needed to keep pasture and soil in good condition.

The capability subclass is IIe.

171D—Bassett loam, 9 to 14 percent slopes. This
strongly sloping, moderately well drained soil is on
convex side slopes in uplands. Individual areas are irreg-
ular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark brown loam
about 6 inches thick. The subsurface layer is dark brown
loam about 5 inches thick. The subsoil is about 32
inches thick. The upper part is dark yellowish brown,
friable loam; the middle part is yellowish brown, friable
loam; and the lower part is yellowish brown, firm loam.
The substratum is mottled grayish brown and yellowish
brown loam. In some areas the surface layer is sandy
loam.

Included with this soil in mapping are areas where the
surface layer is thinner and the organic matter content
is lower. Those areas are on the steepest part of slopes
and on convex nose slopes. They make up less than 10
percent of the map unit.

Permeability is moderate, but the soil is more perme-
able in the upper part than in the lower part and substra-
tum. Because of the difference in permeability, water
tends to move laterally, and seepy areas may develop for
short periods in wet seasons. Runoff is moderately
rapid. The available water capacity is high. The organic
matter content in the plow layer is 1.5 to 2.0 percent.
Reaction in the surface layer is generally medium acid to
very strongly acid unless the soil has been limed in the
past 5 years. The subsoil is very low in available phos-
phorus and very low in available potassium. Tilth gener-
ally is good.
Most areas are hayland, pastureland, or woodland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, may be needed. If this soil is contoured or terraced, seepy spots may develop unless tile drains are installed. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases run-off. Proper stocking, pasture rotation, and deferred grazing are needed to keep pasture and soil in good condition.

The capability subclass is Ile.

**171D2—Bassett loam, 9 to 14 percent slopes, moderately eroded.** This strongly sloping, moderately well drained soil is on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark grayish brown loam with some mixing of dark brown loam and is about 7 inches thick. The subsoil is about 28 inches thick. The upper part is dark yellowish brown, friable loam, and the lower part is yellowish brown, firm loam. The substratum is mottled grayish brown and yellowish brown loam. In some areas the surface layer is sandy loam.

Included with this soil in mapping are small areas where nearly all of the surface layer has been removed by erosion. In those areas the organic matter content is lower than in this Bassett soil. Those areas are on the steepest part of side slopes and convex nose slopes. They make up less than 10 percent of the map unit.

Permeability is moderate, but the soil is more permeable in the upper part than in the lower part. Because of the difference in permeability, water tends to move laterally, and seepy areas may develop for short periods in wet seasons. Surface run-off is moderately rapid. The available water capacity is high. The organic matter content in the plow layer is 1.0 to 1.5 percent. Reaction in the surface layer is generally medium acid to very strongly acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is poor, and the soil is commonly cloudy.

Most areas are cropland. Some are pastureland or hayland. This soil is moderately suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Because material from the subsoil, which is very low in available phosphorus and available potas-

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**175—Dickinson fine sandy loam, 0 to 2 percent slopes.** This nearly level, well drained and somewhat excessively drained soil is on benches and upland ridgetops. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is very dark brown fine sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 11 inches thick. The subsoil is about 18 inches thick. The upper part is dark brown, very friable fine sandy loam, and the lower part is dark yellowish brown, very friable loamy sand. The substratum is yellowish brown loamy sand. In some areas on stream benches, coarse sand and gravel are below 4 feet.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content in the plow layer is about 1.5 to 2.5 percent. Reaction in the surface layer is generally slightly acid or medium acid. The subsoil is generally very low in available phosphorus and available potassium. Tilth generally is good.

Most areas are cropland. Some areas are hayland or pasture. This soil is moderately suited to cultivated crops, small grain, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Yields are below average if rainfall is low during July and August. Wind erosion is a hazard in cultivated areas. Conservation tillage and winter cover crops reduce wind erosion. Returning crop residue or adding other organic material helps to maintain tilth and fertility and to reduce wind erosion.

This soil is moderately suited to hay and pasture. There is little hazard of erosion on pastureland or hay-
land. The carrying capacity for pasture is slightly reduced because of droughtiness during dry spells.

The capability subclass is I.I.

175B—Dickinson fine sandy loam, 2 to 5 percent slopes. This gently sloping, well drained and somewhat excessively drained soil is on upland ridgelines and on high stream benches. Individual areas are irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is very dark brown fine sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 9 inches thick. The subsoil is about 15 inches thick. The upper part is dark yellowish brown and brown, very friable fine sandy loam, and the lower 5 inches is dark yellowish brown, very friable loamy sand. The substratum is yellowish brown and brown sand and loamy sand. In some areas on stream benches, coarser sand and gravel is below 4 feet.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content in the plow layer is about 1.0 to 1.5 percent. Reaction in the surface layer is generally slightly acid or medium acid. The subsoil is generally very low in available phosphorus and available potassium. Tilth generally is good.

Most areas are cropland. Some are hayland or pasture. This soil is moderately suited to cultivated crops, small grain, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Yields are below average if rainfall is low during July and August. There is a hazard of both wind and water erosion in cultivated areas. Conservation tillage, contouring, winter cover crops, and grassed waterways reduce soil loss by wind and water. Terraces may be difficult to construct and maintain because of poor stability. Returning crop residue or adding other organic material helps to maintain fertility and to reduce erosion.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion, however, on pastureland or hayland. The carrying capacity for pasture is limited because of droughtiness during dry spells.

The capability subclass is I.I.

177—Saude loam, 0 to 2 percent slopes. This nearly level, well drained soil is on steam terraces along rivers and streams. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark brown loam about 6 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 14 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown, very friable loamy sand. The substratum is dark yellowish brown and yellowish brown gravelly sand.

Permeability is moderate in the upper part of the soil and very rapid in the lower part. Surface runoff is slow. The available water capacity is low to moderate. The organic matter content in the plow layer is 2.5 to 3.5 percent. Reaction is generally medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth generally is good.

Most areas are cropland. Some are pastureland or hayland. This soil is moderately suited to cultivated crops and to grasses and legumes. It is moderately or poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. It is droughty in years when rainfall is below average and during hot dry periods in summer. There is some hazard of wind erosion in cultivated areas. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.
This soil is moderately suited to grasses and legumes for hay and pasture. Pasture may be limited during hot dry periods. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is I1s.

177B—Saude loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on benches along rivers and streams. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 14 inches thick. It is brown, friable loam in the upper and middle parts and dark yellowish brown, very friable sandy loam in the lower 2 inches. The substratum is dark yellowish brown and yellowish brown gravelly sand.

Permeability is moderate in the upper part of the soil and very rapid in the lower part. Surface runoff is medium. The available water capacity is low to moderate. The organic matter content in the plow layer is 2.5 to 3.0 percent. Reaction in the surface layer is generally medium acid unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tillth generally is good.

Most areas are cropland. Some are pastureland or hayland. This soil is poorly suited to cultivated crops and moderately suited to grasses and legumes. It is well suited or moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. It is droughty in years when rainfall is below average and during hot dry periods in summer. There is some hazard of erosion in cultivated areas. Conservation tillage and winter cover crops reduce soil loss. Erosion control practices, such as contouring and terracing, may be difficult to use in most areas because of irregular contour and short slopes. Terracing exposes the coarse textured substratum. Unless topsoil is placed over the areas of exposed substratum, those areas are very droughty. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Pasture may be limited during hot dry periods. Overgrazing or grazing when the soil is wet compacts the soil and results in poorer tilth and increased runoff. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is I1e.

177C—Saude loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on stream benches along rivers and streams, commonly on the bench escarpment. Individual areas are generally long and narrow and range from 10 to 50 acres.

Typically, the surface layer is very dark brown loam about 11 inches thick. The subsoil is brown, friable loam about 13 inches thick. The substratum is yellowish brown gravelly sand. In some places, the surface layer is as thin as 7 inches because of erosion.

Included with this soil in mapping are areas where sand or gravel is at or near the surface. Those areas are more droughty than this Saude soil. They are on the steepest part of the slopes. They make up 10 to 15 percent of the map unit.

Permeability is moderate in the upper part of this soil and very rapid in the lower part. Surface runoff is medium. The available water capacity is low to moderate. The organic matter content in the plow layer is 2.0 to 2.5 percent. Reaction is generally medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tillth generally is good.

Most areas are cropland. Some are pastureland or hayland. This soil is poorly suited to cultivated crops and moderately suited to grasses and legumes. It is moderately or poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Because it is droughty, yields are low unless rainfall is timely. Erosion is a hazard in cultivated areas. Conservation tillage and winter cover crops reduce soil loss. Erosion control practices, such as contouring or terracing, are difficult to use because of the irregular contour and short slopes. Terracing exposes the coarse textured substratum in areas. These areas are very droughty unless topsoil is placed over them. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Pasture is limited during hot dry periods. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tilth and increased runoff. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is I1e.

178—Waukee loam, 0 to 2 percent slopes. This nearly level, well drained soil is on stream benches along rivers and major streams. Individual areas are irregular in shape and range from 5 to 100 acres or more.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown loam about 8 inches thick. The subsoil is friable loam about 21 inches thick. The upper part is very dark grayish brown and brown, and the lower part is dark yellowish brown. The substratum is yellowish brown coarse sand.

Included with this soil in mapping are a few areas that are more droughty than this Waukee soil because sandy
material is at or near the surface. Those areas are on slight rises. They make up less than 2 percent of the map unit.

Permeability is moderate in the upper part of this Waukee soil and very rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content in the plow layer is about 3.0 to 4.0 percent. Reaction in the surface layer is generally slightly acid. The subsoil is generally low in available phosphorus and very low in available potassium. Tilth is good.

Almost all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately suited to many engineering uses.

This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of wind erosion in cultivated areas. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stock- ing, pasture rotation, and deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIE.

178B—Waukee loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on stream benches along rivers and major streams. Individual areas are irregular in shape and range from 5 to 200 acres or more.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 11 inches thick. The subsoil is friable loam about 19 inches thick. The upper part is brown, and the lower part is yellowish brown. The subsoil is yellowish brown coarse sand with some gravel.

Included with this soil in mapping are areas where sandy and gravelly material is at or near the surface. Those areas are on the steepest part of slopes. They are more droughty than this Waukee soil. They make up 2 to 5 percent of the map unit.

Permeability is moderate in the upper part of this Waukee soil and very rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction in the surface layer is generally slightly acid. The subsoil is generally low in available phosphorus and very low in available potassium. Tilth is good.

Almost all areas are cropland. This soil is moderately suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In many places the use of erosion control practices, such as contouring and terracing, is difficult because of complex contours and short slopes. Terracing may expose the coarse textured substratum. Areas of exposed substratum are very droughty. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIE.

184B—Klinger silty clay loam, 1 to 4 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is on upland ridges and around the heads of drainageways. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is dark brown and very dark brown silty clay loam about 9 inches thick. The subsoil is about 31 inches thick. The upper part is dark grayish brown, friable silty clay loam, and the lower part is yellowish brown, firm loam. The subsoil is yellowish brown loam. In some areas the loess is 40 to 48 inches thick over loam glacial till.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 5.0 to 6.0 percent. Reaction in the surface layer is generally slightly acid. The subsoil is very low in available phosphorus and available potassium. Tilth generally is good unless the soil has been worked when too wet.

Almost all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a slight hazard in cultivated areas. The soil may be subject to overwash from higher lying soils. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In many places using erosion control practices, such as contouring or terracing, is difficult because of the complex contours. If this soil is terraced, tile drainage is needed. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIE.

198B—Floyd loam, 1 to 4 percent slopes. This gently sloping, somewhat poorly drained soil is in con-
cave positions at the heads of drainageways or on concave side slopes along drainageways. Individual areas are irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark grayish brown loam about 15 inches thick. The subsoil is about 38 inches thick. The upper 7 inches is dark grayish brown, friable loam with grayish brown and yellowish brown mottles. The middle part is grayish brown, friable, light sandy clay loam and sandy loam. The lower part is yellowish brown and grayish brown, firm loam. The subsoil is mottled yellowish brown and grayish brown loam. In some areas the surface layer is sandy loam. In some unimproved areas stones and boulders are at or near the surface.

Included with this soil in mapping are a few areas where 6 to 20 inches of lighter colored recent overwash has been deposited. The recent material is lower in organic matter than this Floyd loam. These areas are adjacent to areas of steeper soils that surround the Floyd soils. They make up 2 to 5 percent of the map unit.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 5.0 to 6.0 percent. Reaction in the surface layer is generally neutral. The subsoil is very low in available phosphorus and available potassium. Tilt is generally good unless the soil is worked when too wet.

Many areas are cropland. Some are pastureland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Artificial drainage, however, is needed. Because wetness is partly caused by hillside seepage, a drainage system that intercepts laterally moving water is best. In some areas erosion is a problem. Terraces reduce erosion but should be combined with tile drains for best results. Some areas have never been cropped because stones and boulders are at or near the surface.

This soil is well suited to grasses and legumes for pasture or hay. Removing rocks and installing tile are beneficial on pastureland and necessary on hayland. Overgrazing or grazing when the soil is too wet compacts the soil, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing when the soil is wet are needed to keep the pasture and soil in good condition.

The capability subclass is I1e.

207C—Whalan loam, 20 to 30 inches to limestone, 2 to 9 percent slopes. This gently sloping and moderately sloping, well drained soil is on ridgtops and side slopes in uplands. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark grayish brown loam about 2 inches thick. The subsurface layer is brown loam about 3 inches thick. The subsoil is about 23 inches thick. The upper and middle parts are dark yellowish brown, friable loam, and the lower 2 inches is dark yellowish brown, firm silty clay. Shattered, fractured limestone bedrock is at a depth of 28 inches.

Included with this soil in mapping are a few areas where limestone bedrock is at the surface. These areas are on the short, steeper part of the slope, generally near a drainageway. They make up less than 2 percent of the map unit.

Permeability is moderate. Surface runoff is medium. The available water capacity is low. The organic matter content in the plow layer is about 2.5 to 3.5 percent.
Reaction in the surface layer is commonly slightly acid or medium acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tlth is generally good.

Most areas are cropland. A few are pastureland. This soil is poorly suited to cultivated crops and moderately suited to grasses and legumes for hay and pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain because of moderate depth to bedrock. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, grassed waterways, and contouring help to prevent excessive soil loss. Terracing is difficult because of the moderate depth to bedrock. Returning crop residue or other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is wet compacts the surface and increases runoff. Pasture rotation and proper stocking are needed to keep the pasture and soil in good condition.

The capability subclass is I1e.

220—Nodaway silt loam, 0 to 2 percent slopes.

This nearly level, moderately well drained soil is on recently formed alluvial flood plains along rivers, streams, and narrow upland drainageways. It is subject to frequent flooding. Individual areas are irregular or long and range from 20 to 200 acres or more.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The substratum is stratified dark grayish brown and very dark grayish brown silt loam.

Included with this soil in mapping are somewhat poorly drained areas that may require supplemental drainage. Those areas are in depressions or old stream channels. They make up less than 2 percent of the map unit.

Permeability is moderate in this Nodaway soil. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 2.0 to 3.0 percent. Reaction in the surface layer is generally neutral or slightly acid. The substratum is medium in available phosphorus and available potassium. Tlth is good.

Many areas on the wider flood plains are cropland. Most in the narrow drainageways are pastureland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. It is subject to frequent flooding. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the soil and pasture in good condition.

The capability subclass is I1w.

221B—Palms muck, 1 to 4 percent slopes. This gently sloping, very poorly drained soil generally occurs as hillside seeps at the base of slopes or in upland drainageways. Some areas are on stream benches. Some areas are subject to frequent flooding. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is black, very friable muck about 10 inches thick. The subsurface layer is black muck about 16 inches thick. The substratum is black silt loam to a depth of 32 inches and dark gray silt loam to a depth of 52 inches.

Included with this soil in mapping are areas where muck is 72 inches or more thick over the substratum. Those areas are on landscape positions similar to those of this Palms soil. They make up as much as 15 percent of the map unit.

Permeability is moderate and moderately slow. Surface runoff is very slow. The available water capacity is high. The organic matter content in the plow layer is more than 20 percent. Reaction in the surface layer is generally neutral or slightly acid. This soil is very low in available phosphorus and available potassium.

Most areas are pastureland or wasteland. This soil is poorly suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain unless it is drained. Draining it is difficult because water moves to areas of this soil in the coarse textured layers below the organic material. The water must be intercepted before it reaches areas of this soil. Locating the coarse textured layers and placing the tile properly are difficult.

This soil is poorly suited to grasses and legumes for hay and pasture unless it is drained.

The capability subclass is I1w.

226—Lawler loam, 32 to 40 inches to sand or gravel, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on benches along streams and rivers. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is loam about 13 inches thick. The upper part is very dark gray and the lower part is very dark grayish brown. The subsoil is about 17 inches thick. The upper 9 inches is dark grayish brown, friable loam with yellowish brown mottles. The middle 4 inches is dark grayish brown, friable sandy loam with yellowish brown mottles. The lower 4 inches is dark yellowish brown, very friable gravelly sand. The substratum is yellowish brown and brown sand and gravelly sand.

Included with this soil in mapping are areas where depth to sand and gravel is as little as 24 inches. These areas may be slightly droughty during dry periods. They
are generally on the slightly higher rises. They make up as much as 15 percent of the map unit. Permeability is moderate in the upper part of this Lawler soil and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content in the plow layer is about 4.0 to 5.0 percent. Reaction in the surface layer is generally slightly or medium acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth generally is good unless the soil has been worked when too wet.

Most areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses. This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of soil blowing in cultivated areas. Areas that are shallower to sand and gravel are slightly droughty during extended dry periods. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Surface compaction and poor tilth can result, however, from overstocking or from grazing during wet periods. Proper stocking rates, pasture rotation, timely defemnt of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability subclass is IIs.

284—Flagler sandy loam, 0 to 2 percent slopes.

This nearly level, somewhat excessively drained soil is on benches along streams and rivers. Individual areas are irregular in shape and range from 10 to 100 acres or more.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown sandy loam about 15 inches thick. The subsoil is about 13 inches thick. The upper part is dark yellowish brown, very friable sandy loam, and the lower part is brown, loose gravelly sand. The substratum is brown sand with some gravel. Permeability is moderately rapid in the upper part of the soil and very rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content in the plow layer is about 1.5 to 2.5 percent. Reaction in the surface layer is generally slightly acid or medium acid unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is good.

Most areas are pastureland or hayland. Some are cropland. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture. It is moderately suited to most engineering uses. This soil is poorly suited to corn, soybeans, and small grain. Because of droughtiness, yields are low unless rainfall is average or above average and very timely. There is some hazard of erosion in cultivated areas. Conservation tillage and winter cover crops reduce soil loss. Erosion control practices, such as contouring or terracing, may be difficult to use because of irregular contours and short slopes. Terracing exposes the coarse textured subsoil or substratum. These coarse textured areas are very droughty unless topsoil is placed over them. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Production of pasture and hay is limited during hot dry periods. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth and increased runoff. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is II.

285C—Burkhardt sandy loam, 2 to 9 percent slopes.

This gently sloping to moderately sloping, some-
what excessively drained soil is on upland knolls and stream escarpments. Individual areas are irregular in shape and range from 5 to 10 acres.

Typically, the surface layer is very dark brown sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown, friable sandy loam; the middle part is brown, very friable gravelly loamy sand; and the lower part is strong brown, very friable gravelly sand. The substratum is brown and strong brown gravelly sand.

Included with this soil in mapping are areas where the surface layer is lighter colored or thinner. These areas generally are on upland knobs. They make up about 15 percent of the map unit.

Permeability is moderately rapid in the upper part of the soil and rapid in the lower part. Surface runoff is medium. The available water capacity is very low. The organic matter content in the plow layer is about 0.5 to 1.5 percent. Reaction in the surface layer is generally slightly acid to strongly acid unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tillth is good.

Most areas are pastureland or hayland, the best use for this soil. Some are cropland because the management of this soil is typically determined by that of the surrounding soils. This soil is poorly suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Erosion is a hazard on cultivated areas. The soil is also very droughty. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. The use of contouring or terracing is difficult because of the short, irregular slopes. In addition, terracing exposes coarse textured material. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is poorly suited to grasses and legumes for hay and pasture. Because of the very low available water capacity, production is very low during summer months. The soil is better suited to hay or pasture, however, than to row crops.

The capability subclass is IVs.

291—Atterberry silt loam, 1 to 3 percent slopes.

This nearly level, somewhat poorly drained soil is on nearly level, broad loess covered areas in uplands or in areas around the heads of drainageways. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 34 inches thick. The upper 5 inches is brown, and the rest is grayish brown with yellowish brown and strong brown mottles. The substratum is grayish brown silt loam.

Permeability is moderate and moderately slow. Runoff is slow (fig. 10). The available water capacity is high. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction in the surface layer is generally slightly acid to medium acid if the soil has not been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tillth generally is fair unless the soil is worked when too wet.

Most areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Because it is somewhat poorly drained soil, tile drains may be needed for timely field operations. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tillth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.

293C—Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes. This map unit consists of gently rolling, excessively drained and well drained soils on upland ridges and side slopes. Individual areas range from 20 to several hundred acres.

This unit is about 40 percent Chelsea soils, 30 percent Lamont soils, 20 percent Fayette soils, and 10 percent included soils. Areas of these soils are so intricately mixed or are so small that it is not practical to map them separately.

Typically, the surface layer of the Chelsea soil is dark brown loamy fine sand about 4 inches thick. The subsurface layer is brown, yellowish brown, and dark yellowish brown fine sand about 37 inches thick. The next layer is similar to the subsurface layer but has bands of brown, very friable loamy fine sand 1/4 inch to 2 inches thick.

Typically, the surface layer of the Lamont soil is very dark gray fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 5 inches thick. The subsoil is very friable sandy loam about 26 inches thick. The upper part is dark yellowish brown and the lower part is dark brown and yellowish brown. The substratum is yellowish brown fine sand.

Typically, the surface layer of the Fayette soil is very dark grayish brown silt loam about 4 inches thick. The subsurface layer is brown and dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 35 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Included with these soils in mapping are small areas which are slightly less fertile because part of the surface layer has been removed by erosion. These included
areas are on the steepest part of the slopes. They make up about 15 percent of the map unit.

Permeability is rapid in the Chelsea soil, moderately rapid in the upper part of the Lamont soil and very rapid in the lower part, and moderate in the Fayette soil. Surface runoff is medium in all these soils. The available water capacity is low in the Chelsea and Lamont soils and high in the Fayette soil. The organic matter content in the plow layer is less than 0.5 percent in the Chelsea and Lamont soils and about 1.0 to 2.0 percent in the Fayette soil. Reaction is generally medium acid or strongly acid in the surface layer of all these soils unless the soil has been limed in the past 5 years. The lower part of the Chelsea soil is very low in available phosphorus and potassium. The subsoil of the Lamont soil is generally medium in available phosphorus and very low in available potassium. The subsoil of the Fayette soil is generally high in available phosphorus and very low in available potassium. Tillth is generally good.

Most areas of this unit are pastureland or woodland. This unit is poorly suited to cultivated crops and moderately suited to hay and pasture. It is moderately or poorly suited to most engineering uses.

This unit is poorly suited to corn, soybeans, and small grain. Yields are low unless rainfall is both above average and timely. Erosion by both wind and water is a hazard in cultivated areas. Conservation tillage, contouring, winter cover crops, and grassed waterways reduce erosion. Terraces may be difficult to construct and maintain because of poor stability. Returning crop residue or adding other organic material helps to maintain fertility and reduce erosion.

This unit is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. The carrying capacity for pasture is limited during midsummer because of droughtiness.

The capability subclass is I1l.

293D—Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes. This map unit consists of rolling and hilly, excessively drained and well drained soils on upland ridges and side slopes. Individual areas range from 20 to several hundred acres.

This unit is about 40 percent Chelsea soils, 30 percent Lamont soils, and 20 percent Fayette soils. Areas of
these soils are so intricately mixed or are so small that mapping them separately is not practical.

Typically, the surface layer of the Chelsea soil is brown loamy fine sand about 2 inches thick. The subsurface layer is yellowish brown fine sand about 30 inches thick. The next layer is similar to the subsurface layer but has bands of brown, very friable loamy fine sand 1/4 inch to 2 inches thick.

Typically, the surface layer of the Lamont soil is dark gray fine sandy loam about 3 inches thick. The subsurface layer is brown fine sandy loam about 4 inches thick. The subsoil is very friable sandy loam about 22 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown fine sand.

Typically, the surface layer of the Fayette soil is dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 33 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Included with these soils in mapping are small areas where part of the surface layer has been removed by erosion. These areas are slightly less fertile than surrounding areas. They are on the steepest part of the slopes. They make up about 15 percent of the map unit.

Permeability is moderately rapid in the Chelsea soil, moderately rapid in the upper part of the Lamont soil and very rapid in the lower part, and moderate in the Fayette soil. Surface runoff is moderately rapid on all of these soils. The available water capacity is low in the Chelsea and Lamont soils and high in the Fayette soil. The organic matter content in the plow layer is less than 0.5 percent in the Chelsea and Lamont soils and about 1.0 percent in the Fayette soil. Reaction is generally medium acid or strongly acid in the surface layer of all these soils unless the soil has been limed in the past 5 years. The lower part of the Chelsea soil is very low in available phosphorus and potassium. The subsoil of the Lamont soil is generally medium in available phosphorus and very low in available potassium. The subsoil of the Fayette soil is generally high in available phosphorus and very low in available potassium. Tilth is generally good.

Nearly all areas are pastureland or woodland. This unit is poorly suited to cultivated crops and moderately suited to hay and pasture. It is moderately or poorly suited to most engineering uses.

This unit is poorly suited to corn, soybeans, and small grain. If these soils are cultivated, the hazard of erosion is severe because of slope.

This unit is moderately suited to grasses and legumes for pasture and hay. Many areas are steep enough to cause problems in harvesting hay. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. The carrying capacity for pasture is limited during midsummer because of droughtiness.

Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Vle.

293F—Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes. This map unit consists of steep and very steep, excessively drained and well drained soils on upland ridges and side slopes. Individual areas range from 20 to 200 acres.

This unit is about 40 percent Chelsea soils, 30 percent Lamont soils, and 20 percent Fayette soils. Areas of these soils are so intricately mixed or are so small that mapping them separately is not practical.

Typically, the surface layer of the Chelsea soil is brown loamy fine sand about 2 inches thick. The subsurface layer is yellowish brown, loose fine sand about 26 inches thick. The next layer is similar to the subsurface layer but has bands of brown, very friable loamy fine sand 1/4 inch to 2 inches thick.

Typically, the surface layer of the Lamont soil is dark gray fine sandy loam about 2 inches thick. The subsurface layer is brown fine sandy loam about 4 inches thick. The subsoil is very friable sandy loam about 20 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown fine sand.

Typically, the surface layer of the Fayette soil is very dark grayish brown silt loam about 2 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 29 inches thick. The upper part is dark yellowish brown, and the lower part is yellowish brown. The substratum is yellowish brown silt loam.

Permeability is rapid in the Chelsea soil, moderately rapid in the upper part of the Lamont soil and very rapid in the lower part, and moderate in the Fayette soil. Surface runoff is moderately rapid on all of these soils. The available water capacity is low in the Chelsea and Lamont soils and high in the Fayette soil. The organic matter content in the plow layer is less than 0.5 percent in the Chelsea and Lamont soils and about 1.0 percent in the Fayette soil. Reaction is generally medium acid or strongly acid in the surface layer of all these soils unless the soil has been limed in the past 5 years. The lower part of the Chelsea soil is very low in available phosphorus and potassium. The subsoil of the Lamont soil is generally medium in available phosphorus and very low in available potassium. The subsoil of the Fayette soil is generally high in available phosphorus and very low in available potassium. Tilth is generally good.

Nearly all areas are pastureland. A few are pastureland. This soil is poorly suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This unit is poorly suited to corn, soybeans, and small grain. If it is cultivated, the hazard of erosion by both wind and water is very severe. Yields are very low.

This unit is poorly suited to hay and pasture. If it is used for pasture, there is little hazard of erosion, but careful management is needed to maintain adequate plant cover.
The capability subclass is VIIe.

302B—Coggon loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape and range from 10 to 50 acres. Typically, the surface layer is very dark grayish brown loam about 4 inches thick. The subsurface layer is brown loam about 5 inches thick. The subsoil is about 47 inches thick. The upper part is yellowish brown, friable loam; the middle part is strong brown and yellowish brown, firm clay loam; and the lower part is yellowish brown, firm clay loam. The substratum is yellowish brown loam.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 1.5 to 2.5 percent. Reaction in the surface layer is generally medium acid or strongly acid unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tillth generally is good.

Most areas are woodland or pastureland. A few are cropland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to most engineering uses.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

302C—Coggon loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape and range from 10 to 100 acres. Typically, the surface layer is very dark grayish brown loam about 3 inches thick. The subsurface layer is brown loam about 6 inches thick. The subsoil is about 42 inches thick. The upper few inches is yellowish brown, friable loam; the middle part is strong brown and yellowish brown, firm clay loam; and the lower part is yellowish brown, firm clay loam. The substratum is yellowish brown loam. In some small areas part of the surface layer has been removed by erosion.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 1.0 to 2.0 percent. Reaction in the surface layer is generally medium acid or strongly acid unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tillth generally is good.

Most areas are woodland or pastureland. A few are cropland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, may be needed. Returning crop residue or adding other organic material helps to improve fertility and maintain tillth.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.
yields. Because the organic matter content of the plow layer is lower in this soil than in uneroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some cases causes severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Erosion control practices, such as contouring or terracing, may be needed. Returning crop residue or adding other organic material helps to improve fertility and tilth.

This soil is well suited to legumes and grasses for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ille.

315—Fluvaquents, sandy and loamy. These nearly level soils consist of recently deposited, highly stratified sediment that has not been in place long enough for soil horizon to develop. They are frequently flooded, and each flood adds new sediment. The sediment, which varies in texture, is mainly loam, silt loam, sandy loam, and loamy sand.

Much of this unit is channeled and contains low natural levees, small ponds, sloughs, and small oxbows (fig. 11). Natural drainage ranges from very poor and poor in the channels to well drained or excessively drained in the natural levees.

Most areas are wildlife habitat, pastureland, or woodland. The soils are poorly suited to cultivated crops and to hay and pasture. They are poorly suited to most engineering uses.

These soils are poorly suited to corn, soybeans, and small grain. They are subject to frequent flooding. The low areas may remain ponded for considerable lengths of time.

These soils are poorly suited to building site development and onsite waste disposal. They are subject to frequent flooding and have a high water table.

The capability subclass is Vw.

Figure 11.—Typical area of Fluvaquents, sandy and loamy, along the Cedar River showing the many remnants of former stream channels.
350—Waukegan silt loam, 0 to 2 percent slopes.
This nearly level, well drained soil is on stream benches along rivers and major streams. Individual areas are irregular in shape and range from 10 to 100 acres or more.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is very dark grayish brown silt loam about 5 inches thick. The subsoil is about 36 inches thick. The upper part is brown and dark yellowish brown, friable silty clay loam; the middle part is dark yellowish brown, friable silt loam and loam; and the lower part is yellowish brown, loose loamy sand. The substratum is yellowish brown sand.

Included in mapping are areas where depth to sand is as little as 26 inches. These areas are more dry than this Waukegan soil. They are on slight rises. They make up 5 to 10 percent of the map unit.

Permeability is moderate in the upper part of the soil and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content in the plow layer is about 3.5 to 4.5 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is generally good.

Almost all areas are cropland. This soil is moderately suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Because the available water capacity is moderate, the soil is slightly dry during extended dry spells. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In many places using control erosion practices, such as contouring and terracing, is difficult because of complex contour and short slopes. Terracing may expose areas of the coarse textured material. These areas are very dry. Returning crop residue or adding other organic material helps to improve fertility and maintain soil.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is II.

350B—Waukegan silt loam, 2 to 5 percent slopes.
This gently sloping, well drained soil is on stream benches along rivers and major streams. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil is about 34 inches thick. The upper part is dark yellowish brown, friable silty clay loam; the middle part is dark yellowish brown, friable silt loam and loam; and the lower part is yellowish brown, loose loamy sand. The substratum is yellowish brown sand.

Included in mapping are areas where sand is at a depth of as little as 26 inches. These areas are slightly dry. They are on the steepest part of the slope. They make up 10 to 15 percent of the map unit.

Permeability is moderate in the upper part of the soil and rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The organic matter content in the plow layer is about 3.0 to 4.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is generally good.

Almost all areas are cropland. This soil is moderately suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Because the available water capacity is moderate, the soil is slightly dry during extended dry spells. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In many places using control erosion practices, such as contouring and terracing, is difficult because of complex contour and short slopes. Terracing may expose areas of the coarse textured material. These areas are very dry. Returning crop residue or adding other organic material helps to improve fertility and maintain soil.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is wet compacts the surface, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is II.

352B—Whittier silt loam, 1 to 4 percent slopes.
This gently sloping, well drained soil is on high stream benches along rivers and major streams. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsoil is about 24 inches thick. The upper and middle parts are dark yellowish brown, friable silty clay loam; and the lower part is dark yellowish brown, friable loam. The substratum is yellowish brown loamy sand.

Permeability is moderate in the upper part of the soil and rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is generally fair.

Most areas are cropland or pastureland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately to poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. It is slightly dry in years when rainfall is
below average. There is some hazard of erosion in cultivated areas. Winter cover crops, conservation tillage, and grassed waterways reduce soil loss. Erosion control practices, such as contouring and terracing, may be difficult to use because of the irregular contour and short slopes in most areas. Terracing may expose areas of the coarse textured substratum. These areas are very droughty unless topsoil is placed over them. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth and increased runoff. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

377B—Dinsdale silty clay loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape. They range from 10 to several hundred acres and extend across several farms.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 33 inches thick. The upper part is brown, friable silty clay loam, and the lower 9 inches is brown and yellowish brown, firm loam. The substratum is yellowish brown loam. In some areas the depth to the firm loam is less than 24 inches.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is 2.5 to 3.5 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is generally good.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is well suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places contouring or terracing to control erosion is difficult because of complex slopes. In most places, however, these practices are suitable. Terracing may expose glacial till, which has lower fertility and poor tilth. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

377C—Dinsdale silty clay loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is very dark brown silty clay loam about 7 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 27 inches thick. The upper part is brown, friable silty clay loam, and the lower part is yellowish brown, firm loam. The substratum is yellowish brown loam. In some areas the surface layer is thinner and the depth to firm loam is less than 24 inches.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is 2.5 to 3.5 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is generally good.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is well suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places contouring or terracing to control erosion is difficult because of complex slopes. In most places, however, these practices are suitable. Terracing may expose glacial till, which has lower fertility and poor tilth. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on pastureland or hayland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

377C2—Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained soil is on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is dark brown silty clay loam with some mixing of brown silty clay loam and is about 8 inches thick. The subsoil is about 25 inches thick. The upper part is brown, friable silty clay loam, and the lower part is yellowish brown, firm loam. The substratum is yellowish brown loam. In some areas firm loam is at or near the surface.
Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 2.0 to 3.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is generally fair unless the soil has been worked when too wet.

Nearly all areas are cropland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is well suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Because material from the subsoil, which is low in available phosphorus and very low in available potassium and in organic matter, has been mixed into the plow layer, more fertilizer is needed to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in uneroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, lowers yields and in some cases causes severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places, contouring or terracing is difficult because of irregular contours. In most places, however, these practices are suitable. Terracing may expose glacial till, which has lower fertility and poor tilth. Returning crop residue or adding other organic material helps to improve fertility and tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep pasture and soil in good condition.

The capability subclass is I1e.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Tile drains are needed. Wind erosion is a slight hazard in cultivated areas. Minimum tillage and winter cover crops reduce the hazard of wind erosion. Returning crop residue or adding other organic material helps to improve fertility and tilth.

This soil is well suited to grasses and legumes for hay and pasture if it is adequately drained. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is I1w.

391B—Clyde-Floyd complex, 1 to 4 percent slopes. This map unit consists of gently sloping, poorly drained and somewhat poorly drained, moderately permeable soils. These soils are on upland drainageways. Individual areas range from 100 to several hundred acres and extend across several farms.

This unit is about 60 percent Clyde soils and 40 percent Floyd soils. The Clyde soil is in the lowest part of the drainageways and the Floyd soil along the upper part. The Clyde soil is subject to frequent flooding.

Typically, the surface layer of the Clyde soil is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark gray silty clay loam about 14 inches thick. The subsoil is about 22 inches thick. The upper part is dark grayish brown, olive gray, and dark gray, friable silty clay loam and loam. The middle part is olive gray, very friable sandy loam and loamy sand. The lower part is mottled gray and yellowish brown, firm loam. The substratum is gray and yellowish brown loam.

Typically, the surface layer of the Floyd soil is black loam about 8 inches thick. The subsurface layer is very dark grayish brown and black loam about 15 inches thick. The subsoil is about 38 inches thick. The upper part is dark grayish brown, friable loam. The middle part is grayish brown, friable sandy clay loam and sandy loam with yellowish brown mottles. The lower part is mottled yellowish brown and grayish brown, firm loam. The substratum is mottled yellowish brown and grayish brown loam. In some areas the surface layer is sandy loam.

Included with this unit in mapping are areas of Schley soils, which are more acid and have a thinner surface layer than Clyde and Floyd soils. They are on similar landscape positions. They make up about 10 percent of the map unit.

Permeability is moderate in Clyde and Floyd soils. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 9.0 to 11.0 percent in the Clyde soil and about 5.0 to 6.0 percent in the Floyd soil. Reaction in the surface layer is generally neutral or slightly acid in both soils. The subsoil is very low in available phosphorus and potassium. Tilth is fair to good.

382—Maxfield silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on broad ridgetops in uplands. Individual areas are irregular in shape and range from 50 to 100 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 13 inches thick. The upper part is black and the lower part is very dark gray. The subsoil is about 29 inches thick. The upper part is dark gray and olive gray, friable silty clay loam; the middle part is light olive gray and yellowish brown, very friable sandy loam; and the lower part is gray and yellowish brown, firm loam. The substratum is gray and yellowish brown loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 6.0 to 7.0 percent. Reaction in the surface layer is generally neutral. The subsoil is very low in available phosphorus and available potassium. Tilth generally is fair unless the soil is worked when too wet.
Many areas are cropland and pastureland. This unit is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This unit is well suited to corn, soybeans, and small grain. Tile drainage, however, is needed to utilize the full potential of the unit. Because wetness is partly the result of hillside seepage, a drainage system that intercepts laterally moving water is most successful. Stones and boulders are common in many areas and must be removed before the soil can be cropped. Returning crop residue or adding other organic material helps to improve fertility and tilth.

This unit is well suited to hay or pasture if it is adequately drained and the stones and boulders are removed. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing help to keep pasture and soil in good condition.

The capability subclass is 1lw.

398—Tripoll clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on broad upland ridge-tops. Individual areas are irregular in shape and range from 20 to 100 acres.

Typically, the surface layer is black clay loam about 7 inches thick. The subsurface layer is black and very dark gray clay loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is dark grayish brown, friable clay loam with light olive brown mottles; the middle few inches is olive brown, friable loam; and the lower part is mottled yellowish brown and grayish brown, firm loam. The substratum is yellowish brown and light brownish gray loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 6.0 to 7.0 percent. Reaction is generally neutral or slightly acid in the surface layer. The subsoil is very low in available phosphorus and available potassium. Tilth is generally good unless the soil is worked when wet.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately or poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Tile drains, however, are needed. Wind erosion is a slight hazard in cultivated areas. Minimum tillage and winter cover crops reduce this hazard. Retuming crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is 1lw.

399—Readlyn loam, 1 to 3 percent slopes. This nearly level, somewhat poorly drained soil is on moderately wide, slightly convex ridgetops in uplands. Individual areas are irregular in shape and range from 10 to 100 acres or more.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray and very dark grayish brown loam about 11 inches thick. The subsoil is about 27 inches thick. The upper 4 inches is brown, friable loam with grayish brown and yellowish brown mottles. The middle 7 inches is mottled grayish brown and yellowish brown, firm loam. The lower part is yellowish brown, firm loam with grayish brown mottles. The substratum is yellowish brown and brown loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 4.5 to 5.5 percent. Reaction is generally slightly acid or medium in the surface layer unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is generally good unless the soil has been worked when too wet.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Tile drains may be needed, however, to maintain timely field operations. Wind erosion is a slight hazard in cultivated areas. Conservation tillage and winter cover crops reduce this hazard. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is too wet compacts the surface and causes poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep pasture and soil in good condition.

The capability class is I.

407B—Schley loam, 1 to 4 percent slopes. This gently sloping, somewhat poorly drained soil is on concave to plane slopes around the heads or along the sides of upland drainageways. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown and brown loam about 11 inches thick. The subsoil is about 42 inches thick. The upper part is grayish brown, friable loam with yellowish brown mottles; the middle part is grayish brown and yellowish brown, friable sandy loam; and the lower part is grayish brown, brown, yellowish brown, and gray, firm loam. In some areas a sandy loam layer below the middle part of the subsoil extends to depths of 50 to 60 inches or more.

Included with this soil in mapping are areas where the surface layer is sandy loam. These areas are generally more seepy and wet than the areas where the surface layer is loam. They are on landscape positions similar to those of this Schley soil and are adjacent to the better drained soils. They make up about 10 percent of the map unit.
Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction is generally strongly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is generally good.

Most areas are cropland. Some are pastureland. This soil is moderately suited to cultivated crops and to hay and pasture. It is moderately or poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Tile drains are needed. Because wetness is partly the result of hillside seepage, a drainage system that intercepts laterally moving water is most successful. Some areas are subject to erosion. Conservation tillage, winter cover crops, and grassed waterways reduce soil loss. Terracing should be combined with tile drains. Contouring increases wetness unless the soil is properly drained. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. Tile drains are needed for best results, especially on hayland. Overgrazing or grazing when the soil is too wet compacts the surface and causes poorer tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is llw.

408C—Olin fine sandy loam, 5 to 9 percent slopes.

This gently sloping, well drained and somewhat excessively drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape and range from 20 to 200 acres.

Typically, the surface layer is very dark brown fine sandy loam about 11 inches thick. The subsurface layer is very dark grayish brown and brown fine sandy loam about 13 inches thick. The subsoil is about 29 inches thick. The upper part is dark yellowish brown, very friable sandy loam, and the lower part is dark yellowish brown, firm loam. The subsoil is yellowish brown and dark yellowish brown loam.

Permeability is moderately rapid in the upper part of the soil and moderate in the lower part and the subsoil. Because of the difference in permeability, water tends to move laterally. In wet seasons seepy areas may develop for short periods. Surface runoff is medium. The available water capacity is moderate. The organic matter content in the plow layer is about 0.5 to 1.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is generally good.

Most areas are cropland. A few are pastureland. This soil is moderately suited to cultivated crops and to hay and pasture. It is well suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. It may be slightly droughty during extended dry periods. Erosion by both wind and water is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways reduce soil loss. Erosion control practices, such as contouring or terracing, may be needed. Seepy spots may develop in terrace channels unless tile drains are installed. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is llw.
runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep pasture and soil in good condition.

The capability subclass is Ille.

412C—Sogn loam, 5 to 9 percent slopes. This moderately sloping, somewhat excessively drained soil is on side slopes and ridgetops in uplands. Individual areas are irregular in shape and range from 5 to 50 acres. Typically, the surface layer is very dark gray loam about 4 inches thick. The subsurface layer is very dark brown loam about 11 inches thick. Shattered and fractured limestone is at a depth of 15 inches.

Included with this soil in mapping are areas where the limestone bedrock is exposed. These areas are on the steepest part of the slope. They make up 8 to 12 percent of the map unit.

Permeability is moderate. Surface runoff is medium. The available water capacity is very low. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction is slightly acid or neutral in the surface layer. The soil is generally very low in available phosphorus and available potassium. Tilth is good.

Most areas are permanent pasture or woodland. This soil is poorly suited to cultivated crops and hay and moderately suited to pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain because it is shallow over rock. Erosion is a hazard in cultivated areas. Tillage is difficult because limestone outcrops and limestone fragments occur in the soil.

This soil is moderately suited to pasture. There is little hazard of erosion on pastureland. Overgrazing or grazing when the soil is wet compacts the surface and increases runoff. Pasture rotation and proper stocking are needed to keep the pasture and soil in good condition.

This soil is moderately suited to trees. Planting may be difficult because the soil is shallow over rock.

The capability subclass is VIIa.

412D—Sogn loam, 9 to 18 percent slopes. This strongly sloping and moderately steep, somewhat excessively drained soil is on side slopes in uplands. Individual areas are irregular in shape and range from 10 to 100 acres or more.

Typically, the surface layer is very dark gray loam about 4 inches thick. The subsurface layer is dark brown loam about 8 inches thick. Shattered and fractured limestone bedrock is at a depth of 12 inches.

Included with this soil in mapping are areas where the limestone bedrock is exposed. These areas are on the steepest part of the slope. They make up 10 to 15 percent of the map unit.

Permeability is moderate. Surface runoff is rapid. The available water capacity is very low. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction is slightly acid or neutral in the surface layer. The soil is generally very low in available phosphorus and available potassium. Tilth is good.

Most areas are woodland or wildlife habitat. This soil is poorly suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain and to hay and pasture because of slope and shallowness over limestone bedrock.

This soil is best suited to use as wildlife habitat, but management or seeding may be difficult because of the slope.

The capability subclass is VIIa.

412F—Sogn loam, 18 to 40 percent slopes. This steep and very steep, somewhat excessively drained soil is on side slopes in uplands. Individual areas are irregular in shape and range from 5 to 100 acres.

Typically, the surface layer is dark brown loam about 4 inches thick. The subsurface layer is dark brown loam about 4 inches thick. Shattered and fractured limestone bedrock is at a depth of 6 to 8 inches.

Included with this soil in mapping are areas where the limestone bedrock is exposed. These areas are on the steepest part of the slope. They make up 10 to 15 percent of the map unit.

Permeability is moderate. Surface runoff is rapid. The available water capacity is very low. The organic matter content in the plow layer is about 0.5 to 1.5 percent. Reaction is slightly acid or neutral in the surface layer. The soil is generally very low in available phosphorus and available potassium. Tilth is good.

Nearly all areas are woodland or wildlife habitat. This soil is poorly suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain and to legumes and grasses for hay and pasture because of shallowness over rock and steepness of slopes.

This soil is best suited to use as wildlife habitat, but management or seeding may be difficult because of the slope.

The capability subclass is VIIa.

420—Tama silty clay loam, benches, 0 to 2 percent slopes. This nearly level, well drained soil is on slopes covered high stream benches. Individual areas are irregular in shape and range from 5 to 60 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 11 inches thick. The subsoil is friable silty clay loam about 35 inches thick. The upper part is dark brown and brown, and the lower part is dark yellowish brown. The substratum is yellowish brown silt loam. Loamy sand or sandy loam with some gravel is typically at a depth of about 5 feet but in places is at 4 feet.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 3.5 to 4.5 percent. Reaction is generally medium acid or slightly acid in the sur-
face layer and the upper part of the subsoil. The subsoil is generally medium in available phosphorus and very low in available potassium. Tilth is good.

Nearly all areas are cropland. This soil is well suited to cultivated crops, hay and pasture, and trees. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of wind erosion in cultivated areas. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.

426B—Aredale loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on rounded ridgetops and convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 200 acres or more.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 13 inches thick. The subsoil is about 44 inches thick. The upper part is brown, friable loam; the middle part is dark yellowish brown, very friable sandy loam; and the lower part is dark yellowish brown, firm loam. The substratum is dark yellowish brown loam. In some small areas the surface layer is sandy loam. These areas are slightly droughty and are less productive than this Aredale loam.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 3.0 to 4.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is generally very low in available phosphorus and available potassium. Tilth is good.

Most areas are cropland. Some are permanent pasture. This soil is well suited to cultivated crops and to hay and pasture. It is well suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places using erosion control practices, such as contouring and terracing, is difficult because of irregular contours. In most places, however, these practices are suitable. Terracing may expose areas of the sandy loam material. These areas are droughty unless recovered with topsoil. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pasture. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep pasture and soil in good condition.

The capability subclass is Ile.

426C—Aredale loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown loam about 11 inches thick. The subsoil is about 39 inches thick. The upper part is brown, friable loam; the middle part is dark yellowish brown, very friable sandy loam; and the lower part is dark yellowish brown, firm loam. The substratum is dark yellowish brown loam. In some small areas the
surface layer is sandy loam. These areas are slightly

droughty and are less productive than this Aredale loam.

Permeability is moderate. Surface runoff is medium.
The available water capacity is high. The organic matter
content in the plow layer is 2.5 to 3.5 percent. Reaction
is generally slightly acid or medium acid in the surface
layer unless the soil has been limed in the past 5 years.
The subsoil is generally very low in available phosphorus
and available potassium. Tillth is generally good.

Most areas are cropland. Some are permanent pastures.
This soil is moderately suited to cultivated crops and
to hay and pasture. It is well suited to most engineering
uses.

This soil is moderately suited to corn, soybeans, and
small grain. Erosion is a hazard in cultivated areas.
Conservation tillage, winter cover crops, and grassed
waterways help to prevent excessive soil loss. In places,
using erosion control practices, such as contouring and terracing,
is difficult because of irregular contours. In most
places, however, these practices are suitable. Areas of
sandy loam may be exposed in terracing. These areas
are droughty unless re-covered with topsoil material.
Returning crop residue or adding other organic material
helps to improve fertility and maintain tillth.

This soil is moderately suited to grasses and legumes
for hay and pasture. There is little hazard of erosion on
hayland and pastureland. Overgrazing or grazing when
the soil is wet compacts the surface and increases
runoff. Pasture rotation, proper stocking, and deferred
grazing during wet periods are needed to keep the past-
ture and soil in good condition.

The capability subclass is Ille.

428B—Ely silt loam, 2 to 5 percent slopes. This

gently sloping, somewhat poorly drained soil is on allu-
"vial fans or foot slopes at the base of slopes in uplands.
Individual areas are irregular in shape and range from 5
to 25 acres.

Typically, the surface layer is black silt loam about 8
inches thick. The subsurface layer is silty clay loam
about 26 inches thick. The upper part is black; the
middle part is very dark gray; and the lower part is very
dark grayish brown. The subsoil is dark grayish brown,
frail silty clay loam about 24 inches thick. The subsus-
tum is yellowish brown sandy loam and dark yellowish
brown loam.

Permeability is moderate. Surface runoff is medium.
The available water capacity is high. The organic matter
content in the plow layer is about 5.0 to 6.0 percent.
Reaction is generally neutral or slightly acid in the sur-
face layer. The subsurface layer and the subsoil are very
low in available phosphorus and available potassium.
Tillth is generally good.

Most areas are cropland. Some are pastureland. This
soil is well suited to cultivated crops and to hay and
pasture. It is moderately or poorly suited to most engi-
neering uses.

This soil is well suited to corn, soybeans, and small
grain. Tile drains, however, may be needed in some
places to remove seepage from the uplands. The soil is
also subject to overwash and silting from upslope. Re-
turning crop residue or adding organic material helps to
improve fertility and maintain tillth.

This soil is well suited to grasses and legumes for hay
and pasture. Overgrazing or grazing when the soil is wet
may compact the surface, increase runoff, and result in
poorer tillth. Proper stocking, pasture rotation, deferred
grazing, and restricted use during wet periods are
needed to keep the pasture and soil in good condition.

The capability subclass is Ilw.

536—Hanlon fine sandy loam, 0 to 2 percent
slopes. This nearly level, moderately well drained soil is
on alluvial flood plains along rivers and major streams. It
is subject to occasional flooding. Individual areas are
irregular in shape and range from 10 to 200 acres.

Typically, the surface layer is black fine sandy loam
about 7 inches thick. The subsurface layer is fine sandy
loam about 41 inches thick. It is black in the upper part
grading to very dark grayish brown in the lower part. The
subsoil is friable sandy loam at least 12 inches thick and
is very dark grayish brown with dark brown mottles.

Permeability is moderately rapid. Surface runoff is
slow. The available water capacity is moderate. The or-
organic matter content in the plow layer is about 2.0 to 3.0 percent. Reaction is generally neutral or slightly acid in the surface layer. The subsurface layer and the subsoil are very low in available phosphorus and available potassium. Tilth is good.

Most areas are cropland. Some are pastureland. This soil is moderately suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses. This soil is moderately suited to corn, soybeans, and small grain. It is subject to flooding. Higher areas within the unit are only occasionally flooded. This map unit also includes a few bayous which are wetter than the surrounding area. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. The bayous may be wet enough to interfere with harvesting hay. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIw.

**727—Udolpho loam, 32 to 40 inches to sand or gravel, 0 to 2 percent slopes.** This nearly level, somewhat poorly drained soil is on benches along streams and rivers. It is subject to rare flooding. Individual areas are irregular in shape and range from 10 to 75 acres. Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsurface layer is dark grayish brown and grayish brown loam about 9 inches thick. The subsoil is about 24 inches thick. The upper part is dark grayish brown and grayish brown, friable loam. The lower part is dark grayish brown and grayish brown, very friable loamy sand. The substratum is yellowish brown gravelly sand.

Included with this soil in mapping are areas where sand and gravel are at a depth of as little as 24 inches. These areas may be slightly droughty during dry periods. They are in landscape positions similar to those of this Udolpho soil. They make up 10 to 15 percent of the map unit.

Permeability is moderate in the upper part of the soil and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content in the plow layer is 2.0 to 3.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is generally good unless the soil has been worked when too wet.

Most areas are cropland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately or poorly suited to most engineering uses. This soil is moderately suited to corn, soybeans, and small grain. There is some hazard of soil blowing in cultivated areas. Areas that are shallower over sand or gravel are slightly droughty during extended dry periods. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth. Planting corn or soybeans may be delayed in the spring because of wetness.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is too wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is IIIw.

**729B—Nodaway-Radford silt loams, 2 to 5 percent slopes.** This map unit consists of gently sloping, moderately well drained and somewhat poorly drained, moderately permeable soils in narrow upland drainageways along small streams and waterways. It is subject to frequent flooding. Individual areas range from 20 acres to areas extending across several farms. This unit is about 60 percent Nodaway soils and 30 percent Radford soils. The Nodaway soil is along the stream or waterway, and the Radford soil is in a band along the edges of the unit. Areas of these soils are so intricately mixed that it is not practical to map them separately.

Typically, the surface layer of the Nodaway soil is very dark grayish brown silt loam about 7 inches thick. The substratum is stratified dark grayish brown and very dark grayish brown silt loam.

Typically, the surface layer of the Radford soil is very dark grayish brown silt loam about 11 inches thick. The subsurface layer is a very dark gray silt loam about 6 inches thick. The substratum is very dark gray silt loam with thin strata of grayish brown. The substratum is underlain by a buried soil that is black silty clay loam.

Permeability is moderate in these soils. Runoff is medium but overwash is received from adjacent soils. The available water capacity is high. The organic matter content in the plow layer is about 2.0 to 3.0 percent. The reaction in the surface layer is generally slightly acid or neutral. The substratum in these soils is medium in available phosphorus and potassium. Tilth is generally good.

Most areas are pastureland. Some are cropland. A few are woodland. Most areas of this unit are in the same use as the surrounding areas because individual areas are generally too narrow to be cropped separately. This unit is moderately suited to cultivated crops and well suited to hay and pasture. It is poorly suited to most engineering uses.

This unit is moderately suited to corn, soybeans, and small grain. Because seepage water from the uplands keeps this unit wet during spring and wet periods, tile drains are generally needed. The unit is subject to overwash and siltation from the soils upslope. It is subject to frequent flooding of short duration. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.
This unit is well suited to grasses and legumes for hay and pasture. Overwash and siltation from adjacent soils may cause some damage to hay and pasture. Artificial drainage is needed to maintain a good stand for hay and pasture. Overgrazing or grazing when the soil is too wet compacts the soil, increases runoff, and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ilw.

771B—Waubeek silt loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically, the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsoil is about 52 inches thick. The upper part is brown, friable silty clay loam; the middle part is dark yellowish brown and grayish brown, firm loam; and the lower part is mottled yellowish brown and grayish brown, firm loam. The substratum is yellowish brown loam with grayish brown mottles. In some areas the surface layer is loam.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is about 1.5 to 2.5 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is medium in available phosphorus and very low in available potassium. Tilth is generally fair.

Nearly all areas are cropland. A few are pastureland or woodland. This soil is well suited to cultivated crops and to hay and pasture. It is well suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Erosion, however, is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places the use of erosion control practices, such as contouring or terracing, is difficult because of complex slopes. In most places, however, these practices are suitable. Terracing may expose glacial till, which has lower fertility and poor tilth. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ille.

771C2—Waubeek silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained soil is on convex side slopes in uplands. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically, the surface layer is very dark grayish brown silt loam mixed with brown silt loam. It is about 7 inches thick. The subsoil is about 48 inches thick. The upper part is brown, friable silty clay loam; the middle part is dark yellowish brown, friable silty clay loam; and the lower part is yellowish brown and grayish brown, firm loam. The substratum is yellowish brown loam with grayish brown mottles.

Permeability is moderate. Surface runoff is medium. The available water capacity is high. The organic matter
content in the plow layer is about 1.0 to 2.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is medium in available phosphorus and very low in available potassium. Tilth is generally poor.

Most areas are cropland. This soil is moderately suited to cultivated crops and well suited to hay and pasture. It is moderately or well suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Because material from the subsoil, which is very low in available potassium and organic matter, has been mixed into the plow layer, more fertilizer is needed to maintain high yields. Because the organic matter content of the plow layer is lower in this soil than in uneroded adjacent soils, less herbicide is needed. Failure to adjust the rates of herbicides, particularly those that are very sensitive to organic matter levels, may lower yields and in some cases may cause severe loss of plant population. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. In places, using erosion control practices, such as contouring or terracing, is difficult because of complex slopes. In most places, however, these practices are suitable. Terracing may expose glacial till, which has lower fertility and even poorer tilth than uneroded Waubeek soils. Returning crop residue or adding other organic material helps to improve fertility and tilth.

This soil is well suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface, increases runoff, and results in poorer tilth. Pasture rotation, proper stocking, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.

778B—Sattre loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on benches along rivers and streams. Individual areas are irregular in shape and range from 10 to 50 acres. Typically, the surface layer is dark brown loam about 7 inches thick. The subsurface layer is brown loam about 2 inches thick. The subsoil is about 22 inches thick. It is dark yellowish brown, friable loam grading to sandy loam in the lower part. The substratum is brownish yellow sand.

Included with this soil in mapping are areas where coarse textured material is at a depth as shallow as 24 inches. These areas are more droughty than this Sattre soil. They are located on or near escarpments or short, steep slopes. They make up 10 to 15 percent of the map unit.

Permeability is moderate in the upper part of this Sattre soil and very rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The organic matter content in the plow layer is 1.5 to 2.5 percent. Reaction is generally medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and low in available potassium. Tilth is generally good.

Most areas are cropland. Some are hayland or pasture. This soil is well suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of soil blowing in cultivated areas. Areas that are shallower over sand and gravel are somewhat droughty. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Pasture may be limited, however, during hot dry periods. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.
tum. These areas are very droughty unless re-covered with topsoil. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Pasture may be limited during hot, dry periods. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth and increased runoff. Proper stocking, pasture rotation, and deferred grazing during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

782B—Donnan silt loam, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained and moderately well drained soil is on convex ridgetops or side slopes in uplands. Individual areas are irregular in shape and range from 5 to 20 acres.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 2 inches thick. The subsoil is more than 51 inches thick. The upper part is dark brown, friable loam; the middle part is yellowish brown, very friable sandy loam; and the lower part is grayish brown very firm silty clay. In some areas the lower subsoil is reddish brown clay loam.

Included with this soil in mapping are areas where the grayish brown silty clay is at a depth of less than 24 inches. These areas are slightly wetter than this Donnan soil. They are on the steepest part of the landscape. They make up 10 to 15 percent of the map unit.

Permeability is moderate in the upper part of this Donnan soil and very slow in the lower part. Because of the difference in permeability, water tends to move laterally and often causes seepy spots and wet spots. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is 2.0 to 3.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is fair.

Many areas are cropland. Many are pastureland or hayland. This soil is moderately suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is moderately suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Practices that improve drainage and those that reduce erosion tend to conflict. Erosion control practices slow down movement of surface water so that more infiltration occurs. Extra water entering the soil complicates drainage, especially in wet years. A combination of terraces and tile drains may be needed. Tile must be placed carefully because permeability is very slow. Tile drains may not be effective in all areas. If the clayey subsoil is deep enough, tile may be placed above it. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ile.

782C2—Donnan silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, somewhat poorly drained and moderately well drained soil is on convex ridgetops and side slopes in uplands. Individual areas are irregular in shape and range from 5 to 80 acres.

Typically, the surface layer is very dark grayish brown silt loam mixed with some brown silt loam. It is about 8 inches thick. The subsoil is at least 52 inches thick. The upper 4 inches is brown and yellowish brown, friable loam; the next 12 inches is yellowish brown, very friable sandy loam; and the lower part is grayish brown, very firm silty clay. In some areas, the lower subsoil is reddish brown clay loam.

Included with this soil in mapping are areas where the grayish brown silty clay is at a depth of less than 24 inches. These areas are slightly wetter than the Donnan soil. They are on the steepest part of the landscape. They make up 10 to 15 percent of the map unit.

Permeability is moderate in the upper part of this Donnan soil and very slow in the lower part. Because of the difference in permeability, water tends to move laterally and commonly causes seepy spots and wet spots. Surface runoff is medium. The available water capacity is high. The organic matter content in the plow layer is 1.5 to 2.0 percent. Reaction is generally slightly acid or medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is very low in available phosphorus and available potassium. Tilth is generally poor.

Many areas are cropland. Many are pastureland or hayland. This soil is poorly suited to cultivated crops and moderately suited to hay and pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. Erosion is a hazard in cultivated areas. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Practices that provide adequate drainage and those that reduce erosion tend to conflict. Erosion control practices slow movement of surface water so that more infiltration occurs. The extra water entering the soil complicates drainage, especially in wet years. A combination of terraces and tile drains may be needed. Careful placement of tile is needed because of the very slow permeability in the subsoil. Tile drains may not be effective in all areas. If
the clayey subsoil is deep enough, tile may be placed above it. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is moderately suited to grasses and legumes for hay and pasture. There is little hazard of erosion on hayland or pastureland. Overgrazing or grazing when the soil is too wet compacts the surface and increases runoff. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability subclass is Ille.

1043—Bremer silty clay loam, sandy substratum, 0 to 2 percent slopes. This nearly level, poorly drained soil is on low stream terraces. It formed in alluvium. It is subject to rare flooding. Individual areas are irregular in shape and range from 5 to 50 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray silty clay loam about 12 inches thick. The subsoil is friable silty clay loam about 27 inches thick. The upper part is dark gray and very dark gray, and the lower part is light olive gray and olive gray. The substratum is olive gray loamy coarse sand.

Permeability is moderately slow. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 5.0 to 7.0 percent. Reaction is generally neutral or slightly acid in the surface layer and upper part of the subsoil. The subsoil is low in available phosphorus and available potassium. Tilth is generally fair if the soil is not worked when too wet.

Almost all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Artificial drainage is needed. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses for hay and pasture. Overgrazing or grazing when the soil is wet compacts the soil and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I. Ilw.

1119—Muscatine silty clay loam, benches, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on loess covered high stream benches. Individual areas are irregular in shape and range from 20 to 100 acres.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 12 inches thick. The subsoil is friable silty clay loam about 26 inches thick. The upper and middle parts are dark grayish brown, and the lower part is dark grayish brown mottled with grayish brown and grayish yellow. The substratum is olive gray silt loam with grayish brown mottles. Loamy sand or sandy loam with some gravel is at a depth of about 5 feet but is at 4 feet in some pedons.

Permeability is moderate. Surface runoff is slow. The available water capacity is very high. The organic matter content in the plow layer is about 5.0 to 6.0 percent. Reaction is generally medium acid or strongly acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and available potassium. Tilth is generally fair or good unless the soil has been worked when too wet.

Nearly all areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately or poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. There is, however, some hazard of soil blowing in
cultivated areas. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth. Tile drains may be needed, and in some areas diversion terraces may be needed to prevent overwash from adjacent higher soils.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stockin, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.

1133—Colo silty clay loam, channeled, 0 to 2 percent slopes. This nearly level, poorly drained soil is on alluvial flood plains dissected by old stream channels, meandering stream channels, and bayous. Most of these channels cannot be crossed with farm machinery. Some are filled with water at least part of the year. This soil is subject to frequent flooding. Individual areas are generally long and range from 10 to 50 acres or more.

Typically, the surface layer is black silty clay loam about 7 inches thick. The subsurface layer is silty clay loam about 31 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is olive gray friable silty clay loam about 13 inches thick. The substratum is olive gray silty clay loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 5.0 to 7.0 percent. Reaction is generally neutral or slightly acid in the surface layer. The lower part of the surface layer is medium in available phosphorus and very low in available potassium. Tiltth is generally fair unless the soil is worked when too wet.

Most areas are pastureland. This soil is poorly suited to cultivated crops and hay and moderately suited to pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, and small grain. It is poorly or very poorly drained and may be ponded at times. Surface drainage and tile drains are needed. Tile drains function slowly because of slow permeability of this soil. Returning crop residue or adding other organic material helps to improve fertility and maintain tilt.

This soil is moderately suited to legumes and grasses for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Ilw.

1291—Atterberry silt loam, benches, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on loess covered high stream benches. Individual areas are irregular in shape and range from 10 to 80 acres.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The subsurface layer is dark grayish brown silt loam about 5 inches thick. The subsoil is friable silty clay loam about 34 inches thick. The upper part is brown; the middle part is grayish brown; and the lower part is grayish brown and light olive brown. The substratum is grayish brown silt loam. It is loamy sand or sandy loam with some gravel at a depth of 5 to 6 feet. In some areas this coarse textured material is at a depth of as little as 40 inches.

Permeability is moderate and moderately slow. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is 2.5 to 3.5 percent. Reaction is generally slightly acid. The subsoil is low in available phosphorus and very low in available potassium. Tiltth is generally fair unless the soil is worked when too wet.

Most areas are cropland. This soil is well suited to cultivated crops and to hay and pasture. It is poorly suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Tile drains may be needed for timely field opera-
ations. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is wet compacts the surface and results in poorer tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability class is I.

1485—Spillville loam, channeled, 0 to 2 percent slopes. This nearly level, moderately well drained and somewhat poorly drained soil is on alluvial flood plains dissected by old stream channels, meandering stream channels, and bayous. Most of these channels cannot be crossed with farm machinery. Some contain water at least part of the year. This soil is subject to frequent flooding. Individual areas are generally long and range from 20 to 200 acres.

Typically, the surface layer is very dark brown loam about 21 inches thick. The subsurface layer is about 31 inches thick and is also very dark brown loam. The substratum is dark brown fine sand.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 4.5 to 5.5 percent. Reaction is generally slightly acid or medium acid in the upper part of the surface layer. The upper part of the subsurface layer is low in available phosphorus and very low in available potassium. Tilth is generally good.

Most areas are in pasture. This soil is poorly suited to cultivated crops and to hay and is moderately suited to pasture. It is poorly suited to most engineering uses.

This soil is poorly suited to corn, soybeans, small grain, and hay. Many old stream channels, stream meanders, and bayous interfere with cropping. The soil is also subject to frequent flooding. Small areas may be cropped with adjoining soils.

This soil is moderately suited to grasses and legumes for pasture. Overgrazing or grazing when soil is wet compacts the surface and results in poor tilth. Proper stocking, pasture rotation, deferred grazing, and restricted use during wet periods are needed to keep the pasture and soil in good condition.

The capability subclass is Vw.

1688—Kosza silt loam, loamy substratum, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on moderately wide, low alluvial stream benches along rivers and major streams. It is subject to rare flooding. Individual areas are irregular in shape and range from 20 to 100 acres or more.

Typically, 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 is friable silty clay loam about 38 inches thick. The upper part is dark grayish brown with yellowish brown mottles, and the lower part is grayish brown and olive gray. The substratum is brown and reddish brown sandy loam.

Permeability is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content in the plow layer is about 2.5 to 3.5 percent. Reaction is generally medium acid in the surface layer unless the soil has been limed in the past 5 years. The subsoil is low in available phosphorus and very low in available potassium. Tilth is generally good.

Most areas are cropland. Some are pastureland or hayland. This soil is well suited to cultivated crops and to hay and pasture. It is moderately suited to most engineering uses.

This soil is well suited to corn, soybeans, and small grain. Tile drains may be needed to maintain timely field operations. This soil is subject to flooding during very high water, but flooding is generally of short duration. Returning crop residue or adding other organic material helps to improve fertility and maintain tilth.

This soil is well suited to grasses and legumes for hay and pasture. Overgrazing or grazing when the soil is too wet compacts the surface and causes poor tilth. Proper stocking, pasture rotation, and deferred grazing are needed to keep the pasture and soil in good condition.

The capability class is I.

5030—Pits, quarries. These pits are 40 feet deep or more. Piles of spoil 30 feet high or more surround them. The pits are irregular in shape and range from a few acres to as much as 40 acres. Some of the pits with steep side walls contain water a few to many feet deep. The pits are areas where limestone has been quarried for roads and for agricultural lime. Two are areas where gravel has been quarried.

The spoil surrounding the pits is variable in texture. Most, however, is loamy and contains a variable amount of limestone fragments. In some areas the spoil has been leveled and smoothed. In others it is irregular and very uneven. The level areas can be planted to trees or grass. The pH of the spoil is variable but generally ranges from medium acid to mildly alkaline.

These areas are most suitable for wildlife habitat. The pits that contain water will support fish. The steep side walls and the variable depth of the water are hazards that limit use for recreation. Onsite investigation is needed to determine whether an area is safe to use.

5040—Orthents, loamy. This map unit consists of loamy soils in borrow areas and fill areas.

Most borrow areas are along roads and railroads. About 3 to 10 feet of material has been removed for construction purposes. In most areas grass is growing on the sloping banks, but the vertical cuts in some areas are difficult to vegetate.

The soils in the fill areas are variable in texture. Most areas are nearly level and smooth. Some adjoin construction sites. A few are rolling areas of spoil from limestone quarries.

Most soils of this unit have grass on them but are idle. Onsite investigation is needed to determine suitability for any particular use.
Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

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

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

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

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

Crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Soil maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

The acreage of crops in Benton County was about 288,000 in 1970. The acreage in pasture was about 78,000. Much woodland, which was used for pasture, is included in this acreage. About 79,000 acres was roads, farmsteads, idle land, unharvested cropland, and other farm uses.

Corn, soybeans, oats, legumes, and legume-grass hay are the main crops. Small acreages of popcorn, sorghum, and wheat are grown in some years. A large acreage of the corn is grown for seed.

Most permanent pastures in Benton County are in bluegrass. Some have been renovated. Other grasses used for pasture are bromegrass and orchardgrass. Also used are grass-legume mixtures such as alfalfa and bromegrass.

Many soils are subject to erosion. The most extensive soils on which erosion control practices are needed are the Aredale, Bassett, Coggon, Dinsdale, Downs, Fayette, Kenyon, Lindley, Olin, and Tama soils. The Tama, Dinsdale, Downs, and Fayette soils commonly have long, uniform slopes and are well suited to erosion control practices. Erosion control structures control gullying in watercourses.

Providing both erosion control and drainage is difficult on the Aredale, Bassett, Coggon, Kenyon, and Olin soils because the permeability of the loamy material in the surface layer differs from that of the material derived from glacial till in the subsoil. Water moves downward more rapidly in the loamy material than in the subsoil. It tends to accumulate at the contact line and then move laterally over the till. Steep areas develop on side slopes in wet years. Terracing and tiling is most likely to be effective.

Drainage tile reduces wetness in the Colo, Clyde, Floyd, Bremer, Garvin, and Zook soils. It works well in all these soils except Zook soils. In Zook soils, drainage may be slower than in the other soils even if tile are more closely spaced. Surface drainage and protection from runoff also help to reduce wetness in the Colo, Bremer, and Zook soils.

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 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium,
and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

**Land capability classification**

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined 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. The classes are defined as follows:

- **Class I** soils have slight limitations that restrict their use.
- **Class II** soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- **Class III** soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.
- **Class IV** soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.
- **Class V** soils are not likely to erode but have other limitations, impractical to remove, that limit their use.
- **Class VI** soils have severe limitations that make them generally unsuitable for cultivation.
- **Class VII** soils have very severe limitations that make them unsuitable for cultivation.
- **Class VIII** soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

**Capability subclasses** are soil groups within one class. They are designated by adding a small letter, e, w, s, or c, to the class numeral, for example, Ile. The letter e shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, dry, or stony; and c, used in only a part of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by w, s, or c because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, range, woodland, wildlife habitat, or recreation.

**Windbreaks and environmental plantings**

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well-prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

**Recreation**

The soils and topography of Benton County are suited to many recreation facilities. Several parks have been developed in the uplands. The largest is Hanon Park, which has facilities for picnicking, camping, fishing, and boating (fig. 12). Hanon Park is in the Fayette-Downs association as are several small parks with various kinds of facilities.
Several recreation facilities in the Fluvaquents-Spillville-Flagler association provide public access to the Cedar River for boating as well as areas for hunting and fishing. Areas of the Colo-Ely-Waukegan association along the Iowa River are also suited to recreation facilities. Fishing is an important recreation activity, especially along the Cedar River and in many private ponds throughout the county.

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In
planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

*Camp areas* require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

*Picnic areas* are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

*Playgrounds* require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

*Paths and trails* for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

**Wildlife habitat**

In Benton County the trend to larger farms, larger fields, and more intensive cropping systems has impaired the balance of food, cover, and water that is needed for wildlife. Entire habitats have been destroyed. If this trend continues, the outlook for wildlife is not good.

Any area can be used as wildlife habitat, but areas differ in their degree of suitability for specific habitats and wildlife. For example, the forested Fayette soils provide excellent habitat for such small animals as fox, squirrel, rabbit, ground hog, and birds but do not provide suitable habitat for wetland wildlife such as duck and muskrat.

Topography, fertility, and other soil characteristics influence wildlife. Topography affects wildlife through its influence on land use. Extremely rough, irregular areas such as those of the steep and very steep Sogn, Fayette, and Lindley soils may be hazardous to livestock and unsuited to crops but valuable to wildlife. If suitable vegetation is not native to an area, it can generally be developed to improve habitat for desirable kinds of wildlife.

Soil wetness, permeability, topography, and available water capacity must be considered in selecting areas for constructing ponds for fish and for developing and maintaining habitat for wetland wildlife. The Lindley soils are well suited to ponds for wildlife. The Clyde, Colo, Floyd, and Tripoli soils are moderately suited to wetland wildlife. In areas of Fluvaquents, sandy and loamy, many small undrained depressions support marsh vegetation and hold water part of the year if not all year. Muskrat and mink use these areas. Migrating waterfowl feed and nest there, and mallard, teal, and other ducks nest and raise their young in these areas.

Wooded areas on Fayette, Chelsea, and Lindley soils give protection to fox, squirrel, deer, and many other animals. Cultivated areas of these soils are intermingled with the wooded areas, making food and cover easily accessible to wildlife.

In areas of the other soils, such as Dinsdale, Garvin, Muscatine, and Tama soils, farms are larger and more intensively cropped. Fences have been removed so that large equipment can be used efficiently. The fence rows were valuable as nesting places and travel lanes for wildlife. They also provide a limited food supply. Although the food supply is abundant in the heavily cropped fields, it is not available to wildlife because cover is not available. Year-round cover is needed. Quail, pheasant, and rabbit need cover to escape predators and game and songbirds need cover for nesting places.

The local Soil Conservation Service District Office can provide information and technical assistance in developing and managing wildlife habitat.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various
kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of good indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of fair indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of poor indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of very poor indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

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

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

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated good are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wild rice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following table: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construc-
tion. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

**Building site development**

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered slight if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; moderate if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and severe if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

**Shallow excavations** are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

**Dwellings and smaller commercial buildings** are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

**Local roads and streets** have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

**Sanitary facilities**

Table 10 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered slight if soil properties and site features are gener-
ally favorable for the intended use and limitations are minor and easily overcome; moderate if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and severe if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of good indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; fair indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and poor indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated
good, fair, or poor as a source of roadfill, topsoil, sand, and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering properties and classifications provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated good contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated fair are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated poor have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are 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 the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 13.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated good have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated fair are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated poor are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Table 12 gives information on the soil properties and site features that affect water management. The kinds of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; drainage; irrigation; terraces and diversions; and grassed waterways. Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.
The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects traffiability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering properties and classifications

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravely." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (5) and the system adopted by the American Association of State Highway and Transportation Officials (7).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML,
CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and plasticity index (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the range of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and chemical properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are low, a change of less than 3 percent; moderate, 3 to 6 percent; and high, more than 6 percent. Very high, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can
occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion 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 more than 35 percent clay. These soils are slightly erodible. Crops can be grown if measures to control wind erosion 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. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can be grown if measures to control wind erosion are used.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and water features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations. Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams and by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. None means that flooding is not probable; rare that it is unlikely but possible under unusual weather conditions; common that it is likely under normal conditions; occasional that it occurs on an average of once or less in 2 years; and frequent that it occurs on an average of more than once in 2 years. Duration is expressed as very brief if less than 2 days, brief if 2 to 7 days, and long if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter
content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in Table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in Table 15.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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

Depth to bedrock is shown for all soils that are underlain by bedrock, at a depth of 5 to 6 feet or less. For many soils, the limited 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 on other observations during the mapping of the soils. The kind of bedrock and its 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 is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as low, moderate, or high, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as low, moderate, or high. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (13). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In Table 16, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in soil. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (Aqu, meaning water, plus oll, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplauquolls (Hapl, meaning minimal
horizonation, plus aquoll, the suborder of the Molliisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective Typic identifies the subgroup that typifies the great group. An example is Typic Haplauquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistency, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, mesic Typic Haplauquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistency, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (12). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (12). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

Aredale series

The Aredale series consists of well drained, moderately permeable soils on ridgetops and convex side slopes. These soils formed in loamy material and the underlying loam glacial till. The slope range is 2 to 9 percent.

Aredale soils are commonly adjacent to Dinsdale, Dickinson, and Kenyon soils. They have more sand in the upper part of the solum than the Dinsdale soils but less sand than the Dickinson soils. They have a thicker deposit of loamy material over firm loam glacial till than do Kenyon soils.

Typical pedon in an area of Aredale loam, 5 to 9 percent slopes, in a cultivated field 1,250 feet north and 594 feet west of the center sec. 33, T. 66 N., R. 12 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam; dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; sand part is dominantly very fine sand; neutral; abrupt smooth boundary.

A12—8 to 14 inches; very dark grayish brown (10YR 3/2) loam; common black (10YR 2/1) coating on peds; grayish brown (10YR 5/2) dry; sand part is dominantly very fine sand; neutral; clear smooth boundary.

A3—14 to 19 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; few very dark brown (10YR 2/2) worm casts; medium acid; clear smooth boundary.

B1—19 to 27 inches; brown (10YR 4/3) light loam; common dark brown (10YR 3/3) coatings on peds; weak fine subangular blocky structure; very friable; medium acid; gradual smooth boundary.

B2—27 to 42 inches; dark yellowish brown (10YR 4/4) light sandy loam; weak medium prismatic structure parting to weak fine and medium subangular blocky; very friable; medium acid; abrupt smooth boundary.

IIB—42 to 58 inches; dark yellowish brown (10YR 4/4) loam; yellowish brown (10YR 5/6) coatings on peds; weak coarse prismatic structure parting to weak medium subangular blocky; firm; slightly acid; clear smooth boundary.

IIC—58 to 65 inches; dark yellowish brown (10YR 4/4) loam; few distinct strong brown (7.5YR 5/6) mottles; massive; firm; slight effervescence; mildly alkaline.

The solum is commonly 4 feet or more thick. The upper part formed in loamy sediment free of stones and pebbles. Depth to firm loam glacial till ranges from about 40 to 60 inches. In many places, a coarser textured layer as much as 24 inches thick is between the loamy glacial sediment and the glacial till.

The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2).

The B2 horizon has hue of 10YR, value of 4 or 5, and chroma of 3 through 6. It is free of low chroma mottles to at least 3 feet. It is loam, sandy loam, and loamy sand. Reaction ranges from slightly acid to strongly acid in the B horizon. The IIB3 varies greatly in thickness within short distances. It is typically loam or sandy loam but in places is loamy sand.
Atterberry series

The Atterberry series consists of somewhat poorly drained, moderately permeable and moderately slowly permeable soils on nearly level areas of broad, loess covered uplands or high, loess covered stream benches. The slope range is 0 to 3 percent.

The Atterberry soils in Benton county are grayer in the upper part of the B horizon than is typical for the Atterberry series. This difference does not alter the use or behavior of these soils.

Atterberry soils are similar to Downs and Muscatine soils and are commonly adjacent to Downs and Tama soils. They have a thinner, lighter colored A1 horizon than do Muscatine soils. They have an A2 horizon; the Muscatine soils do not. Atterberry soils have a grayer B horizon and are more poorly drained than Downs soils. They have a thinner A1 horizon and a grayer B horizon and are more poorly drained than Tama soils.

Typical pedon in an area of Atterberry silt loam, 1 to 3 percent slopes, in a cultivated area 795 feet west and 230 feet north of the southeast corner sec. 19, T. 82 N., R. 11 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

A2—9 to 14 inches; dark grayish brown (10YR 4/2) silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; light brownish gray (10YR 6/2) silt coatings on peds dry; weak medium platy structure parting to moderate fine subangular blocky; friable; slightly acid; clear smooth boundary.

B1—14 to 19 inches; brown (10YR 4/3) light silty clay loam; dark grayish brown (10YR 4/2) coatings on peds; few fine distinct yellowish brown (10YR 5/6) mottles; light brownish gray (10YR 6/2) silt coatings on peds dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

B2t—19 to 25 inches; grayish brown (10YR 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; light brownish gray (10YR 6/2) silt coatings on peds dry; moderate fine subangular blocky structure; friable; thin discontinuous dark brownish gray (10YR 4/2) clay films on peds; medium acid; clear smooth boundary.

B2t—25 to 34 inches; grayish brown (10YR 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate fine and medium subangular blocky structure; friable; thin nearly continuous dark grayish brown (10YR 4/2) clay films; common fine dark reddish brown (5YR 3/2) oxide concretions; strongly acid; gradual smooth boundary.

B2t—34 to 43 inches; grayish brown (10YR 5/2) silty clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; thin discontinuous dark grayish brown (10YR 4/2) clay films; few black (10YR 2/1) oxide concretions; strongly acid; gradual smooth boundary.

B3t—43 to 48 inches; grayish brown (10YR 5/2) light silty clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to weak fine subangular blocky; friable; very thin clay films on some prism faces; slightly acid; clear smooth boundary.

C—48 to 60 inches; grayish brown (2.5Y 5/2) heavy silt loam; many fine distinct yellowish brown (10YR 5/6) mottles; massive with some vertical cleavage; friable; common fine black (5YR 2/1) oxide concretions; neutral.

The solum ranges from 40 to 60 inches or more in thickness.

The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 6 to 10 inches thick. The A2 horizon ranges from 3 to 12 inches in thickness.

The B2 horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 through 4. Content of clay ranges from about 29 to 34 percent. Reaction is medium acid or strongly acid in the most acid part of the B2t horizon. The B3 horizon generally has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 or 2 with higher chroma mottles.

Backbone series

The Backbone series consists of somewhat excessively drained soils that are moderately rapidly permeable in the upper part and moderately slowly permeable in the lower part. These soils are on upland ridges and convex side slopes. They are moderately deep to limestone bedrock. They formed in dominantly wind deposited material and the underlying residuum of limestone. The slope range is 4 to 12 percent.

The Backbone soils in Benton county have a lighter colored surface layer than is typical for the Backbone series. This difference does not alter their use or behavior.

Backbone soils are commonly adjacent to Bassett, Lamont, Sogn, and Whalan soils. They are no more than 40 inches deep over limestone bedrock; Bassett and Lamont soils are much thicker over bedrock. Backbone soils have more sand in the A and B horizons than do Whalan and Sogn soils. They are thicker over limestone bedrock than Sogn soils.

Typical pedon in an area of Backbone fine sandy loam, 4 to 12 percent slopes, in a cultivated field 77 feet south and 1,350 feet east of the center sec. 10, T. 85 N., R. 10 W.

Ap—0 to 9 inches; dark brown (10YR 3/3) and some brown (10YR 4/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; slightly acid; abrupt smooth boundary.
A2—9 to 11 inches; dark yellowish brown (10YR 4/4) fine sandy loam; brown (10YR 4/3) coatings on pedds; light brownish gray (10YR 6/2) silt coating on pedds dry; moderate thin platy structure; very friable; slightly acid; clear smooth boundary.
B1—11 to 16 inches; dark brown (7.5YR 4/4) fine sandy loam; moderate fine subangular blocky structure; friable; slightly clear; acid smooth boundary.
B2t—16 to 24 inches; dark yellowish brown (10YR 4/4) fine sandy loam; brown (7.5YR 4/4) coatings on pedds; moderate fine subangular blocky structure; friable; thin nearly continuous clay films on ped faces and sand grains; slightly acid; gradual smooth boundary.
B2t—24 to 32 inches; dark yellowish brown (10YR 4/4) fine sandy loam; moderate medium subangular blocky structure; friable; clay coatings on sand grains; clay content lower than in horizon above; neutral; clear wavy boundary.
IIB2—32 to 34 inches; dark yellowish brown (10YR 4/4) silty clay; moderate medium subangular blocky structure; firm; thin nearly continuous clay films on pedds; neutral; abrupt wavy boundary.
R—34 inches; fractured limestone with dark yellowish brown (10YR 4/4) silty clay in the cracks.

Solum thickness and depth to limestone ranges from 20 to 40 inches. Solum thickness and depth to limestone commonly decreases as slope increases.

The Ap or A1 horizon is very dark gray (10YR 3/1), dark brown (10YR 3/3), and brown (10YR 4/3) fine sandy loam 6 to 10 inches thick. Unless this soil is eroded, the A2 horizon is dark grayish brown (10YR 4/2), brown (10YR 4/3), and dark yellowish (10YR 4/4) fine sandy loam about 2 to 6 inches thick.

The B2 horizon has hue of 10YR and chroma and value of 3 or 4; in places the lower part of the B2 horizon has hue of 7.5YR. Reaction ranges from neutral to strongly acid in the B2 horizon.

The IIB2 horizon is silty clay or clay and is 2 to 10 inches thick.

Bassett series

The Bassett series consists of moderately well drained, moderately permeable soils in uplands. These soils formed in 14 to 26 inches of loamy material and the underlying glacial till. The slope range is 2 to 14 percent.

Bassett soils are similar to Kenyon and Coggon soils. They have a thinner A1 horizon than do Kenyon soils and a thicker A1 horizon than do Coggon soils.

Typical pedon in an area of Bassett loam, 2 to 5 percent slopes, in a cultivated field 153 feet north and 2,375 feet east of the center sec. 10, T. 86 N., R. 10 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; very strongly acid; abrupt smooth boundary.

A2—8 to 11 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on plates and pedds; weak thin platy structure parting to moderate fine granular; friable, medium acid; clear smooth boundary.
B1t—11 to 18 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on pedds; moderate fine subangular blocky structure; friable; light brownish gray (10YR 6/2) sand and silt coatings on pedds; thin discontinuous clay films; medium acid; clear smooth boundary.
IIB2t—18 to 26 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on pedds; moderate medium subangular blocky structure; firm; thin nearly continuous clay films on ped faces; weak pebble band at 18 inches; some 2 to 6 millimeter pebbles; medium acid; gradual smooth boundary.
IIB2t—26 to 34 inches; yellowish brown (10YR 5/6) loam; brown (10YR 4/3) coatings on some pedds; common medium distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin patchy clay films on pedds; some 2 to 6 millimeter pebbles; medium acid; gradual smooth boundary.
IIB3—34 to 48 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) loam; few medium distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; firm; very dark grayish brown (10YR 3/2) filling along root channels and coatings on some prism faces; medium acid; clear wavy boundary.
IIC1—48 to 56 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/4 and 5/6) loam; massive; firm; secondary lime concretions; slight effervescence; mildly alkaline; gradual wavy boundary.
IIC2—56 to 60 inches; yellowish brown (10YR 5/6) loam; common coarse grayish brown (2.5Y 5/2) mottles; massive; firm; slight effervescence; mildly alkaline.

The solum ranges from 36 to 55 inches in thickness. In undisturbed areas the A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick. The A2 horizon ranges from dark brown (10YR 3/3) to brown (10YR 4/3 to 5/3) and is 4 to 6 inches thick. In places it is incorporated wholly in the Ap horizon.

Depth to the IIB horizon ranges from about 14 to 26 inches unless the soil has been eroded. The upper part of the B horizon has hue of 10YR, value of 4 or 5, and chroma of 3 or higher. Distinct lower chroma mottles do not occur in the upper part of the B horizon; depth to low chroma mottles ranges from 24 to about 34 inches. The IIB horizon has hue of 10YR, 2.5Y, and 7.5YR, value of 4 or 5, chroma of 3 or higher and lower chroma mottles. The finest texture in the B horizon is typically heavy loam, but in some places it is light clay loam or sandy clay loam. Reaction is strongly acid or very strongly acid in the most acid part of the B horizon.
Bremer series

The Bremer series consists of poorly drained, moderately slowly permeable soils on low stream benches. The slope range is 0 to 2 percent. The Bremer soils in Benton County have a thinner mollic epipedon than is typical for the series and do not have an argillic horizon. These differences do not alter the use or behavior of these soils.

Bremer soils are similar to Nevin and Wiota soils but have a grayer B horizon and are more poorly drained. Typical pedon in an area of Bremer silty clay loam, sandy substratum, 0 to 2 percent slopes, in a cornfield 790 feet south and 1,860 feet west of the northeast corner sec. 15, T. 86 N., R. 11 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 13 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; gradual smooth boundary.

A3—13 to 20 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; black (10YR 2/1) coatings on peds; few fine distinct olive brown (2.5Y 4/4) mottles; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B21g—20 to 25 inches; dark gray (5Y 4/1) silty clay loam; very dark gray (10YR 3/1) coatings on some peds; few fine and very fine prominent dark brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; few fine dark reddish brown (5YR 3/2) oxides; neutral; gradual smooth boundary.

B22g—25 to 34 inches; olive gray (5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine dark brown (7.5YR 3/2) oxides; neutral; gradual smooth boundary.

B3g—34 to 47 inches; light olive gray (5Y 6/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to weak coarse subangular blocky; friable; few fine dark brown (7.5YR 3/2) oxides; neutral; abrupt wavy boundary.

IICg—47 to 60 inches; olive gray (5Y 5/2) loamy coarse sand; many fine distinct strong brown (7.5YR 5/6) mottles; single grained; loose; neutral.

The solum ranges from 40 to 60 inches in thickness. The A1 or Ap horizon is black (10YR 2/1 or N 2/0) or very dark gray (N 3/0). The A horizon is 16 to 23 inches thick.

The B horizon ranges from dark gray (10YR 4/1) to light olive gray (5Y 6/2) with some mottles. It is light to medium silty clay loam 18 inches to 30 inches thick.

The C horizon is gray (5Y 5/1), dark gray (5Y 4/1), or grayish brown (5Y 5/2) sandy loam to loamy coarse sand. In places it is stratified loam, silt loam, and silty clay loam.

Burkhardt series

The Burkhardt series consists of somewhat excessively drained soils that are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. These soils are on high knolls in uplands and on stream escarpments. They formed in 10 to 20 inches of sandy loam and the underlying gravelly loamy sand and sand. The slope range is 2 to 9 percent.

Burkhardt soils are commonly adjacent to Kenyon, Olin, Flagler, Saude, and Waukee soils. Burkhardt soils are shallower to loamy sand or sand than are Flagler, Saude, and Waukee soils. They have a coarser textured substratum than do Kenyon and Olin soils.

Typical pedon in an area of Burkhardt sandy loam, 2 to 9 percent slopes, in a cultivated field 660 feet west and 396 feet north of the southeast corner sec. 16, T. 86 N., R. 9 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) heavy sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; strongly acid; abrupt smooth boundary.

A3—7 to 11 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (10YR 5/2) dry; very dark brown (10YR 2/2) coatings on peds; weak fine to medium subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B1—11 to 15 inches; dark brown (10YR 3/3) light sandy loam; weak medium subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B21—15 to 27 inches; brown (7.5YR 4/4) gravelly loamy sand; weak coarse subangular blocky structure; clay bridging between sand grains; friable; medium acid; gradual smooth boundary.

B3t—27 to 30 inches; strong brown (7.5YR 5/6) gravelly sand; weak coarse subangular blocky structure; very friable; clay bridging between sand grains; medium acid; clear smooth boundary.

C—30 to 60 inches; brown (7.5YR 4/4) and strong brown (7.5YR 5/6) gravelly sand; single grained; loose; medium acid.

Depth to loamy sand or sand ranges from 10 to 20 inches. Thickness of the solum ranges from 20 to 35 inches.

The A horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and from 7 to 15 inches in thickness. It is typically sandy loam but includes gravelly sandy loam.

The B2 horizon ranges from light sandy loam to gravelly loamy sand or sand. Reaction in the B horizon ranges from slightly acid to strongly acid.

The C horizon ranges from brown (7.5YR 4/4) to yellowish brown (10YR 5/6). It is loamy sand or sand with some gravel.
Chelsea series

The Chelsea series consists of excessively drained, rapidly permeable soils on upland ridges and side slopes. A few areas are on high benches along the major rivers. These soils formed in dominantly wind deposited sand. On benches coarse sand and gravel may occur below 4 feet. The slope range is 1 to 30 percent. Chelsea soils are similar to Sparta, Lamont, and Dickinson soils. They have a higher sand content in the upper 3 feet than do Lamont soils. They have a thinner and generally lighter colored A1 horizon than Sparta soils. They have more sand in the upper solum and a thinner and generally lighter colored A1 horizon than do Dickinson soils. They also have an A2 horizon; the Dickinson soils do not.

Typical pedon in an area of Chelsea loamy fine sand, 5 to 9 percent slopes, in a pasture 1,625 feet east and 805 feet south of northwest corner sec. 16, T. 85 N., R. 9 W.

Ap—0 to 4 inches; dark brown (10YR 3/3) loamy fine sand, brown (10YR 5/3) dry; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

A21—4 to 7 inches; brown (10YR 4/3) loamy fine sand, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; slightly acid; clear smooth boundary.

A22—7 to 13 inches; dark yellowish brown (10YR 4/4) fine sand; single grained; loose; medium acid; gradual smooth boundary.

A23—13 to 41 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; medium acid; clear smooth boundary.

A&B—41 to 60 inches; yellowish brown (10YR 5/4) fine sand A2 part; single grained; loose; 1/2 inch to 2 inches thick bands of brown (7.5YR 4/4) loamy sand at 42 to 59 inches B2t part; medium acid.

The solum ranges from 4 to many feet in thickness. The A1 or Ap horizon has color of 10YR 3/2 to 10YR 4/3. It is loamy fine sand or sand 2 to 6 inches thick. The A2 horizon has color of 10YR 4/3 and 10YR 4/4 in the upper part and 10YR 4/4 to 10YR 6/4 in the lower part. It is loamy fine sand or fine sand. Reaction ranges from slightly acid to strongly acid in the A2 horizon. The B part of the A&B horizon is thin bands of loamy sand or sandy loam. It has hue of 7.5YR or 10YR and value and chroma of 3 or 4. Depth to the uppermost lamella ranges from 27 to 48 inches.

Clyde series

The Clyde series consists of poorly drained, moderately permeable soils in nearly level drainageways and lower concave positions in uplands. These soils formed in 24 to 50 inches of loamy and sandy sediment and in the underlying loam glacial till. The slope range is 0 to 4 percent.

Clyde soils are similar to Floyd soils. They have a grayer B horizon and are more poorly drained than Floyd soils.

Typical pedon in an area of Clyde silt loam, 0 to 2 percent slopes, in a cultivated field 2,350 feet west and 132 feet south of the northeast corner sec. 29, T. 86 N., R. 9 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam clay, high in sand, dark gray (10YR 4/1) dry; weak fine granular structure; friable; few 2 to 3 millimeter pebbles; neutral; abrupt smooth boundary.

A12—9 to 17 inches; black (10YR 2/1) silt loam, high in sand, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; few 2 to 3 millimeter pebbles; neutral; gradual smooth boundary.

A3—17 to 23 inches; very dark gray (5Y 3/1) silt loam, high in sand; very dark grayish brown (10YR 3/2) coatings on peds; few fine prominent yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; few 2 to 3 millimeter pebbles; neutral; clear smooth boundary.

B21—23 to 28 inches; mottled dark grayish brown (2.5Y 4/2) and olive gray (5Y 4/2) gritty light silt loam; few fine prominent yellowish brown (10YR 5/6) mottles; very friable; moderate fine and medium subangular blocky structure; few 2 to 3 millimeter pebbles; neutral; clear smooth boundary.

B22g—28 to 32 inches; dark gray (5Y 4/1) loam; common medium prominent yellowish brown (10YR 5/6) and brown (7.5YR 4/4) mottles; moderate medium subangular blocky structure; very friable; few 2 to 3 millimeter pebbles; neutral; clear smooth boundary.

B23g—32 to 36 inches; olive gray (5Y 5/2) sandy loam; common medium prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few 2 to 3 millimeter pebbles; neutral; clear smooth boundary.

B24g—36 to 41 inches; olive gray (5Y 5/2) loamy sand; common medium prominent mottles; weak medium and coarse subangular blocky structure; very friable; neutral; abrupt smooth boundary.

IIB3—41 to 45 inches; mottled gray (5Y 6/1) and yellowish brown (10YR 5/8) loam; weak coarse prismatic structure parting to moderate medium subangular blocky, firm; few fine distinct black (5YR 2/1) oxide concretions; few 2 to 3 millimeter pebbles; neutral; clear smooth boundary.

IIC—45 to 65 inches; mottled gray (5Y 6/1) and yellowish brown (10YR 5/8) loam; massive; some 2 to 3 millimeter pebbles; strong effervescence; moderately alkaline.
Solum thickness is typically more than 3 1/2 feet and ranges from 2 1/2 to 5 feet or more. Depth to glacial till is typically 3 to 4 feet but ranges from 2 1/2 to 5 feet. The A horizon ranges from about 20 to 24 inches in thickness. It ranges from gritty silty clay loam or clay loam to loam. The B horizon is commonly clay loam or loam, but soils having some strata of silty clay loam and layers of sandy loam or loamy sand typically less than 6 inches thick are within the range of the series.

**Coggon series**

The Coggon series consists of moderately well drained, moderately permeable soils in uplands. These soils formed in 12 to 22 inches of loamy material and in the underlying glacial till. The slope range is 2 to 9 percent. Coggon soils are similar to Kenyon and Bassett soils but have a thinner or lighter colored A1 horizon.

Typical pedon in an area of Coggon loam, 2 to 5 percent slopes, in a wooded pasture, 1,000 feet south and 265 feet west of the northeast corner sec. 9, T. 85 N., R. 9 W.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; neutral; clear wavy boundary.

A2—4 to 9 inches; brown (10YR 4/3) loam, very pale brown (10YR 7/3) dry; weak thin platy structure parting to weak fine subangular blocky; friable; slightly acid; clear smooth boundary.

B1—9 to 15 inches; yellowish brown (10YR 5/4) heavy loam; moderate fine subangular blocky structure; friable; many stones and pebbles in the lower part; very strongly acid; clear wavy boundary.

II B21—15 to 23 inches; strong brown (7.5YR 5/6) light clay loam with yellowish brown (10YR 5/4) coatings on peds; moderate medium subangular blocky structure; firm; thin discontinuous clay films; common black (10YR 2/1) oxide concretions in lower part; very strongly acid; gradual smooth boundary.

II B22—23 to 34 inches; yellowish brown (10YR 5/4 and 5/6) clay loam; strong brown (7.5YR 5/6) coatings on peds; few fine distinct dark red (2.5YR 3/6) mottles and few fine distinct grayish brown (2.5Y 5/2) mottles; moderate medium subangular and angular blocky structure; firm; thin discontinuous clay films; very strongly acid; gradual smooth boundary.

II B23—34 to 40 inches; yellowish brown (10YR 5/4 and 5/6) light clay loam; few fine distinct gray (5Y 5/1) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; few thin discontinuous clay films; very strongly acid; gradual smooth boundary.

II B3—40 to 56 inches; yellowish brown (10YR 5/6) light clay loam; moderate medium prismatic structure parting to strong medium subangular blocky; firm; few olive gray (5Y 2/2) oxide concretions; slightly acid; gradual smooth boundary.

IIC—56 to 60 inches; yellowish brown (10YR 5/6) heavy loam; many fine distinct gray (5Y 5/1) and olive gray (5Y 5/2) mottles; massive; firm; strong effervescence; mildly alkaline.

Solum thickness is typically about 60 inches and ranges from 50 to 70 inches.

The A1 horizon is 2 to 5 inches thick and is commonly very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). If an Ap horizon occurs, it is typically dark grayish brown (10YR 4/2) or brown (10YR 4/3). The A2 horizon is dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), or brown (10YR 4/3 or 5/3). In eroded areas, most of the A2 horizon is mixed with the Ap horizon. The A horizon is typically loam.

The B horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) in the upper part. It is yellowish brown (10YR 5/4 to 5/6) or strong brown (7.5YR 5/6 to 5/8) in the lower part. Below about 30 inches, mottles of 2 chroma or lower increase in size and number as depth increases. The II B2 horizon is commonly heavy loam but ranges to loam, clay loam, or sandy clay loam. Reaction is strongly or very strongly acid in the II B2 horizon.

**Colo series**

The Colo series consists of poorly drained, moderately permeable soils formed in alluvium on level flood plains and along narrow drains in uplands. The slope range is 0 to 2 percent.

Colo soils are commonly adjacent to Spillville soils. They have a higher clay content and a grayer C horizon than do Spillville soils.

Typical pedon in an area of Colo silty clay loam, 0 to 2 percent slopes, in a cultivated field 2,490 feet south and 140 feet west of the northeast corner sec. 16, T. 86 N., R. 11 W.

Ap—0 to 7 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—7 to 22 inches; black (2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate very fine granular structure; friable; neutral; clear smooth boundary.

A13—22 to 32 inches; black (10YR 2/1) silty clay loam; very dark gray (10YR 3/1) dry; moderate very fine subangular blocky structure; friable; neutral; clear smooth boundary.

A14—32 to 38 inches; very dark gray (10YR 3/1) silty clay loam; few olive gray (5Y 5/2) mottles at 36 to 38 inches; moderate fine subangular blocky structure; friable; few dark brown (7.5YR 4/4) oxides; neutral; clear smooth boundary.
B2—38 to 51 inches; olive gray (5Y 4/2) silty clay loam; few fine yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to weak medium subangular blocky; friable; few dark brown (7.5YR 4/4) oxides; a very dark gray (10YR 3/1) krotovina 1 to 2 inches in diameter; neutral; clear smooth boundary.

C—51 to 60 inches; olive gray (5Y 5/2) silty clay loam; fine common distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure; friable; neutral.

The subsoil ranges from 36 to about 60 inches in thickness. The A horizon has hue of 2.5Y or 10YR, value of 2 or 3 to depths of 36 inches or more, and chroma of 0 or 1. It is typically silty clay loam, but the upper 10 inches ranges to heavy silt loam. Below 10 inches, the clay content is 30 to 35 percent and is as high as 38 percent in thin layers.

The B and C horizons have hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2. Few to common high chroma mottles occur in some places. Soils with sandy or gravelly horizons below 4 feet are within the range of the series. Reaction is slightly acid to neutral throughout the subsoil.

**Dickinson series**

The Dickinson series consists of well drained and somewhat excessively drained soils that are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. They are on upland ridges and high stream benches. They formed in dominantly wind deposited sand. On benches coarse sand and gravel may occur below 4 feet. The slope range is 0 to 9 percent.

Dickinson soils are similar to Lamont and Sparta soils. They have less sand in the A and B horizons than do Sparta soils. They have a thicker and generally darker A1 horizon than do Lamont soils.

Typical pedon in an area of Dickinson fine sandy loam, 2 to 5 percent slopes, in a pasture 1,320 feet east and 792 feet north of the center sec. 29, T. 86 N., R. 9 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

A12—7 to 16 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

B1—16 to 20 inches; dark yellowish brown (10YR 3/4) fine sandy loam; dark brown (10YR 3/3) coatings on ped; moderate fine and medium subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

B2—20 to 26 inches; brown (10YR 4/3) fine sandy loam; dark brown (10YR 3/3) coatings on ped; moderate subangular blocky structure; friable; slightly acid; clear smooth boundary.

B3—26 to 31 inches; dark yellowish brown (10YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C1—31 to 46 inches; yellowish brown (10YR 5/4) sand; single grained; loose; slightly acid; clear smooth boundary.

C2—46 to 60 inches; brown (7.5YR 4/4) loamy sand; single grained; loose; slightly acid.

The subsoil ranges from 24 to 40 inches in thickness. Depth to loamy sand and sand is commonly 24 to 36 inches. Sand particles are dominantly fine and medium in size.

The A horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). It is commonly 10 to 20 inches thick.

The B2 horizon is dark brown (10YR 3/3) or brown (10YR 4/3) in the upper part and dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4 and 5/6) in the lower part. Reaction ranges from slightly to medium acid in the B horizon.

The C horizon ranges from loamy sand to fine sand or sand.

**Dinsdale series**

The Dinsdale series consists of moderately well drained, moderately permeable soils on convex ridgetops and side slopes in uplands. These soils formed in 24 to 40 inches of loess and the underlying glacial till. The slope range is 2 to 9 percent.

Dinsdale soils are similar to Klinger, Maxfield, and Waubeek soils. They are commonly adjacent to Tama and Kenyon soils. They have a thicker A horizon than do Waubeek soils. They contain more sand in the lower part of the B horizon than do Tama soils. They have a browner B horizon and are better drained than Klinger and Maxfield soils. They are lower in sand content in the upper part of the profile and are deeper to firm loam glacial till than are Kenyon soils.

Typical pedon in an area of Dinsdale silty clay loam, 2 to 5 percent slopes, in a cultivated field 2,166 feet west and 165 feet north of the center sec. 27, T. 84 N., R. 12 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) light silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine subangular blocky structure; friable; neutral; clear smooth boundary.

A12—7 to 14 inches; very dark grayish brown (10YR 3/2) light silty clay loam, grayish brown (10YR 5/2) dry; moderate fine and very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

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

B21t—20 to 26 inches; brown (10YR 4/3) silty clay loam; dark brown (10YR 3/3) coatings on peds; moderate fine and very fine subangular blocky structure; friable; thin discontinuous clay films on peds; slightly acid; clear smooth boundary.

B22t—26 to 38 inches; brown (10YR 4/3) silty clay loam; weak medium prismatic structure parting to moderate very fine and fine subangular blocky; friable; thin discontinuous clay films; medium acid; clear smooth boundary.

IIB3t—38 to 47 inches; brown (10YR 5/3) and yellowish brown (10YR 5/4) heavy loam; moderate medium prismatic structure; firm; thin discontinuous clay films on prism faces; few fine dark oxide concretions; few pebbles; slightly acid; gradual smooth boundary.

IIC—47 to 60 inches; yellowish brown (10YR 5/4 and 5/6) heavy loam; few faint strong brown (7.5YR 5/6) mottles; massive; firm; few dark oxide concretions; few pebbles; slightly acid.

The solum is typically about 50 inches thick but ranges from about 40 to 60 inches. Dinsdale soils formed in loess and glacial till. The loess is typically 24 to 40 inches thick and ranges from about 20 to 42 inches.

The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), and very dark grayish brown (10YR 3/2). Thickness ranges from 10 to 20 inches unless the soil is eroded. The upper part of the B horizon, which formed in loess, is dark brown (10YR 3/3), brown (10YR 4/3), and dark yellowish brown (10YR 4/4). The clay content ranges from about 29 to 34 percent. Reaction ranges from slightly acid to strongly acid in the upper part of the B horizon.

The lower part of the B horizon and the C horizon formed in glacial till. These horizons have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 8. These horizons contain few to common mottles that have value of 4 to 6 and chroma of 1 or 2. They are typically loamy. In places, a layer of sandy loam or loamy sand as much as 10 inches thick is between the loess and the glacial till. Carbonates are at a depth of about 45 to 65 inches.

The Dinsdale silt clay loam, 5 to 9 percent slopes, moderately eroded, map unit has Dinsdale soils with a mollic epipedon that is not as thick as the defined range of the Dinsdale series. This difference does not alter the use or behavior of this map unit.

**Donnan series**

The Donnan series consists of somewhat poorly drained and moderately well drained soils that are moderately permeable in the upper part and very slowly permeable in the lower part. They are in uplands. They formed in 24 to 40 inches of loamy material and in the underlying highly weathered paleosol. The slope range is 2 to 9 percent.

The Donnan soils are commonly adjacent to Bassett, Dinsdale, and Kenyon soils. They contain more clay in the lower part of the B horizon than do those soils. Typical pedon in an area of Donnan silt loam, 5 to 9 percent slopes, moderately eroded, in a cultivated field 190 feet west and 70 feet south of the northeast corner sec. 8, T. 86 N., R. 9 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) with some mixing of brown (10YR 4/3) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

B1—8 to 12 inches; brown (10YR 4/3) loam, pale brown (10YR 6/3) dry; few fine faint brown (7.5YR 4/4) mottles; moderate very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21t—12 to 21 inches; yellowish brown (10YR 5/4) light loam; dark yellowish brown (10YR 4/4) coatings on peds; moderate very fine subangular blocky structure; very thin patchy clay films on peds; friable; slightly acid; clear smooth boundary.

B22t—21 to 25 inches; yellowish brown (10YR 5/4) sandy loam; few fine distinct grayish brown (10YR 5/2) mottles; weak very fine subangular blocky structure; clay coatings on sand grains and some clay bridging between sand grains; very friable; slightly acid; abrupt smooth boundary.

IIB23t—25 to 33 inches; grayish brown (2.5Y 5/2) silty clay; few fine distinct yellowish red (5YR 5/6) mottles; strong very fine subangular blocky structure; thin continuous clay films on peds; very firm; strongly acid; gradual smooth boundary.

IIB24t—33 to 60 inches; grayish brown (2.5Y 5/2) silty clay; few fine faint olive brown (2.5Y 5/4) mottles; strong very fine subangular blocky structure; thin continuous clay films on peds; very firm; medium acid.

The solum ranges from 50 inches to more than 80 inches in thickness. All of the solum is friable because the part of the soil that developed from loamy material merges with a buried paleosol. The loamy overburden ranges from 20 to 40 inches thick over the buried soil.

The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 6 to 8 inches thick. In some areas the soil has Au horizon. It is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) and is 2 to 5 inches thick. In places it is wholly incorpo-rated in the Ap horizon. The A horizon ranges from loam or gritty silt loam to light clay loam or gritty silty clay loam.

The upper part of the B horizon has hue of 10YR or 2.5Y, value of 4 and 5, and chroma of 3 or 4 and may be mottled. It is clay loam, loam, or sandy loam but ranges to gritty silty clay loam. Reaction ranges from slightly acid to strongly acid in the B2 horizon.

The IIB horizon developed in a clay or silty clay paleosol. It has hue of 5Y or 2.5Y, value of 5 and 6,
chroma of 1 or 2. Higher chroma mottles are common in places.

**Downs series**

The Downs series consists of well drained, moderately permeable soils on loess covered upland ridges and side slopes. These soils formed in loess that is more than 48 inches deep. Most of the Downs soils are along the major rivers. The slope range is 2 to 14 percent.

Downs soils are similar to Fayette and Tama soils. They have an A1 horizon that is thicker or darker colored than that of Fayette soils but thinner and lighter colored than that of Tama soils.

Typical pedon in an area of Downs silt loam, 2 to 5 percent slopes, in a pasture 145 feet south and 65 feet east of the northwest corner of sec. 29, T. 82 N., R. 11 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

A2—7 to 10 inches; brown (10YR 4/3) silt loam; dark grayish brown (10YR 4/2) coatings on some peds; moderate fine subangular blocky structure; friable; pale brown (10YR 6/3) silt coatings on peds dry; very dark grayish brown (10YR 3/2) fill in root channels; slightly acid; clear smooth boundary.

B1—10 to 16 inches; brown (10YR 4/3) light silty clay loam; dark brown (10YR 3/3) coatings on peds; moderate fine and very fine subangular blocky and angular blocky structure; friable; pale brown (10YR 6/3) silt coatings on peds dry; slightly acid; clear smooth boundary.

B21t—16 to 22 inches; dark yellowish brown (10YR 4/4) silty clay loam; brown (10YR 4/3) coatings on peds; moderate fine subangular and angular blocky structure; friable; thin patchy clay films; slightly acid; clear smooth boundary.

B22t—22 to 27 inches; dark yellowish brown (10YR 4/4) silty clay loam; brown (10YR 4/3) coatings on peds; moderate fine subangular blocky and angular blocky structure; friable; thin patchy clay films; few small dark oxide concretions; medium acid; clear smooth boundary.

B23t—27 to 31 inches; dark yellowish brown (10YR 4/4) silty clay loam; brown (10YR 4/3) coatings on peds; moderate fine subangular blocky structure; friable; thin patchy clay films; common small dark oxide concretions; medium acid; clear smooth boundary.

B31t—31 to 42 inches; brown (10YR 5/3) light silty clay loam; few fine faint grayish brown (10YR 5/2) mottles; few fine distinct strong brown (7.5YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; thin patchy clay films; few fine dark reddish brown (5YR 2/2) oxide concretions; strongly acid; gradual smooth boundary.

B32—42 to 52 inches; mottled brown (10YR 5/3) and yellowish brown (10YR 5/4) heavy silt loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; common fine dark reddish brown (5YR 3/2) oxide concretions; medium acid; gradual smooth boundary.

C—52 to 80 inches; mottled brown (10YR 5/3) and yellowish brown (10YR 5/4) silt loam; common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; common fine dark reddish brown (5YR 3/2) oxide concretions; medium acid.

The solum ranges from 42 to 70 inches in thickness.

The A1 horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and is 6 to 10 inches thick. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) and is 2 to 4 inches thick. In some areas the A2 horizon is incorporated wholly in the Ap horizon.

The upper part of the B horizon is commonly brown (10YR 4/3) to dark yellowish brown (10YR 4/4), grading to value of 4 or 5 and chroma of 3 to 6 with increasing depth. The finest textured part of the B horizon is light to medium silty clay loam. The clay content ranges from 30 to 35 percent. Depth to low chroma mottles is typically more than 30 inches. Reaction ranges from slightly acid to strongly acid in the B horizon.

**Ely series**

The Ely series consists of somewhat poorly drained, moderately permeable soils formed in medium textured alluvium on foot slopes and on alluvial fans at the base of slopes in uplands. The slope range is 2 to 5 percent.

Ely soils are similar to Colo soils. They have a browner B horizon and are better drained than Colo soils.

Typical pedon in an area of Ely silt loam, 2 to 5 percent slopes in a cultivated field 1,310 feet north and 740 feet west of the southeast corner sec. 17, T. 86 N., R. 11 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam; very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 16 inches; black (10YR 2/1) light silty clay loam; dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

A13—16 to 24 inches; very dark gray (10YR 3/1) silty clay loam; dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on peds; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—24 to 34 inches; very dark grayish brown (10YR 3/2) silty clay loam; very dark gray (10YR 3/1) coatings on peds; few fine faint dark grayish brown (2.5Y 4/2) mottles; few fine distinct dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
B2—34 to 42 inches; dark grayish brown (10YR 4/2) light silty clay loam; dark gray (10YR 4/1) coatings on peds; few fine distinct dark brown (7.5YR 4/4) and strong brown (5YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

B3—42 to 58 inches; dark grayish brown (2.5Y 4/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate medium prismatic structure parting to moderate fine subangular blocky; friable; few fine dark reddish brown (5YR 2/2) oxides; neutral; clear smooth boundary.

C1—58 to 62 inches; yellowish brown (10YR 5/4) sandy loam; single grained; loose; few 5 to 10 millimeter pebbles; neutral; clear smooth boundary.

C1C2—62 to 65 inches; dark yellowish brown (10YR 4/4) loam; few fine distinct olive gray (5Y 5/2) mottles; firm; mildly alkaline.

The solum is usually more than 48 inches thick and ranges from 40 to more than 70 inches.

The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It has colors with value of 3 to a depth of 24 to 36 inches. It is silt loam or silty clay loam.

The matrix of the B2 horizon is typically dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2), but in the lower part it may be higher in chroma and have low chroma mottles. The B horizon is silty clay loam that contains about 30 to 35 percent clay. Reaction typically ranges from slightly acid to medium acid in the most acid part of the soil but may be neutral throughout.

**Fayette series**

The Fayette series consists of well drained, moderately permeable soils on loess covered upland ridges and side slopes. These soils formed in loess more than 48 inches deep. Most Fayette soils are along the major rivers and on pahas. The slope range is 2 to 40 percent.

Fayette soils are similar to Downs and Tama soils. They have a thinner A1 horizon and a thicker A2 horizon than Downs soils have. They have a thinner A1 horizon than do Tama soils. They also have an A2 horizon; Tama soils do not.

Typical pedon in an area of Fayette silty loam, 2 to 5 percent slopes, in wooded area 2,100 feet north and 20 feet east of the southwest corner sec. 23, T. 85 N., R. 9 W.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A2—5 to 10 inches; brown (10YR 4/3) silt loam; light gray (10YR 7/2) dry; dark grayish brown (10YR 4/2) coatings on peds; moderate medium platy structure parting to weak very fine subangular blocky; friable; slightly acid; clear wavy boundary.

B1—10 to 14 inches; brown (10YR 4/3) heavy silt loam; moderate very fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

B21—14 to 18 inches; dark yellowish brown (10YR 4/4) light silty clay loam; yellowish brown (10YR 5/4) coatings on peds; moderate fine and medium angular blocky and subangular blocky structure; friable; thin nearly continuous clay films on ped surfaces and in most channels; strongly acid; clear smooth boundary.

B221—18 to 24 inches; brown (10YR 4/3) silty clay loam; brown (10YR 5/3) coatings on peds; very pale brown (10YR 7/3) silty and sand coatings on peds dry; strong fine and medium angular blocky structure; friable; thin nearly continuous clay films on ped surfaces; few dark reddish brown (5YR 2/2) stains on peds; strongly acid; gradual smooth boundary.

B231—24 to 35 inches; dark yellowish brown (10YR 4/4) silty clay loam; very pale brown (10YR 7/3) silt and sand coatings on peds dry; strong medium angular blocky structure; firm; thin nearly continuous clay films on ped surfaces; few dark reddish brown (5YR 2/2) stains on peds; strongly acid; gradual smooth boundary.

B31—35 to 46 inches; yellowish brown (10YR 5/4) light silty clay loam; few fine faint brown (10YR 5/3) mottles and few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure; friable; thin patchy clay films on prism surfaces; few dark reddish brown (5YR 2/2) stains on peds; few dark reddish brown (5YR 2/2) oxide concretions; strongly acid; gradual smooth boundary.

C—46 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine faint brown (10YR 5/3) mottles and few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; strongly acid.

The solum ranges from 36 to 55 inches in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges in thickness from 2 to 5 inches. In cultivated areas the Ap horizon ranges from 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 4/3). It is 4 to 8 inches thick. In eroded areas all the A2 horizon may be incorporated into the Ap horizon.

The B2t horizon ranges in value from 4 to 5 and in chroma from 3 through 6. It is typically light to medium silty clay loam that is 28 to 34 percent clay. In some places the lower part of the B horizon and the C horizon have mottles of 10YR or 2.5Y hue, 5 value, and 1 or 2 chroma. On convex slopes, depth to these grayish mottles typically decreases with increasing gradient. Reaction ranges from strongly acid to very strongly acid in the B horizon.
Finchford series

The Finchford series consists of excessively drained, very rapidly permeable soils formed in coarse textured alluvium on level high flood plains along the major rivers. The slope range is 0 to 2 percent.

Finchford soils are commonly adjacent to Hanlon and Spillville soils. They have less clay and more medium and coarse sand in the solum than do those soils.

Typical pedon in an area of Finchford loamy sand, 0 to 2 percent slopes, in a cultivated field, 925 feet south and 65 feet east of the northwest corner sec. 8, T. 85 N., R. 10 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy sand; dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; few 2 to 3 millimeter pebbles; slightly acid; clear smooth boundary.

A12—8 to 19 inches; very dark grayish brown (10YR 3/2) loamy sand; grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

B—19 to 37 inches; dark brown (10YR 3/3) sand; weak coarse subangular blocky structure; loose; slightly acid; gradual smooth boundary.

C—37 to 60 inches; very dark grayish brown (10YR 3/2) loamy sand; few fine faint dark yellowish brown (10YR 4/4) and dark grayish brown (10YR 4/2) mottles; weak coarse subangular blocky structure; very friable; medium acid.

The solum ranges from 20 to 40 inches in thickness. The A horizon has hue of 7.5YR or 10YR, value of 2 through 4, and chroma of 2 through 4. It is sand or loamy sand that is generally more than 30 percent medium and coarse sand.

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

Flagler series

The Flagler series consists of somewhat excessively drained soils that are moderately rapidly permeable in the upper part and very rapidly permeable in the lower part. They are on stream benches along major streams and rivers. These soils formed in 10 to 36 inches of sandy loam and in the underlying sand and gravel. The slope range is 0 to 5 percent.

Flagler soils are commonly adjacent to Saude, Waukie, and Lawler soils. They have more sand and are coarser in texture in the upper horizons than those soils. They have a brown B horizon and are better drained than Lawler soils.

Typical pedon in an area of Flagler sandy loam, 0 to 2 percent slopes, in pasture 1,810 feet north and 50 feet east of the center sec. 17, T. 85 N., R. 10 W.

Ap—0 to 8 inches; black (10YR 2/1) heavy sandy loam; dark gray (10YR 4/1) dry; moderate fine granular structure; very friable; few pebbles more than 2 millimeters; neutral; clear smooth boundary.

A12—8 to 18 inches; very dark brown (10YR 2/2) heavy sandy loam; dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; few pebbles more than 2 millimeters; neutral; clear smooth boundary.

A3—18 to 23 inches; very dark grayish brown (10YR 3/2) heavy sandy loam; weak fine subangular blocky structure; very friable; few pebbles more than 2 millimeters; slightly acid; clear smooth boundary.

B2—23 to 29 inches; dark yellowish brown (10YR 3/4) light sandy loam; weak medium and fine subangular blocky structure; very friable; few pebbles more than 2 millimeters; medium acid; abrupt smooth boundary.

B1B3—29 to 36 inches; brown (7.5YR 4/4) gravelly sand; single grained; loose; slightly acid; gradual smooth boundary.

B1C1—36 to 49 inches; brown (10YR 4/3) sand; single grained; loose; few pebbles more than 2 millimeters; slightly acid; gradual smooth boundary.

B1C2—49 to 65 inches; brown (10YR 5/3) sand; single grained; loose; many pebbles more than 2 millimeters; slightly acid.

Solum thickness typically ranges from 30 to 40 inches. Depth to loamy sand, gravelly sand, or sand ranges from 24 to 30 inches.

The A1 or Ap horizon is black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). The A horizon ranges from about 12 to 24 inches in thickness.

The B2 horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 through 6. It ranges from 10 to 18 percent clay and is typically 60 to 70 percent sand. Reaction ranges from slightly to strongly acid in the B horizon.

The B1C horizon has hue of (10YR or 7.5YR), value of 4 or 5, and chroma of 3 through 8. It is typically sand, coarse sand, gravelly sand, or gravelly loamy sand.

Floyd series

The Floyd series consists of somewhat poorly drained, moderately permeable soils in uplands. These soils formed in 30 to 45 inches of loamy and sandy sediment and in the underlying loam glacial till. The slope range is 1 to 4 percent.

Floyd soils are commonly adjacent to Schley, Readlyn, and Clyde soils. They have a thicker and generally darker colored A horizon than do Schley soils. They are more stratified, deeper to the firm loam glacial till, and less acid than Readlyn soils. They are neither as gray in the B horizon nor so poorly drained as Clyde soils.

Typical pedon in an area of Floyd loam, 1 to 4 percent slopes, in a pasture 250 feet east and 1,450 feet north of the center sec. 29, T. 86 N., R. 9 W.
Ap—0 to 8 inches; black (10YR 2/1) loam; dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.
A1—8 to 19 inches; black (10YR 2/1) loam; dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
A2—19 to 23 inches; very dark grayish brown (10YR 3/2) loam; few fine faint yellowish brown (10YR 5/4 and 10YR 5/6) mottles; very dark gray (10YR 3/1) coatings on peds; moderate fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.
B1—23 to 29 inches; dark grayish brown (10YR 4/2) loam; common fine distinct yellowish brown (10YR 5/4 and 10YR 5/6) mottles; very dark grayish brown (10YR 3/2) on some surfaces of peds; moderate fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.
B2—29 to 34 inches; grayish brown (10YR 5/2) light sandy clay loam; many fine distinct yellowish brown (10YR 5/6 and 10YR 5/8) mottles; moderate medium subangular blocky structure; friable; pebble band at 34 inches; neutral; clear smooth boundary.
B2d—34 to 43 inches; grayish brown (10YR 5/2) sandy loam; many medium yellowish brown (10YR 5/6 and 10YR 5/8) mottles; weak medium subangular blocky structure; friable; few pebbles more than 2 millimeters; neutral; clear smooth boundary.
IIIB—43 to 61 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) heavy loam; grayish brown (2.5Y 5/2) coatings on peds; weak coarse prismatic structure parting to moderate coarse subangular blocky; firm; neutral; clear wavy boundary.
IIIC—61 to 76 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) heavy loam; massive; firm; slight effervescence; mildly alkaline.

The solum thickness ranges from about 40 to 72 inches. Thickness of the loamy overburden over loam glacial till ranges from 30 to 45 inches.
The A1 horizon is typically black (10YR 2/1) but ranges from black (N 2/0) to very dark gray (10YR 3/1). The A3 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (2.5Y 3/2). The A horizon is typically loam but ranges to gritty silt loam, light clay loam, and gritty light silty clay loam.
The B horizon has hue of 2.5Y and 10YR, value of 4 to 5, and chroma of 2 to 6. Texture of the B horizon includes loam, gritty silty clay loam, sandy clay loam, light clay loam, and thin horizons of sandy loam with a weighted clay content of more than 18 percent. Depth to carbonates ranges from 50 to 80 inches. Reaction in the B horizon ranges from neutral to slightly acid.

Garwin series

The Garwin series consists of poorly drained, moderately permeable soils formed in loess on uplands. The slope range is 0 to 2 percent.

Garwin soils are similar to Maxfield, Muscatine, and Tama soils. They do not have firm, loam in the lower part of the solum as do Maxfield soils. They have a gray B horizon and are more poorly drained than Tama and Muscatine soils.

Typical pedon in an area of Garwin silty clay loam, 0 to 2 percent slopes, in a cultivated field 70 feet east and 1,850 feet north of the southwest corner sec. 16, T. 85 N., R. 12 W.
Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam; dark gray (10YR 4/1) dry; moderate subangular blocky structure; friable; neutral; abrupt smooth boundary.
A1—7 to 16 inches; black (N 2/0) silty clay loam; dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; neutral; gradual smooth boundary.
A2—16 to 22 inches; very dark gray (10YR 3/1) silty clay loam; moderate very fine subangular blocky structure; friable; neutral; gradual smooth boundary.
B1—22 to 31 inches; olive gray (5Y 5/2) silty clay loam; dark gray (10YR 4/1) coatings on peds; few fine faint olive (5Y 4/3) mottles and few fine faint olive brown (2.5Y 4/4) mottles; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.
B2—31 to 39 inches; olive gray (5Y 5/2) light silty clay loam; few fine faint olive brown (2.5Y 4/4) mottles; moderate fine subangular blocky structure; few fine black (10YR 2/1) oxide concretions; neutral; clear smooth boundary.
B3—39 to 48 inches; olive gray (5Y 5/2) light silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; few fine black (10YR 2/1) oxide concretions; neutral; gradual smooth boundary.
C1—48 to 60 inches; light brownish gray (2.5Y 6/2) heavy silt loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few fine black (10YR 2/1) oxides; neutral; gradual smooth boundary.
C2—60 to 70 inches; mottled light olive brown (2.5Y 5/4) and light olive gray (5Y 6/2) heavy silt loam; massive; friable; neutral.

The solum ranges from 36 to 50 inches in thickness. The A1 or Ap horizon ranges from black (N 2/0) to very dark gray (10YR 3/1). The A horizon ranges from 14 to 23 inches in thickness and from silty clay loam to heavy silt loam in texture.
The B2 horizon has hue of 5Y and 2.5Y, value of 3 to 5, and chroma of 1 or 2. The B1 or B2 horizon ranges from 30 to 36 percent clay. Depth to carbonates is 48 to 70 inches or more. Reaction is slightly acid to neutral in the B horizon.
Hanlon series

The Hanlon series consists of moderately well drained, moderately rapidly permeable soils formed in medium textured alluvium along major streams and rivers. The slope range is 0 to 2 percent.

Hanlon soils are commonly adjacent to Spillville soils. Hanlon soils have more sand in the solum than do Spillville soils.

Typical pedon in an area of Hanlon fine sandy loam, 0 to 2 percent slopes, in a cultivated field 285 feet east and 2,625 feet north of the southwest corner sec. 10, T. 86 N., R. 12 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam; dark gray (10YR 4/1) dry; weak fine granular structure; very friable; neutral; abrupt smooth boundary.

A12—7 to 27 inches; black (10YR 2/1) fine sandy loam; dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

A13—27 to 42 inches; very dark brown (10YR 2/2) fine sandy loam; dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

A14—42 to 48 inches; very dark grayish brown (10YR 3/2) sandy loam; few fine faint dark brown (7.5YR 3/2) mottles; weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

B2—48 to 60 inches; very dark grayish brown (10YR 3/2) sandy loam; common fine faint dark brown (7.5YR 3/2) mottles; weak coarse prismatic structure; neutral.

The solum ranges from 46 to 65 inches in thickness. The A horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), black (10YR 2/1), or very dark gray (10YR 3/1). It is fine sandy loam and sandy loam 40 to 60 inches thick.

The B horizon is very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) sandy loam.

Kenyon series

The Kenyon series consists of moderately well drained, moderately permeable soils in uplands. These soils formed in 14 to 24 inches of loamy material and in the underlying glacial till. The slope range is 2 to 14 percent.

Kenyon soils are similar to Bassett and Readlyn soils and are commonly adjacent to Floyd and Clyde soils. They have a thicker A1 horizon than Bassett soils. They have a browner B horizon and are better drained than Readlyn, Floyd, and Clyde soils.

Typical pedon in an area of Kenyon loam, 2 to 5 percent slopes, in a hayfield 1,000 feet west and 450 feet north of the southeast corner sec. 1, T. 85 N., R. 10 W.

A11—0 to 11 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—11 to 15 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; very dark brown (10YR 2/2) coatings on peds; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.

A3—15 to 18 inches; dark brown (10YR 3/3) loam; very dark grayish brown (10YR 3/2) and a few very dark brown (10YR 2/2) coatings on peds; moderate fine and medium subangular blocky structure; friable; medium acid; clear smooth boundary.

IIB1—18 to 25 inches; brown (10YR 4/3) loam; with very dark grayish brown (10YR 3/2) coatings on peds; moderate fine and medium subangular blocky structure; friable; pebble band at 22 inches; medium acid; clear smooth boundary.

IIB2—25 to 32 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

IIB2—32 to 39 inches; yellowish brown (10YR 5/6) loam; few fine distinct grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; firm; medium acid; clear smooth boundary.

IIB3—39 to 48 inches; yellowish brown (10YR 5/4) loam; few fine distinct grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; slightly acid; clear smooth boundary.

IIB3—48 to 54 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) loam; few fine distinct strongly brown (7.5YR 5/6) mottles; moderate medium prismatic structure; firm; neutral; clear smooth boundary.

IIC—54 to 60 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) loam; few fine distinct strongly brown (7.5YR 5/6) mottles; moderate medium prismatic structure; firm; slight effervescence; mildly alkaline.

The solum thickness ranges from 45 to 60 inches. The A1 horizon is black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). It ranges from about 10 to 20 inches in thickness, unless the soil is eroded, and generally decreases as gradient increases. The A horizon is typically loam but includes silt loam high in content of sand.

The B2 horizon has hue of 10YR, value of dominantly 3 to 5, and chroma of 3 to 6.

Depth to the IIB horizon is 14 to 24 inches unless the soil has been eroded. Reaction ranges from medium acid to strongly acid in the B2 horizon.

The IIB horizon has hue of 10YR, value of 4 or 5, and chroma of 2 to 8 with mottles. It is typically heavy loam but includes light clay loam and sandy clay loam.

The IIC horizon is similar in color and texture to the IIB horizon except that grayish mottles are more common.
In Benton County, Kenyon loam, 5 to 9 percent slopes, moderately eroded, and Kenyon loam, 9 to 14 percent slopes, moderately eroded, have a mollic epipedon that is not as thick as the defined range of the Kenyon soils. This difference does not alter the use or behavior of the soils.

**Klinger series**

The Klinger series consists of somewhat poorly drained, moderately permeable soils in loess covered uplands. These soils formed in loess 24 to 40 inches thick and in the underlying glacial till. The slope range is 1 to 4 percent.

Klinger soils are commonly adjacent to Dinsdale and Muscatine soils. They have a grayer B horizon and are more poorly drained than Dinsdale soils. They have a higher sand content in the lower part of the B horizon than do Muscatine soils.

Typical pedon in an area of Klinger silty clay loam, 1 to 4 percent slopes, in a hayfield, 1,210 feet west and 595 feet south of the center sec. 31, T. 86 N., R. 11 W.

A0—0 to 8 inches; black (10YR 2/1) light silty clay loam; dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A1—8 to 14 inches; very dark brown (10YR 2/2) silty clay loam; dark grayish brown (10YR 4/2) dry; black (10YR 2/1) coatings on ped; moderate fine granular structure; friable; medium acid; clear smooth boundary.

A2—14 to 17 inches; dark brown (10YR 3/3) silty clay loam; very dark brown (10YR 2/2) coatings on ped; moderate fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21t—17 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam; moderate fine and medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

B22t—24 to 39 inches; dark grayish brown (10YR 4/2) silty clay loam; few strong brown (7.5YR 5/6) mot- tles; moderate medium subangular blocky structure; friable; few thin discontinuous clay films on ped; a few clay lined pores; few fine dark reddish brown (5YR 2/2) oxides; slightly acid; abrupt smooth boundary.

B23—39 to 48 inches; yellowish brown (10YR 5/8) loam; common fine distinct grayish brown (2.5Y 5/2) mottles; weak coarse prismatic structure; firm; slightly acid; clear wavy boundary.

B24—48 to 60 inches; yellowish brown (10YR 5/8) loam; common fine distinct grayish brown (2.5Y 5/2) mottles; massive; firm; slight effervescence; mildly alkaline.

The solon ranges from about 40 to 60 inches in thickness.

The A horizon is typically black (10YR 2/1) or very dark brown (10YR 2/2) grading to value of 3 and chroma of 1 to 3 in the lower part. It ranges in thickness from 16 to 22 inches.

The B2 horizon, formed in loess, is dominantly dark grayish brown (10YR 4/2) but includes value of 5 and chroma of 3 to 4 in a minor part of the matrix. The B2t horizon ranges from 28 to 35 percent clay. Reaction in the B horizon ranges from slightly acid to medium acid.

Depth to the IIIBt horizon is 24 to 40 inches. The IIIBt horizon varies in hue and has value of 4 to 5 and chroma of 2 to 8. Texture is loam, light clay loam, or sandy clay loam.

**Koszta series**

The Koszta series consists of somewhat poorly drained, moderately permeable soils on nearly level low stream benches. These soils formed in silty alluvium. The slope range is 0 to 2 percent. The Koszta soils in Benton County are grayer in the upper part of the B horizon than is typical for the Koszta series. This difference does not alter use or behavior of the soils.

Koszta soils are similar to Wiota and Nevin soils. They have a grayer B horizon and are more poorly drained than Wiota soils. They have a thinner, lighter colored A1 horizon than do Nevin soils.

Typical pedon in an area of Koszta silt loam, loamy substratum, 0 to 2 percent slopes, in a cultivated field 1,300 feet south and 567 feet east of the northwest corner sec. 21, T. 82 N., R. 9 W.

A0—0 to 7 inches; very dark gray (10YR 3/1) heavy silt loam; grayish brown (10YR 5/2) dry; moderate very fine granular structure; friable; neutral; abrupt smooth boundary.

A1—7 to 13 inches; dark grayish brown (10YR 4/2) heavy silt loam; light brownish gray (10YR 6/2) dry; very dark gray (10YR 3/1) coatings on some plates; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium platy structure parting to moderate very fine subangular blocky; friable; strongly acid; clear smooth boundary.

B1—13 to 19 inches; dark grayish brown (10YR 4/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; strongly acid; moderate very fine subangular blocky structure; friable; gradual smooth boundary.

B21t—19 to 23 inches; dark grayish brown (10YR 4/2) silty clay loam; many fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate very fine subangular blocky structure; friable; very thin patchy clay films on ped; strongly acid; gradual smooth boundary.

B22t—23 to 30 inches; dark grayish brown (10YR 4/2) silty clay loam; many fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate fine subangular blocky structure; friable; thin nearly continuous clay films on ped; few soft black oxides; strongly acid; gradual smooth boundary.
B2t—30 to 45 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; friable; thin nearly continuous clay films on prisms and ped; medium acid; gradual smooth boundary.

B3—45 to 51 inches; olive gray (5Y 5/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure; friable; medium acid; abrupt smooth boundary.

C—51 to 60 inches; mottled brown (10YR 4/3) and reddish brown (5YR 5/6) sandy loam; massive; loose; slightly acid.

The solum ranges from 40 to 60 inches in thickness. The A1 horizon is silt loam. It ranges from 6 to 10 inches in thickness and from black (10YR 2/1) to very dark grayish brown (10YR 3/2) in color. The A2 horizon is silt loam. It is very dark gray (10YR 3/1) to grayish brown (10YR 5/2) and is 3 to 6 inches thick.

The B horizon is dark grayish brown (10YR 4/2) mottled with grayish brown (2.5Y 5/2), gray (5Y 5/1), light gray (5Y 6/1), olive gray (5Y 5/2), and yellowish brown (10YR 5/4, 5/6, and 5/8). Reaction ranges from medium to strongly acid. The C horizon ranges from sandy loam to loamy sand but includes stratiﬁed loam and silt loam.

**Lamont series**

The Lamont series consists of well drained soils that are moderately rapidly permeable in the upper part and very rapidly permeable in the lower part. They are on upland ridges and side slopes and on high stream benches. They formed in dominantly wind deposited sand. On benches coarse sand and gravel may occur below 4 feet. The slope range is 2 to 30 percent.

Lamont soils are similar to Chelsea and Dickinson soils. They have a thinner and generally a lighter colored A1 horizon than do Dickinson soils. They are not as coarse textured as are Chelsea soils.

Typical pedon in an area of Lamont fine sandy loam, 2 to 5 percent slopes, in a pasture, 1,625 feet north and 200 feet east of the southwest corner sec. 36, T. 85 N., R. 9 W.

A1—0 to 4 inches; very dark gray (10YR 3/1) fine sandy loam; grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; medium acid; clear smooth boundary.

A2—4 to 10 inches; brown (10YR 4/3) light fine sandy loam; pale brown (10YR 6/3) dry; weak coarse platy structure; very friable; common very dark gray (10YR 3/1) worm casts; medium acid; clear smooth boundary.

B2t—10 to 15 inches; dark yellowish brown (10YR 4/4) sandy loam; very fine and fine subangular blocky structure; friable; few very dark gray (10YR 3/1) worm casts; some clay bridging between sand grains; medium acid; gradual smooth boundary.

B2t—15 to 21 inches; dark brown (7.5YR 4/4) heavy sandy loam; moderate fine and medium subangular blocky structure; friable; some clay bridging between sand grains; medium acid; clear smooth boundary.

B2t—21 to 25 inches; yellowish brown (10YR 5/4) light sandy loam; weak medium subangular blocky structure; very friable; some clay bridging between sand grains; strongly acid; clear smooth boundary.

B3—25 to 33 inches; yellowish brown (10YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; strongly acid; clear smooth boundary.

B3—33 to 40 inches; yellowish brown (10YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; strongly acid; clear smooth boundary.

C—40 to 60 inches; yellowish brown (10YR 5/4) loamy sand; single grained; loose; dark yellowish brown (10YR 4/4); clay band at 52 to 54 inches; strongly acid.

The solum ranges from 24 to 60 inches in thickness. The A1 horizon is dark grayish brown (10YR 4/2), dark gray (10YR 4/1), or very dark gray (10YR 3/1). Unless eroded, the A2 horizon ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) and brown (10YR 4/3). In some places the A2 horizon may be wholly incorporated in the Ap horizon.

The B2 horizon ranges from sandy loam to light loam and light sandy clay loam. It has hue of 10YR to 7.5YR, value of 4 or 5, and chroma of 3 to 6. Reaction ranges from medium acid to very strongly acid.

**Lawler series**

The Lawler series consists of somewhat poorly drained soils that are moderately permeable in the upper part and rapidly permeable in the lower part. They are on benches along river and streams. These soils formed in 32 to 40 inches of loamy material and in the underlying coarse textured material. The slope range is 0 to 2 percent.

Lawler soils are commonly adjacent to Udolpho, Saude, and Waukee soils. They are also similar to those soils but have a thicker A1 horizon than do Udolpho soils and are more poorly drained and have a grayier B horizon than the Saude and Waukee soils.

Typical pedon in an area of Lawler loam, 32 to 40 inches to sand or gravel, 0 to 2 percent slopes, in a cultivated field 1,800 feet west and 325 feet south of northeast corner sec. 36, T. 86 N., R. 10 W.

Ap—0 to 8 inches; black (10YR 2/1) loam; dark gray (10YR 4/1) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—8 to 15 inches; very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) dry; moderate fine suban-
regular blocky structure; friable; medium acid; clear smooth boundary.

A3—15 to 21 inches; very dark grayish brown (10YR 3/2) loam; very dark gray (10YR 3/1) coatings on peds; weak medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B2—21 to 30 inches; dark grayish brown (10YR 4/2) heavy loam; common fine distinct yellowish brown (10YR 5/6) mottles; few thin discontinuous light brownish gray (10YR 6/2) silt coatings on peds dry; weak medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B31—30 to 34 inches; dark grayish brown (10YR 4/2) sandy loam; many fine distinct yellowish brown (10YR 5/6) mottles; few thin discontinuous light brownish gray (10YR 6/2) silt coatings on peds; weak coarse subangular blocky structure; friable; medium acid; abrupt smooth boundary.

B32—34 to 38 inches; dark yellowish brown (10YR 4/4) gravelly sand; weak coarse prismatic structure; very friable; many 3 to 8 centimeter pebbles; medium acid; gradual smooth boundary.

B1—7 to 11 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; firm; strongly acid; clear smooth boundary.

B21—11 to 16 inches; yellowish brown (10YR 5/4) light clay loam; moderate fine subangular blocky structure; firm; thin nearly continuous clay films; strongly acid; gradual smooth boundary.

B22—16 to 26 inches; yellowish brown (10YR 5/6) light clay loam; light brownish gray (10YR 6/2) silt coatings on many peds dry; strong fine and medium subangular blocky and angular blocky structure; firm; thin nearly continuous clay films on peds; strongly acid; diffuse wavy boundary.

Depth to coarse textured material ranges from 32 to 40 inches, and generally corresponds to solum thickness.

The A horizon is loam or silt loam high in content of sand. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1). The A3 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). Total thickness of the A horizon typically ranges from 12 to 18 inches, but in some areas ranges to 24 inches.

The B2 horizon is typically dark grayish brown (2.5Y or 10YR 4/2) with high chroma mottles. It is typically heavy loam but ranges from loam to light sandy clay loam. Reaction is slightly acid or medium acid in the B horizon.

In areas where depth to sand and gravel is near the minimum described for the series, the soil has a IB3 horizon that formed in coarse material. The IB3 horizon or the upper part of the C horizon typically ranges from loamy coarse sand to loamy medium gravel.

Lindley series

The Lindley series consists of well drained, moderately slowly permeable soils on convex lower side slopes of uplands. These soils formed in glacial till. The slope range is 14 to 25 percent.

Lindley soils are commonly adjacent to Fayette soils. They contain more sand throughout the solum than do Fayette soils.

Typical pedon in an area of Lindley loam, 18 to 25 percent slopes, in a pasture 1,920 feet south and 200 feet west of the northeast corner sec. 34, T. 82 N., R. 11 W.

Ap—0 to 5 inches; dark brown (10YR 3/3) and brown (10YR 4/3) loam, brown (10YR 5/3) dry; moderate very fine granular structure; friable; medium acid; abrupt smooth boundary.

A2—5 to 7 inches; mixed brown (10YR 4/3) and brown (10YR 5/3) loam, yellowish brown (10YR 5/4) dry; some dark brown (10YR 3/3) coatings on peds; weak thin platy structure; friable; very strongly acid; abrupt smooth boundary.

B1—7 to 11 inches; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; firm; strongly acid; clear smooth boundary.

B21—11 to 16 inches; yellowish brown (10YR 5/4) light clay loam; moderate fine subangular blocky structure; firm; thin nearly continuous clay films; strongly acid; gradual smooth boundary.

B22—16 to 26 inches; yellowish brown (10YR 5/6) light clay loam; light brownish gray (10YR 6/2) silt coatings on many peds dry; strong fine and medium subangular blocky and angular blocky structure; firm; thin nearly continuous clay films on peds; strongly acid; diffuse wavy boundary.

Solum thickness ranges from 35 to 60 inches.

The A1 horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2) and brown (10YR 4/3). It is typically loam but is silt loam in places and includes clay loam in eroded areas. The A1 horizon is 1 to 5 inches thick. The A2 horizon has hue of 10YR, value of 4 through 6, and chroma of 2 or 4. It is loam and is 2 to 7 inches thick.

The Bt horizon is dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) clay loam and is 20 to 40 inches thick.

The C horizon is yellowish brown (10YR 5/4) or (10YR 5/6) and has light gray to strong brown and olive mottles.
Maxfield series

The Maxfield series consists of poorly drained, moderately permeable soils on broad, nearly level ridgetops in uplands. These soils formed in a mantle of loess and in the underlying firm loam glacial till. The slope range is 0 to 2 percent.

Maxfield soils are similar to Dinsdale, Klinger and Waubeek soils. They have a gray B horizon and are more poorly drained than those soils.

Typical pedon in an area of Maxfield silty clay loam, 0 to 2 percent slopes, in a cultivated field 55 feet west and 105 feet south of the northeast corner sec. 31, T. 86 N., R. 9 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—8 to 16 inches; black (N 2/0) silty clay loam; very dark gray (N 3/0) dry; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

A3—16 to 21 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; few fine faint olive gray (5Y 4/2) mottles; moderate fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

B1g—21 to 24 inches; dark gray (5Y 4/1) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; very dark gray (10YR 3/1) coatings on peds; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

B2g—24 to 27 inches; mottled dark gray (5Y 4/1) and olive gray (5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; some very dark gray (10YR 3/1) coatings on some peds; moderate fine subangular blocky structure; friable; neutral; clear wavy boundary.

B2g—27 to 33 inches; olive gray (5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; dark gray (10YR 4/1) coatings on some peds; moderate fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

B3g—33 to 37 inches; mottled light olive gray (5Y 6/2) and yellowish brown (10YR 5/4) sandy loam; common medium faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; neutral; abrupt smooth boundary.

IIB3g—37 to 41 inches; mottled gray (5Y 5/1) and yellowish brown (10YR 5/6) loam; light olive gray (5Y 6/2) on faces of prisms; few coarse distinct strong brown (7.5YR 5/8) mottles; weak medium prismatic structure; firm; neutral; abrupt smooth boundary.

IIB3g—41 to 50 inches; mottled gray (5Y 5/1) and yellowish brown (10YR 5/8) loam; light gray (5Y 6/1) on faces of prisms; weak medium prismatic structure; firm; slight effervescence; mildly alkaline; clear smooth boundary.

IIC—50 to 65 inches; mottled gray (5Y 5/1) and yellowish brown (10YR 5/8) loam; massive; firm; slight effervescence; mildly alkaline.

Solum thickness is typically about 48 inches and ranges from about 40 to 55 inches. The loess mantle is typically 24 to 40 inches thick but ranges from 20 to 42 inches.

The A horizon is black (N 2/0 or 10YR 2/1) and very dark gray (10YR or 5Y 3/1).

The upper part of the B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It ranges from heavy silt loam to silty clay loam.

The IIB3 horizon has hue of 7.5YR to 5Y, value of 4 or 5, and chroma of 3 through 8 with lower chroma mottles. It is typically loam and ranges to light clay loam and sandy clay loam. A layer of loamy sand or sand typically less than 10 inches thick commonly separates the loess and the underlying glacial till. The IIC horizon has the same color and texture as the IIB3. Carbonates are at a depth of about 40 to 60 inches. Reaction is typically neutral but ranges to slightly acid in the most acid part of the solum.

Muscatine series

The Muscatine series consists of somewhat poorly drained, moderately permeable soils on loess covered upland divides and loess covered stream benches. The slope range is 0 to 5 percent.

Muscatine soils are similar to Garwin, Tama, and Atterberry soils. They have a thicker A1 horizon than do Atterberry soils and do not have an A2 horizon. They have a browner B horizon and are better drained than the Garwin soils. They have a grayer B horizon and are more poorly drained than the Tama soils.

Typical pedon in an area of Muscatine silty clay loam, 0 to 2 percent slopes, in a cultivated field 2,060 feet east and 267 feet north of the southwest corner sec. 8, T. 85 N., R. 12 W.

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

A12—8 to 12 inches; very dark brown (10YR 2/2) light silty clay loam, dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on peds; moderate fine granular structure; friable; medium acid; clear smooth boundary.

A13—12 to 17 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on peds; moderate fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

A3—17 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam; very dark gray (10YR 3/1) coatings on peds; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.
B21t—20 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark gray (10YR 3/1) coatings on peds; moderate fine subangular blocky structure; friable; thin discontinuous clay films on peds and in root channels; medium acid; gradual smooth boundary.

B22t—24 to 30 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) coatings on peds; few fine faint grayish brown (10YR 5/2) mottles; moderate fine and medium subangular blocky structure; friable; thin nearly continuous clay films; medium acid; gradual smooth boundary.

B23t—30 to 38 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium prismatic structure; friable; thin discontinuous clay films; very dark grayish brown (10YR 3/2) stains along root channels; slightly acid; clear boundary.

B3—38 to 46 inches; dark grayish brown (2.5Y 4/2) light silty clay loam; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure; friable; few dark reddish brown (5YR 2/2) oxides; neutral; gradual boundary.

C—46 to 60 inches; olive gray (5Y 5/2) heavy silt loam; common fine distinct yellowish brown (10YR 5/6) mottles; massive with some vertical cleavage; friable; few dark reddish brown (5YR 2/2) oxides; neutral.

Solum thickness ranges from 50 to 70 inches.

The A horizon ranges from black (10YR 2/1) and very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2). It is 14 to 20 inches thick.

The B horizon has hue of 10YR and 2.5Y, value of 4 or 5, and chroma of 2 with higher chroma mottles. The B2 horizon is about 27 to 35 percent clay. Reaction in the B2 horizon is slightly acid to strongly acid.

**Nevin series**

The Nevin series consists of somewhat poorly drained, moderately permeable soils on nearly level, low stream benches. These soils formed in silty alluvium. The slope range is 0 to 2 percent. The Nevin soils in Benton County have a thinner mollic epipedon than is defined for the Nevin series and do not have an argillic horizon. These differences do not alter the use or behavior of the soils.

Nevin soils are similar to Wiota and Bremer soils. Nevin soils have a grayer B horizon and are more poorly drained than Wiota soils. They have a browner B horizon and are better drained than Bremer soils.

Typical pedon in an area of Nevin silty clay loam, sandy substratum, 0 to 2 percent slopes, in a cultivated field 650 feet south and 45 feet west of the northeast corner sec. 20, T. 82 N., R. 9 W.

Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1) dry; moderate very fine granular blocky structure; friable; neutral clear smooth boundary.

A12—7 to 11 inches; black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A13—11 to 17 inches; very dark grayish brown (10YR 3/2) light silty clay loam; very dark gray (10YR 3/1) coatings on peds; moderate very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B1—17 to 22 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark grayish brown (10YR 3/2) coatings on some ped surfaces; few fine faint yellowish brown (10YR 5/4) mottles; moderate very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21t—22 to 27 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark gray (10YR 3/1) coatings on some peds; few fine faint yellowish brown (10YR 5/4) mottles; moderate very fine subangular blocky structure; friable; thin patchy clay films on peds; medium acid; clear smooth boundary.

B22t—27 to 32 inches; dark grayish brown (10YR 4/2) silty clay loam; very dark gray (10YR 3/1) coatings on a few peds; common fine faint yellowish brown (10YR 5/6) mottles; moderate very fine subangular blocky structure; friable; thin nearly continuous clay films on peds; medium acid; clear smooth boundary.

B23t—32 to 38 inches; grayish brown (10YR 5/2) silty clay loam; common fine and medium distinct brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to moderate fine subangular blocky; friable; very thin patchy clay films on prisms and peds; few black (5YR 2/1) oxides; medium acid; clear smooth boundary.

B3—38 to 44 inches; dark grayish brown (2.5Y 4/2) medium silty clay loam; common fine and medium distinct brown (7.5YR 5/6) mottles; moderate medium prismatic structure; friable; few black (5YR 2/1) oxides; medium acid; abrupt smooth boundary.

C1—44 to 55 inches; dark grayish brown (2.5Y 4/2) loam high in fine sand; common fine and medium distinct brown (7.5YR 5/4) and strong brown (7.5YR 5/6) mottles; massive; friable; medium acid; abrupt smooth boundary.

C2—55 to 60 inches; mottled dark yellowish brown (10YR 4/4), brown (10YR 5/3), and yellowish brown (10YR 5/4) loamy sand; single grained; loose; medium acid.

Solum thickness is typically more than 40 inches and ranges from 36 to 60 inches or more.

The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). It ranges from 18 to 24
inches in thickness to 30 inches in a few places. It is typically light silt clay loam but ranges to silt loam.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3 with high chroma mottles. It ranges from about 30 percent to about 35 percent clay. Reaction ranges from slightly acid to medium acid.

The C horizon ranges from sandy loam to loamy sand or sand but includes stratified loam and silt loam in some places.

Nodaway series

The Nodaway series consists of moderately well drained, moderately permeable soils formed in recently deposited silty alluvium along rivers, major streams, and narrow upland drainageways. The slope range is 0 to 5 percent.

Nodaway soils are similar to Colo and Spillville soils. They are lighter colored and more stratified, lower in clay content, and better drained than Colo soils. They have more silt and less sand than do Spillville soils.

Typical pedon in an area of Nodaway silt loam, 0 to 2 percent slopes, in a pasture 2,420 feet east and 265 feet north of the southwest corner sec. 32, T. 82 N., R. 11 W.

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak very thin platy structure caused by stratification; very friable; slightly acid; clear smooth boundary.

C1—7 to 10 inches; dark grayish brown (10YR 4/2) silt loam; weak very thin platy structure caused by stratification; very friable; slightly acid; clear smooth boundary.

C2—10 to 16 inches; very dark grayish brown (10YR 3/2) silt loam; weak very thin platy structure caused by stratification; very friable; slightly acid; clear smooth boundary.

C3—16 to 60 inches; stratified dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) silt loam; weak very thin platy structure caused by stratification; common fine distinct dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles or stains along root channels or buried plant material; very friable; neutral.

The A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick and generally shows some evidence of stratification. In cultivated areas, the Ap horizon is very dark grayish brown (10YR 3/2).

The C horizon dominantly has hue of 10YR, value of 3, 4, or 5, and chroma of 2 and 3. Some strata have chroma of 1. Dark, medium or moderately fine textured buried soils are below 40 inches in some areas. Texture is typically silt loam, but in some layers is light silty clay loam. Only thin lenses of material coarser than silt loam are at a depth of less than 40 inches. Sandy material is below 40 inches in some places. Reaction ranges from slightly acid to neutral.

Olin series

The Olin series consists of well drained and somewhat excessively drained soils that are moderately rapidly permeable in the upper part and moderately permeable in the lower part. They are on convex upland ridges and side slopes. These soils formed in 20 to 36 inches of sandy loam and in the underlying glacial till. The slope range is 2 to 9 percent.

Olin soils are commonly adjacent to Kenyon, Dickinson, and Sparta soils. They are shallower over firm loam than the Dickinson soils. They have more sand in the upper part of the solum than do Kenyon soils. They contain less sand than do Sparta soils.

Typical pedon in an area of Olin fine sandy loam, 2 to 5 percent slopes, in a pasture 240 feet south and 2,120 feet west of the northeast corner sec. 29, T. 86 N., R. 9 W.

A11—0 to 11 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; very friable; slightly acid; gradual smooth boundary.

A12—11 to 20 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

A3—20 to 24 inches; brown (10YR 4/3) fine sandy loam; dark brown (10YR 3/3) coatings on pedes; moderate fine subangular blocky structure; very friable; medium acid; clear smooth boundary.

B1—24 to 28 inches; dark yellowish brown (10YR 4/4) heavy sandy loam; moderate fine and medium subangular blocky structure; very friable; pebble band at 28 inches; medium acid; clear smooth boundary.

II B21—28 to 31 inches; dark yellowish brown (10YR 4/4) loam; moderate fine and medium subangular blocky structure; firm; medium acid; clear smooth boundary.

II B22—31 to 40 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; firm; medium acid; clear smooth boundary.

II B23—40 to 47 inches; dark yellowish brown (10YR 4/4) loam; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few pebbles more than 2 millimeters; medium acid; clear smooth boundary.

II B3—47 to 53 inches; dark yellowish brown (10YR 4/4) loam; few fine distinct yellowish brown (10YR 5/6) mottles; some brown (10YR 4/3) coatings on some vertical faces of pedes; moderate medium prismatic structure; firm; few small dark reddish brown (5YR 2/2) oxides; few pebbles more than 2 millimeters; slightly acid; clear wavy boundary.

II C—53 to 60 inches; mottled yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) loam; common fine faint yellowish brown (10YR 5/6) mottles; massive; firm; few small dark reddish brown (5YR 2/2) oxides; few pebbles more than 2 millimeters; neutral; abrupt wavy boundary.
IIC2—60 to 62 inches; mottled yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) loam; common fine faint yellowish brown (10YR 5/6) mottles; massive; firm; slight effervescence; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. The A horizon ranges from 14 to 24 inches in thickness. It has color of (10YR 2/2), (10YR 3/2), or (10YR 2/1). It is fine sandy loam or sandy loam.

The upper part of the B horizon has hue of 10YR, value of 3 to 5, and chroma of 3 or 4. It is fine sandy loam or sandy loam. The lower part of the B horizon has hue of 10YR, value of 3 to 5, and chroma of 3 to 6. It is commonly loam but may be light clay loam or sandy clay loam. Depth to carbonates ranges from 50 to 80 inches. Reaction in the B horizon is slightly acid to strongly acid.

**Palms series**

The Palms series consists of very poorly drained, moderately and moderately slowly permeable soils on uplands and high stream benches. These soils formed in 20 to 50 inches of organic material over mineral material. The slope range is 1 to 4 percent.

The Palms soils in Benton County contain more mineral material in the organic part and are more sloping than is typical for the series. These differences do not alter the use or behavior of the soils.

Palms soils are commonly adjacent to Clyde and Floyd soils. They have layers of decomposed organic material more than 20 inches thick; Clyde and Floyd soils do not. They are more poorly drained than Floyd and Clyde soils.

Typical pedon in an area of Palms muck, 1 to 4 percent slopes, in a permanent pasture 1,390 feet north and 270 feet east of the southwest corner sec. 23, T. 86 N., R. 11 W.

Oa—0 to 10 inches; black (10YR 2/1), broken face and rubbed sapric material, very dark gray (10YR 3/1) dry; fiber content 25 percent undisturbed, 10 percent rubbed; 35 percent mineral material; weak fine granular structure; very friable; neutral; gradual smooth boundary.

Oa2—10 to 26 inches; black (10YR 2/1) broken face and rubbed sapric material; fiber content 30 percent undisturbed, greater than 10 percent rubbed; 30 percent mineral material; weak coarse platy structure; very friable; neutral; clear smooth boundary.

IIC—32 inches; dark gray (5Y 4/1) silt loam; massive; friable; neutral.

The depth to the IIC horizon generally ranges from 20 to 40 inches but in places is as much as 50 inches. The Oa horizon is black (10YR 2/1) to very dark brown (10YR 2/2).

The IIA1b horizon is black (N 2/0 or 10YR 2/1). It ranges from 0 to 12 inches in thickness. It is variable in texture but is generally silt loam, silty clay loam, loam, or clay loam.

The IIC horizon ranges from black (10YR 2/1) to dark gray (5Y 4/1) and light olive gray (5Y 6/2). It is variable in texture but is typically silty clay loam, loam, or silt loam and contains sandy strata in places. Reaction in the IIC horizon is typically neutral but ranges from slightly acid to mildly alkaline.

**Radford series**

The Radford series consists of somewhat poorly drained, moderately permeable soils on narrow upland drainageways. These soils formed in recently deposited alluvium. The slope range is 2 to 5 percent.

Radford soils are adjacent to Nodaway soils. They have a dark buried soil at 24 to 40 inches; Nodaway soils do not.

Typical pedon in an area of Radford silt loam in an area of Nodaway-Radford, silt loams, 2 to 5 percent slopes, in a cultivated field 1,000 feet east and 1,000 feet south of the northwest corner sec. 21, T. 82 N., R. 11 W.

Ap—0 to 11 inches; very dark grayish brown (10YR 3/2) silt loam, gray (10YR 5/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—11 to 17 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; few fine faint dark reddish brown (5YR 3/4) mottles; weak fine granular structure; friable; neutral; clear smooth boundary.

C—17 to 27 inches; very dark gray (10YR 3/1) with thin strata of grayish brown (10YR 5/2) silt loam; few fine faint dark reddish brown (5YR 3/4) mottles; moderate coarse prismatic structure parting to weak fine granular; friable; neutral; clear smooth boundary.

IIA1b—27 to 42 inches; black (10YR 2/1) silty clay loam; moderate very fine and fine subangular blocky structure; friable; neutral; clear smooth boundary.

IIA12b—42 to 60 inches; black (10YR 2/1) silty clay loam; moderate fine and medium subangular blocky structure; friable; neutral.

Radford soils are highly stratified in the upper 20 to 40 inches. In those horizons color is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). Texture generally is silt loam, but some thin strata that are high in sand may occur. Reaction is slightly acid or neutral in the A and C horizons.

The IIA1b horizon is silty clay loam or silt loam. It is black (10YR 2/1) or very dark grayish brown (10YR 3/2).
Readlyn series

The Readlyn series consists of somewhat poorly drained, moderately permeable soils on moderately wide convex ridgetops in uplands. These soils formed in 14 to 20 inches of loamy material and in the underlying glacial till. The slope range is 1 to 3 percent.

Readlyn soils are similar to and are commonly adjacent to Kenyon and Tripoli soils. They have a gray B horizon and are more poorly drained than Kenyon soils. They have a browner B horizon and are better drained than Tripoli soils.

Typical pedon in an area of Readlyn loam, 1 to 3 percent slopes, in a cultivated field 370 feet south and 900 feet west of the northeast corner sec. 35, T. 86 N., R. 10 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A12—8 to 16 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; black (10R 2/1) coatings on ped; moderate fine and very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

A3—16 to 19 inches; very dark grayish brown (10YR 3/2) loam; moderate fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21—19 to 23 inches; brown (10YR 4/3) loam, dark grayish brown (10YR 4/2) coatings on ped; common fine distinct yellowish brown (10YR 5/6) mottles; few fine faint dark grayish brown (10YR 4/2) mottles; moderate fine and medium subangular blocky structure; friable; pebble band at 22 to 23 inches; medium acid; clear smooth boundary.

IIb2—23 to 31 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) loam; few fine faint dark grayish brown (10YR 4/2) mottles; moderate fine and medium subangular blocky structure; firm; few pebbles more than 2 millimeters; medium acid; gradual smooth boundary.

IIb3—31 to 46 inches; yellowish brown (10YR 5/6) loam; many fine distinct grayish brown (10YR 5/2) mottles; few fine faint yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; few pebbles more than 2 millimeters; slightly acid; gradual smooth boundary.

IIc—46 to 65 inches; mottled yellowish brown (10YR 5/6) and brown (10YR 5/3) loam; many fine faint grayish brown (10YR 5/2) mottles; few fine faint yellowish brown (10YR 5/8) mottles; massive; firm; few pebbles more than 2 millimeters; slight effervescence; mildly alkaline.

Solum thickness is typically 40 to 60 inches.

The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark brown (10YR 2/2) in the upper part and very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in the lower part. It ranges in thickness from about 15 to 20 inches.

The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 through 8.

The IIb horizon and IIc horizon are heavy loam or light clay loam. Depth to carbonates commonly coincides with solum thickness. Reaction in the B horizon is slightly acid to strongly acid.

Rockton series

The Rockton series consists of well drained, moderately permeable soils on ridgetops and side slopes in uplands. These soils formed in 20 to 30 inches of loamy material over limestone bedrock. The slope range is 2 to 9 percent.

Rockton soils are similar to Whalan and Sogn soils. They are deeper to limestone bedrock than are Sogn soils. They have a thicker and generally darker colored A1 horizon than do Whalan soils.

Typical pedon in an area of Rockton loam, 20 to 30 inches to limestone, 2 to 9 percent slopes, in a cultivated area 280 feet west and 570 feet south of the northeast corner sec. 4, T. 85 N., R. 10 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; medium acid; abrupt smooth boundary.

A12—6 to 11 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; very dark brown (10YR 2/2) coatings on ped; moderate fine granular structure; friable; medium acid; clear wavy boundary.

A3—11 to 17 inches; dark brown (10YR 3/3) loam; very dark grayish brown (10YR 3/2) coatings on ped; moderate fine granular structure; friable; medium acid; clear wavy boundary.

B21—17 to 24 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on ped; moderate fine subangular blocky structure; friable; thin patchy clay films; strongly acid; abrupt wavy boundary.

IIb2—24 to 26 inches; dark yellowish brown (10YR 3/4) clay; moderate fine subangular blocky structure; firm; thin continuous clay films on ped; slightly acid; abrupt wavy boundary.

R—26 inches; limestone bedrock, shattered in the upper 2 to 3 feet.

Solum thickness and depth to limestone bedrock ranges from 20 to 30 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is 10 to 18 inches thick. It is typically loam, but silt loam is within the range.

The B2t horizon has value of 3 to 5 and chroma of 3 or 4, and hue of 10YR in the upper part and 7.5YR or 10YR in the lower part. Reaction ranges from medium to
Sattre series

The Sattre series consists of well drained soils that are moderately permeable in the upper part and very rapidly permeable in the lower part. They are on benches along rivers and streams. These soils formed in 32 to 40 inches of loamy material and in the underlying sand and gravel. The slope range is 0 to 5 percent.

Sattre soils are similar to Waukee, Saude, Lawler, and Udolpho soils. They have a thinner dark colored A horizon than do Waukee, Saude, and Lawler soils. They have a browned B horizon and are better drained than Lawler and Udolpho soils.

Typical pedon in an area of Sattre loam, 0 to 2 percent slopes, in a hayfield 550 feet east and 1,250 feet south of the center sec. 2, T. 85 N., R. 10 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A2—8 to 13 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) coatings on peds; discontinuous light brownish gray (10YR 6/2) sand and silt coatings on peds when dry; weak medium platy structure; friable; slightly acid; clear wavy boundary.

B1—13 to 17 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; slightly acid; gradual smooth boundary.

B2t—17 to 24 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; light brownish gray (10YR 6/2) silt and sand coatings on peds when dry; moderate medium angular and subangular blocky structure; friable; few thin discontinuous clay films on peds; clay lined channels and pores; medium acid; gradual smooth boundary.

B2t—24 to 32 inches; dark yellowish brown (10YR 4/4) loam; dark brown (10YR 4/3) coatings on peds; moderate medium angular and subangular blocky structure; friable; thin nearly continuous clay films on peds; medium acid; clear smooth boundary.

B3t—32 to 35 inches; yellowish brown (10YR 5/6) sandy loam; moderate coarse subangular blocky structure; friable; thin discontinuous dark yellowish brown (10YR 4/3) clay films on peds; medium acid; clear smooth boundary.

IIB 3t—35 to 40 inches; yellowish brown (10YR 5/6) sand; weak coarse subangular blocky structure; very friable; clay bridging between sand grains; medium acid; gradual smooth boundary.

Solum thickness ranges from about 30 to 50 inches. Thickness of the solum may or may not correspond to the depth to loamy sand or sand. Depth to these materials ranges from 32 to 40 inches.

The A1 or Ap horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or very dark gray (10YR 3/1). It ranges from 6 to 10 inches in thickness. The A2 horizon is commonly brown (10YR 4/3 or 5/3) or dark grayish brown (10YR 4/2). In some eroded areas, the A2 horizon may be wholly incorporated in the Ap horizon.

The B2 horizon is loam, light clay loam, or light sandy clay loam that grades to sandy loam or loamy sand in the B3 horizon. Clay content of the B2 ranges from 18 to 22 percent.

The C horizon ranges from loamy sand to sand and gravel. The content of gravel is variable, ranging from low in places to 20 to 30 percent by volume in some strata. Reaction is medium acid or strongly acid in the most acid part of the solum.

Saude series

The Saude series consists of well drained soils that are moderately permeable in the upper part and very rapidly permeable in the lower part. These soils are on benches along rivers or major streams. They formed in 24 to 32 inches of loamy material and in the underlying sandy material. The slope range is 0 to 9 percent.

Saude soils are similar to Waukee, Lawler, and Sattre soils. They have a thicker A1 horizon than do Sattre soils. They are better drained and have a browned B horizon than do Lawler soils. They are shallower over underlying sandy material than are Waukee soils.

Typical pedon in an area of Saude loam, 2 to 5 percent slopes, in a cultivated field 830 feet west and 40 feet south of the northeast corner sec. 19, T. 84 N., R. 9 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; friable; neutral; abrupt smooth boundary.

A2—8 to 13 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; very dark brown (10YR 2/2) coatings on peds; moderate very fine subangular blocky structure; friable; strongly acid; clear smooth boundary.

B1—13 to 17 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) coatings on peds; moderate very fine subangular blocky structure; friable; strongly acid; clear smooth boundary.
B21—17 to 25 inches; brown (10YR 4/3) loam; moderate very fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.

B22—25 to 27 inches; dark yellowish brown (10YR 4/4) heavy sandy loam; moderate very fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

IIIC—27 to 60 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) gravelly sand; single grained; loose; medium acid.

The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2), unless the soil has been eroded. Total thickness of the A horizon typically ranges from 10 to 16 inches.

The B horizon typically has hue of 10YS, value of 4 or 5, and chroma of 3 to 6. The B horizon ranges from 12 to 20 percent clay.

The C horizon is typically medium and coarse loamy sand and sand with some gravel. Depth to loamy sand, gravelly sand, and sand typically ranges from 24 to 32 inches with an extreme range of about 18 to 36 inches. The coarse material is acid. Carbonates are leached to 6 feet or more. The percentage by volume of gravel ranges from 5 to 15 percent.

**Schley series**

The Schley series consists of somewhat poorly drained, moderately permeable soils on straight to concave heads of upland drainageways or on side slopes along drainageways. These soils formed in 30 to 50 inches of loamy and sandy stratified material and in the underlying firm loam glacial till. The slope range is 1 to 4 percent.

Schley soils are similar to Floyd and Clyde soils. They are commonly adjacent to Kenyon, Bassett, Floyd, and Clyde soils. Schley soils have a thinner A1 horizon than do Kenyon, Clyde, and Floyd soils. They are more poorly drained than Kenyon and Bassett soils but better drained than Clyde soils.

Typical pedon in an area of Schley loam, 1 to 4 percent slopes, in a cultivated field 290 feet west and 2,125 feet north of the center sec, 30, T. 86 N., R. 9 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) loam; dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A21—7 to 13 inches; dark grayish brown (10YR 4/2) loam; light brownish gray (10YR 6/2) dry; moderate very thin platy structure; friable; strongly acid; clear smooth boundary.

A22—13 to 18 inches; brown (10YR 4/3) loam; light brownish gray (10YR 6/2) dry; common fine faint yellowish brown (10YR 5/4) mottles; moderate very thin platy structure; friable; strongly acid; clear wavy boundary.

B21—18 to 24 inches; grayish brown (2.5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; very strongly acid; clear smooth boundary.

B22—24 to 30 inches; grayish brown (2.5Y 5/2) loam; many fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; friable; thin discontinuous clay films; strongly acid; clear smooth boundary.

B23—30 to 45 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) sandy loam; few fine distinct yellowish red (5YR 5/6) mottles; weak fine subangular blocky structure; friable; clay bridging between sand grains; few pebbles more than 2 millimeters; medium acid; clear smooth boundary.

IIBB4—45 to 52 inches; mottled grayish brown (2.5Y 5/2), yellowish brown (10YR 5/4), and brown (7.5YR 5/4) loam; moderate medium and weak subangular blocky structure; firm; few thin clay films; slightly acid; clear smooth boundary.

IIBB3—52 to 60 inches; mottled yellowish brown (10YR 5/6) and gray (5Y 5/1) loam; weak coarse prismatic structure; firm; slightly acid.

The solon is commonly about 50 inches thick but ranges to 60 inches or more.

The A1 or A2 horizon is typically very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2), but the A1 horizon is black (10YR 2/1) in some places. The A2 horizon is dark grayish brown (10YR 4/2), brown (10YR 4/3), or grayish brown (10YR 5/2) with higher chroma mottles. It ranges from about 8 to 12 inches in thickness. The A horizon is loam or silt loam high in content of sand.

The B2 horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 to 4. It ranges from loam and silt loam high in sand content to heavy sandy loam. Reaction of the B2 horizon ranges from medium acid to very strongly acid. A pebble band commonly separates the overlying stratified material and the glacial till. Loamy sand may occur in this zone.

The IIBB3 and IIC horizons are typically mottled 7.5YR, 10YR, 2.5Y, and 5Y hue with value of 4 to 6 and chroma of 1 to 6. They are typically heavy loam, light clay loam, or sandy clay loam.

**Sogn series**

The Sogn series consists of somewhat excessively drained, moderately permeable soils on ridgetops and side slopes in uplands. These soils formed in 4 to 20 inches of loamy material over limestone bedrock. The slope range is 5 to 40 percent. The Sogn soils in Benton County have a more moist climate and are steeper than is typical for the series. These differences do not alter the use or behavior of the soils.

Sogn soils are similar to Rokton, Whalan, and Backbone soils but are shallower over bedrock than those soils.

Typical pedon in an area of Sogn loam, 9 to 18 percent slopes, in a wooded area 510 feet south and 520
feet east of the northwest corner sec. 10, T. 85 N., R. 9 W.

A11—0 to 4 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A12—4 to 10 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; very dark grayish brown (10YR 3/2) coatings on peds; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A3—10 to 12 inches; dark brown (10YR 3/3) heavy loam; moderate fine and medium subangular blocky structure; friable; slightly acid; clear wavy boundary.

R—12 inches; shattered and fractured limestone.

Thickness of the solum and depth to limestone is 4 to 15 inches. The A1 horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), dark brown (10YR 3/3), or very dark grayish brown (10YR 3/2). It is 5 to 15 inches thick. An A3 horizon occurs in some profiles. It is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). The A horizon ranges from loam to heavy sandy loam or light clay loam. In some places 1 to 4 inches of clay or silty clay material is just above the limestone.

**Sparta series**

The Sparta series consists of excessively drained soils that are moderately rapidly permeable in the upper part and rapidly permeable in the lower part. They are on benches and in uplands. They formed in sand that was deposited dominantly by wind. The slope range is 0 to 14 percent.

Sparta soils are similar to Chelsea soils. They have a darker colored A1 horizon than do Chelsea soils and do not have the banded A & B horizon characteristic of those soils.

Typical pedon in an area of Sparta loamy fine sand, 2 to 5 percent slopes, in a hayfield 900 feet north and 140 feet west of the center sec. 33, T. 86 N., R. 10 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to single grained; very friable; medium acid; gradual smooth boundary.

A12—8 to 20 inches; very dark grayish brown (10YR 3/2) loamy fine sand, gray (10YR 5/1) dry; weak medium subangular blocky structure parting to single grained; very friable; medium acid; gradual wavy boundary.

B2—20 to 28 inches; brown (10YR 4/3) loamy fine sand; weak medium subangular blocky structure parting to single grained; very friable; medium acid; gradual wavy boundary.

C—28 to 72 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; medium acid.

Thickness of the solum ranges from 24 to about 40 inches. Thickness of the mollic epipedon ranges from 13 to 24 inches.

The A horizon ranges from loamy fine sand to loamy sand or fine sand.

The B horizon has hue of 10YR and value and chroma of 3 to 6. It is fine sand, loamy sand, or loamy fine sand. Fine and medium sand are dominant throughout the control section. Reaction is medium acid to strongly acid in the B horizon.

**Sperry series**

The Sperry series consists of poorly drained or very poorly drained, slowly and very slowly permeable soils on nearly level to slightly depressional areas in uplands. The slope range is 0 to 1 percent.

Sperry soils are similar to Atterberry and Muscatine soils. Sperry soils have an A2 horizon; Muscatine soils do not. They have a grayer B horizon than do Muscatine soils. Sperry soils have a thicker A1 horizon and a grayer B horizon than Atterberry soils.

Typical pedon in an area of Sperry silt loam, 0 to 1 percent slopes, in a cultivated field 310 feet east and 160 feet south of the center sec. 27, T. 83 N., R. 12 W.

Ap—0 to 9 inches; black (10YR 2/1) silt loam; dark gray (10YR 4/1) dry; weak very fine granular structure; friable; some partly decomposed plant material; slightly acid; abrupt smooth boundary.

A12—9 to 14 inches; very dark gray (10YR 3/1) heavy silt loam, gray (10YR 5/1) dry; moderate fine granular structure; friable; some partly decomposed plant material; slightly acid; clear smooth boundary.

A21—14 to 18 inches; dark gray (10YR 4/1) silt loam; gray (10YR 6/1) dry; very dark gray (10YR 3/1) coatings on peds; moderate medium platy structure parting to weak fine subangular blocky; friable; medium acid; clear smooth boundary.

B22—18 to 22 inches; dark gray (10YR 4/1) silt loam; gray (10YR 6/1) dry; very dark gray (10YR 3/1) coatings on peds; moderate medium platy structure; friable; medium acid; abrupt smooth boundary.

B21—22 to 26 inches; black (10YR 2/1) light silty clay; few fine distinct yellowish brown (10YR 5/4) mottles; moderate very fine subangular blocky structure; firm; thin continuous clay films on ped surfaces; medium acid; clear smooth boundary.

B23—26 to 31 inches; very dark gray (10YR 3/1) heavy silty clay loam; few fine faint dark gray (10YR 4/1) mottles; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; slightly acid; clear smooth boundary.

B23t—31 to 37 inches; dark gray (5Y 4/1) heavy silty clay loam; very dark gray (10YR 3/1) coatings on
some peds; few fine faint gray (5Y 5/1) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin nearly continuous clay films on prisms and peds; slightly acid; gradual smooth boundary.

B31t—37 to 46 inches; dark gray (10YR 4/1) silty clay loam; very dark gray (10YR 3/1) coatings on prism faces; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure; firm; slightly acid; gradual wavy boundary.

C—46 to 60 inches; dark gray (5Y 4/1) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; firm; slightly acid.

Solum thickness ranges from 45 to more than 60 inches. The A1 horizon is 10 to 14 inches thick. It is black (10YR 2/1 or N 2/0) or very dark gray (10YR 3/1) silty loam. The A2 horizon is 6 to 10 inches thick. It is silt loam, and typically is very dark gray (10YR 4/1).

The B horizon is black (10YR 2/1) to dark gray (5Y 5/1) heavy silty clay loam or light silty clay. Reaction in the B horizon ranges from slightly acid to strongly acid.

The solum thickness ranges from 40 to 60 inches. Reaction in the solum is commonly neutral or slightly acid.

The A horizon is typically black (10YR 2/1) or very dark brown (10YR 2/2), but in some profiles it is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) in the lower part. These colors extend to a depth of 36 inches or more. Texture of the A horizon is typically loam but may be silt loam high in content of sand.

Below the A horizon is either a B or C horizon with hue commonly of 10YR, value of 3 or 4, and chroma of 1 to 3. It is commonly loam but may be sandy loam with strata of loamy sand or sand below 40 inches.

Tama series

The Tama series consists of well drained, moderately permeable soils on loess covered uplands and some loess covered benches. The slope range is 0 to 9 percent.

Tama soils are commonly adjacent to Muscatine and Dinsdale soils. Tama soils have a browner B horizon and are better drained than the Muscatine soils. Tama soils, formed in silty material more than 48 inches thick, have less sand in the lower part of the B horizon than do Dinsdale soils.

Typical pedon in an area of Tama silty clay loam, 2 to 5 percent slopes, in a cultivated area 530 feet north and 100 feet west of southeast corner sec. 30, T. 86 N., R. 12 W.

Ap—0 to 8 inches; black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—8 to 15 inches; very dark grayish brown (10YR 3/2) light silty clay loam, dark grayish brown (10YR 4/2) dry; very dark brown (10YR 2/2) coatings on peds; moderate fine and very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B1—15 to 18 inches; brown (10YR 4/3) silty clay loam; dark brown (10YR 3/3) coatings on peds; moderate fine and very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21t—18 to 27 inches; dark yellowish brown (10YR 4/4) silty clay loam; brown (10YR 4/3) coatings on peds; moderate fine subangular blocky structure; friable; very thin continuous clay films on surfaces of peds; medium acid; gradual smooth boundary.

B22t—27 to 36 inches; dark yellowish brown (10YR 4/4) silty clay loam; brown (10YR 4/3) coatings on peds; moderate fine and medium subangular blocky structure; friable; very thin continuous clay films on surface of peds; slightly acid; gradual smooth boundary.

B3—36 to 44 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) light silty clay loam; few fine faint yellowish brown (10YR 5/6) mottles;
few fine faint grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine dark reddish brown (5YR 2/2) oxides; friable; slightly acid; gradual smooth boundary.

C1—44 to 56 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) silt loam; massive; friable; slightly acid; abrupt wavy boundary.

IC2—56 to 64 inches; yellowish brown (10YR 5/4) sandy loam; single grained; loose; neutral; abrupt wavy boundary.

IC3—64 to 66 inches; yellowish brown (10YR 5/4) loam; massive; friable; neutral.

Solum thickness ranges from about 40 to 60 inches. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It ranges from 13 to 20 inches in thickness unless eroded. The A horizon is typically silty clay loam but ranges to silt loam.

The B horizon typically has hue of 10YR, value of 3 to 5, and chroma of 3 to 6. The B2t horizon ranges from 27 to 35 percent in clay content. Depth to grayish mottles is about 30 to 50 inches. Reaction is slightly acid to strongly acid in the B horizon.

The Tama silty clay loam, 5 to 9 percent slopes, moderately eroded, map unit is Tama soils with mollic epipedons that are not as thick as the defined range of the Tama series. This difference does not alter the use or behavior of these soils.

**Tripoli series**

The Tripoli series consists of poorly drained, moderately permeable soils on broad, nearly level ridgetops in uplands. These soils formed in 18 to 24 inches of loamy material and in the underlying glacial till. The slope range is 0 to 2 percent.

Tripoli soils are similar to Kenyon and Readlyn soils. They are commonly adjacent to Clyde and Floyd soils. Tripoli soils are more poorly drained and have a grayer B horizon than the Floyd, Kenyon, and Readlyn soils. They are shallower over firm loam glacial till and over carbonates than are Clyde soils.

Typical pedon in an area of Tripoli clay loam, 0 to 2 percent slopes, in a cultivated field 1,180 feet north and 1,230 feet east of the center sec. 13, T. 86 N., R. 10 W.

Ap—0 to 7 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; moderate fine granular structure; friable; slightly acid; abrupt smooth boundary.

A1—7 to 12 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A2—12 to 17 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

B1g—17 to 21 inches; dark grayish brown (2.5Y 4/2) clay loam; very dark gray (10YR 3/1) and dark gray (10YR 4/1) coatings on peds; common fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; few hard strong brown (7.5YR 5/6) oxides; neutral; clear smooth boundary.

B21g—21 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam; discontinuous dark gray (10YR 4/1) coatings on peds; common fine distinct light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; stone line at 24 inches; neutral; abrupt smooth boundary.

B1b2—24 to 27 inches; olive brown (2.5Y 4/4) heavy loam; discontinuous dark gray (10YR 4/1) coatings on peds; weak medium subangular blocky structure; friable; few hard light olive brown (2.5Y 4/4) oxides; neutral; clear smooth boundary.

B1b3—27 to 39 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) heavy loam; weak coarse subangular blocky structure; firm; few hard very dark brown (7.5YR 2/2) and strong brown (7.5YR 5/6) oxides; neutral; abrupt wavy boundary.

IC—39 to 60 inches; mottled yellowish brown (10YR 5/6) and light brownish gray (2.5 6/2) heavy loam; massive; firm; common fine distinct soft white lime accumulations; slight effervescence; mildly alkaline.

The solum thickness ranges from about 36 to 50 inches. The A horizon is black (N 2/0 or 10YR 2/1) in the upper part and very dark gray (10YR 3/1 or 5Y 3/1) in the lower part. It ranges from 15 to 22 inches in thickness. It ranges from silty clay loam high in content of sand to clay loam.

The B1b2 horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 6 with higher chroma mottles. The B1b horizon and IC horizon are generally heavy loam but range to light clay loam. Carbonates typically occur within a depth of 60 inches. Reaction ranges from neutral to slightly acid in the A horizon and from neutral to mildly alkaline in the B horizon.

**Udolpho series**

The Udolpho series consists of somewhat poorly drained soils that are moderately permeable in the upper part and rapidly permeable in the lower part. They are on benches along streams and rivers. These soils formed in 32 to 40 inches of loamy material and in the underlying coarse textured material. The slope range is 0 to 2 percent.

Udolpho soils are similar to and associated with Waukee, Saudee, Sattre, and Lawler soils. They have a grayer B horizon and are more poorly drained than the Waukee, Saudee, and Sattre soils. They have a thinner A1 horizon than do Lawler soils.

Typical pedon in an area of Udolpho loam, 32 to 40 inches to sand or gravel, 0 to 2 percent slopes, in a cultivated field 1,056 feet west and 1,160 feet south of the center sec. 15, T. 86 N., R. 10 W.
Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; neutral.
A2—7 to 16 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) loam, light gray (10YR 7/2) dry; moderate thin platy structure; friable; many fine distinct dark brown (7.5YR 3/2) and reddish brown (5YR 3/4) soft oxides; slightly acid; abrupt smooth boundary.
B1—16 to 21 inches; dark grayish brown (10YR 4/2) loam; grayish brown (10YR 5/2) coatings on peds; moderate medium subangular blocky structure; friable; common fine distinct dark brown (7.5YR 3/2) and reddish brown (5YR 4/4) oxides; medium acid; clear wavy boundary.
B21t—21 to 28 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) loam; moderate medium subangular blocky structure; friable; common fine distinct dark brown (7.5YR 3/2 and 4/4) oxides; clay flows in pores and root channels; thin patchy clay films on ped faces; strongly acid; gradual wavy boundary.
B22t—28 to 36 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) light loam; weak medium subangular blocky structure; friable; common fine distinct dark brown (7.5YR 3/2 and 4/4) oxides; thin discontinuous clay films on ped faces; strongly acid; abrupt wavy boundary.
IIB3—36 to 40 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) loamy sand with some gravel; weak coarse subangular blocky structure; very friable; common fine distinct dark brown (7.5YR 3/2 and 4/4) oxides; strongly acid; clear smooth boundary.
IIC—40 to 60 inches; yellowish brown (10YR 5/4) gravelly sand; single grained; loose; strongly acid.

Soil thickness ranges from about 24 to 40 inches. Depth to underlying coarse textured material, or contrasting textures, ranges from about 32 to 40 inches.
The A1 or Ap horizon ranges from 6 to 10 inches in thickness. It 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 10 inches thick.
The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 or 2.
The upper part of the B horizon is typically loam, silt loam high in content of sand, or light clay loam.
The lower part of the B horizon is sandy loam or loamy sand in some places. The lower part of the B horizon or the C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 6. Reaction is medium or strongly acid in the B horizon. The C horizon is dominantly loamy sand, coarse sand, or sand with some gravel.

Vesser series

The Vesser series consists of somewhat poorly drained or poorly drained, moderately permeable soils in level or slightly depressed areas on flood plains along major streams or on low stream benches. The slope range is 0 to 2 percent. The Vesser soils in Benton County have a thinner and more weakly expressed albic horizon than is typical for the Vesser series. This difference does not alter the use or behavior of the soils.
Vesser soils are commonly adjacent to Colo, Nevin, and Bremer soils. Vesser soils do not have as thick an A1 horizon as do Colo, Nevin, and Bremer soils. Vesser soils have a light colored A2 horizon; the Colo, Nevin and Bremer soils do not.
Typical pedon in an area of Vesser silt loam, 0 to 2 percent slopes, in a cultivated field 1,120 feet west and 1,000 feet north of the southeast corner sec. 24, T. 86 N., R. 11 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) heavy silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; friable; neutral; abrupt smooth boundary.
A12—7 to 11 inches; very dark gray (10YR 3/1) heavy silt loam, gray (10YR 5/1) dry; few fine distinct dark reddish brown (2.5YR 2/4) mottles; moderate fine granular structure; friable; medium acid; abrupt smooth boundary.
A21—11 to 15 inches; very dark gray (10YR 3/1) silt loam; gray (10YR 6/1) dry; many fine faint dark gray (10YR 4/1) mottles; moderate medium platy structure; friable; strongly acid; clear wavy boundary.
A22—15 to 19 inches; very dark gray (10YR 3/1) silt loam, continuous light gray (10YR 7/1) coatings on peds; fine distinct dark brown (7.5YR 4/4) mottles; moderate medium platy structure; friable; strongly acid; abrupt wavy boundary.
B21—19 to 31 inches; black (10YR 2/1) medium to heavy silty clay loam; few patchy gray (10YR 6/1) coatings on peds; few fine distinct reddish brown (5YR 4/4) and few fine faint dark gray (10YR 4/1) mottles; moderate medium prismatic structure parting to fine subangular blocky and angular blocky; firm; few thin continuous clay films on peds; strongly acid; clear smooth boundary.
B22t—31 to 39 inches; mottled dark gray (5Y 4/1) and gray (5Y 5/1) heavy silty clay loam; very dark gray (10YR 3/1) coatings on peds and prisms; common fine distinct dark brown (7.5YR 4/4) mottles; moderate medium prismatic structure parting to fine subangular blocky and angular blocky; firm; thin nearly continuous clay films on prisms and peds; strongly acid; clear smooth boundary.
B23t—39 to 45 inches; dark gray (5Y 4/1) silty clay loam; very dark gray (10YR 3/1) coatings on some prisms; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; thin patchy
clay films on prism faces; strongly acid; clear smooth boundary.

B24tg—45 to 54 inches; light gray (5Y 6/1) light silty clay loam; common fine and medium prominent reddish brown (5YR 4/4) and yellowish red (5YR 4/6) mottles; moderate medium prismatic structure; firm; thin patchy clay films on prism faces; dark stains in root channels; weak medium acid; clear smooth boundary.

B3g—54 to 60 inches; light gray (5Y 6/1) light silty clay loam; gray (5Y 5/1) coatings on some prisms; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; slightly acid.

Solum thickness ranges from 50 to 70 inches or more. The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A1 horizon ranges from heavy silt loam to light silty clay loam. It is 11 to 20 inches thick. The A2 horizon ranges from very dark gray (10YR 3/1) or dark gray (10YR 4/1) to grayish brown (10YR 5/2). The A2 horizon is silt loam. It is 8 to 20 inches thick.

The B2tg horizon has hue of 10YR or 5Y, value of 3 through 6, and chroma of 1 or 2. The B2tg horizon is heavy to light silty clay loam. Reaction in the B2 horizon is medium acid or strongly acid.

**Walford series**

The Walford series consists of poorly drained or very poorly drained, slowly permeable soils in flat or slightly depressed areas on loess covered high stream benches. The slope range is 0 to 1 percent. Walford soils are similar to the bench phases of Atterbury, Muscatine, and Tama soils. They have a thicker and more prominent A2 horizon than do Atterbury soils. They have an A2 horizon; the Muscatine and Tama soils do not. They have a grayer B horizon and are more poorly drained than the Atterbury, Muscatine, and Tama soils.

Typical pedon in an area of Walford silt loam, sandy substratum, 0 to 1 percent slopes, in a cultivated field 660 feet east and 660 feet north of the southwest corner sec. 19, T. 86 N., R. 10 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; few fine distinct brown (7.5YR 4/4) oxide concretions; slightly acid; abrupt smooth boundary.

A2—8 to 16 inches; grayish brown (10YR 5/2) silt loam, light gray (10YR 7/2) dry; very dark grayish brown (10YR 3/2) coatings on peds; few fine faint brown (7.5YR 4/4) mottles; weak thick platy structure; friable; medium acid; clear smooth boundary.

B1—16 to 21 inches; grayish brown (10YR 5/2) light silty clay loam; gray (10YR 5/1) coatings on peds; many medium distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; friable; many faint light gray (10YR 7/1) silt coatings on peds dry; few fine brown (7.5YR 4/4) oxide concretions; medium acid; clear smooth boundary.

B21t—21 to 28 inches; gray (10YR 5/1) silty clay loam; light gray (10YR 6/1) coatings on peds, many medium distinct yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to weak fine subangular blocky; firm; few thin discontinuous clay films; nearly continuous white (10YR 8/1) silt coatings on peds dry; medium acid; gradual smooth boundary.

B22t—28 to 38 inches; gray (10YR 5/1) silty clay loam; dark gray (10YR 4/1) coatings on peds; many medium distinct yellowish brown (10YR 5/6) mottles; moderate fine prismatic structure; firm; discontinuous clay films on surfaces of peds and in root channels; many fine brown (7.5YR 4/4) oxide concretions; medium acid; gradual smooth boundary.

B31t—38 to 47 inches; gray (10YR 5/1) light silty clay loam; many fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; friable; few thick discontinuous very dark gray (10YR 3/1) clay films on surfaces of peds and in root channels; common fine brown (7.5YR 4/4) oxide concretions; medium acid; abrupt smooth boundary.

II-B32—47 to 60 inches; yellowish brown (10YR 5/4) gravelly loamy sand; few fine faint grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; very friable; slightly acid.

Solum thickness ranges from 50 to 70 inches. The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 6 to 9 inches thick. The A2 horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 or 2. It ranges from 6 to 14 inches thick.

The B21t horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 1 or 2 with higher chroma mottles. Clay content of the Bt horizon ranges from 32 to 38 percent with a weighted clay average of less than 35 percent. Depth to loamy sand or gravelly loamy sand is 45 to 58 inches. Reaction is medium acid to strongly acid in the most acid part of the B horizon.

**Waukeek series**

The Waukeek series consists of moderately well drained, moderately permeable soils in uplands. These soils formed in 24 to 40 inches of loess and in the underlying glacial till. The slope range is 2 to 9 percent. Waukeek soils are similar to Dinsdale, Klinger, and Maxfield soils. They have a thinner A horizon than do those soils. They have a browner B horizon and are better drained than the Klinger and Maxfield soils.

Typical pedon in an area of Waukeek silt loam, 2 to 5 percent slopes, in a pasture 1,700 feet east and 327 feet north of the center sec. 2, T. 85 N., R. 11 W.
Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) heavy silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

B1t—7 to 11 inches; brown (10YR 4/3) light silty clay loam, pale brown (10YR 6/3) dry; some dark brown (10YR 3/3) coatings on peds; moderate very fine granular structure; friable; thin discontinuous clay films on ped faces; slightly acid; clear smooth boundary.

B2t—11 to 16 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate very fine subangular blocky structure; friable; thin nearly continuous clay films on ped faces; strongly acid; clear smooth boundary.

B2e—16 to 23 inches; dark yellowish brown (10YR 4/4) silty clay loam; dark brown (10YR 4/3) coatings on peds; moderate fine and very fine subangular blocky structure; friable; few light grayish brown (10YR 6/2) silt coatings on peds, dry; thin nearly continuous clay films on ped faces; strongly acid; gradual boundary.

B2f—23 to 33 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium and fine subangular blocky structure; friable; light grayish brown (10YR 6/2) silt coatings on peds, dry; thin nearly continuous clay films on ped faces; stone line at 33 inches; strongly acid; abrupt smooth boundary.

B2g—33 to 36 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) light loam; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; light brownish gray (10YR 6/2) silt coatings on peds, dry; thin discontinuous clay films on peds and sand grains; faint stone line at 36 inches; strongly acid; abrupt smooth boundary.

B2h—36 to 46 inches; yellowish brown (10YR 5/6) heavy loam; grayish brown (2.5Y 5/2) coatings on some prism faces; many fine distinct grayish brown (2.5Y 5/2) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; thin discontinuous clay films on peds; medium acid; gradual wavy boundary.

B2i—46 to 59 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) heavy loam; moderate medium prismatic structure; firm; thin discontinuous brown (10YR 4/3) clay films on some prism faces and in root channels; medium acid; abrupt wavy boundary.

IIC—59 to 63 inches; yellowish brown (10YR 5/4) heavy loam; common medium distinct grayish brown (2.5Y 5/2) mottles; heavy loam; massive; firm; slight effervescence; neutral.

The solum thickness is typically more than 45 inches and ranges from 42 to 60 inches. The loess is commonly 24 to 40 inches thick and ranges from 20 to 40 inches.

The A1 or Ap horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or very dark gray (10YR 3/1). It is 6 to 10 inches thick. If an A2 horizon occurs, it is dark grayish brown (10YR 4/2) or brown (10YR 4/3 or 5/3). In some cultivated or eroded areas, the A2 horizon is completely incorporated into the Ap horizon. In some pedons, the Ap horizon is underlain abruptly by a B1 horizon that is brown (10YR 4/3) and has dark brown (10YR 3/3) coatings on peds.

The upper part of the B horizon is silty clay loam with 28 to 33 percent clay. It has hue of 10YR, value of 4 or 5, and chroma of 3 to 5. The lower part of the B horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 through 8 with few to common low chroma mottles. The lower B horizon ranges from loam or sandy clay loam to light clay loam. Lenses of sandy loam or loamy sand as much as 10 inches thick are between the loess and the glacial till in places. Reaction ranges from medium to strongly acid in the B horizon.

**Waukee series**

The Waukee series consists of well drained soils that are moderately permeable in the upper part and are very rapidly permeable in the lower part. They are on benches. They formed in 32 to 40 inches of loam and in the underlying coarse sand and gravel. The slope range is 0 to 5 percent.

Waukee soils are similar to Saude, Sattre, and Lawler soils. They are deeper to coarse textured material than the Saude soils. They have a thicker A1 horizon than do Sattre soils. They have a brown B horizon and are better drained than Lawler soils.

Typical pedon in an area of Waukee loam, 0 to 2 percent slopes, in a cultivated field 1,475 feet west and 75 feet north of the southeast corner sec. 25, T. 86 N., R. 10 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; neutral; abrupt smooth boundary.

A1—8 to 16 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

B1—16 to 23 inches; very dark grayish brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B2—23 to 27 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) coatings on some peds; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B2—27 to 35 inches; dark yellowish brown (10YR 4/4) loam; dark brown (10YR 3/3) coatings on peds; moderate medium subangular blocky structure; friable; medium acid; abrupt smooth boundary.

B3—35 to 37 inches; dark yellowish brown (10YR 4/4) sandy loam with some gravel; dark brown (10YR
3/3) coatings on some peds; weak medium subangular blocky structure; very friable; neutral; abrupt wavy boundary.

C—37 to 60 inches; yellowish brown (10YR 5/4) coarse sand with some gravel; single grained; loose; neutral.

Thickness of the solum may or may not correspond to the depth to coarse loamy sand or gravelly sand. Depth to sandy and gravelly material is typically 32 to 40 inches.

The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is loam or silt loam high in content of sand. The A horizon ranges from 13 to 18 inches in thickness.

The B2 horizon typically has hue of 10YR, value of 4 or 5, and chroma of 3 through 6. The B2 horizon is loam, sandy clay loam, or heavy sandy loam. It ranges from about 18 to 24 percent clay. Reaction is medium or strongly acid in the B horizon.

The C horizon is loamy coarse sand, coarse sand, gravelly sand, or sand. It is about 10 to 20 percent gravel but ranges to as much as 20 to 50 percent by volume in some places.

**Waukegan series**

The Waukegan series consists of well drained soils that are moderately permeable in the upper part and are rapidly permeable in the lower part. They are on benches. They formed in 24 to 40 inches of silty material and in the underlying sandy material. The slope range is 0 to 5 percent.

Waukegan soils are similar to Whittier soils. They are associated with Waukee soils. They have a thicker and generally darker colored A horizon than do Whittier soils. They contain less sand in the upper part of the solum than do Waukee soils.

Typical pedon in an area of Waukegan silt loam, 0 to 2 percent slopes, in a cultivated area 60 feet west and 915 feet south of the center sec. 29, T. 82 N., R. 12 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; friable; neutral; abrupt smooth boundary.

A12—8 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderately fine subangular blocky structure; friable; slightly acid; clear wavy boundary.

B1—13 to 18 inches; brown (10YR 4/3) light silty clay loam; dark brown (10YR 3/3) coatings on peds; moderate very fine subangular blocky structure; friable; medium acid; clear wavy boundary.

B21—18 to 25 inches; dark yellowish brown (10YR 4/4) light silty clay loam; moderate medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

B22—25 to 33 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; few light brownish gray (10YR 6/2) silt coatings on peds; medium acid; abrupt smooth boundary.

B23—33 to 36 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; medium acid; abrupt smooth boundary.

IlB3—36 to 49 inches; yellowish brown (10YR 5/4) loamy sand; single grained; loose; medium acid; clear wavy boundary.

IlC1—49 to 60 inches; yellowish brown (10YR 5/6) sand; single grained; loose; medium acid.

Thickness of the solum ranges from 42 to about 60 inches. Depth to contrasting textures ranges from about 30 to 40 inches.

The A1 horizon is typically black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). If an A3 horizon occurs, it is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). Total thickness of the A horizon ranges from 10 to 17 inches.

The B2 horizon typically has hue of 10YR, value of 4 or 5, and chroma of 3 through 6. It is typically silty clay loam but ranges to silt loam, loam, and loamy sand. Reaction in the B horizon ranges from medium to strongly acid.

The C horizon has hue of 10YR, value of 4 or 5, and chroma of 3 through 6. It is stratified loamy sand and sand.

**Whalan series**

The Whalan series consists of well drained soils that are moderately permeable in the upper part and moderately slowly or slowly permeable in the lower part. They are on ridgetops and side slopes in uplands. These soils formed in 20 to 30 inches of loamy material over limestone bedrock. The slope range is 2 to 9 percent.

Whalan soils are similar to Rockton soils but have a thinner and generally lighter colored A1 horizon than do those soils.

Typical pedon in an area of Whalan loam, 20 to 30 inches to limestone, 2 to 9 percent slopes, in a pasture 1,260 feet north and 490 feet west of the center sec. 14, T. 85 N., R. 10 W.

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) light loam; grayish brown (10YR 5/2) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A2—2 to 5 inches; brown (10YR 4/3) light loam; light brownish gray (10YR 6/2) dry; weak fine platy structure; friable; medium acid; clear wavy boundary.

B1—5 to 10 inches; dark yellowish brown (10YR 4/4) loam; light brownish gray (10YR 6/2) sand and silt coatings on peds dry; some dark brown (10YR 3/3) coats on peds; moderate fine angular blocky structure; friable; medium acid; clear wavy boundary.
B21—10 to 16 inches; dark yellowish brown (10YR 4/4) heavy loam; moderate fine and medium angular blocky structure; friable; thin discontinuous brown (10YR 4/3) clay films on peds; medium acid; gradual smooth boundary.

B22—16 to 26 inches; dark yellowish brown (10YR 4/4) heavy loam; moderate fine and medium angular blocky structure; friable; thin discontinuous clay films on peds; medium acid; clear wavy boundary.

IIB23—26 to 28 inches; dark yellowish brown (10YR 4/4) silty clay; moderate fine subangular blocky structure; firm; thin continuous clay films on peds; few dark (10YR 3/3) stains on peds; about 50 percent by volume limestone fragments; neutral; abrupt wavy boundary.

R—28 inches; fragmented limestone.

Solum thickness and depth to limestone bedrock is 20 to 30 inches. The A1 horizon ranges from 2 to 6 inches in thickness. It is very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3). The A2 horizon is 2 to 6 inches thick. It is dark grayish brown (10YR 4/2), brown (10YR 4/3), or grayish brown (10YR 5/2).

The upper part of the B horizon is dark yellowish brown (10YR 4/4) or brown (10YR 4/3) loam. Reaction is medium acid to strongly acid in the upper part of the B2 horizon. If a IIB horizon occurs, it is clay loam, silty clay or clay 2 to 4 inches thick.

### Whittier series

The Whittier series consists of well drained soils that are moderately permeable in the upper part and rapidly permeable in the lower part. These soils are on high stream benches along rivers and major streams. They formed in 24 to 40 inches of silty material and in the underlying sand and gravel. The slope range is 1 to 4 percent.

Whittier soils are similar to Waukegan soils but have a thinner and generally lighter colored A horizon than do those soils.

Typical pedon in an area of Whittier silt loam, 1 to 4 percent slopes, in a cultivated field 1,700 feet east and 275 feet north of the center sec. 6, T. 85 N., R. 10 W.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam; brown (10YR 5/3) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

B1—7 to 11 inches; dark yellowish brown (10YR 4/4) light silt loam; pale brown (10YR 6/3) silt coatings on peds dry; moderate very fine subangular blocky structure; friable; brown (10YR 4/3) thin discontinuous clay films on ped faces; neutral; clear smooth boundary.

B21—11 to 21 inches; dark yellowish brown (10YR 4/4) silt loam; pale brown (10YR 6/3) silt coatings on peds dry; moderate fine angular blocky and subangular blocky structure; friable; brown (10YR 4/3) thin nearly continuous clay films on ped faces; slightly acid; abrupt smooth boundary.

B22—21 to 27 inches; dark yellowish brown (10YR 4/4) silty clay loam; pale brown (10YR 6/3) silt coatings on peds dry; moderate fine and medium angular blocky and subangular blocky structure; friable; brown (10YR 4/3) thin nearly continuous clay films on ped faces; medium acid; abrupt wavy boundary.

IIB23—27 to 31 inches; dark yellowish brown (10YR 4/4) loam; weak coarse prismatic structure parting to moderate medium subangular blocky; friable; medium acid; clear wavy boundary.

IIC1—31 to 39 inches; yellowish brown (10YR 5/4) loamy sand, single grained; loose; several dark yellowish brown (10YR 4/4) clay discontinuous bands about 1 inch thick; slightly acid; clear wavy boundary.

IIC2—39 to 60 inches; yellowish brown (10YR 5/6) loamy sand with some gravel; single grained; slightly acid.

Solum thickness typically ranges from 30 to 48 inches. It may or may not correspond to the depth to loamy sand or sand. Depth to the sandy material is typically 30 to 40 inches but may be as little as 24 inches.

The A1 or Ap horizon is dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2). It is 6 to 9 inches thick. If an A2 horizon occurs, it is dark grayish brown (10YR 4/2) or brown (10YR 4/3). It typically is about 2 to 5 inches thick, but in eroded areas it may be wholly incorporated into the plow layer.

The B2 horizon has hue of 10YR, value of dominantly 4 or 5, and chroma of 3 or 4. It is silty clay loam with 28 to 33 percent clay. The IIB horizon is loam or sandy loam. Reaction ranges from medium acid to strongly acid in the most acid part.

The C horizon is fine sand or loamy sand.

### Wiota series

The Wiota series consists of well drained soils that are moderately permeable in the upper part and rapidly or very rapidly permeable in the lower part. They are on low stream benches. They formed in moderately fine textured alluvium. The slope range is 1 to 3 percent. The Wiota soils in Benton County do not have the argillic horizon that is typical for the Wiota series. This difference does not alter the use or behavior of these soils.

Wiota soils are similar to Nevin and Bremer soils. They have a B horizon that is not so gray as that of those soils. They are also better drained than those soils.

Typical pedon in an area of Wiota silt loam, loamy substratum, 1 to 3 percent slopes, in a cultivated field 1,760 feet south and 635 feet east of the northwest corner sec. 27, T. 82 N., R. 10 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granu-
lar structure; friable; neutral; abrupt smooth boundary.
A12—7 to 12 inches; very dark grayish brown (10YR 3/2) light silty clay loam, grayish brown (10YR 5/2) dry; very dark brown (10YR 2/2) coatings on peds; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.
A3—12 to 16 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; very dark grayish brown (10YR 3/2) coatings on some peds; weak very fine subangular blocky structure; friable; medium acid; clear smooth boundary.
B1—16 to 22 inches; brown (10YR 4/3) silty clay loam; moderate very fine and fine subangular blocky structure; friable; very thin patchy clay films on peds; few very fine dark oxides; medium acid; clear smooth boundary.
B21—22 to 31 inches; brown (10YR 4/3) silty clay loam; moderate fine and medium subangular blocky structure; friable; thin nearly continuous clay films on peds; common very fine soft oxides; medium acid; gradual smooth boundary.
B22—31 to 37 inches; brown (10YR 4/3) silty clay loam; moderate fine and medium subangular blocky structure; friable; thin nearly continuous clay films on peds; pale brown (10YR 6/3) sand and silt coatings on peds dry; few soft oxides; medium acid; clear smooth boundary.
B23—37 to 47 inches; brown (10YR 4/3) silty clay loam; common fine faint dark grayish brown (10YR 5/2) mottles; common fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak fine prismatic structure parting to moderate fine and very fine subangular blocky; friable; thin patchy clay films on prism and ped faces; pale brown (10YR 6/3) sand and silt coatings on peds dry; slightly acid; abrupt wavy boundary.
C—47 to 60 inches; dark yellowish brown (10YR 4/4) sandy loam; common fine faint dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) mottles; massive; very friable; slightly acid.

The solum ranges from 36 to 60 inches in thickness. The A1 or Ap horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). The A horizon is heavy silt loam or light silty clay loam. It is about 14 to 24 inches thick.

The B horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). It is silty clay loam 20 to 40 inches thick. Reaction is slightly acid or medium acid in the most acid part of the B2 horizon.

The C horizon is brown (10YR 4/4) with grayish brown and yellowish brown mottles. It typically is sandy loam or loamy sand but ranges to stratified loam or silt loam in places.

Zook series

The Zook series consists of poorly drained, slowly permeable soils formed in alluvium on level flood plains along rivers and major streams. The slope range is 0 to 2 percent.

Zook soils are associated with Colo soils. They have a higher clay content throughout the profile than do Colo soils.

Typical pedon in an area of Zook silty clay loam, 0 to 2 percent slopes, in a cultivated area 2,175 feet east and 200 feet north of the southwest corner sec. 29, T. 82 N., R. 12 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure parting to moderate fine granular; firm; neutral; clear boundary.
A12—8 to 14 inches; black (N 2/0) heavy silt clay loam, dark gray (10YR 4/1) dry) moderate very fine subangular blocky structure; firm; neutral; gradual smooth boundary.
A13—14 to 26 inches; black (N 2/0) heavy silt clay loam, dark gray (10YR 4/1) dry; weak medium prismatic structure parting to moderate very fine subangular blocky and granular; firm; neutral; gradual smooth boundary.
A14—26 to 37 inches; black (N 2/0) light silt clay; weak medium prismatic structure parting to moderate very fine subangular blocky and granular; firm; sheen on faces of peds; neutral; gradual smooth boundary.
AC—37 to 45 inches; black (N 2/0) silty clay; weak fine prismatic structure; firm; sheen on faces of peds; neutral; gradual smooth boundary.
C1—45 to 53 inches; black (10YR 2/1) silty clay; weak medium prismatic structure; firm; neutral; gradual smooth boundary.
C2—53 to 60 inches; very dark gray (10YR 3/1) clay loam; few fine faint dark grayish brown (2.5Y 4/2) mottles; massive; common hard dark reddish brown (5YR 2/2) 2 to 3 millimeter oxides; neutral.

Solum thickness ranges from 36 to 60 inches. The A horizon is black (N 2/0 or 10YR 2/1). It is heavy silty clay loam in the upper part and heavy silty clay loam to silty clay in the lower part. It is 36 to 45 inches thick.

The B horizon, where present, and the C horizon are very dark gray (10YR 3/1), dark gray (10YR to 5Y 4/1), and gray (5Y 5/1). They are heavy silty clay loam, light silty clay, or clay loam.

Formation of the soils

In this section the factors of soil formation are discussed and related to the soils in the survey area. In addition, the influence of man on the soil is discussed.
Factors of soil formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (a) the physical and mineral composition of the parent material, (b) the climate under which the soil has accumulated and existed since accumulation, (c) the plant and animal life on and in the soil, (d) the relief, or lay of the land, and (e) the length of time the forces of soil development have acted on the soil material (2).

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 with genetically related horizons. The effects of climate and vegetation are conditioned by relief. Parent material also affects the kind of profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed. It may be much or little, but some time is required for horizon differentiation. A long period generally is required for distinct horizons to develop.

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 one 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 soils in Benton County formed as the result of weathering in place of bedrock. Most soils, however, formed in material that was transported from the site of the parent rock and redeposited through the action of glacial ice, water, wind, and gravity.

The principal parent materials in Benton 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 transported by glacier ice, all deposits made by glacier ice, and all deposits of dominantly glacial origin made in the sea or in bodies of glacial meltwater. It includes glacial till, which is unsorted sediment made up of particles ranging in size from boulders to clay (7).

At least twice during the glacial period, continental ice or glaciers moved over Benton County. The record of these invasions is contained in the unconsolidated rock material deposited by the melting ice and by meltwater streams. The older ice sheet, known as the Nebraskan, occurred some 750,000 years ago (3). 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 (4) as the lowan substage of the Wisconsin glaciation, but recent studies indicate that conclusions formed from studies made before 1960 are questionable. Intensive, detailed geomorphic stratigraphic work shows that the landscape is a multilevel sequence of erosion surfaces and that many of the levels are cut into Kansan and Nebraskan till. Ruhe's study in Tama and Linn Counties (9) demonstrated that lowan till does not exist, but that an erosion surface complex does exist in the lowan region. The multilevel lowan surface is a series of steps from major drainageways toward bounding divides. It is marked by a stone line where it cuts Kansan and Nebraskan till. The stone line occurs on all levels of the stepped surfaces and passes under the alluvium along drainageways.

Soils formed in glacial drift on the lowan erosion surface are the Bassett, Clyde, Coggon, Donnan, Floyd, Kenyon, Readlyn, Schley, and Tripoli soils. In these soils a loamy surficial sediment about 1 to 2 feet thick overlies the glacial material. This sediment is deeper, however, in such soils as the Clyde, Floyd, and Schley soils on lower concave slopes and in waterways. 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 in the clayey paleosol derived from glacial till.

Loess is windblown silt. It forms a mantle of variable thickness over the glacial drift in much of the upland. In general the loess is thickest along the southern boundary of the county. Very little loess is in the northeastern corner of the county. Where the loess is more than 40 inches thick, the Tama, Downs, or Fayette soils formed. Where the loess is 20 to 40 inches thick over glacial till, Dinsdale, Klinger, Maxfield, or Waubeek soils formed. The elongated, loess-capped ridges oriented northwest-erly to southeasterly and are called pahas (10, 11). They stand apart on the lowan plain or merge with similar features to form lengthy ridges or broad plateaus.

Alluvium is sediment transported and deposited by water. Alluvial deposits of Late Wisconsin age occur under the flood plains and terraces of watercourses in Benton County as lenses and layers of sand, gravel, silt, and clay. Along major streams alluvial material is as much as 95 feet thick; along small streams it is less than 5 feet thick. Waukee soils formed in loamy alluvium over sand and gravel. The Waukegan soils formed in silty alluvium over sand and gravel.

Some alluvial material, which was transported only a short distance, 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 area from which it eroded. The Ely soil is an example. It occurs at the foot of slopes, directly below loess-derived soils.

When streams overflow their channels and water spreads over the flood plain, coarse-textured material is deposited first. Fine-textured sediment, such as silt, is deposited by more slowly moving water. After the flood has passed, the finest particles, or clay, settle from the water left standing in the lowest part of the flood plain.
Spilville soils formed in loamy material. Nodaway soils formed in finer textured silty material. Colo soils, which are on the lowest part of the flood plain, contain more clay and typically are silty clay loam throughout.

_Eolian sand or wind-deposited sand_ occurs in uplands and on benches. In glacial till uplands, sand occurs as low mounds or dunes underlain by till at various depths. Sand also occurs in areas intermingled with areas of loess soils. Wind-deposited sand consists largely of quartz which is very fine and fine in size and is highly resistant to weathering. It has not been altered appreciably since it was deposited. Soils that formed mainly in wind-deposited sand are Dickinson, Lamont, and Sparta soils.

**Organic deposits** occur in old lakebeds or swamps that supported a thick growth of water-tolerant plants. Poor drainage retarded the decay of the plant remains, which accumulated over a period of time. The organic material ranges from about 10 to 60 inches in thickness and in a few areas it is more than 60 inches thick. Palms soils formed in organic material.

**Residuum** is the material derived from the weathering in places of sedimentary rock or of the material just over sedimentary rock. It is a very minor parent material in Benton County. The underlying bedrock belongs to the Devonian and Pennsylvanian systems. Strata of sandstone, limestone, dolomite, and shale are stacked in layer-cake fashion. The Upper and Middle Devonian series crops out or underlies the glaciation till in most of the county. The Pennsylvanian system underlies the glacial till in an area of the southern part of the county.

**Climate**

The morphology of most of the soils indicates that the climate under which they formed was similar to the present one. At present, the climate is fairly uniform throughout the county. It is marked by wide seasonal extremes in temperature. Precipitation is distributed throughout the year. According to available evidence, the soils of Benton County have developed under this midcontinental, subhumid climate for at least 3,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to the growth of forest vegetation (6).

Temperature, rainfall, relative humidity, and length of frost-free period are important in determining the vegetation. Climate is also a major factor in determining the kinds of soils that develop from plant materials because the rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by climate.

The influence of the general climate of the region is somewhat modified by local conditions in or near the developing soil. For example, south-facing, dry, sandy slopes have a local climate or microclimate that is warmer and less humid than the 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 region.

**Plant and animal life**

All living organisms—plants, animals, bacteria, and fungi—influence soil formation. Plants are responsible for the content of organic matter and nutrients and the color of the surface layer. Animals such as earthworms and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

Most of the soils in Benton 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 soil, the soils have a thick, dark surface layer. Kenyon and Floyd soils are examples.

The soils which developed under timber vegetation have a thinner, lighter surface layer. Organic matter, principally from leaves, was deposited only on the surface of the soil. Fayette and Coggon soils are examples.

In many areas soils developed for a time under prairie grasses and then under forest vegetation. These soils are intermediate between soils formed entirely under grass and those formed entirely under forest. Downs and Waubeek soils are examples.

The Tam, Downs, and Fayette soils are members of a group of soils that formed from the same kind of parent material under comparable environment except for native vegetation. Differences in native vegetation account for the main differences in morphology of soils of this group.

**Relief**

Relief, or topography, influences soil development mainly through its effect on drainage, run off, and erosion. In Benton County the relief ranges from level to very steep.

Water soaks into nearly level areas that are not flooded. On steeper slopes, more water runs off and less penetrates the soil. The Dinsdale, Klinger, and Maxfield soils all formed in the same kind of parent material under similar vegetation but differ because of topographic position. Maxfield soils are on broad, level or nearly level, high upland flats. Klinger soils are on nearly level ridges and long, gentle, concave slopes. Dinsdale soils are on gently sloping to moderately sloping uplands.

In depressions which collect and impound water for a period of time, the soils are poorly drained and have a distinct, lighter colored subsurface layer and a gray subsoil. Walford soils formed in depressions.

Soils on steep slopes have weak soil development. Most of the water that falls on their surface runs off. Sogn soils are an example.

Soils that formed in alluvium on bottom lands, such as Colo and Spilville soils, are nearly level. Their microrelief, however, affects runoff, depth to water table, and
amount of new sediment. Colo soils, which are on low elevations, have a high water table and impound water for short periods of time. Spillville soils, on slightly higher elevations are moderately well drained.

Aspect as well as gradient influences soil development. 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 are moderately rapid to rapidly permeable.

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 strongly developed soils show well defined genetic horizons. The Tama, Downs, and Fayette soils are examples. A younger soil shows only weakly developed horizons. Some soils that formed in alluvium show little or no profile development because fresh material is deposited periodically. The material has not been in place long enough for well defined genetic horizons to develop under the influence of the climate and vegetation. Nodaway soils are an example. Soils on steep slopes show little or no development because soil material is removed before it has time to develop into a deep profile. Sogn soils are an example.

The resistance of materials may modify the effect of time. Soils that formed in material resistant to weathering, such as quartz sand, do not change much with time. Examples are Chelsea and Sparta soils.

Where organic material, such as wood, has been buried by deposition through the action of ice, water, or wind, the age of a landscape can be determined by a process known as radiocarbon dating ($\delta$).

The loess in Benton County, from which Tama, Downs, and Fayette soils formed, is probably 14,000 to 20,000 years old. Recent studies by Ruhe and others (9) show that the lowan erosion surface formed during loess deposition time. The lowan surface beneath the loess could be as young as 14,000 years, which dates the close of the major loess deposition in Iowa. The surface not covered by loess can be younger than the loess. The lowan surface where covered by loam surficial sediment is younger than 14,000 years, and soils on the slopes are probably much younger. Soils such as the Bassett, Kenyon, Aredale, Readlyn, and Tripoli soils are on this surface. The Floyd, Clyde, and Schley soils are younger, as they are cut in and below these higher-lying soils.

The influence of man

Important changes occurred when man settled Benton County and began to cultivate the soils. Some had little effect on soil productivity, and others had drastic effects.

Water erosion caused the most obvious changes. Cultivation makes sloping areas more susceptible to erosion, which removes topsoil, organic matter, and plant nutrients. Sheet erosion, which is the most prevalent in the county, removes a few inches of topsoil at a time, but in deep soils cultivation usually destroys all evidence of this loss. In places, shallow and deep gullies have formed, and the eroded material has been deposited on the lower slopes.

Wind erosion also occurs when man cultivates the soil. Coarse textured soils blow, especially when the land is left bare and the topsoil is dry. On nearly level fields that have been fallplowed, dark topsoil can be seen mixed with the snow or piled along fence rows and road ditches.

The well developed granular structure of the surface layer, apparent in virgin grassland, begins to break down in fields that are continuously cultivated. The surface soil tends to bake and become hard when dry. Fine-textured soils that have been plowed continually when wet tend to puddle and are less permeable than similar soils in undisturbed areas. In some fields of fine-textured soils, a compact layer which is hard when dry and is less permeable than the subsoil has formed below the plowed layer. This layer is called a "plowsole", or "plowpan."

In many places, dark-colored, low-lying soils have received lighter colored deposits. Nodaway silt loam is a soil formed in recent alluvium that shows the influence of man. It has strata of light and dark colored material washed from the hillsides and deposited by floods. This erosion has taken place since man began cultivating the hillsides.

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, which can now be cultivated. He has also added commercial fertilizers to counteract deficiencies in plant nutrients so that the soil can be more productive than virgin soil.

References


(5) Portland Cement Association. 1962. PCA soil primer. 52 pp., illus.

Glossary

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.
Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.
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—

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Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.
Bottom land. The normal flood plain of a stream, subject to flooding.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.
Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.
Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.
Coarse textured soil. Sand or loamy sand.
Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.
Conservation tillage. Preparing a seedbed with a minimum of soil disturbance and leaving the needed amount of crop residue on the surface to protect the soil.
Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—
Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.
Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tiled crops or summer fallow.
Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.
Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.
Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.
Depth to rock. Bedrock is too near the surface for the specified use.

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.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil.

Fertility. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, till, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called normal field capacity, normal moisture capacity, or capillary capacity.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as pro-
tection against erosion. Conducts surface water away from cropland.

**Gravel.** Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

**Horizon, soil.** A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

*O horizon.*—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

*A horizon.*—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

*B horizon.*—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have 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 in which the solum 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.

**Hydrologic soil groups.** Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

**Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

**Liquid limit.** The moisture content at which the soil passes from a plastic to a liquid state.

**Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

**Loess.** Fine grained material, dominantly of silt-sized particles, deposited by wind.

**Low strength.** The soil is not strong enough to support loads.

**Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.

**Miscellaneous areas.** Areas that have little or no natural soil and support little or no vegetation.

**Morphology, soil.** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

**Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

**Muck.** Dark colored, finely divided, well decomposed organic soil material.

**Munsell notation.** A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

**Neutral soil.** A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

**Nutrient, plant.** Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

**Paha.** A loess-capped prominence, elliptical in shape, surrounded by soils that formed in glacial till.

**Parent material.** The unconsolidated organic and mineral material in which soil forms.

**Percolation.** The downward movement of water through the soil.
Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

- Very slow: less than 0.06 inch
- Slow: 0.06 to 0.20 inch
- Moderately slow: 0.2 to 0.6 inch
- Moderate: 0.6 inch to 2.0 inches
- Moderately rapid: 2.0 to 6.0 inches
- Rapid: 6.0 to 20 inches
- Very rapid: more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

<table>
<thead>
<tr>
<th>Acidity Level</th>
<th>pH Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely acid</td>
<td>Below 4.5</td>
</tr>
<tr>
<td>Very strongly acid</td>
<td>4.5 to 5.0</td>
</tr>
<tr>
<td>Strongly acid</td>
<td>5.1 to 5.5</td>
</tr>
<tr>
<td>Medium acid</td>
<td>5.6 to 6.0</td>
</tr>
<tr>
<td>Slightly acid</td>
<td>6.1 to 6.5</td>
</tr>
<tr>
<td>Neutral</td>
<td>6.6 to 7.3</td>
</tr>
<tr>
<td>Mildly alkaline</td>
<td>7.4 to 7.8</td>
</tr>
<tr>
<td>Moderately alkaline</td>
<td>7.9 to 8.4</td>
</tr>
<tr>
<td>Strongly alkaline</td>
<td>8.5 to 9.0</td>
</tr>
<tr>
<td>Very strongly alkaline</td>
<td>9.1 and higher</td>
</tr>
</tbody>
</table>

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinkage 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.

Soll. A natural, three-dimensional body at the earth’s surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

<table>
<thead>
<tr>
<th>Millimeter Size</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very coarse sand</td>
<td>2.0 to 1.0</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>1.0 to 0.5</td>
</tr>
<tr>
<td>Medium sand</td>
<td>0.5 to 0.25</td>
</tr>
<tr>
<td>Fine sand</td>
<td>0.25 to 0.10</td>
</tr>
<tr>
<td>Very fine sand</td>
<td>0.10 to 0.05</td>
</tr>
<tr>
<td>Silt</td>
<td>0.05 to 0.02</td>
</tr>
<tr>
<td>Clay</td>
<td>Less than 0.002</td>
</tr>
</tbody>
</table>

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer
than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

**Substratum.** The part of the soil below the solum.

**Subsurface layer.** Any surface soil horizon (A1, A2, or A3) below the surface layer.

**Surface layer.** 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."

**Taxadjuncts.** Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

**Terrace.** An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that 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.

**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."

**Thin layer** (in tables). Otherwise suitable soil material too thin for the specified use.

**Tilth, soil.** The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

**Topsoil.** The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

**Upland** (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.
<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature (°F)</th>
<th>Precipitation (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Maximum</td>
</tr>
<tr>
<td>January</td>
<td>27.5</td>
<td>18.3</td>
</tr>
<tr>
<td>February</td>
<td>33.5</td>
<td>24.1</td>
</tr>
<tr>
<td>March</td>
<td>43.8</td>
<td>34.2</td>
</tr>
<tr>
<td>April</td>
<td>60.9</td>
<td>49.5</td>
</tr>
<tr>
<td>May</td>
<td>72.5</td>
<td>60.7</td>
</tr>
<tr>
<td>June</td>
<td>81.8</td>
<td>70.2</td>
</tr>
<tr>
<td>July</td>
<td>85.5</td>
<td>73.9</td>
</tr>
<tr>
<td>August</td>
<td>83.6</td>
<td>71.9</td>
</tr>
<tr>
<td>September</td>
<td>75.6</td>
<td>63.4</td>
</tr>
<tr>
<td>October</td>
<td>65.4</td>
<td>53.3</td>
</tr>
<tr>
<td>November</td>
<td>47.2</td>
<td>37.6</td>
</tr>
<tr>
<td>December</td>
<td>33.0</td>
<td>24.7</td>
</tr>
<tr>
<td>Year</td>
<td>59.2</td>
<td>48.5</td>
</tr>
</tbody>
</table>

¹ Recorded in the period 1951-74 at Vinton, Iowa.

² A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50°F).
### TABLE 2.--FREEZE DATES IN SPRING AND FALL

<table>
<thead>
<tr>
<th>Probability</th>
<th>Temperature^1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20°F or lower</td>
</tr>
<tr>
<td>Last freezing temperature in spring:</td>
<td></td>
</tr>
<tr>
<td>1 year in 10 later than--</td>
<td>April 20</td>
</tr>
<tr>
<td>2 years in 10 later than--</td>
<td>April 15</td>
</tr>
<tr>
<td>5 years in 10 later than--</td>
<td>April 7</td>
</tr>
<tr>
<td>First freezing temperature in fall:</td>
<td></td>
</tr>
<tr>
<td>1 year in 10 earlier than--</td>
<td>October 13</td>
</tr>
<tr>
<td>2 years in 10 earlier than--</td>
<td>October 18</td>
</tr>
<tr>
<td>5 years in 10 earlier than--</td>
<td>October 27</td>
</tr>
</tbody>
</table>

^1Recorded in the period 1951-74 at Vinton, Iowa.

### TABLE 3.--GROWING SEASON

<table>
<thead>
<tr>
<th>Probability</th>
<th>Daily minimum temperature during growing season^1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Higher than 24°F</td>
</tr>
<tr>
<td></td>
<td>Days</td>
</tr>
<tr>
<td>9 years in 10</td>
<td>185</td>
</tr>
<tr>
<td>8 years in 10</td>
<td>191</td>
</tr>
<tr>
<td>5 years in 10</td>
<td>202</td>
</tr>
<tr>
<td>2 years in 10</td>
<td>214</td>
</tr>
<tr>
<td>1 year in 10</td>
<td>220</td>
</tr>
</tbody>
</table>

^1Recorded in the period 1951-74 at Vinton, Iowa.
<table>
<thead>
<tr>
<th>Map Symbol</th>
<th>Soil name</th>
<th>Acres</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>11B</td>
<td>Colo-Elly complex, 2 to 5 percent slopes</td>
<td>50,960</td>
<td>11.1</td>
</tr>
<tr>
<td>47</td>
<td>Sparta loamy fine sand, 0 to 2 percent slopes</td>
<td>2,480</td>
<td>0.5</td>
</tr>
<tr>
<td>41A</td>
<td>Sparta loamy fine sand, 2 to 5 percent slopes</td>
<td>2,185</td>
<td>0.5</td>
</tr>
<tr>
<td>41C</td>
<td>Sparta loamy fine sand, 5 to 9 percent slopes</td>
<td>440</td>
<td>0.1</td>
</tr>
<tr>
<td>41D</td>
<td>Sparta loamy fine sand, 9 to 14 percent slopes</td>
<td>1,130</td>
<td>0.2</td>
</tr>
<tr>
<td>51</td>
<td>Veesar silt loam, 0 to 2 percent slopes</td>
<td>990</td>
<td>0.2</td>
</tr>
<tr>
<td>54</td>
<td>Veesar silt loam, 1 to 5 percent slopes</td>
<td>1,030</td>
<td>0.2</td>
</tr>
<tr>
<td>63B</td>
<td>Chelsea loamy fine sand, 1 to 5 percent slopes</td>
<td>1,870</td>
<td>0.4</td>
</tr>
<tr>
<td>63C</td>
<td>Chelsea loamy fine sand, 5 to 9 percent slopes</td>
<td>435</td>
<td>0.1</td>
</tr>
<tr>
<td>63D</td>
<td>Chelsea loamy fine sand, 9 to 18 percent slopes</td>
<td>555</td>
<td>0.1</td>
</tr>
<tr>
<td>63F</td>
<td>Chelsea loamy fine sand, 18 to 25 percent slopes</td>
<td>800</td>
<td>0.2</td>
</tr>
<tr>
<td>65E2</td>
<td>Lindley loam, 14 to 18 percent slopes, moderately eroded</td>
<td>450</td>
<td>0.1</td>
</tr>
<tr>
<td>65F</td>
<td>Lindley loam, 18 to 25 percent slopes</td>
<td>2,185</td>
<td>0.5</td>
</tr>
<tr>
<td>65F3</td>
<td>Lindley clay loam, 18 to 25 percent slopes, severely eroded</td>
<td>14,280</td>
<td>2.3</td>
</tr>
<tr>
<td>83B</td>
<td>Kenyon loam, 2 to 5 percent slopes</td>
<td>10,045</td>
<td>2.3</td>
</tr>
<tr>
<td>83C</td>
<td>Kenyon loam, 5 to 9 percent slopes</td>
<td>15,555</td>
<td>3.4</td>
</tr>
<tr>
<td>83D</td>
<td>Kenyon loam, 9 to 14 percent slopes</td>
<td>450</td>
<td>0.1</td>
</tr>
<tr>
<td>83D2</td>
<td>Kenyon loam, 9 to 14 percent slopes, moderately eroded</td>
<td>2,970</td>
<td>0.6</td>
</tr>
<tr>
<td>84</td>
<td>Clyde silt loam, 0 to 2 percent slopes</td>
<td>2,010</td>
<td>0.4</td>
</tr>
<tr>
<td>109C</td>
<td>Backbone fine sandy loam, 4 to 12 percent slopes</td>
<td>1,310</td>
<td>0.3</td>
</tr>
<tr>
<td>110B</td>
<td>Lomont fine sandy loam, 2 to 5 percent slopes</td>
<td>690</td>
<td>0.2</td>
</tr>
<tr>
<td>110C</td>
<td>Lomont fine sandy loam, 5 to 9 percent slopes</td>
<td>5,375</td>
<td>1.2</td>
</tr>
<tr>
<td>119</td>
<td>Muscatine silt loam, 0 to 2 percent slopes</td>
<td>10,575</td>
<td>2.3</td>
</tr>
<tr>
<td>119B</td>
<td>Muscatine silt loam, 2 to 5 percent slopes</td>
<td>11,825</td>
<td>2.6</td>
</tr>
<tr>
<td>120</td>
<td>Tama silt clay loam, 0 to 2 percent slopes</td>
<td>2,045</td>
<td>0.4</td>
</tr>
<tr>
<td>120C</td>
<td>Tama silt clay loam, 2 to 5 percent slopes</td>
<td>2,045</td>
<td>0.4</td>
</tr>
<tr>
<td>120C2</td>
<td>Tama silt clay loam, 5 to 9 percent slopes</td>
<td>2,045</td>
<td>0.4</td>
</tr>
<tr>
<td>122</td>
<td>Sperry silt loam, 0 to 1 percent slopes</td>
<td>1,310</td>
<td>0.3</td>
</tr>
<tr>
<td>127</td>
<td>Sperry silt loam, loamy subsoil, 1 to 3 percent slopes</td>
<td>1,142</td>
<td>0.3</td>
</tr>
<tr>
<td>133</td>
<td>Coly clay loam, 0 to 2 percent slopes</td>
<td>21,835</td>
<td>4.8</td>
</tr>
<tr>
<td>159</td>
<td>Finchford loamy sand, 0 to 2 percent slopes</td>
<td>945</td>
<td>0.2</td>
</tr>
<tr>
<td>162B</td>
<td>Downs silt loam, 2 to 5 percent slopes</td>
<td>1,450</td>
<td>0.3</td>
</tr>
<tr>
<td>162C</td>
<td>Downs silt loam, 5 to 9 percent slopes</td>
<td>1,450</td>
<td>0.3</td>
</tr>
<tr>
<td>162D</td>
<td>Downs silt loam, 9 to 14 percent slopes</td>
<td>670</td>
<td>0.1</td>
</tr>
<tr>
<td>162D2</td>
<td>Downs silt loam, 9 to 14 percent slopes, moderately eroded</td>
<td>755</td>
<td>0.2</td>
</tr>
<tr>
<td>163B</td>
<td>Fayette silt loam, 2 to 5 percent slopes</td>
<td>4,960</td>
<td>1.1</td>
</tr>
<tr>
<td>163C</td>
<td>Fayette silt loam, 5 to 9 percent slopes</td>
<td>4,960</td>
<td>1.1</td>
</tr>
<tr>
<td>163C2</td>
<td>Fayette silt loam, 5 to 9 percent slopes, moderately eroded</td>
<td>4,960</td>
<td>1.1</td>
</tr>
<tr>
<td>163D</td>
<td>Fayette silt loam, 9 to 14 percent slopes</td>
<td>5,260</td>
<td>1.2</td>
</tr>
<tr>
<td>163D2</td>
<td>Fayette silt loam, 9 to 14 percent slopes, moderately eroded</td>
<td>5,260</td>
<td>1.2</td>
</tr>
<tr>
<td>163E</td>
<td>Fayette silt loam, 14 to 18 percent slopes, moderately eroded</td>
<td>5,170</td>
<td>1.2</td>
</tr>
<tr>
<td>163F</td>
<td>Fayette silt loam, 18 to 25 percent slopes</td>
<td>5,740</td>
<td>1.2</td>
</tr>
<tr>
<td>163F2</td>
<td>Fayette silt loam, 18 to 25 percent slopes, moderately eroded</td>
<td>5,740</td>
<td>1.2</td>
</tr>
<tr>
<td>163G</td>
<td>Fayette silt loam, 25 to 40 percent slopes</td>
<td>2,230</td>
<td>0.5</td>
</tr>
<tr>
<td>171B</td>
<td>Bassett loam, 2 to 5 percent slopes</td>
<td>945</td>
<td>0.2</td>
</tr>
<tr>
<td>171C</td>
<td>Bassett loam, 5 to 9 percent slopes</td>
<td>580</td>
<td>0.1</td>
</tr>
<tr>
<td>171C2</td>
<td>Bassett loam, 5 to 9 percent slopes, moderately eroded</td>
<td>1,540</td>
<td>0.3</td>
</tr>
<tr>
<td>171D</td>
<td>Bassett loam, 9 to 14 percent slopes</td>
<td>485</td>
<td>0.1</td>
</tr>
<tr>
<td>171D2</td>
<td>Bassett loam, 9 to 14 percent slopes, moderately eroded</td>
<td>1,590</td>
<td>0.3</td>
</tr>
<tr>
<td>175</td>
<td>Dickinson fine sandy loam, 0 to 2 percent slopes</td>
<td>355</td>
<td>0.1</td>
</tr>
<tr>
<td>175B</td>
<td>Dickinson fine sandy loam, 2 to 5 percent slopes</td>
<td>1,865</td>
<td>0.4</td>
</tr>
<tr>
<td>177</td>
<td>Saude loam, 0 to 2 percent slopes</td>
<td>470</td>
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<tr>
<td>214</td>
<td>Veesar loam, 10 to 20 percent slopes</td>
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<td>Palms muck, 1 to 4 percent slopes</td>
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<tr>
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See footnote at end of table.
### TABLE 4.—ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS—Continued

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<th>Soil name</th>
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<td>Burkhardt sandy loam, 2 to 9 percent slopes</td>
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<tr>
<td>350C</td>
<td>Waukegan silt loam, 2 to 5 percent slopes</td>
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* Less than 0.1 percent.
TABLE 5.—YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

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<tr>
<th>Soil name and map symbol</th>
<th>Corn</th>
<th>Soybeans</th>
<th>Oats</th>
<th>Grass-legume hay</th>
<th>Smooth bromegrass</th>
<th>Bromegrass-alfalfa</th>
<th>Kentucky bluegrass</th>
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<td>Bu</td>
<td>Bu</td>
<td>Bu</td>
<td>Ton</td>
<td>AUM*</td>
<td>AUM*</td>
<td>AUM*</td>
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See footnotes at end of table.
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<th>Oats (Bu)</th>
<th>Grass-legume hay (Ton)</th>
<th>Smooth bromegrass (AUM*)</th>
<th>Bromegrass-alfalfa (AUM*)</th>
<th>Kentucky bluegrass (AUM*)</th>
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* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.
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* See description of the map unit for composition and behavior characteristics of the map unit.
TABLE 7.—RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

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* See description of the map unit for composition and behavior characteristics of the map unit.
TABLE 8.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

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* See description of the map unit for composition and behavior characteristics of the map unit.
## TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

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* See description of the map unit for composition and behavior characteristics of the map unit.
# Table 10: Sanitary Facilities

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated.]

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<tr>
<th>Soil name and map symbol</th>
<th>Septic tank absorption fields</th>
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* See description of the map unit for composition and behavior characteristics of the map unit.

**Danger of ground water contamination.
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* See description of the map unit for composition and behavior characteristics of the map unit.
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* See description of the map unit for composition and behavior characteristics of the map unit.
TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

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<th>Soil reaction</th>
<th>Shrink-swell potential</th>
<th>Erosion factors</th>
<th>Wind erodibility group</th>
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<td>0.18-0.20</td>
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TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

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<th>Available water capacity</th>
<th>Soil reaction</th>
<th>Shrink-swell potential</th>
<th>Erosion factors</th>
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* See description of the map unit for composition and behavior characteristics of the map unit.
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<th>Bedrock</th>
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<td>Moderate</td>
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<th>Duration</th>
<th>Months</th>
<th>Depth Kind</th>
<th>Months</th>
<th>Depth</th>
<th>Hardness</th>
<th>Potential frost action</th>
<th>Uncoated steel</th>
<th>Concrete</th>
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<th>High water table</th>
<th>Bedrock</th>
<th>Potential frost action</th>
<th>Risk of corrosion</th>
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<tr>
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<td>Waubeek</td>
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See footnote at the end of table.
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<tr>
<th>Soil name and map symbol</th>
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<th>High water table</th>
<th>Bedrock</th>
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<th>Risk of corrosion</th>
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* See description of the map unit for composition and behavior characteristics of the map unit.
## TABLE 16.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjudant to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

<table>
<thead>
<tr>
<th>Soil name</th>
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<tr>
<td>Aredale</td>
<td>Fine-loamy, mixed, mesic Typic Hapludolls</td>
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<td><em>Atterberry</em></td>
<td>Fine-silty, mixed, mesic Udollic Ochraqualfs</td>
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<tr>
<td><em>Backbone</em></td>
<td>Coarse-loamy, mixed, mesic Mollic Hapludolls</td>
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<td><em>Bremer</em></td>
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<tr>
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<td>Sandy, mixed, mesic Typic Hapludolls</td>
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<td>Chelsea</td>
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<td>Spillville</td>
<td>Fine-loamy, mixed, mesic Cumulic Hapludolls</td>
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