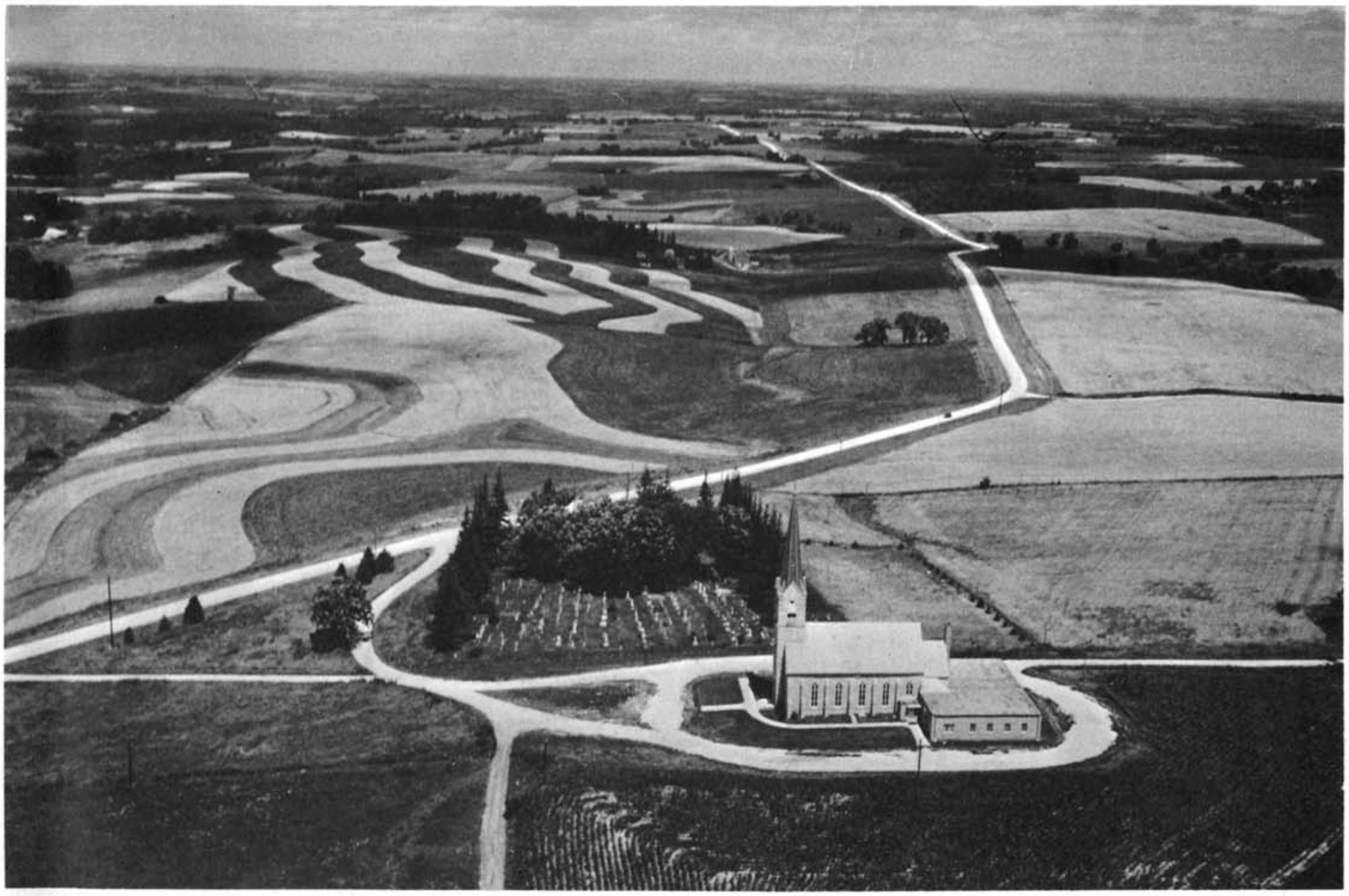
Issued June 1968

SOIL SURVEY
Winneshiek County, Iowa



UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
IOWA AGRICULTURAL EXPERIMENT STATION

Major fieldwork for this soil survey was done in the period 1956 to 1960. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1966. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agricultural Experiment Station; it is part of the technical assistance furnished to the Winneshiek County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Winneshiek County, Iowa, contains information that can be applied in managing farms and woodland; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

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

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

Finding and Using Information

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

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the section that describes the soils and from the section that discusses management of soils for cultivated crops and pasture.

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

Engineers and builders will find under "Engineering Applications" tables that give engineering descriptions of the soils in the county and that name soil features affecting engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Genesis, Classification, and Morphology of Soils."

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

Newcomers in Winneshiek County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Area," which gives additional information about the county.

Cover picture: Typical scene showing stripcropped fields and fields of small grains in soil association 4, near Decorah. The soils are mainly Fayette and Downs.

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EXPLANATION

Series Year and Series Number

Series year and number were dropped from all soil surveys sent to the printer after December 31, 1965. Many surveys, however, were then at such advanced stage of printing that it was not feasible to remove series year and number. Consequently, the last issues bearing series year and number will be as follows:

- Series 1957, No. 23, Las Vegas and Eldorado Valleys Area, Nev.
- Series 1958, No. 34, Grand Traverse County, Mich.
- Series 1959, No. 42, Judith Basin Area, Mont.
- Series 1960, No. 31, Elbert County, Colo. (Eastern Part)
- Series 1961, No. 42, Camden County, N.J.
- Series 1962, No. 13, Chicot County, Ark.
- Series 1963, No. 1, Tippah County, Miss.

Series numbers will be consecutive in each series year, up to and including the numbers shown in the foregoing list. The soil survey for Tippah County, Miss., will be the last to have a series year and series number.

SOIL SURVEY OF WINNESHIEK COUNTY, IOWA

BY KENNETH K. KITTLESON AND RAYMOND I. DIDERIKSEN, SOIL CONSERVATION SERVICE

FIELDWORK BY KENNETH K. KITTLESON, KENNETH C. HINKLEY, HERBERT D. HOLDORF, EARL J. KERKER, AND ROBERT C. RUSSELL, SOIL CONSERVATION SERVICE

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

WINNESHIEK COUNTY is in the northeastern part of Iowa (fig. 1). It is the second county west of the Mississippi River and is bordered on the north by the State of Minnesota. The county has a total area of 688 square miles.

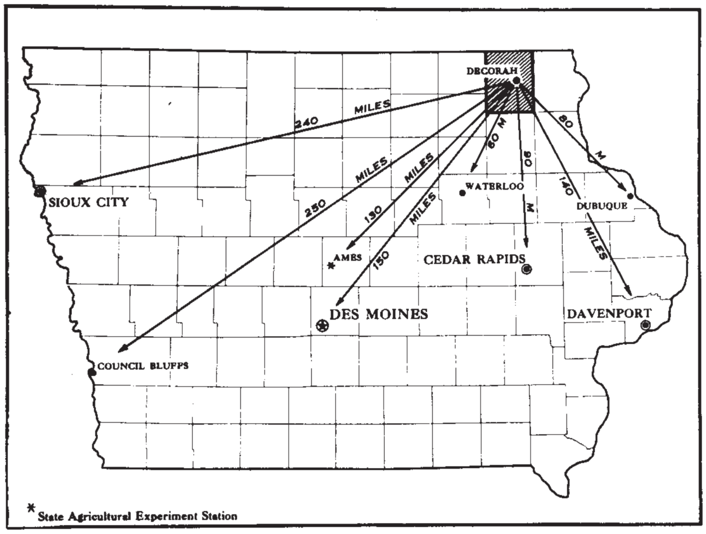

Figure 1.—**Location of Winneshiek County in Iowa.**

Decorah, the county seat, is near the center of the county and is along the Upper Iowa River. It had a population of 6,435 in 1960. The rural population and the population of several of the smaller towns in this county is slowly decreasing. The population of several of the larger towns is increasing.

This county is primarily agricultural. Most of the farm income is derived from the sale of dairy products and hogs, but the feeding of beef cattle is also important. Corn, oats, soybeans, and hay are the principal crops. The crops are fed mainly to livestock.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Winneshiek County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Fayette and Dubuque, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Bassett loam and Bassett silt loam are two soil types in the Bassett series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Downs silt loam, 5 to 9 percent slopes, is one of several phases of Downs silt loam, a soil type that ranges from nearly level to hilly.

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

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

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed and so small in size that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Otter-Ossian complex.

Another kind of mapping unit is the undifferentiated soil group, which consists of two or more soils not separated on the map, because differences among them are small, their practical value is limited, or they are too difficult to reach. An example is Colo and Otter silt loams. Also, on most soil maps, areas are shown that are so rocky, so shallow, or so frequently worked by wind and water that they scarcely can be called soils. These areas are shown on a soil map like other mapping units, but they are given descriptive names, such as Alluvial land or Steep rock land, and are called land types rather than soils.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, farm managers, and engineers. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in soil surveys. On the basis of the yield and practice tables and other data, the soil scientists set up trial groups, and then test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

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

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

The nine soil associations in Winneshiek County are described in the following pages. All of the associations are on uplands, except parts of association 6 that are on stream benches and flood plains.

1. Downs-Tama Association

Well-drained, gently sloping to strongly sloping, dark colored and moderately dark colored, silty soils

This association consists mainly of soils on moderately wide, convex, gently sloping ridgetops in the uplands and on the sloping or strongly sloping sides of the ridges. It includes soils in narrow, but well-defined, drainageways and also some gullied areas. Most of the drainageways or gullies can be crossed by farm machinery. This association occupies about 8,960 acres, but the individual areas are less than a mile wide.

The Downs and Tama soils make up the major part of this association (fig. 2). They formed in loess that is 150 to 200 inches thick. In some places the Downs and Tama soils have a dark-colored, friable surface layer. In other places their surface layer is moderately dark colored and thin and is underlain by a light-colored subsurface layer. The subsoil of these soils is brownish, lacks mottling, and does not contain stones or pebbles.

A minor part of the association is occupied by poorly drained or somewhat poorly drained Atterberry, Colo, Otter, Ossian, and Lawson soils. The Atterberry soils, in upland coves or swales, have a thin to moderately thick, dark-colored surface layer and a mottled gray and brown subsoil. The Colo, Otter, Ossian, and Lawson soils, in drainageways, have a thick, dark-colored surface layer that is high in content of organic matter. They have a mottled gray or gray and brown subsoil.

The soils on the ridgetops and side slopes are well drained, but the few areas in the coves or swales at the heads of drainageways and in drainageways are somewhat poorly drained or poorly drained. The soils of

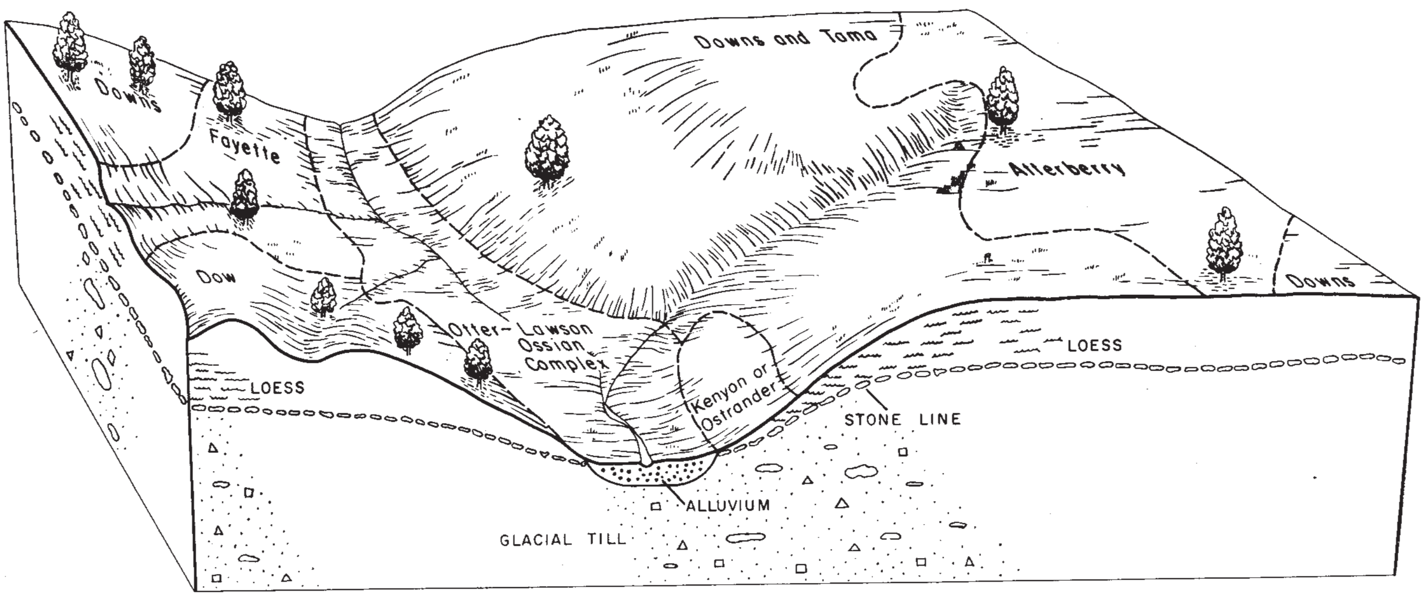

Figure 2.—Cross section of soil associations 1 and 3 showing the topography, soils, and underlying material.

this association have high available moisture capacity. Erosion is a slight to moderate hazard on the sloping soils, and those soils need protection to reduce losses from erosion.

Nearly all of the association is suited to row crops, and a large part of it is used for that purpose. The crops need to be rotated, however, and contour tillage, stripcropping, and terracing should be practiced in the sloping areas. Tile drainage is needed in the drainageways and in a few of the upland swales.

Farming is diversified. Most of the farmers raise hogs, and many of them have a herd of dairy cattle. Grain crops are grown on most farms, and much of this grain is fed to livestock. Nearly all of the farm buildings are well maintained and are occupied. The farms vary in size, but they generally occupy about 175 acres. The trend is toward larger farm units.

2. Downs Association

Well-drained, nearly level to sloping, moderately dark colored, silty soils

Nearly level to gently sloping soils on narrow, convex ridgetops and sloping soils on the sides of the ridges make up the major part of this association. The drainage pattern is moderately well defined, but drainageways are fewer than in association 1. Most of the areas form a watershed divide between two drainage systems. This association occupies about 9,600 acres, but the individual areas are generally less than one-half mile wide.

Well-drained Downs soils occupy the major part of the association. They are mainly on ridgetops and on the sides of ridges, where they formed in loess that ranges from 150 to 200 inches in thickness. In areas that are not eroded, the surface layer of these soils is moderately dark colored when moist and is fairly light colored when dry. The surface layer ranges from thin to moderately thick, and it is underlain by a distinct, light-colored subsurface layer. Below the subsurface layer is a brownish subsoil that lacks mottling and is free of stones and pebbles.

A smaller part of this association than of association 1 is occupied by somewhat poorly drained or poorly drained soils in swales or drainageways. A small acreage of somewhat poorly drained Atterberry soils, however, is in coves or swales at the heads of drainageways. The Atterberry soils, unlike the Downs, have a mottled gray and brown subsoil. Many of the drainageways near which they occur are too narrow to be shown on the soil map.

The soils of this association have high available moisture capacity. Erosion is a slight to moderate hazard on the sloping soils, and those soils need protection to reduce losses from erosion. The nearly level soils are not subject to erosion.

A large part of this association is used for row crops. Some of the soils are suited to intensive use for row crops, but rotating those crops with other crops is better on most of the soils. Contour tillage, stripcropping, or terracing helps to control erosion in the sloping areas. Tile drainage is needed in some of the drainageways and upland swales.

Farming is diversified in this association, and grain and livestock are the main farm products. Many of the farmers raise hogs and also have a herd of dairy cattle. Nearly all of the grain is fed to livestock. The farm buildings are in good repair, and most of them are occupied. The farms are about 175 acres in size, but the trend is toward larger farm units.

3. Fayette Association

Well-drained, nearly level to sloping, light-colored, silty soils

Areas of this association form a watershed divide between two or more drainage systems. Nearly level and gently sloping soils on narrow ridgetops and gently sloping and sloping soils on the sides of the ridges are typical features of the landscape. Sinkholes are common; an area 20 acres in size generally contains four or five. The sinkholes are 60 to 80 feet across, and some are covered with trees. Many are too deep to be crossed with farm machinery. The drainage pattern is moderately well defined because many waterways begin in this area. This association occupies about 1,280 acres.

Well-drained Fayette soils, formed in a layer of loess 180 to 240 inches thick, occupy most of this association. In areas of these soils that have not been cultivated, the surface layer is thin and moderately dark colored, and it is underlain by a distinct, light-colored subsurface layer. In cultivated areas part of the subsurface layer has been mixed with the plow layer and the present surface layer is light colored both when moist and when dry. The subsoil is brownish and is free of mottles. No stones or pebbles are on the surface or in the soil profile.

In the sinkholes and along the drainageways, the surface layer is slightly darker colored than on the ridgetops and on the sides of ridges. Those areas are usually not wet, because they are underlain by fractured limestone. Most of the drainageways are narrow.

The soils of this association have high available moisture capacity. Erosion is a slight to moderate hazard in the sloping areas, and in those areas protection is needed to reduce losses from erosion.

Except for the areas in sinkholes, most of this association is cultivated. The nearly level areas are suited to intensive use for row crops, but row crops ought to be rotated with other crops in the sloping areas. Contour tillage, terracing, or stripcropping is needed to protect the soils in the sloping areas (fig. 3). Tile drainage is not needed in the drainageways and sinkholes.

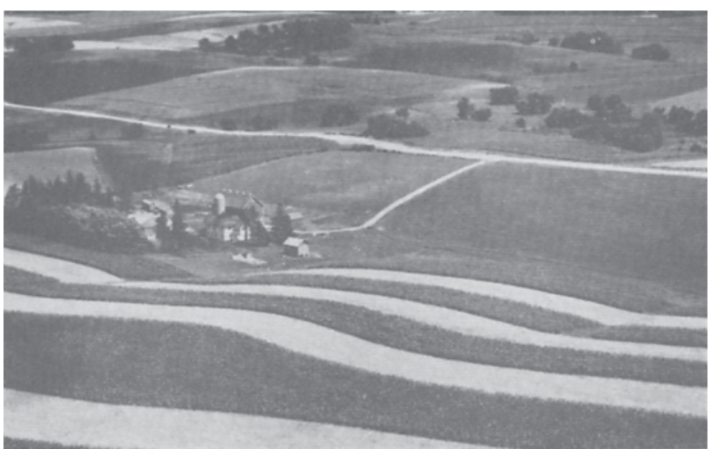

***Figure 3.*—Typical stripcrop pattern in soil association 3.**

Farming is diversified in this association. Some grain is grown as a cash crop, but much of it is fed to dairy cattle and hogs. Most of the farm buildings are in good repair and are occupied. The farms are 160 to 200 acres in size, but the trend is toward larger units.

4. Downs-Fayette Association

Well-drained, sloping to moderately steep, moderately dark colored and light-colored, silty soils

Sloping soils on narrow ridgetops and sloping to moderately steep soils on the sides of ridges are typical of this association. The side slopes are dissected by drainageways. The association contains the main stems of upland drainageways. The water from those drainageways has cut gullies and other drainageways that can be crossed with farm machinery. Limestone bedrock is exposed in the gullies and drainageways in some places. A few sinkholes are in this association, but not so many as are in association 3. Scattered trees grow in the drainageways and along fences in some places, and there are a few small timbered areas of irregular shape. This association is in all parts of the county, except in the southwestern. It occupies the most extensive areas underlain by deep loess.

Well-drained Downs and Fayette soils, formed on uplands in a layer of loess 100 to 200 inches thick, occupy the major part of this association. The Downs soils have a thin, moderately dark colored surface layer, a light-colored subsurface layer, and a brownish subsoil that is free of mottling. The Fayette soils are similar to the Downs, but they have a thinner surface layer and, in many places, a more distinct, lighter colored subsurface layer.

A minor part of this association is occupied by well-drained Nasset soils and by a somewhat poorly drained, gray subsoil variant of the Franklin series. Soils of the Otter-Lawson-Ossian complex and of the Dorchester-Chaseburg-Volney complex also occupy a small acreage in the drainageways and on bottom lands. The Nasset soils are similar to the Downs, except that they are underlain by limestone at a depth of 30 to 50 inches. The gray subsoil variant of the Franklin series has a mottled, gray subsoil and is underlain by glacial till at a depth of 15 to 40 inches. The soils of the Otter-Lawson-Ossian complex have a thick, dark-colored surface layer and a mottled gray and brown subsoil. The Volney soils of the Dorchester-Chaseburg-Volney complex also have a thick, dark-colored surface layer, but they contain many fragments of limestone. The Dorchester and Chaseburg soils of that complex have a distinctly light-colored surface layer that is low in content of organic matter.

Except for the few areas of soils underlain by limestone, nearly all of the soils have high available moisture capacity. The sloping soils are slightly to severely eroded, and practices are needed to protect them from further erosion. Tile drainage is needed in some drainageways, and the gullies and drainageways ought to be reshaped and seeded in some places. In places the drainageways limit the size of fields.

A medium to large part of the association is used for row crops. Most of the soils are suited to row crops grown in rotation with other crops, but farming on the contour, constructing terraces, or stripcropping is necessary.

Farming is diversified, and field crops and livestock are the main farm products. Most of the grain is fed to hogs and dairy cattle. Nearly all of the farm buildings are occupied and are in good repair. The farms vary in size, but the size of many of them is 160 to 200 acres. The general trend is toward larger farm units.

5. Fayette-Dubuque Association

Well-drained, sloping to moderately steep, light-colored, very deep and moderately deep, silty soils

Within this association are sloping soils on narrow ridgetops, and sloping to moderately steep soils on the sides of ridges that extend down to well-defined drainageways. The side slopes are dissected by drainageways. Limestone bedrock crops out along the lower part of the drainageways, at the base of the slopes, and in many of the road cuts. Water flows in the main stem of the drainageways during most of the year. Sinkholes are common, and some are too deep to be crossed safely with farm machinery. Trees are common along the drainageways and fences, and some timbered areas are managed as woodland. Areas of this association lie between areas of associations 4 and 6. They are scattered throughout all parts of the county, except Jackson, Sumner, and Lincoln Townships.

Well-drained Fayette and Dubuque soils, on uplands, make up a major part of this association. They formed in a layer of loess that ranges from 15 to 100 inches in thickness. In areas that have been cultivated, the Fayette soils have a light-colored surface layer and subsurface layer. The subsoil is brownish and contains no mottles. The Dubuque soils are similar to the Fayette in color and texture, but at a depth of 15 to 30 inches, they are underlain by limestone bedrock or by a thin layer of material weathered from limestone.

A minor part of this association is occupied by well-drained Nasset, Palsgrove, Frankville, and Nordness soils. Another small part is occupied by a complex of well drained or moderately well drained Dorchester, Chaseburg, and Volney soils that occupy many of the drainageways. The minor soils vary in the color of their surface layer and in depth to bedrock. Drainageways that cannot be crossed by farm machinery dissect many areas of the Dorchester, Chaseburg, and Volney soils.

Most areas of the soils on the uplands are low in content of organic matter, and their available moisture capacity is moderate to high. Because erosion is slight to severe in the sloping upland areas, practices are needed to reduce losses from erosion. The areas immediately above the outcroppings of limestone are subject to gullying. In some places shaping and reseeding of the side-valley drainageways is needed. The soils in the drainageways are generally not wet, but tile drainage is needed in a few areas on minor soils in the uplands. In places the drainageways or outcroppings of limestone limit the size of fields.

About half of this association is used for crops. Many of the soils are suited to row crops grown in rotation, but it is necessary to grow the crops on the contour, construct terraces, or stripcrop. The soils that are shallow over limestone bedrock can be used for pasture, as woodland, or for wildlife habitats.

Farming is diversified. Grain is grown and fed to hogs and dairy cattle, and the livestock also utilize the available native pasture. Nearly all of the farm buildings are occupied and are in good repair. The size of the farms ranges from 160 to 200 acres, but the general trend is toward larger farm units.

6. Steep Rock Land-Dubuque-Dorchester Association

Steep, rocky land; moderately steep, shallow, silty soils; and nearly level to sloping, silty and loamy soils

This association is along the Turkey, Yellow, and Upper Iowa Rivers and their main tributaries. Typical of the landscape are narrow, meandering valleys bordered by steep, irregular side slopes where limestone bedrock crops out. The limestone forms steep bluffs that rise to a height of 10 to more than 200 feet. One to several of these bluffs, or steep rises, are between the bottom lands and the highest upland ridges. Multiple rises are most common in Glenwood, Pleasant, and Highland Townships.

This is a scenic area. The streams are well entrenched (fig. 4) and contain clear, fast-moving water. Rapids flow over the limestone streambeds in some places. Many of the streams are fed by springs. Only a few winding roads cross the valleys, and limestone bedrock crops out in most of the road cuts. Woodland and pasture border the bluffs in many places in the uplands. Many of the farm buildings are on foot slopes of the side valleys and on benches along streams. Most of the areas are less than 1½ miles wide, but some areas in the west-central part of Pleasant Township are more than twice that wide. The areas of bottom lands are generally less than one-fourth of a mile wide. The soils on most areas of the bottom lands along the Turkey River have a dark-colored surface layer and extremely variable texture. Those in the areas along the Yellow and Upper Iowa Rivers have a light-colored surface layer.

Steep rock land and areas of well-drained Dubuque and Dorchester soils occupy the major part of the association. Steep rock land, which consists of outcroppings of fractured limestone, makes up a major part of the upland areas. The Dubuque soils, also on uplands, consist of 15 to 30 inches of silty material over limestone bedrock or over a thin layer of material weathered from bedrock. They have a light-colored surface layer and a brownish subsoil that is free of mottling. Silty, well-drained Dorchester soils are dominant on the bottom lands. They are light colored and contain lime.

A minor part of this association is made up of Chaseburg and Volney soils. Those soils are on foot slopes and in drainageways in the uplands.

The soils of the uplands in this association have medium to low available moisture capacity. Runoff is rapid, and erosion is a hazard where the cover of plants is sparse. The drainage of the soils on the bottom lands and stream benches ranges from excessive to poor. The bottom lands are flooded nearly every year for a short time. Flooding generally occurs during thaws early in spring or after heavy rains, prior to the growing season. The streams and the outcroppings of limestone limit the shape and size of the fields in some places, and access to fields is poor in many places. The major limitations of

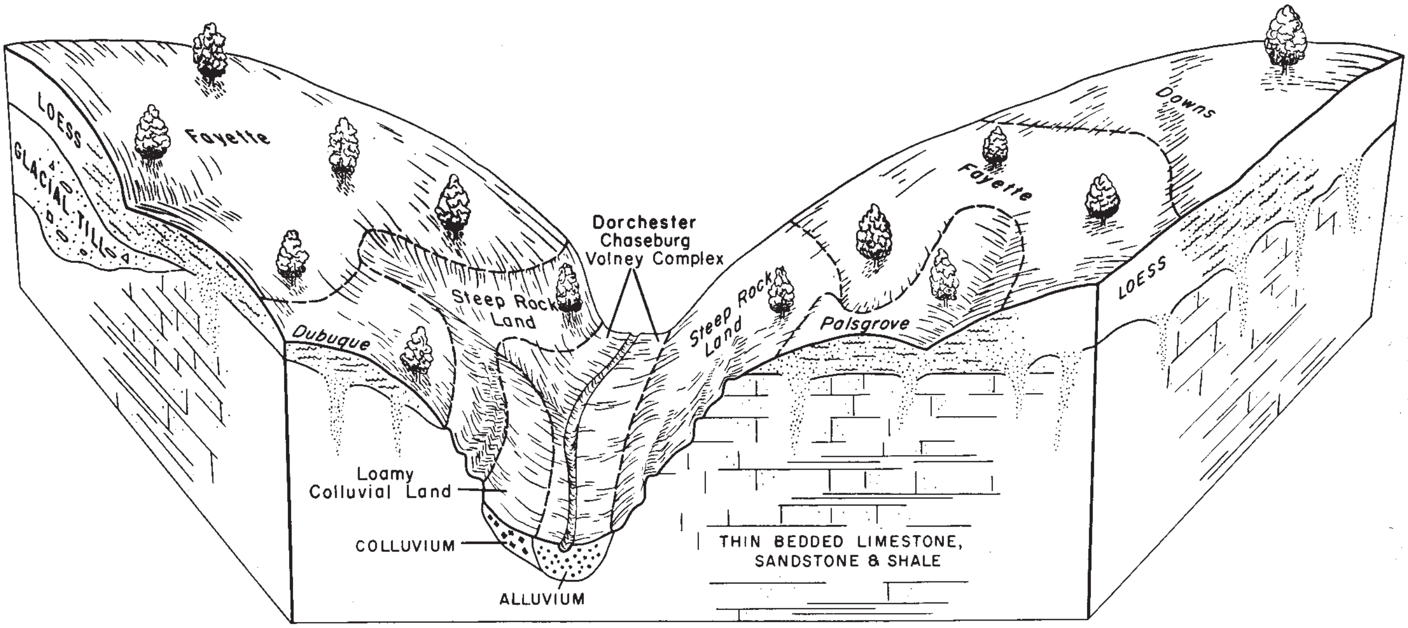

Figure 4.—**Cross section of association 6 and of some areas of association 4 showing the topography, vegetation, soils, and underlying material.**

the soils on uplands are the hazard of erosion and bedrock near the surface.

Row crops are grown on only a small part of this association. The soils of bottom lands are farmed intensively, however, and they can be managed separately from the soils on uplands. The soils of the uplands are mainly in pasture or woods, and they can also be used for wildlife habitats. Most of the timbered tracts consist of unimproved second- and third-growth trees of poor quality.

In general, farming is diversified. The grain that is grown on the bottom lands and stream benches is fed to livestock. Most farmers raise hogs and have a herd of dairy cattle. Farms are fewer than in the other associations, and they range from 200 to 240 acres or more in size. The farm buildings that are occupied are in good repair. The trend in farming is to crop intensively the soils of foot slopes, bottom lands, and stream benches, and to use for pasture the upland areas where the soils are shallow over limestone. Numerous gravel pits and limestone quarries are within this association.

7. Orwood Association

Well-drained, gently undulating to rolling, moderately dark colored, loamy to silty soils

Rounded upland knolls and distinct mounds that have short side slopes are typical features of the landscape in this association. The areas do not contain continuous ridges, and some of them extend from northwest to southeast. They are distinctly rolling, but the drainage systems are not well defined, and many of the drainageways are small. This soil association occupies about 1,920 acres.

Orwood soils make up the major part of this association. They formed in deep deposits of windblown material that contains more sand than typical for loess. They do not contain stones or pebbles. These soils have a thin to moderately thick, loamy surface layer. Their surface layer is moderately dark colored in areas that are not eroded, but it is somewhat light colored in dry eroded or cultivated areas. These soils have a distinct, light-colored subsurface layer. Their subsoil is brownish and lacks mottling.

A minor part of the association is occupied by Downs soils. Their color is similar to that of the Orwood soils, but the Downs soils have a distinctly lower content of sand than the Orwood soils.

For the soils of this association on knolls and side slopes, the hazard of erosion ranges from slight to severe if the surface is left bare. Losses from erosion can be reduced by practicing contour tillage, terracing, or stripcropping. Wetness is not a problem, but the size of fields is limited in some places by the steepness and shape of the slopes.

Most of this association is used for row crops grown in rotation. The steep areas are used for permanent pasture. They consist of small isolated areas where the timber has never been cleared. Some trees grow along the drainageways and fence rows.

Farming is diversified, and grain and livestock are the main products. Much of the grain is fed to hogs and dairy cattle. The individual farms are about 175 acres in size, and only a few farms are wholly within the association. Many of the farm buildings are in good repair and are occupied.

8. Bassett-Floyd Association

Well-drained to poorly drained, nearly level to sloping, dark colored and moderately dark colored, loamy soils

This association is made up of indistinct ridgetops, or highs, and of long, smooth, gentle slopes that are dissected in places by moderately wide, concave drainageways. These drainageways are less entrenched than those in the other associations, except association 7. A distinct band of stones or pebbles can be seen in new road cuts at a depth of 14 to 24 inches (fig. 5). Piles of stones are common along fence rows and in the drainageways. The county roads run along section lines in many places. This association is mainly in the southwestern part of the county.

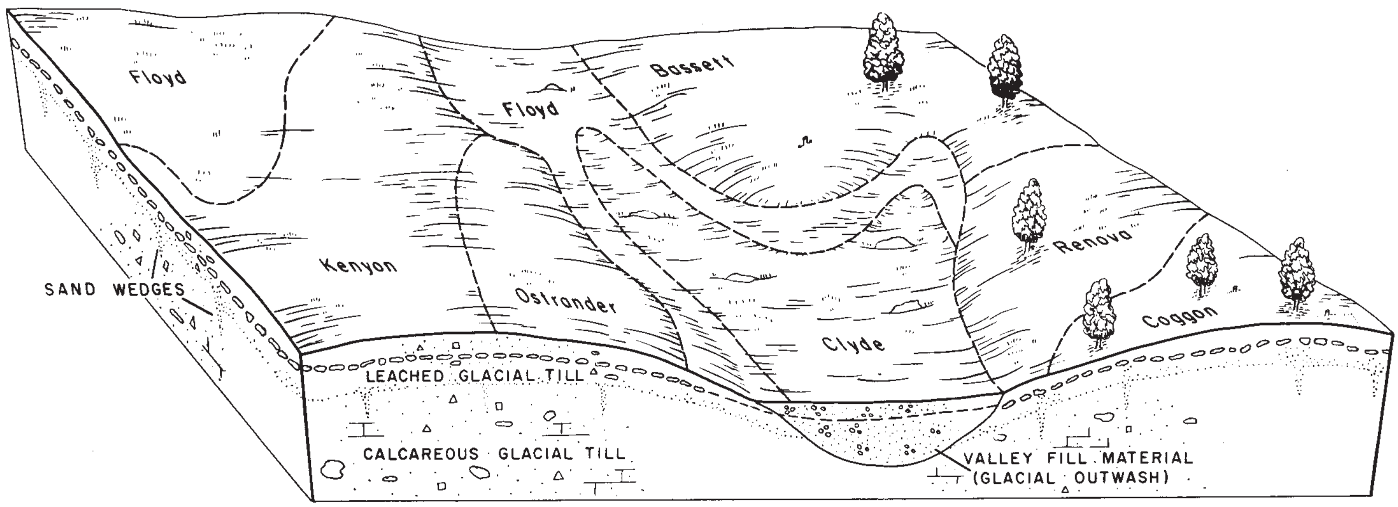

Figure 5.—**Cross section of association 8 showing the topography, vegetation, soils, and underlying material. A distinct band of stones or pebbles is in the underlying material.**

Moderately well drained Bassett and somewhat poorly drained Floyd soils occupy a major part of the association. These soils formed mainly in glacial sediment or glacial till. In some areas of these soils in sections 28, 32, and 33 of Orleans Township, only about 20 inches of silty material overlies the glacial till. The Bassett soils have a thin to moderately thick, moderately dark colored surface layer that is underlain by a distinct, light-colored subsurface layer. Their subsoil is brownish. It is mottled in a few places and contains stones and pebbles. The Floyd soils, in or near upland drainageways, have a thick, dark-colored surface layer and a mottled gray and brown subsoil that contains stones and pebbles.

A minor part of this association is made up of poorly drained Clyde soils that have stones and pebbles on their surface and are in drainageways adjacent to areas of Floyd soils. Another small part is made up of well drained or moderately well drained Kenyon, Ostrander, Racine, Renova, and Coggon soils, and of well-drained or excessively drained Dickinson, Lamont, and other sandy soils. All of these soils are on uplands.

The hazard of erosion ranges from slight to moderate, but losses from erosion can be reduced by protecting the soils. Nearly all of the soils have high available moisture capacity.

This association has the highest potential for growing row crops of any association in the county. If the soils are properly managed, the nearly level areas are suited to intensive use for row crops. Crops on the sloping areas ought to be rotated, however, and contouring, terracing and stripcropping help to control erosion in those areas. In many of the nearly level areas and in the drainageways, tile drainage is needed, and it is essential in areas where the drainage is poor. If the wet draws and waterways are not drained, they limit the size of fields. In some areas glacial stones and boulders must be removed before a field can be cultivated. Many areas of permanent pasture in the drainageways are too wet and boggy for proper utilization by livestock.

Farming is generally diversified in this association. Some grain is grown as a cash crop, but most of the grain is fed to hogs, dairy cattle, and beef cattle. The farms range from 160 to 240 acres in size, but the trend is toward larger farms. Nearly all of the farm buildings are occupied and are in good repair.

9. Winneshiek-Rockton-Marlean Association

Well-drained, gently sloping to moderately steep, loamy soils underlain by limestone and shale

Typical of the landscape in this association are nearly level to gently sloping, high structural benches and sloping to moderately steep foot slopes and side slopes dissected by drainageways. Limestone and, in some places, shale crop out in the road cuts and drainageways. In many areas seepage takes place at the point where the shale crops out. Areas of permanent pasture are numerous. Trees are common but are less numerous than in association 6. This association is mainly in the west-central part of the county; it occupies about 51,840 acres.

Well-drained Winneshiek and Rockton soils and well-drained to excessively drained Marlean soils occupy a major part of the association. These soils formed in glacial till or loamy sediments that are underlain by limestone. The Winneshiek soils have a thin to moderately thick, moderately dark colored surface layer and a brownish subsoil that contains a few stones and pebbles. Hard limestone is at a depth of 15 to 30 inches. The Rockton soils are similar to the Winneshiek, except that they have a darker colored, thicker surface layer. The Marlean soils consist of only 5 to 15 inches of moderately dark colored soil material over soft, fragmented limestone. On knolls where the Marlean soils are cultivated, their surface layer is distinctly light colored.

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A minor part of the association is made up of poorly drained or somewhat poorly drained Jacwin and poorly drained Calamine soils. The Jacwin and Calamine soils have a dark or moderately dark colored surface layer and a mottled gray or gray and brown subsoil. They are underlain by shale.

The available moisture capacity is low or very low in the areas underlain by limestone; the soils in most of those areas are droughty. The sloping soils are susceptible to erosion where the cover of plants is sparse. The soils in the few areas that are underlain by shale are commonly wet, and tile drainage is needed in those areas. In some places the size and shape of the fields are limited by bedrock near the surface. In other places they are limited by drainageways that cannot be crossed with farm machinery.

Many of the sloping areas where the soils are shallow over limestone or shale are in permanent pasture. Nearly all of the areas of nearly level or gently sloping soils are cultivated, but those soils are only moderately well suited to row crops. The areas of sloping soils need to be stripcropped or farmed on the contour. The steeper soils ought to be kept in permanent pasture or trees, and they can be used for wildlife habitats. Several timbered areas, about 80 acres in size, can be managed as woodland. A few areas that are not cultivated should be seeded to pasture.

Farming is diversified in this association, and hogs and dairy cattle are raised on many farms. In some parts of the association, not enough grain is grown to support the livestock. As a rule, this association is not used for building sites, but the homes and other structures are in the adjoining associations.

Descriptions of the Soils

This section is provided for those who want information about the soils in the county. It describes the single soils, or mapping units; that is, the areas on the detailed soil map that are bounded by lines and are identified by a symbol. For more general information about the soils, the reader can refer to the section "General Soil Map" in which the broad patterns of soils in the county are described. The acreage and proportionate extent of each soil mapped are given in table 1. Their location is shown on the soil map at the back of this soil survey.

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

Mapping unit	Acres	Percent
Alluvial land	3,263	0.7
Arenzville silt loam	559	.1
Atkinson loam, 2 to 5 percent slopes	573	.1
Atterberry silt loam, 1 to 4 percent slopes	546	.1
Backbone loamy sand, 2 to 5 percent slopes	428	.1
Backbone loamy sand, 5 to 9 percent slopes	439	.1
Backbone loamy sand, 9 to 14 percent slopes	180	(1)
Bassett loam, 0 to 2 percent slopes	539	.1
Bassett loam, 2 to 5 percent slopes	8,781	2.0
Bassett loam, 5 to 9 percent slopes	2,619	.6
Bassett loam, 5 to 9 percent slopes, moderately eroded	1,005	.2
Bassett silt loam, 2 to 5 percent slopes	440	.1
Bassett silt loam, 5 to 9 percent slopes	162	(1)
Bertrand silt loam, 0 to 2 percent slopes	109	(1)
Bertrand silt loam, 2 to 5 percent slopes	214	(1)
Bixby loam, 0 to 2 percent slopes	240	.1
Bixby loam, 2 to 5 percent slopes	380	.1
Bixby loam, 5 to 9 percent slopes, moderately eroded	128	(1)
Burkhardt soils, 0 to 5 percent slopes	135	(1)
Burkhardt soils, 5 to 14 percent slopes, moderately eroded	193	(1)
Calamine silty clay loam, 0 to 2 percent slopes	219	(1)
Calamine silty clay loam, 2 to 5 percent slopes	231	.1
Calmar clay loam, 2 to 5 percent slopes	462	.1
Calmar clay loam, 5 to 14 percent slopes	414	.1
Camden silt loam, 0 to 2 percent slopes	131	(1)
Camden silt loam, 2 to 5 percent slopes	156	(1)
Camden silt loam, 5 to 9 percent slopes	63	(1)
Caneek silt loam	768	.2
Canoe silt loam	184	(1)
Chaseburg silt loam, 0 to 2 percent slopes	70	(1)
Chaseburg silt loam, 2 to 5 percent slopes	146	(1)
Chelsea loamy fine sand, 1 to 5 percent slopes	215	(1)
Chelsea loamy fine sand, 5 to 14 percent slopes	260	.1
Clyde silt loam, 0 to 4 percent slopes	5,808	1.3
Coggon loam, 2 to 5 percent slopes	445	.1
Coggon loam, 5 to 9 percent slopes, moderately eroded	503	.1
Colo and Otter silt loams	1,419	.3
Colo-Otter-Ossian complex	2,704	.6
Dickinson sandy loam, 0 to 2 percent slopes	595	.1
Dickinson sandy loam, 2 to 5 percent slopes	1,986	.5
Dickinson sandy loam, 5 to 9 percent slopes	737	.2
Dickinson sandy loam, 9 to 14 percent slopes	127	(1)
Donnan loam, 2 to 5 percent slopes	141	(1)
Dorchester silt loam	8,907	2.0
Dorchester-Chaseburg-Volney complex, 2 to 5 percent slopes	8,774	2.0
Dow silt loam, 14 to 24 percent slopes, severely eroded	279	.1
Downs silt loam, 0 to 2 percent slopes	459	.1
Downs silt loam, 2 to 5 percent slopes	19,932	4.5
Downs silt loam, 5 to 9 percent slopes	28,176	6.4
Downs silt loam, 9 to 14 percent slopes	2,639	.6
Downs silt loam, 14 to 18 percent slopes, moderately eroded	3,542	.8
Downs silt loam, 18 to 24 percent slopes, moderately eroded	311	.1
Downs and Tama silt loams, 2 to 5 percent slopes	4,155	.9
Downs and Tama silt loams, 5 to 9 percent slopes	4,128	.9
Downs and Tama silt loams, 5 to 9 percent slopes, moderately eroded	17,339	4.0
Downs and Tama silt loams, 9 to 14 percent slopes, moderately eroded	14,586	3.3
Dubuque silt loam, 5 to 9 percent slopes, moderately eroded	1,067	.2
Dubuque silt loam, 9 to 14 percent slopes, moderately eroded	2,986	.7
Dubuque silt loam, 9 to 14 percent slopes, severely eroded	794	.2
Dubuque silt loam, 14 to 18 percent slopes, moderately eroded	5,635	1.3
Dubuque silt loam, 14 to 18 percent slopes, severely eroded	1,263	.3
Dubuque silt loam, 18 to 30 percent slopes, moderately eroded	2,142	.5
Fayette silt loam, 0 to 2 percent slopes	158	(1)
Fayette silt loam, 2 to 5 percent slopes	10,244	2.3

See footnote at end of table.

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

Mapping unit	Acres	Percent
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	46, 775	10. 6
Fayette silt loam, 5 to 9 percent slopes, severely eroded	567	. 1
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	31, 676	7. 2
Fayette silt loam, 9 to 14 percent slopes, severely eroded	10, 268	2. 3
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	10, 434	2. 3
Fayette silt loam, 14 to 18 percent slopes, severely eroded	6, 434	1. 5
Fayette silt loam, 18 to 24 percent slopes, moderately eroded	2, 581	. 6
Fayette silt loam, 18 to 24 percent slopes, severely eroded	1, 163	. 3
Fayette silt loam, 24 to 35 percent slopes	437	. 1
Festina silt loam, 0 to 2 percent slopes	176	(1)
Festina silt loam, 2 to 5 percent slopes	44	(1)
Floyd loam, 0 to 5 percent slopes	9, 866	2. 2
Floyd-Clyde complex, 0 to 4 percent slopes	2, 204	. 5
Franklin silt loam, gray subsoil variant, 2 to 5 percent slopes	267	. 1
Frankville silt loam, 5 to 9 percent slopes	382	. 1
Frankville silt loam, 9 to 14 percent slopes, moderately eroded	947	. 2
Frankville silt loam, 14 to 18 percent slopes, moderately eroded	898	. 2
Hagener loamy sand, 0 to 2 percent slopes	127	(1)
Hagener loamy sand, 2 to 5 percent slopes	104	(1)
Hagener loamy sand, 5 to 14 percent slopes	108	(1)
Hayfield loam, deep, 0 to 3 percent slopes	419	. 1
Hayfield loam, moderately deep, 0 to 4 percent slopes	188	(1)
Huntsville silt loam, 0 to 2 percent slopes	473	. 1
Huntsville silt loam, 2 to 6 percent slopes	367	. 1
Jacwin loam, 0 to 2 percent slopes	597	. 1
Jacwin loam, 2 to 5 percent slopes	1, 534	. 3
Jacwin loam, 5 to 9 percent slopes	472	. 1
Jacwin loam, 9 to 14 percent slopes	136	(1)
Kato loam, moderately deep, 0 to 4 percent slopes	219	(1)
Kato loam, deep, 0 to 4 percent slopes	1, 223	. 3
Kato loam, deep, clay shale substratum, 1 to 5 percent slopes	944	. 2
Kato loam, deep, clay shale substratum, 5 to 9 percent slopes	165	(1)
Kenyon loam, 2 to 5 percent slopes	601	. 1
Lamont sandy loam, 1 to 5 percent slopes	603	. 1
Lamont sandy loam, 5 to 9 percent slopes	271	. 1
Lamont sandy loam, 9 to 14 percent slopes	133	(1)
Lamont sandy loam, till subsoil variant, 2 to 9 percent slopes	301	. 1
Lawson and Kennebec silt loams, 0 to 2 percent slopes	330	. 1
Lawson silt loam, 2 to 5 percent slopes	263	. 1
Loamy colluvial land, 9 to 18 percent slopes	654	. 1
Loamy colluvial land, 18 to 24 percent slopes	207	(1)
Loamy terrace escarpments, 16 to 30 percent slopes	156	(1)
Marlean loam, 2 to 5 percent slopes	1, 382	. 3
Marlean loam, 5 to 9 percent slopes	2, 667	. 6
Marlean loam, 5 to 9 percent slopes, moderately eroded	4, 074	. 9
Marlean loam, 9 to 14 percent slopes, moderately eroded	3, 980	. 9
Marlean loam, 9 to 14 percent slopes, severely eroded	812	. 2
Marlean loam, 14 to 24 percent slopes, moderately eroded	2, 179	. 5
Marlean loam, 14 to 24 percent slopes, severely eroded	836	. 2
Nasset silt loam, 5 to 9 percent slopes, moderately eroded	179	(1)
Nasset silt loam, 9 to 14 percent slopes, moderately eroded	234	. 1
Nasset silt loam, 14 to 18 percent slopes, moderately eroded	195	(1)
Nordness silt loam, 5 to 14 percent slopes	1, 755	. 4
Nordness silt loam, 14 to 24 percent slopes	5, 591	1. 3
Oran loam, 0 to 2 percent slopes	367	. 1
Oran loam, 2 to 5 percent slopes	870	. 2
Orwood silt loam, 2 to 5 percent slopes	377	. 1
Orwood silt loam, 5 to 9 percent slopes, moderately eroded	2, 353	. 5
Orwood silt loam, 9 to 14 percent slopes, moderately eroded	2, 358	. 5
Orwood silt loam, 14 to 18 percent slopes, moderately eroded	980	. 2
Orwood silt loam, 14 to 18 percent slopes, severely eroded	344	. 1
Orwood silt loam, 18 to 30 percent slopes, moderately eroded	540	. 1
Ossian silt loam	315	. 1
Ostrander loam, 0 to 2 percent slopes	147	(1)
Ostrander loam, 2 to 5 percent slopes	2, 239	. 5
Ostrander loam, 5 to 9 percent slopes	269	. 1
Otter-Lawson-Ossian complex, 1 to 4 percent slopes	5, 165	1. 2
Otter-Ossian complex	1, 910	. 4
Otter and Ossian silt loams, overwashed	568	. 1
Palsgrove silt loam, 5 to 9 percent slopes, moderately eroded	406	. 1
Palsgrove silt loam, 9 to 14 percent slopes, moderately eroded	1, 941	. 4
Palsgrove silt loam, 9 to 14 percent slopes, severely eroded	201	(1)
Palsgrove silt loam, 14 to 18 percent slopes, moderately eroded	2, 157	. 5
Palsgrove silt loam, 14 to 18 percent slopes, severely eroded	285	. 1
Palsgrove silt loam, 18 to 24 percent slopes, moderately eroded	265	. 1
Peaty muck	608	. 1
Peaty muck, overwashed	304	. 1
Racine loam, 0 to 2 percent slopes	194	(1)
Racine loam, 2 to 5 percent slopes	11, 193	2. 5
Racine loam, 5 to 9 percent slopes	2, 379	. 5
Racine loam, 5 to 9 percent slopes, moderately eroded	908	. 2
Racine loam, 9 to 14 percent slopes, moderately eroded	259	. 1
Renova loam, 2 to 5 percent slopes	954	. 2
Renova loam, 5 to 9 percent slopes	410	. 1
Renova loam, 5 to 9 percent slopes, moderately eroded	193	(1)
Renova loam, 9 to 14 percent slopes, moderately eroded	198	(1)
Renova loam, 9 to 14 percent slopes, severely eroded	141	(1)
Renova loam, 14 to 18 percent slopes, moderately eroded	386	. 1
Renova loam, 14 to 18 percent slopes, severely eroded	206	(1)
Riceville loam, 2 to 7 percent slopes	320	. 1
Rockton loam, 0 to 2 percent slopes	648	. 1
Rockton loam, 2 to 5 percent slopes	3, 949	. 9
Rockton loam, 5 to 9 percent slopes	784	. 2
Rockton loam, 9 to 14 percent slopes	153	(1)
Rowley silt loam, 0 to 4 percent slopes	154	(1)
Rowley and Lawson silt loams, overwashed	857	. 2
Sattre loam, moderately deep, 0 to 2 percent slopes	1, 098	. 2
Sattre loam, moderately deep, 2 to 5 percent slopes	1, 814	. 4
Sattre loam, moderately deep, 5 to 9 percent slopes, moderately eroded	857	. 2

See footnote at end of table.

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

Mapping unit	Acres	Percent	Mapping unit	Acres	Percent
Sattre loam, moderately deep, 9 to 14 percent slopes, moderately eroded	218	(1)	Waukegan loam, deep, 2 to 5 percent slopes	802	.2
Sattre loam, deep, 0 to 2 percent slopes	774	.2	Waukegan loam, moderately deep, 0 to 2 percent slopes	1,136	.3
Sattre loam, deep, 2 to 5 percent slopes	374	.1	Waukegan loam, moderately deep, 2 to 5 percent slopes	261	.1
Sattre loam, deep, 5 to 9 percent slopes, moderately eroded	155	(1)	Whalan loam, 2 to 5 percent slopes	1,244	.3
Spillville loam	971	.2	Whalan loam, 5 to 9 percent slopes, moderately eroded	790	.2
Steep rock land	23,184	5.3	Whalan loam, 9 to 14 percent slopes, moderately eroded	435	.1
Steep sandy land, 14 to 30 percent slopes	860	.2	Whalan loam, 14 to 24 percent slopes, moderately eroded	404	.1
Terril loam, 0 to 2 percent slopes	1,707	.4	Whalan loam, 14 to 18 percent slopes, severely eroded	178	(1)
Terril loam, 2 to 5 percent slopes	784	.2	Winneshiek loam, 0 to 2 percent slopes	340	.1
Turlin gritty silt loam, 0 to 2 percent slopes	60	(1)	Winneshiek loam, 2 to 5 percent slopes	8,649	2.0
Turlin gritty silt loam, 2 to 5 percent slopes	537	.1	Winneshiek loam, 5 to 9 percent slopes	2,320	.5
Volney channery silt loam, 0 to 1 percent slopes	329	.1	Winneshiek loam, 5 to 9 percent slopes, moderately eroded	322	.1
Volney channery silt loam, 2 to 5 percent slopes	380	.1	Winneshiek loam, 9 to 14 percent slopes	528	.1
Volney silt loam, overwashed, 0 to 1 percent slopes	355	.1	Winneshiek loam, 14 to 18 percent slopes	351	.1
Volney silt loam, overwashed, 2 to 5 percent slopes	118	(1)	Total	440,320	100.0
Waucoma loam, 0 to 2 percent slopes	146	(1)			
Waucoma loam, 2 to 5 percent slopes	975	.2			
Waucoma loam, 5 to 9 percent slopes	288	.1			
Waucoma loam, 9 to 14 percent slopes	204	(1)			
Waukegan loam, deep, 0 to 2 percent slopes	1,286	.3			

[1] Less than 0.05 percent.

In the descriptions that follow, the soils in a series are first discussed as a group by describing important features that apply to all the soils in the series. The location of the soils in the county is given, as well as the position of the soils in the landscape. Some of the nearby or similar soils are named and compared with the soils in the series being described. The general description of the series is ended with a broad statement that tells how the soils are used.

Following the description of each series are descriptions of each soil in the series. Generally, these descriptions tell how the profile of the soil described differs from the one described as representative of the series. They also tell about the use and suitability of the soil described and something about its management needs.

Technical descriptions of profiles, which give details layer by layer, are not given in this subsection. A profile representative of each soil series is described in the section "Genesis, Classification, and Morphology of Soils."

Some of the terms used in the soil descriptions are defined in the subsection "How This Survey Was Made." Other terms are defined in the Glossary at the back of this soil survey.

Alluvial Land

Alluvial land (0 to 1 percent slopes) (Ab) is a nearly level or undulating miscellaneous land type that consists of mixed alluvium. The soil material varies in texture and color, but it is generally light colored and sandy near the surface. Flooding is frequent; each time the areas are flooded, additional light-colored sandy or loamy material is deposited on the surface.

This land type occupies a narrow belt of bottom lands that are adjacent to the channels of streams. Old oxbows are common in the areas, and some of them are filled with water for long periods.

Where flooding is not controlled, this land type is used for pasture, as woodland, or for wildlife habitats. Most of the areas are in pasture or idle, and few of them are cultivated. If row crops are grown, the excess water must be controlled by constructing dikes, improving the stream channels, and installing tile or surface drainage. Even in areas that are already drained, a crop may be lost as the result of flooding. The trees and shrubs need to be removed to make some areas suitable for crops or pasture, and they also need to be removed from some areas already in pasture. Where stream channels are numerous, fences are difficult to maintain.

Crop yields are variable on this land type. In areas that are drained, however, yields are generally about average for the county if management is good. This land type is generally slightly acid to neutral, and it contains lime in some places. It is very low in nitrogen, phosphorus, and potassium. Where drainage has been improved, response to fertilizer is moderate. (Capability unit IIIw-2)

Arenzville Series

In the Arenzville series are well drained or moderately well drained, light-colored soils that formed in stratified silty alluvium. In many places a dark, buried soil is at a depth of 24 to 36 inches.

The Arenzville soils are on undulating bottom lands, adjacent to meandering streams or near the center of upland drainageways. In places the areas are dissected by a stream that cannot be readily crossed with farm machinery. As a result, it is necessary to manage some large areas of these soils as two fields. These soils are adjacent to Kennebec, Lawson, Otter, and Chaseburg soils.

Representative profile:

0 to 30 inches, dark grayish-brown, friable silt loam that contains thin strata of very dark gray and brown.
30 to 46 inches, black, friable silt loam.

In general the color of the surface layer ranges from very dark grayish brown to dark grayish brown. In some areas that have been cultivated for some time, the surface layer is slightly darker than typical.

These soils have high available moisture capacity and are moderately permeable. They are flooded occasionally, but wetness is not a problem in years when rainfall is average. The soils dry out quickly and are easily tilled.

The Arenzville soils are suited to row crops. They are neutral, and lime is not needed. However, these soils are very low in available nitrogen, low in available phosphorus, and only medium in available potassium.

Arenzville silt loam (0 to 1 percent slopes) (Ar).—This is the only Arenzville soil mapped in this county. It consists of dark grayish-brown (moist) silt loam to a depth of 20 inches or more but is lighter colored when dry.

This soil is on bottom lands that are bordered by stream channels, and it is also in upland drainageways. Adjacent to it are Kennebec, Otter, Lawson, and Chaseburg soils.

Wetness is generally not a problem, although some areas of this soil are susceptible to flooding and need protection.

This soil is suited to intensive use for corn or other row crops, and most of it is cultivated. If management is good, yields of corn are generally above average. Response to fertilizer is good. (Capability unit I–2)

Atkinson Series

Well-drained soils of uplands are in the Atkinson series. These soils formed in friable, loamy glacial material that is between 30 and 50 inches thick and is underlain by hard limestone bedrock. In most places the subsoil contains a thin layer of material weathered from limestone that lies just above the bedrock. The slopes range from 2 to 9 percent but are between 2 and 5 percent in most places.

The Atkinson soils are in the western part of the county. They occur with the Rockton, Waucoma, Jacwin, Marlean, and Ostrander soils.

Representative profile:

0 to 13 inches, very dark brown, friable loam.
13 to 36 inches, very dark grayish-brown, brown to dark-brown, and some dark yellowish-brown, friable loam and clay loam; some pebbles are at a depth of 16 inches and below that depth.
36 to 40 inches, dark-brown and yellowish-brown, firm clay; hard limestone bedrock is at a depth below 40 inches.

The color of the surface layer ranges from black or very dark gray to very dark brown, and the surface layer remains dark colored, both when moist and when dry. In some places the texture of the surface layer is silt loam instead of loam.

The surface layer has a high content of organic matter. Permeability is moderate, and the available moisture capacity is medium. Wetness is not a problem, and these soils are in good tilth and can be easily cultivated. The underlying limestone limits growth of the roots of some plants.

These soils are suited to row crops. The more sloping areas are susceptible to erosion, however, and they should be used for row crops less frequently than the nearly level areas. The soils are medium acid. Legumes grown on them respond well to applications of lime. The supply of available nitrogen, phosphorus, and potassium is low.

Atkinson loam, 2 to 5 percent slopes (AtB).—This is the only Atkinson soil mapped in the county. In most places its surface layer is very dark brown loam, but a few areas have a texture of silt loam. The surface layer is 8 to 15 inches thick and is in good tilth. Limestone bedrock is at a depth between 36 and 50 inches in most places.

Some nearly level areas of this soil lie below Waucoma, Rockton, Ostrander, and Jacwin soils. The gently sloping areas lie above Waucoma, Jacwin, and Marlean soils.

Included in mapped areas of this soil are a few patches in which the surface layer is thinner than the one in the profile described as typical for the series and in which limestone is nearer the surface. In areas that are adjacent to Ostrander soils, the profile is 40 to 50 inches thick over limestone.

This Atkinson soil is suited to row crops, but it is susceptible to water erosion. Therefore, tillage ought to be on the contour where row crops are grown, or terraces should be constructed. Corn or other row crops can be grown intensively if the areas are terraced. Because of the limestone near the surface, graded terraces ought to be constructed to minimize large cuts and fills. If tilth becomes poor, a larger part of the rotation ought to consist of meadow. Yields of corn are generally above average if good management is used. Response to fertilizer is good. (Capability unit IIe–4)

Atterberry Series

In the Atterberry series are silty soils that are somewhat poorly drained. These soils formed in loess. They do not have stones or pebbles on the surface, and none are in the profile. Their slopes range from 1 to 4 percent.

These soils are on upland divides and in or near a few upland drainageways in the eastern part of the county. They are adjacent to Downs and Fayette soils. The size of the areas varies, and in many places these soils are managed with the Downs soils.

Representative profile:

0 to 8 inches, very dark gray, friable silt loam.
8 to 14 inches, dark grayish-brown, friable silt loam; a few olive-brown mottles or concretions of an oxide.
14 to 54 inches, dark grayish-brown, grayish-brown, olive-gray, and light olive-brown, friable light silty clay loam to silt loam; a few yellowish-brown mottles.
54 to 68 inches, mottled yellowish-brown and olive-gray, friable silt loam.

The color of the surface layer ranges from black to very dark gray. The thickness of that layer ranges from 4 to 8 inches.

The surface layer of these soils is moderately high in content of organic matter, and it is generally in good tilth. Permeability is moderate, but in some places the moderately high water table restricts the movement of water in the subsoil. The available moisture capacity is high or very high.

These soils are suited to row crops. They are slightly acid to medium acid, however, and the requirements for lime vary. These soils are low in available nitrogen and phosphorus and only medium in available potassium.

Atterberry silt loam, 1 to 4 percent slopes (AyA).—This is the only Atterberry soil mapped in this county. It has a very dark gray surface layer that is 4 to 8 inches thick and a fairly distinct, light-colored subsurface layer.

This soil is on moderately wide ridgetops and at the heads of drainageways. In many places it is surrounded by areas of Downs and Fayette soils.

Included in mapped areas of this soil are areas of a soil that has a black surface layer of silt loam, 8 to 14 inches thick, and no subsurface layer. Also included are a few areas of a soil that has slopes between 5 and 9 percent.

Except in a few of the more sloping areas, runoff is generally slight. A moderately high water table and some seepage make this soil wet. The degree of wetness varies, but wetness delays field operations in spring and after periods of heavy rainfall. Areas near the upland drainageways are commonly tiled, and field operations are more timely where tile drainage has been established. Tile drains function well in this soil, and outlets are not difficult to establish. The more sloping areas ought to be terraced or tilled on the contour.

Corn or other row crops can be grown intensively on this soil if erosion is controlled in the sloping areas. Yields of corn are generally above average if management is good. Tilth is improved by adding manure. If tilth becomes poor, meadow crops should be grown for a longer time than normal in the rotation. Response to fertilizer is good. (Capability unit I–3)

Backbone Series

Well-drained to excessively drained soils are in the Backbone series. These soils formed in sandy material that is underlain by a thin layer of clay loam or clay, which overlies hard limestone bedrock. The limestone bedrock is at a depth of 20 to 40 inches. The slopes range from 2 to 14 percent.

The Backbone soils are on uplands throughout the western part of the county, adjacent to Lamont and Chelsea soils. The areas border valleys of the major streams.

Representative profile:

0 to 8 inches, very dark gray, very friable loamy sand to sandy loam.
8 to 24 inches, dark-brown to brown, very friable sandy loam.
24 to 27 inches, dark-brown and dark yellowish-brown, firm or very firm heavy clay loam; this layer is underlain by hard limestone bedrock.

The surface layer of these soils ranges from very dark gray to very dark brown in color. In areas where the soil material has not been mixed by tillage, the surface layer is underlain by a distinct light-colored subsurface layer. In places the surface layer in cultivated areas is lighter colored than the one described in the preceding paragraph. The layer of soil material just above bedrock ranges from loam to clay in texture. That layer is generally 2 to 7 inches thick, but it is as much as 12 inches thick in some places.

Permeability is rapid in the loamy sand to sandy loam in the upper part of the profile and slow in the thin layer of clay loam or clay. The available moisture capacity is low. These soils are susceptible to erosion by water and wind.

The less sloping areas of these soils are suited to row crops, and the steeper areas are suited to pasture or trees. Lime is needed, and the supply of available nitrogen, phosphorus, and potassium is very low. Adding manure does not greatly improve the tilth or available moisture capacity of these soils.

Backbone loamy sand, 2 to 5 percent slopes (BaB).—In cultivated areas the plow layer of this soil is very dark gray or very dark grayish brown and is 10 inches thick in some places. In areas that have not been cultivated, the surface layer is very dark gray to very dark brown and is 6 to 8 inches thick. In those areas the surface layer is underlain by a somewhat distinct, dark grayish-brown subsurface layer. In many places limestone is at a depth between 24 and 40 inches.

This soil is on convex ridges and side slopes in the uplands. In many places it is downslope from Lamont soils. The individual areas are less than 15 acres in size.

Included in mapped areas of this soil are areas of a soil that has a very dark grayish-brown surface layer only 6 inches thick. Also included are a few spots where only about 15 inches of sandy material overlies the limestone bedrock.

Wind and water from runoff erode this Backbone soil where it is bare or only sparsely covered with plants. Crop residue ought to be kept on the surface when the soil is not protected by a growing crop. Corn or other row crops can be tilled on the contour or grown in contour strips. If this soil is stripcropped, row crops can be grown 2 years in 4. This soil is not suitable for terraces, because limestone is near the surface and the subsoil is low in fertility. Yields of corn are generally below average for this county, even if management is good. Response to fertilizer is fair to poor. (Capability unit IVs–1)

Backbone loamy sand, 5 to 9 percent slopes (BaC).—The surface layer of this soil is 4 to 8 inches thick and is very dark brown, very dark gray, or very dark grayish brown. In many cultivated areas, the light-colored subsurface layer has been mixed with the surface layer. Limestone bedrock is generally at a depth between 20 and 36 inches, but it is at a depth of as much as 40 inches in places.

This soil is on extended narrow ridges in the uplands and on convex side slopes. It is downslope from Lamont soils in many places and is adjacent to Chelsea soils in some places.

A few areas are included where limestone is at a depth of only 15 inches and the texture above the limestone is sandy loam. Also included are areas of darker colored soils that lack a light-colored subsurface layer.

Wind and water erode areas of this Backbone soil that are not protected. The crops can be tilled on the contour or grown in contour strips. Crop residue should be kept on the surface when the soil is not protected by a growing crop. This soil can be used for row crops 2 years in 5 if it is stripcropped. Because yields of field crops are low, however, much of the acreage is in permanent pasture. The limestone bedrock near the surface makes this soil unsuitable for terraces, for in many places limestone would be exposed in the channel if terraces were constructed. Also the fertility of the subsoil is too low to justify terracing.

Yields of corn grown on this soil are generally below average, and yields of meadow are often below average for this county, even if management is good. Response to fertilizer is poor, but legumes respond to applications of lime. (Capability unit IVs-2)

Backbone loamy sand, 9 to 14 percent slopes (BaD).—In cultivated areas the surface layer of this soil is 3 to 6 inches thick and is very dark brown, very dark gray, or very dark grayish brown. The subsoil is dark brown or brown and is exposed in a few places. In timbered areas the surface layer is very dark gray and is 4 to 8 inches thick. It is underlain by a brown subsurface layer. Limestone bedrock is at a depth of 20 to 30 inches in many places, but the depth ranges to as much as 40 inches.

This soil is on convex side slopes below less sloping Backbone and Lamont soils. In places it is adjacent to slopes occupied by Chelsea soils. The individual areas are small, and many of them are managed with the adjoining soils. Included in mapped areas of this soil are areas of a soil in which limestone is at a depth of only 15 inches.

Wind and water from runoff erode this Backbone soil if the surface is not protected. This soil is suited to permanent pasture, trees, or wildlife habitats. Controlled grazing is needed where the areas are used for pasture or meadow. Burrowing rodents are likely to destroy old seedings in meadows, and oats are often grown as a nurse crop when a meadow is renovated. Meadows that have been seeded respond to applications of lime and phosphate fertilizer, but yields of meadow are generally below average, even where management is good. Areas now in trees ought to be managed as woodland. (Capability unit VIs-1)

Bassett Series

In the Bassett series are moderately well drained soils that formed in 14 to 24 inches of loamy or silty material over friable or firm glacial till. Between them and the underlying till is a slight concentration of stones and pebbles. The slopes range from 0 to 9 percent.

These soils are on convex highs, on ridgetops, and on side slopes in the uplands in the western part of the county. In many places they are adjacent to Coggon, Racine, Oran, and Ostrander soils. They are upslope from the Floyd and Clyde soils.

Representative profile:

0 to 7 inches, very dark gray, friable loam.
7 to 13 inches, brown to dark-brown, friable loam.
13 to 44 inches, brown to dark-brown and yellowish-brown, friable to firm loam; some pebbles, grayish coatings, and a very few mottles below a depth of 28 inches.
44 to 50 inches, mottled yellowish-brown and olive-gray, friable to firm sandy clay loam that contains a few pebbles.

In some areas the surface layer is silt loam instead of loam. In areas that have not been cultivated, the color of the surface layer ranges from very dark gray to black and there is a distinct, light-colored subsurface layer. In areas that have been cultivated, the surface layer ranges from very dark gray to very dark grayish brown when moist, but it is fairly light colored when dry.

These soils have high available moisture capacity and moderate to moderately slow permeability. The sloping areas are susceptible to water erosion.

The Bassett soils are suited to row crops, but they are strongly acid and are low in available nitrogen, phosphorus, and potassium. Lime is needed.

Bassett loam, 0 to 2 percent slopes (BeA).—In areas that have not been plowed, this soil has a very dark gray surface layer that is 6 to 8 inches thick, and a distinct, light-colored subsurface layer. In areas that have been plowed, the surface layer is somewhat light colored when dry.

This soil is on ridgetops, above areas of more strongly sloping Bassett, Oran, Coggon, and Racine soils.

Included in mapped areas of this soil are areas in which limestone is at a depth below 40 inches. Also included are a few areas of a soil that is somewhat poorly drained.

Wetness is not a serious hazard, although runoff is slow on this nearly level Bassett soil. In some places, however, this soil is in poor tilth because it is low or moderately low in content of organic matter. It is used intensively for corn or other row crops. Yields of corn are generally above average if management is good. However, lime and a commercial fertilizer are needed and manure is beneficial. Response to fertilizer is good. (Capability unit I-3)

Bassett loam, 2 to 5 percent slopes (BeB).—When moist, this soil has a very dark gray or very dark grayish-brown surface layer, but the surface layer is somewhat light colored when dry. The layer that was formerly the subsurface layer is now a part of the plow layer. Dark grayish-brown to dark-brown soil material that was formerly part of the subsoil is also mixed with the plow layer in places. Where erosion has exposed the subsoil, tilth is poor.

This soil is on ridgetops and side slopes, below less sloping Ostrander soils and above Floyd and Oran soils. Adjacent to it in many places are more strongly sloping Bassett, Racine, and Waucoma soils.

Runoff causes erosion on this soil; therefore, tillage ought to be on the contour if row crops are grown. Where this soil is terraced and well managed, corn or other row crops can be grown intensively. Yields of corn are generally above average if management is good. Lime and fertilizer are needed, however, for the optimum growth of crops. Response to fertilizer is good. (Capability unit IIe-1)

Bassett loam, 5 to 9 percent slopes (BeC).—This soil has a surface layer that is very dark gray and is 4 to 8 inches thick Its subsurface layer is dark grayish brown to dark brown.

This soil is on ridges and side slopes, below areas of Ostrander soils and upslope from areas of Floyd soils. In many places it is near Racine, Oran, and Waucoma soils and is managed with those soils.

Included in mapped areas of this soil are areas of a soil that has a dark-colored surface layer, more than 8 inches thick, and no light-colored subsurface layer. Also included are a few areas of a somewhat poorly drained soil that has a grayish subsoil.

In some places this Bassett soil is in permanent pasture or in scattered timber. Where cultivated crops are grown, runoff is likely to cause erosion; therefore, cultivated crops ought to be grown on the contour. If this soil is terraced or stripcropped, corn or other row crops can be grown 3 years in 5. A greater part of the rotation should consist of meadow, however, if tilth becomes poor. If management is good, yields of corn are generally above average, but legumes need lime. Response to fertilizer is good. (Capability unit IIIe-1)

Bassett loam, 5 to 9 percent slopes, moderately eroded (BeC2).—The surface layer of this soil is very dark gray to very dark grayish brown. The subsurface layer has been mixed with the plow layer in most places.

This soil is on sharply convex ridges and side slopes, above Racine, Waucoma, or Winneshiek soils. It is adjacent to Oran and Floyd soils in some places.

Included in mapped areas of this soil are a few patches where erosion has exposed the brown or dark-brown subsoil. In those areas the soil material is low in content of organic matter and is in poor tilth.

Runoff easily erodes this Bassett soil when the cover of plants is sparse or absent. Therefore, row crops ought to be grown on the contour, or this soil should be terraced or stripcropped. Corn or other row crops can be grown about 2 years in 4 where the fields are terraced or stripcropped. Yields of corn are generally above average if management is good. Manure is beneficial, and legumes need lime. Response to fertilizer is good. (Capability unit IIIe-1)

Bassett silt loam, 2 to 5 percent slopes (BIB).—This soil has a very dark gray surface layer that is 4 to 8 inches thick. The texture of silt loam extends to a depth of about 20 inches in most places.

This soil is on ridges above Floyd, Clyde, and more sloping Bassett and Racine soils. Adjacent to it in some places is the gray subsoil variant of the Franklin series.

Included in mapped areas of this Bassett soil are areas of a soil in which the layer of silt loam is as thick as 40 inches. Also included are a few areas in which the surface layer is lighter colored than typical.

When the surface is bare, water erosion is a hazard. If row crops are grown, this soil can be tilled on the contour or terraced. Corn or other row crops can be grown intensively if this soil is terraced and is well managed. Yields of corn are generally above average if management is good. Response to fertilizer and lime is good. (Capability unit IIe-1)

Bassett silt loam, 5 to 9 percent slopes (BIC).—The surface layer of this soil is very dark gray to very dark grayish brown. In areas that are cultivated, part of the light-colored subsurface layer has been mixed into the plow layer in some places. Erosion has exposed the brown subsoil in a few places, and those areas are indicated on the soil map by the symbol for severe erosion.

This soil is on side slopes, below less sloping Bassett soils and above areas of Floyd and Clyde soils. Adjacent to it is the gray subsoil variant of the Franklin series.

Included in mapped areas of this soil are areas of a soil in which the layer of silt loam is 20 to 40 inches thick. Also included are a few areas of a soil that has a lighter colored surface layer and a thicker subsurface layer than typical.

Where row crops are grown, tillage can be on the contour so that runoff will be reduced and erosion controlled. Corn or other row crops can be grown 3 years in 5 if this soil is terraced or stripcropped. Yields of corn are generally above average if management is good. The eroded areas are very low in content of organic matter and are in poor tilth. Therefore, applications of manure are beneficial. Lime is needed for legumes. Response to fertilizer is good. (Capability unit IIIe-1)

Bertrand Series

In the Bertrand series are well-drained soils that formed in friable, silty alluvium. These soils have a distinct, light-colored subsurface layer, and they are free of stones or pebbles. Their slopes range from 0 to 5 percent.

These soils are on stream benches, above Chaseburg and Volney soils. Many of the areas are small and are managed with the Festina and Canoe soils, which are adjacent.

Representative profile:

0 to 8 inches, dark-gray, friable silt loam.
8 to 14 inches, dark grayish-brown and brown, friable silt loam.
14 to 48 inches, brown to dark-brown and yellowish-brown, friable silt loam that grades to loam in the lower part of the horizon.
48 to 52 inches, dark yellowish-brown, friable gravelly clay loam.

The color of the surface layer ranges from very dark gray to dark gray.

The available moisture capacity is high, and these soils are moderately permeable. The sloping areas are susceptible to erosion. The content of organic matter is very low. Surface sealing may restrict the intake of water in some places.

Manure ought to be applied to improve the tilth and water intake of these soils. Lime is needed because these soils are medium acid to strongly acid. The soils are very low in available nitrogen and low in available phosphorus and potassium.

Bertrand silt loam, 0 to 2 percent slopes (BnA).—Where this soil has been cultivated, its surface layer is dark gray when moist and is much lighter colored when dry. The areas in timber or pasture, however, have a very dark gray surface layer, and this dark color extends to a depth of 2 to 4 inches.

This soil occurs on stream benches with the Festina and Canoe soils. The individual areas vary in size, but many of them are small. Included in mapped areas of this soil in places is a soil that has slight mottling in the subsoil.

Only a small amount of water runs off this Bertrand soil. This soil takes in water well, and artificial drainage is not needed. The content of organic matter is very low.

If this soil is properly managed, it can be used intensively for corn or other row crops. Yields of corn are generally above average under good management. Surface crusting and sealing can be reduced by adding manure. Lime and fertilizer are needed for the optimum growth of crops. Response to fertilizer is good. (Capability unit I-1)

Bertrand silt loam, 2 to 5 percent slopes (BnB).—The profile of this soil is similar to the one described as representative for the series. The surface layer is dark gray or dark grayish brown when moist and is much lighter colored when dry. The subsurface layer is mixed with the plow layer in most places. The surface layer is low in content of organic matter.

This soil is on the undulating parts of some stream benches or on short slopes that border stream benches. Adjacent to it on the benches are Festina and Canoe soils. This soil also occurs with Chaseburg and Volney soils, which are on the adjacent bottom lands.

Included in mapped areas of this soil are a few patches in which the surface layer is darker and slightly thicker than typical for the Bertrand series. Also included are areas of a soil that has a slightly mottled subsoil.

This Bertrand soil is easily eroded by runoff. Therefore, corn or other row crops ought to be tilled on the contour. In some places terraces are difficult to establish because of the shape of the slopes. Diversion terraces can be placed upslope, however, to provide protection from erosion. Yields of corn are generally above average if management is good, but lime is needed for legumes. Response to fertilizer is good. (Capability unit IIe–1)

Bixby Series

In the Bixby series are well-drained to excessively drained soils of the uplands. These soils have formed in loamy material, but leached sand and gravel are at a depth of 24 to 36 inches. The slopes range from 0 to 9 percent.

These soils are on stream benches, ridgetops, and side slopes. They are adjacent to Camden, Sattre, and Waukegan soils, and are near the Renova soils in some places. The individual areas vary in size, but some of them are large.

Representative profile:

0 to 7 inches, dark grayish-brown, very friable loam.
7 to 12 inches, brown to dark-brown, very friable loam.
12 to 28 inches, dark yellowish-brown and yellowish-brown, friable sandy clay loam.
28 to 44 inches, yellowish-brown, loose sandy loam that grades to gravelly sand at a depth of 32 inches.

In areas that have not been cultivated, these soils have a very dark gray to very dark grayish-brown, loam surface layer, 2 to 4 inches thick, and a distinct, light-colored subsurface layer. In cultivated areas the plow layer ranges from dark gray to dark grayish brown in color, and it is very low in content of organic matter.

These soils have low to medium available moisture capacity. Lack of moisture in their subsoil limits the growth of plants in some years. Permeability is moderate in the solum but rapid in the substratum.

Sloping areas of these soils are susceptible to erosion. The soils are suited to row crops, but lime is needed for the optimum growth of crops. The soils are very low in available nitrogen and low in available phosphorus and potassium.

Bixby loam, 0 to 2 percent slopes (BoA).—The plow layer of this soil is dark gray or dark grayish brown when moist, but it is much lighter colored when dry. Sand and gravel are at a depth of 24 to 36 inches. A large part of the acreage is cultivated.

This soil occurs on stream benches with Camden and Sattre soils. It is also on the uplands, adjacent to Renova and Waukegan soils.

Included in mapped areas of this soil are spots in which the texture of the surface layer is silt loam. Also included are a few areas in which sand and gravel are at a depth of only 20 inches.

In years when rainfall is average for this county, this Bixby soil is somewhat droughty. It absorbs water readily, and little or no water runs off. This soil can be worked soon after rains, and it is suited to intensive use for corn or other row crops. Yields of corn are generally above average if good management is used. Response to fertilizer is good. (Capability unit IIs–1)

Bixby loam, 2 to 5 percent slopes (BoB).—In cultivated areas the plow layer of this soil is dark grayish brown when moist, but it is much lighter colored when dry. In a few areas that are used for pasture or timber, however, the surface layer is thin and is very dark gray. In most places sand and gravel are at a depth of 24 to 36 inches, but they are at a depth of only 20 inches in some places.

This soil is on undulating stream benches or side slopes, below areas of Camden and Waukegan soils, which are on nearly level stream benches. It also occurs on upland ridges with the Renova and Waukegan soils.

Runoff erodes this soil. Therefore, row crops ought to be tilled on the contour. Some of the areas can be protected from erosion by constructing diversion terraces in areas of other soils upslope. This soil is somewhat droughty in years when rainfall is average. If corn or other row crops are planted and tilled on the contour, they can be grown 3 years in 4. Yields of corn are generally above average if management is good. Response to fertilizer is moderate. (Capability unit IIe–6)

Bixby loam, 5 to 9 percent slopes, moderately eroded (BoC2).—The surface layer of this soil varies in thickness. In most places it is very dark gray, dark gray, or dark grayish brown when moist and is much lighter colored when dry. The subsurface layer has been mixed with the surface layer in many places. In a few small areas, erosion has been severe and the color of the surface layer is brown or dark brown. These small areas are shown on the soil map by the symbol for severe erosion.

This Bixby soil occurs on stream benches and escarpments with Camden and Sattre soils, above areas of Chaseburg and Volney soils of the bottom lands. In some places it occurs with the Renova and Sattre soils on side slopes in the uplands. The individual areas are small and are often farmed with the adjacent soils.

When the cover of plants is sparse, this soil is subject to further erosion caused by runoff. Adding manure and plowing under crop residue improve the intake of water. This soil is droughty in years of average rainfall. Where row crops are grown, tillage ought to be on the contour or the field should be stripcropped. If stripcropping is practiced, corn or other row crops can be grown 2 years in 4. Yields of corn are generally average if management is good. Lime is needed to establish a stand of legumes. Response to fertilizer is moderate. (Capability unit IIIe–5)

Burkhardt Series

Excessively drained soils that have a surface layer of sandy loam are in the Burkhardt series. These soils are underlain by sand and gravel at a depth of 15 to 24 inches. The slopes range from 0 to 14 percent.

These soils are on stream benches and on escarpments, ridges, and side slopes in the uplands. In many places on the stream benches, they are adjacent to Dickinson, Lamont, Waukegan, and Sattre soils. In the uplands they are near Renova and Racine soils. In this county the individual areas are small.

Representative profile:

0 to 7 inches, very dark brown, very friable sandy loam.
7 to 17 inches, brown to dark-brown, very friable sandy loam.
17 to 42 inches, yellowish-brown, loose gravelly sand.

The color of the surface layer ranges from very dark gray to very dark brown, and the thickness of that layer ranges from 6 to 10 inches. In some places the surface layer and the subsoil contain gravel.

These soils have low available moisture capacity and are droughty. Permeability is moderate in the soil material above the sand and gravel, but it is very rapid in the sand and gravel. These soils warm up quickly in spring and can be worked soon after rains.

These soils are easily eroded by runoff when the surface is bare or when the cover of plants is sparse. The less sloping Burkhardt soils can be used for row crops, although they are poorly suited to that purpose. The steeper areas are suited to pasture, trees, and wildlife habitats. These soils are very low in available nitrogen, phosphorus, and potassium.

Burkhardt soils, 0 to 5 percent slopes (BuB).—These soils have a surface layer of very dark brown to very dark grayish-brown sandy loam that is low in content of organic matter. They are underlain by sand and gravel at a depth of 15 to 24 inches.

These soils occur on stream benches and upland ridges with Dickinson, Lamont, and moderately deep Waukegan and Sattre soils. In places they also occur on uplands with Racine and Renova soils. The individual areas are small. Included in some mapped areas of the Burkhardt soils are areas of a soil that has a lighter colored surface layer than typical.

Much of the acreage is in permanent pasture. Where row crops are grown, these soils are generally cultivated with the adjoining soils. Runoff erodes these soils when the cover of plants is sparse. Therefore, tillage ought to be on the contour if row crops are grown. Where planting and tillage are on the contour, corn or other row crops can be grown 2 years in 5. Adding manure does not improve the moisture-holding capacity enough to justify the cost, and response to commercial fertilizer is poor. (Capability unit IVs–1)

Burkhardt soils, 5 to 14 percent slopes, moderately eroded (BuC2).—The surface layer of these soils is very dark grayish-brown sandy loam that is low in content of organic matter. In the more severely eroded areas, brown or dark-brown material from the subsoil is mixed into it. Sand and gravel are at a depth of 15 to 24 inches.

These soils are on side slopes and escarpments of stream benches and on side slopes and high knolls in the uplands. Adjacent to them are Dickinson and Lamont soils, as well as moderately deep Waukegan and Sattre soils. In the uplands they are also adjacent to Racine and Renova soils. Included in mapping are a few areas in which the surface layer is lighter colored than typical.

Runoff further erodes these Burkhardt soils when the cover of plants is sparse. Therefore, tillage ought to be on the contour or the field should be stripcropped if row crops are grown. Except in the steeper areas, corn or other row crops can be grown 2 years in 6 if these soils are stripcropped. If corn is grown, however, yields are below average for the county. These soils are suitable for permanent vegetation, and a stand of meadow is often left until it needs to be renovated. Lime is needed to establish pastures that contain legumes. Adding manure does not improve the moisture-holding capacity enough to justify the cost, and response to commercial fertilizer is poor. (Capability unit IVs–2)

Calamine Series

In the Calamine series are soils that are poorly drained. These soils formed in 15 to 30 inches of silty material over firm clay shale. They have slopes of 0 to 5 percent.

The Calamine soils are on structural benches and foot slopes in the western part of the county. They are adjacent to Jacwin and Marlean soils and to areas of Steep rock land.

Representative profile:

0 to 16 inches, black, friable silty clay loam to silt loam.
16 to 28 inches, gray, dark-gray, olive, and olive-gray, firm silty clay; common yellowish-brown mottles.
28 to 48 inches, brownish-yellow and greenish-gray, very firm silty clay loam; common yellowish-brown and strong-brown mottles.

The surface layer ranges from silty clay loam to silt loam in texture. The color ranges from black to very dark gray to a depth of about 20 inches.

These soils have medium available moisture capacity. Their surface layer puddles easily if it is worked when wet. Permeability is moderate above the shale bedrock, but it is slow or very slow in the bedrock and in the material weathered from bedrock. These soils have a temporary perched water table. Seepage from areas upslope keeps them wet.

Some areas of these soils can be tile drained, but placement of the tile and backfilling are important because of the clayey texture and firm consistence of the subsoil and substratum. Where these soils are artificially drained, they are suitable for row crops. The root growth of some crops is somewhat limited, however, by the firm clay in the subsoil.

Sloping areas of these soils are slightly susceptible to erosion. These soils are medium in available nitrogen and low in available phosphorus and potassium. In most places lime is not needed.

Calamine silty clay loam, 0 to 2 percent slopes (CaA).—This soil has a surface layer of black silty clay loam to silt loam that is 14 to 20 inches thick in places. In many places the underlying clay shale is at a depth of only 20 to 30 inches.

This soil occurs on structural benches with the Jacwin soils. Both upslope and downslope from it are areas of Marlean soils and of Steep rock land.

Included in mapped areas of this soil are a few areas in which the texture of the subsoil is silty clay loam. Also included are areas in which the soil material is slightly deeper over shale bedrock than typical.

This Calamine soil is not subject to erosion. It is wet because of seepage and the temporary perched water table above the shale. The areas that have been tile drained are suitable for row crops. Placement of the tile drains and proper backfilling and spacing of the drains are important because of the clay shale near the surface. The tile drains must not be placed too deep in the clay shale, and the backfill needs to be made of porous material.

Areas of this soil that are drained and properly managed can be used for corn or other row crops 3 years in 4. Yields of corn are generally average if management is good. Reponse to fertilizer is moderate. (Capability unit IIIw–1)

Calamine silty clay loam, 2 to 5 percent slopes (CaB).—The surface layer of this soil is black silty clay loam to silt loam that is 12 to 18 inches thick. Clay shale is generally at a depth of 15 to 30 inches.

Some areas of this soil are on structural benches and foot slopes, and others are in and adjacent to upland drainageways. Both upslope and downslope are areas of Marlean soils and Steep rock land.

Included in mapped areas of this soil are some areas in which shale is at a depth of 30 inches. The subsoil in those areas has a texture of silty clay loam.

Seepage water from the soils upslope keep this Calamine soil wet. Water does not percolate readily through the profile. Tile drainage is needed, but correct placement and spacing of the tile are important because of the underlying clay shale. The tile drains must not be placed too deep in the clay shale, and the backfill ought to be made of porous material. Some surface runoff occurs during rains.

Where this soil is tile drained and tilled on the contour, corn or other row crops can be grown 3 years in 4. Contouring alone, however, without tile drainage, increases the hazard of wetness. Yields of corn are generally average if management is good. Response to fertilizer is moderate. (Capability unit IIIw–1)

Calmar Series

In the Calmar series are well drained and moderately well drained soils of the uplands. These soils formed in 24 to 40 inches of loamy material underlain by hard limestone that is fractured to some extent. The slopes range from 2 to 14 percent.

The Calmar soils are on foot slopes in the western and west-central parts of the county. In many places they are adjacent to Marlean and Rockton soils.

Representative profile:

0 to 21 inches, very dark brown, friable clay loam.
21 to 28 inches, very dark grayish-brown and dark-brown, friable to firm clay loam.
28 to 33 inches, dark yellowish-brown and brown to dark-brown, friable to firm clay underlain by limestone (shaly) bedrock.

The color of the surface layer ranges from black or very dark brown to very dark gray. In places these dark colors extend to a depth of 24 inches.

These soils have low to medium available moisture capacity and moderately slow permeability. They are susceptible to erosion. In places the root growth of some plants is limited.

The Calmar soils are suited to row crops. They are low to medium in available nitrogen and low in available phosphorus and potassium.

Calmar clay loam, 2 to 5 percent slopes (CcB).—This soil has a black to very dark brown surface layer that is 18 to 24 inches thick. In places the very dark grayish-brown color of the soil material beneath the surface layer extends to a depth of 30 inches. Limestone bedrock is at a depth between 30 and 40 inches in many places.

This soil is on slightly concave, low foot slopes. It is downslope from more sloping Calmar, Rockton, and Marlean soils. Included in mapped areas of this soil are areas in which the surface layer is silty clay loam.

This Calmar soil is susceptible to erosion caused by runoff from the soils upslope. Sediments are deposited on its surface in places. Where row crops are grown, farming ought to be done on the contour. Corn or other row crops can be grown 3 years in 5 if they are planted and tilled on the contour. Where terraces are constructed, the depth of the cuts and fills ought to be kept to a minimum so that limestone will not be exposed in the terrace channel. Yields of corn are generally above average if management is good. Response to fertilizer is moderate to good. (Capability unit IIe–4)

Calmar clay loam, 5 to 14 percent slopes (CcC).—The surface layer of this soil is very dark gray to very dark brown and is 15 to 20 inches thick. Limestone is at variable depths, but it is at a depth between 24 and 40 inches in most places.

This soil is on high, slightly concave foot slopes, below Rockton and Marlean soils. In many places other less sloping Calmar soils are downslope.

Included in mapped areas of this soil are a few small patches in which limestone is less than 24 inches from the surface. Also included are other small areas in which the texture of the surface layer is silty clay loam. Other inclusions consist of a few areas where the slopes are greater than 14 percent.

This Calmar soil is susceptible to erosion caused by runoff from the Rockton and Marlean soils. If corn or other row crops are grown, they can be tilled on the contour or grown in contour strips. Where this soil is stripcropped, corn or other row crops can be grown 1 year in 5. The amount of runoff can be reduced by constructing diversion terraces. In many places lime is needed to establish a stand of legumes. Yields of corn are generally average if management is good. Response to fertilizer is moderate. (Capability unit IIIe–4)

Camden Series

The Camden series is made up of well-drained soils that formed in 36 to 42 inches of loamy material over leached sand and gravel. In cultivated areas these soils have a light-colored surface layer when dry. The surface layer is low in content of organic matter. This soil does not have pebbles on the surface, and the surface layer and the upper part of the subsoil are also free of pebbles. The slopes range from 0 to 9 percent.

The Camden soils occur on stream benches with Canoe, Dorchester, Sattre, and Bixby soils. They also occur with soils of the Dorchester-Chaseburg-Volney complex.

Representative profile:

0 to 8 inches, very dark gray and dark gray, friable silt loam.
8 to 12 inches, very dark grayish-brown, dark grayish-brown, and dark-brown to brown, friable silt loam.
12 to 39 inches, dark-brown to brown, yellowish-brown, and dark yellowish-brown, friable silt loam that grades to silty clay loam or sandy clay loam with increasing depth.
39 to 60 inches, yellowish-brown, friable to loose loamy sand.

In cultivated areas the color of the surface layer ranges from dark gray to very dark grayish brown and part of the light-colored subsurface layer is mixed with the plow layer. In areas that are not eroded or that have not been cultivated, the surface layer is very dark gray or very dark grayish brown and is 2 to 4 inches thick. In those areas an abrupt boundary separates the surface layer from a distinct, light-colored subsurface layer.

The available moisture capacity is medium. Permeability is moderate, but the intake of water is limited in places by surface crusting and sealing. The low fertility and low available moisture capacity of the underlying sand and gravel limit the growth of roots of some crops.

These soils are suited to row crops, but the sloping Camden soils are susceptible to erosion if they are cultivated. Also, lime is needed, and these soils are very low in available nitrogen and low in available phosphorus and potassium.

Camden silt loam, 0 to 2 percent slopes (CdA).—In cultivated areas the plow layer of this soil is dark gray when moist and is much lighter colored when dry. Beneath the plow layer is a dark grayish-brown subsurface layer. Sand and gravel are at a depth of 36 to 42 inches. Cultivated crops are grown on a large part of the acreage.

This soil occurs on stream benches with Sattre and Canoe soils. Adjacent to it on the bottom lands are the Dorchester soils and soils of the Dorchester-Chaseburg-Volney complex. Many of the areas are small. Included in the areas mapped as this soil are areas of a soil in which sand or gravel is below a depth of 42 inches.

Most of the water that falls on this Camden soil is absorbed. The content of organic matter is low in the surface layer, however, and a crust forms in places when the surface layer dries. Crusting can be reduced by adding crop residue and manure.

This soil can be used intensively for corn or other row crops if the tilth is improved and the supply of plant nutrients is increased. Yields of corn are generally above average if good management is used. Response to fertilizer is good. (Capability unit I-4)

Camden silt loam, 2 to 5 percent slopes (CdB).—The surface layer of this soil is dark gray or dark grayish brown when moist, and is much lighter colored when dry. In many of the areas that have been cultivated, part of the light-colored subsurface layer has been mixed into the plow layer. In some areas that have not been cultivated and that are not eroded, the surface layer is very dark gray and is 2 to 4 inches thick. In those areas an abrupt boundary separates the surface layer from the light-colored subsurface layer. Sand and gravel are at a depth of 36 to 42 inches.

In many places this soil is in undulating or gently sloping areas that border stream benches. It is adjacent to Bixby and Sattre soils. Downslope from it, on the bottom lands, are Dorchester soils and soils of the Dorchester-Chaseburg-Volney complex. Included in mapped areas of this soil are small areas of a soil that has a slightly darker and thicker surface layer than typical.

This Camden soil is susceptible to erosion caused by runoff. Therefore, if row crops are grown, farming ought to be on the contour or terraces should be constructed. Corn or other row crops can be grown intensively if the fields are terraced. Where terraces are constructed, the depth of the cuts and fills ought to be kept to a minimum so that the sandy and gravelly underlying material will not be exposed in the terrace channel.

Yields of corn are generally above average if management is good, but legumes need lime. Adding manure improves the ability of this soil to take in water. Response to fertilizer is good. (Capability unit IIe-4)

Camden silt loam, 5 to 9 percent slopes (CdC).—This soil has a dark-gray or dark grayish-brown surface layer when moist, but the surface layer is much lighter colored when dry. In many cultivated areas, the former light-colored subsurface layer is now a part of the plow layer. The subsoil is dark brown to brown, and it has been exposed by plowing in some places. Some areas that are not eroded or that have not been cultivated have a very dark gray or very dark grayish-brown surface layer that is 1 to 3 inches thick. In a few places the subsoil is mottled. In most places sand and gravel are at a depth of 36 to 42 inches; they are at a depth of less than 36 inches in a few small areas. This soil is loamy, but some layers are lower in content of fine sand than others.

This soil is on convex side slopes and escarpments of stream benches, downslope from less sloping Camden, Bixby, and Sattre soils in some places. Below it are areas of Dorchester soils and of soils of the Dorchester-Chaseburg-Volney complex on bottom lands.

Where the cover of vegetation is sparse, this Camden soil is susceptible to erosion caused by runoff. Adding crop residue and manure improves the tilth and increases the intake of water. Where row crops are grown, the field should be farmed on the contour or should be terraced or stripcropped. Corn or other row crops can be grown 2 years in 4 if stripcropping is practiced or if terraces have been constructed. Placement of the terraces and the depth of the cut and fill are critical for this soil because of the sand and gravel near the surface.

Yields of corn are generally average or above if management is good, but lime is needed to establish a stand of legumes on this soil. Response to fertilizer is moderate to good. (Capability unit IIIe-2)

Caneek Series

In the Caneek series are soils that are somewhat poorly drained. These soils formed in light-colored silty alluvium that contains a large amount of lime. Their surface layer is light colored, both when moist and when dry, and it contains lime.

These soils are on nearly level or undulating first bottoms and in upland drainageways in the eastern part of the county. In many places they are adjacent to areas of Dorchester soils or to soils of the Dorchester-Chaseburg-Volney complex.

Representative profile:

0 to 32 inches, dark grayish-brown, friable silt loam; common, dark reddish-brown and red mottles and some dark-gray and olive-gray colors at increasing depths; calcareous.
32 to 50 inches, black, friable silt loam; common red mottles.

The depth to which the light-colored silt loam extends downward in the profile ranges from 20 to 40 inches.

These soils have high available moisture capacity and are moderately permeable. The height of the water table varies. Surface runoff is slow, and these soils are flooded occasionally. Some tile drainage and protection from overflow are needed.

If these soils are properly managed, they can be used intensively for row crops. They are low in content of organic matter, however, and puddle if they are worked when wet. The content of lime is excessive, but these soils are very low in available nitrogen and phosphorus and medium in available potassium.

Caneek silt loam (0 to 1 percent slopes) (Ce).—This is the only Caneek soil mapped in this county, and its profile is the one described for the series. Its surface layer contains lime and is low in content of organic matter.

This soil occurs in upland drainageways with soils of the Dorchester-Chaseburg-Volney complex. It also occurs with Dorchester soils on the bottom lands.

Included in some mapped areas of this soil are areas of a light-colored soil that contains lime and is only 18 inches thick over the underlying material. Also included are areas of a soil that is poorly drained.

Corn or other row crops can be grown intensively if this Caneek soil is tile drained and protected from flooding. Yields of corn are generally above average if management is good, but crops are benefited if manure is added. Response to fertilizer is good. (Capability unit IIw–2)

Canoe Series

In the Canoe series are somewhat poorly drained soils formed in silty alluvium. The slopes range from 0 to 3 percent.

The Canoe soils are on the convex sloping parts of stream benches along the Upper Iowa and Turkey Rivers and their tributaries. Adjacent to them are areas of Rowley and Festina soils.

Representative profile:

0 to 8 inches, very dark grayish-brown, friable silt loam.
8 to 18 inches, very dark grayish-brown to dark grayish-brown, friable silt loam.
18 to 60 inches, dark grayish-brown to olive-gray, friable silt loam; many yellowish-brown and light olive-brown mottles.
60 to 82 inches, mottled gray and yellowish-brown, friable silt loam to loam.

The surface layer ranges from 4 to 8 inches in thickness. When it is moist, its color ranges from very dark gray to black, but in cultivated areas it is somewhat light colored when dry.

No stones or pebbles are on the surface or in the profile of these soils. The available moisture capacity is high or very high, and permeability is moderate. These soils have somewhat restricted internal drainage, however, because of the moderately high, but variable, water table.

The Canoe soils are suited to row crops, but they are medium acid to strongly acid. Lime is needed, and these soils are also low in available nitrogen, phosphorus, and potassium.

Canoe silt loam (0 to 3 percent slopes) (Cf).—This is the only Canoe soil mapped in the county. Its profile is the one described for the series, but the surface layer ranges from 4 to 8 inches in thickness and from very dark gray to black in color. The surface layer is underlain by a distinct, light-colored subsurface layer. In some areas of this soil adjacent to uplands, about 6 inches of light-colored, silty, calcareous wash has been deposited on the surface. The surface layer is moderately low to low in content of organic matter.

This Canoe soil is on stream benches, adjacent to areas of Festina and Rowley soils. Many of the individual areas are small.

Included in mapped areas of this soil are a few areas of a soil that has a very dark gray surface layer 10 to 12 inches thick. Also included is a small acreage of Curran soils, which are mapped in other counties of the State, but occur in too small a total acreage in Winneshiek County to be mapped separately. The areas of Curran soils are indicated on the soil map by the symbol for wet spots.

This Canoe soil is often wet in spring or during periods of extensive rainfall. In some years wetness delays field operations. Tile outlets are easily established, and if this soil is tile drained, farming operations can be more timely. Diversion terraces placed on the adjacent upland slopes will protect this soil from overflow and silting. Adding manure makes tillage easier. Corn or other row crops can be grown intensively where erosion is controlled. If management is good, yields of corn are generally above average. Response to fertilizer is good. (Capability unit I–3)

Chaseburg Series

Well-drained soils formed in silty alluvium are in the Chaseburg series. These soils are light colored, both when moist and when dry. Their slopes range from 0 to 5 percent.

The Chaseburg soils are in the eastern part of the county at the base of upland slopes and in upland drainageways. Adjacent to them are areas of Arenzville, Bertrand, Dorchester, and Lawson soils.

Representative profile:

0 to 7 inches, dark grayish-brown, friable silt loam.
7 to 34 inches, dark grayish-brown, friable silt loam; some coatings of silt on the peds.
34 to 48 inches, brown to dark-brown and yellowish-brown, friable silt loam.

The combined thickness of the surface layer and subsurface layer ranges from 20 to 36 inches.

The surface layer is low in content of organic matter and does not contain lime. No stones or pebbles are on the surface or in the soil profile. These soils have high available moisture capacity and are moderately permeable. In some years, as a result of runoff from the soils upslope, new sediments that may cover young crops are occasionally deposited on their surface.

These soils are suited to row crops and can be protected from overflow by constructing diversion terraces upslope. They are very low in available nitrogen, low in available phosphorus, and medium in available potassium.

Chaseburg silt loam, 0 to 2 percent slopes (ChA).—This soil generally has a profile like the one described as typical for the series. In places, however, the surface layer consists of somewhat stratified, light-colored recent sediments. The subsurface layer has a light color when it is dry.

Much of the acreage is on stream benches at the base of upland areas. In some places, however, this soil is in moderately wide drainageways in the uplands. Some areas are adjacent to areas of Bertrand, Arenzville, and Dorchester soils.

If this soil is not protected, runoff from the soils upslope occasionally deposits new sediments on the surface. Constructing diversion terraces upslope will protect this soil from overflow.

This soil is suited to intensive use for corn and other row crops. Yields of corn are generally above average if good management is used. Response to fertilizer is good. (Capability unit I-2)

Chaseburg silt loam, 2 to 5 percent slopes (ChB).—The thickness of the surface layer is variable in this soil, but in general, it ranges from 20 to 30 inches. In a few places, the surface layer is slightly less than 20 inches, or more than 36 inches, thick. The surface layer and the subsurface layer are dark grayish brown when moist and are much lighter colored when dry. In some places the surface layer and the subsurface layer appear to be made up of stratified recent sediments.

This Chaseburg soil is at the base of upland areas and in upland drainageways. It is upslope from other Chaseburg and Lawson soils. In places it is adjacent to Dorchester and Bertrand soils.

In some places this Chaseburg soil can be protected from overflow by constructing diversion terraces upslope. Tillage ought to be on the contour. Corn and other row crops can be grown intensively if proper management is used. Yields of corn are generally above average if management is good. Response to fertilizer is good. (Capability unit IIe-2)

Chelsea Series

In the Chelsea series are excessively drained soils of the uplands. These soils formed in sand.

The Chelsea soils are on upland ridges, side slopes, and stream benches that are parallel to the main streams. They are adjacent to Lamont and Backbone soils and to areas of the till subsoil variant of the Lamont series.

Representative profile:

0 to 10 inches, dark grayish-brown, loose loamy fine sand.
10 to 24 inches, brown to dark-brown, loose loamy sand and sand.
24 to 48 inches, yellowish-brown, loose sand; some reddish-brown iron bands below a depth of 37 inches.

In areas that are eroded or that have been cultivated, the color of the surface layer ranges from dark grayish brown to dark gray. In areas that are not eroded and that are in permanent pasture or trees, the surface layer is 2 to 4 inches thick and is very dark gray or very dark grayish brown. It is low in content of organic matter.

These soils have very low available moisture capacity and very rapid permeability. They are susceptible to wind and water erosion. Blowout areas may develop if the soils are left bare for an extended length of time.

Chelsea soils are suitable for row crops, but the more sloping areas are better suited to hay and pasture. Adding manure does not give a good enough return to justify the expenditure. These soils are medium acid and are very low in available nitrogen, phosphorus, and potassium. Crops grown on them need lime.

Chelsea loamy fine sand, 1 to 5 percent slopes (ClB).—In cultivated areas this soil has a dark grayish-brown surface layer when moist, but the surface layer is much lighter colored when dry. Also, the subsurface layer has been mixed with the plow layer in many places. In areas that are not eroded or that have not been cultivated, the surface layer is very dark gray or very dark grayish brown and is underlain by a light-colored subsurface layer.

This Chelsea soil is mainly on ridges and side slopes in the uplands, but a few areas are on stream benches. In many places this soil is adjacent to Lamont soils and upslope from Backbone and more sloping Chelsea soils.

Included in mapped areas of this soil are patches where the surface layer is sandy loam. Also included are areas in which a small amount of chert or fragments of limestone are in the subsoil.

When the surface layer is bare, this Chelsea soil is susceptible to wind and water erosion. Therefore, crop residue ought to be left on the surface. Corn or other row crops can be grown 2 years in 4 if farming is done on the contour. Because this soil is droughty, however, yields of corn are generally below average for the county. Response to fertilizer is moderate to poor. (Capability unit IVs-1)

Chelsea loamy fine sand, 5 to 14 percent slopes (ClD).—Where this soil is in permanent pasture or trees, it has a thin, very dark grayish-brown surface layer and a light-colored subsurface layer. In cultivated areas the surface layer is generally dark grayish brown when moist, but it is dark brown or brown in a few eroded spots. The surface layer has a distinctly lighter color when dry.

This soil is on side slopes in the uplands and on the escarpments of stream benches. It lies below areas of the till subsoil variant of the Lamont series and below areas of less sloping Chelsea soils. Included in the mapped areas of this soil are a few places in which the texture of the surface layer is sandy loam.

Where the cover of vegetation is sparse, this Chelsea soil is susceptible to erosion by wind and water. Crop residue ought to be left on the surface to reduce erosion. Corn or other row crops can be grown 2 years in 5, but if row crops are grown, tillage needs to be on the contour. Yields of corn are below average for the county. Pasture is a better use for this soil than cultivated crops if the areas are large enough to be managed separately. Small areas are generally farmed in rotations with the adjoining soils, but some small areas are used as wildlife habitats. Response to fertilizer is poor. (Capability unit IVs-2)

Clyde Series

Soils that are poorly drained or very poorly drained are in the Clyde series. These soils formed in loamy, reworked glacial material that contains thin layers or pockets of sand and silt. On the surface in many places are glacial stones and boulders that range from 3 inches to 12 feet in diameter. The number of stones and boulders ranges from 10 to 300 or more per acre. Before an area is cultivated, these stones and boulders are usually removed. The slopes range from 0 to 4 percent.

The Clyde soils are in concave drainageways in the uplands and at the base of upland slopes. They are below areas of Ostrander and Kenyon soils, and in many places they are adjacent to areas of Floyd and Oran soils.

Representative profile:

0 to 22 inches, black and very dark gray, friable silt loam or loam.
22 to 33 inches, mottled gray, strong-brown, and yellowish-red, friable silt loam and loam.
33 to 56 inches, gray and olive-gray, friable to firm cobbly sandy loam and clay loam; some yellowish-brown and strong-brown mottles.

The surface layer ranges from 18 to 24 inches in thickness. Its texture is generally silt loam or loam, but it ranges to silty clay loam or clay loam in places.

These soils have high available moisture capacity. They are moderately permeable but are wet because seepage causes them to have a variable, but high, water table. These soils puddle easily if they are worked when wet.

The Clyde soils are suited to row crops, but they should be tile drained. They are medium in available nitrogen and low in available phosphorus and potassium.

Clyde silt loam, 0 to 4 percent slopes (CmB).—This is the only Clyde soil mapped in this county. Its profile is the one described as typical for the series. The surface layer is black, but the color grades to very dark gray with increasing depth. Areas of this soil in permanent pasture have many stones and boulders on the surface. In cultivated areas piles of stones are common along fence rows.

This soil is in concave drainageways and at the base of slopes in the uplands. In most places it is adjacent to Floyd soils, and it is downslope from Kenyon, Ostrander, and Oran soils in some places. The individual areas are small and are often managed with the adjacent soils upslope.

Included in the mapped areas of this soil are a few spots in which sand or gravel is below a depth of 36 inches. Also included are areas of soils that are silty to a depth of 40 inches.

This Clyde soil receives runoff from the soils upslope, and it is also wet because of seepage. In spring or after rains, farm operations are delayed because this soil is too wet for tillage. Tile drainage makes field operations more timely and removes the excess water in the subsoil. Outlets for the tile can generally be established. Where this soil is adequately drained, it can be used intensively for corn or other row crops. If tilth becomes poor, meadow ought to be included in the rotation. Yields of corn are generally above average if good management is used. Response to fertilizer is good. (Capability unit IIw–1)

Coggon Series

Moderately well drained soils that formed in friable to firm loam glacial till are in the Coggon series. These soils contain a thin band of pebbles at a depth of 14 to 24 inches. Also, pebbles and stones are on the surface in eroded areas. The surface layer in areas that have been cultivated is light colored, both when moist and when dry. The slopes range from 2 to 9 percent.

The Coggon soils are on rounded ridgetops and on side slopes in the western part of the county. They are upslope from Oran, Floyd, and Whalan soils and are adjacent to Bassett and Renova soils.

Representative profile:

0 to 6 inches, dark-gray and dark grayish-brown, friable loam.
6 to 10 inches, dark grayish-brown and brown to dark-brown, friable loam.
10 to 40 inches, brown to dark-brown, yellowish-brown, and dark yellowish-brown, friable sandy clay loam that contains some pebbles and has some sandy coatings below a depth of 15 inches.
40 to 44 inches, olive-gray and yellowish-brown, friable to firm loam that contains some pebbles and has some coatings of sandy material.

In areas that have not been cultivated or that are near small drainageways in side valleys, the surface layer is very dark gray to very dark grayish brown and is 2 to 4 inches thick. It is dark gray or dark grayish brown in areas that have been cultivated.

These soils have high available moisture capacity and moderate to moderately slow permeability. The surface layer is low in content of organic matter, and in some places it does not have good granular structure. Erosion is a hazard when the cover of vegetation is sparse or when the surface is bare.

The Coggon soils are suited to row crops, but they are very low in available nitrogen and low in available phosphorus and potassium. Legumes grown on these soils need lime.

Coggon loam, 2 to 5 percent slopes (CoB).—In cultivated areas the surface layer of this soil is dark gray when moist, but it is much lighter colored when dry. In most places this soil does not have stones or pebbles on the surface. In some places the surface layer is silty rather than loamy.

This soil is on rounded upland ridges, adjacent to Bassett and Renova soils. It is upslope from the Oran soils. Many of the individual areas are large enough to be farmed separately.

This soil is susceptible to erosion. Therefore, farming on the contour is necessary if row crops are grown, or the soil should be protected by terraces. If terraces are constructed, stones and pebbles are exposed in the channel of the terrace. Adding manure to the channel improves the intake of water and makes the soil easier to work.

If this soil is terraced and well managed, it is suited to intensive use for corn or other row crops. Meadow can be included in the rotation if tilth becomes poor. Yields of corn are generally above average, but legumes need lime. Response to fertilizer is good. (Capability unit IIe–1)

Coggon loam, 5 to 9 percent slopes, moderately eroded (CoC2).—The surface layer of this soil is very dark gray to dark grayish brown when moist, and it is much lighter colored when dry. In areas that are not eroded or that have not been cultivated, there is a distinct, light-colored subsurface layer. Much of the acreage has been cultivated, however, and in the cultivated areas the subsurface layer is mixed with the surface layer. Erosion has exposed the subsoil in some places, and those areas are shown on the soil map by the symbol for severe erosion. The eroded spots have stones or pebbles on the surface. In a few places, the surface layer has a texture of silt loam.

This soil is on convex side slopes, below less sloping Coggon and Bassett soils. It is upslope from the Whalan soils in a few places. Many of the individual areas are large enough to be managed separately.

When the cover of plants is sparse, this soil is susceptible to further erosion caused by runoff. Therefore, farming should be done on the contour where row crops are grown, or stripcropping or terracing is necessary. If terraces are constructed, stones and pebbles are exposed in the channel of the terrace. Adding manure to the channel improves the intake of water and makes the soil easier to work.

If this soil is stripcropped, corn or other row crops can be grown 2 years in 4. Where the soil is in poor tilth, a larger part of the rotation should consist of meadow. Generally, average yields of corn are obtained if management is good. Response to fertilizer is moderate to good. (Capability unit IIIe-1)

Colo Series

The soils of the Colo series are poorly drained and are flooded occasionally. They formed in silty alluvium. Their surface layer is dark colored, both when moist and when dry, and it does not contain stones or pebbles. The dark color extends to a depth of 3 feet or more. The slopes range from 0 to 2 percent.

The Colo soils are adjacent to Otter and Ossian soils on first bottoms, and they are also at the base of upland slopes that grade to bottom lands or low benches. The individual areas vary in size.

Because the areas of Colo soils are intermingled with areas of Otter or Ossian soils, the Colo soils are mapped with those soils and are managed with them.

Representative profile:

0 to 34 inches, black, friable silt loam to silty clay loam.
34 to 52 inches, very dark gray to gray, friable to firm silty clay loam.

In places stratified coarse-textured material occurs below a depth of 48 inches.

These soils have high available moisture capacity and moderately slow permeability. The water table is generally high, but its height is variable. Tile drains work well in these soils.

These soils are suited to intensive use for row crops. Their supply of available nitrogen and potassium is medium, and their supply of available phosphorus is low. These soils are slightly acid to neutral, and they generally do not need lime.

Colo and Otter silt loams (0 to 1 percent slopes) (Cs).—Because of the pattern in which they occur, the soils of this undifferentiated unit were not mapped separately. Both soils have a black to very dark gray surface layer that is high in content of organic matter. The dark color extends to a depth of 36 inches or more in places. The subsoil is gleyed. Both the surface and the soil profile are free of stones and pebbles.

These soils are on bottom lands. In most places they are adjacent to stream benches or to areas of uplands and are some distance from a stream channel. In some places, however, they are also adjacent to areas of Ossian soils. The individual areas vary in size, but many of them are large enough that they can be managed separately.

These soils are wet, for they have a high water table and are flooded occasionally. Surface runoff is slow, and water collects in slight depressions in a few places. The soils puddle if they are tilled when wet. Tile drains work well, and many areas are suitable for outlets. Even after the Colo soil has been drained, however, it still dries somewhat slowly and cannot be tilled soon after rains.

Where these soils have been drained by tile and protected from overflow, corn or other row crops can be grown intensively. Yields of corn are generally above average if management is good. Response to fertilizer is good. (Capability unit IIw-2)

Colo-Otter-Ossian complex (0 to 4 percent slopes) (Ct).—The soils of this complex have a surface layer of black or very dark gray silt loam or silty clay loam. The surface layer is high in content of organic matter, but it puddles easily if the soils are worked when wet. In a few places, a layer of light-colored sandy material, 6 to 12 inches thick, has been deposited on the surface.

These soils are on narrow bottom lands and in upland drainageways, downslope from Floyd and Clyde soils. On the bottom lands, they are also near areas of Turlin and Terril soils. Many of the areas are long and narrow.

Unless they have been tile drained, these soils are wet. The waterways need to be shaped and seeded in places so that tile outlets can be established. These soils dry out slowly in spring and puddle easily if they are worked when wet. Some areas need protection from overflow.

In many places these soils are cropped with the adjacent soils. Where the soils are tile drained, corn or other row crops can be grown intensively. Yields of corn are generally above average if management is good. Meadow ought to be included in the rotation where these soils are in poor tilth. Response to fertilizer is good. (Capability unit IIw-2)

Dickinson Series

In the Dickinson series are well-drained to excessively drained soils that have a surface layer of sandy loam. These soils are underlain by loamy sand and sand at a depth of 24 to 30 inches. They do not contain stones or pebbles, and their surface is free of stones and pebbles. The slopes range from 0 to 14 percent.

The Dickinson soils are along the major streams, on ridges, side slopes, and stream benches in the western part of the county. They are adjacent to Hagener soils. In the uplands they generally occur as islands that are adjacent to areas of medium-textured soils, such as the Kenyon and Ostrander. Many of the individual areas are large and can be managed separately or with the adjoining sandy soils.

Representative profile:

0 to 20 inches, very dark brown, grading to very dark grayish-brown, very friable sandy loam.
20 to 28 inches, brown to dark-brown, very friable sandy loam.
28 to 52 inches, dark yellowish-brown and yellowish-brown, friable to loose loamy sand and sand.

Because of the low available moisture capacity and rapid permeability of these soils, water drains below the root zone of most crops. As a result, unless rainfall is timely, crops are likely to be damaged by lack of moisture during part of the growing season. These soils are susceptible to wind and water erosion when the cover of plants is sparse. They warm up quickly in spring, can be worked soon after rains, and are easily tilled.

These soils are suited to row crops if they are properly managed. Lime is needed, however, because these soils are acid. The soils are very low in available nitrogen and low in available phosphorus and potassium.

Dickinson sandy loam, 0 to 2 percent slopes (DcA).—This soil has a very dark brown surface layer. In most places dark to moderately dark colors extend to a depth of 20 inches. The underlying material is loamy sand in most areas.

This soil is on stream benches and in the uplands. In many places in the uplands, the areas occur as islands adjacent to medium-textured soils, such as the Kenyon and Ostrander. The areas are large, and some of them can be managed separately. Included in mapped areas of this soil are areas of a soil in which sand and gravel are at a depth of 36 inches.

In many years this Dickinson soil does not hold enough moisture to meet the needs of growing crops. Much of the water from rainfall is leached below the root zone of most crops and is not available for the use of plants. Unless rains are timely in midsummer, crops are damaged from lack of moisture.

Corn or other row crops can be grown intensively on this soil. If enough rainfall is received and if the rainfall is well distributed, yields of corn are generally average or above under good management. Melons and other special crops do well. Response to fertilizer is good. (Capability unit IIIs–1)

Dickinson sandy loam, 2 to 5 percent slopes (DcB).—This soil generally has a very dark brown surface layer that is 8 to 10 inches thick. In some cultivated areas, however, the surface layer is very dark grayish brown. Loamy sand and sand are at a depth of 24 to 30 inches in most places.

This soil is on stream benches and on upland ridges. In many places it occurs as islands adjacent to medium-textured soils, such as the Kenyon and Ostrander. Many of the individual areas are less than 10 acres in size.

Included in the mapped areas of this soil are a few areas of a soil in which loamy sand and sand are at a depth of less than 20 inches. Also included in some places on the benches are areas in which sand and gravel are below a depth of 36 inches.

This Dickinson soil takes in water rapidly and has gentle slopes. Therefore, erosion caused by runoff is normally only slight. Erosion does occur, however, when the surface is bare or when the cover of vegetation is sparse. Where corn or other row crops are grown, tillage ought to be on the contour and crop residue should be returned to the soil. If this soil is terraced, row crops can be grown intensively. Yields of corn are generally average for the county if management is good, but the yields may be above average if rainfall is timely. Special truck crops do well on this soil. Response to fertilizer is moderate to good. (Capability unit IIIe–7)

Dickinson sandy loam, 5 to 9 percent slopes (DcC).—In most places the surface layer of this soil is very dark brown to very dark grayish brown. Part of the subsoil has been mixed with the plow layer in a few eroded areas, however, and in those spots the surface layer is dark brown to brown. The surface layer varies in thickness.

In some places near the base of slopes or near drainageways in side valleys, the surface layer is slightly darker and thicker than in other places. Sand and loamy sand are generally at a depth of 24 to 30 inches, but they are at a depth of only 20 inches in some small areas.

This soil is on narrow ridges in the uplands, on the sides of ridges, and on the escarpments of stream benches. It is adjacent to Hagener soils in some places, but most generally it is adjacent to medium-textured soils. In places this soil lies upslope from the Backbone soils and from the till subsoil variant of the Lamont series.

Included in mapped areas of this soil on a few of the stream benches are areas in which gravel and sand are below a depth of 36 inches. However, this Dickinson soil is underlain by sand and loamy sand, rather than by gravel, in most places.

Where the cover of plants is sparse, this soil is susceptible to erosion caused by runoff. It is also droughty, as much of the water from rainfall is leached below the root zone of most crops. If corn or other row crops are grown, this soil ought to be tilled on the contour or stripcropped. Where this soil is stripcropped, row crops can be grown 2 years in 4. If rainfall is timely and management is good, yields of corn are generally average. Response to fertilizer is moderate. (Capability unit IIIe–7)

Dickinson sandy loam, 9 to 14 percent slopes (DcD).—This soil generally has a very dark brown or very dark grayish-brown surface layer that is 6 to 12 inches thick. In areas that have never been cultivated, however, or that are at the base of slopes or near drainageways in side valleys, the surface layer is thicker. Also, in a few eroded spots, the surface layer is dark brown or brown. This soil is underlain by loamy sand and sand that is mainly at a depth of 24 to 30 inches. A few areas are included in which loamy sand and sand are at a depth of 20 inches.

This soil is on side slopes, below ridges occupied by less sloping Dickinson soils. Also, in many places it is below areas of medium-textured soils, such as the Kenyon and Ostrander. The individual areas are small, and therefore, this soil is managed with the adjacent soils.

This soil is easily eroded by runoff. Therefore, row crops ought to be tilled on the contour or grown in contour strips. The large areas are suitable for hay or pasture, and a row crop is grown in those areas only when a meadow is renovated. Gophers often destroy old seedings of meadow.

This soil is droughty, and much of the water from rainfall drains below the root zone of many crops. If the soil is terraced or stripcropped, corn or other row crops can be grown 1 year in 5. Yields of corn are generally below average for the county, however, even though good management is used. Lime is needed to establish a new stand of legumes. Response to fertilizer is moderate to poor. (Capability unit IVe–4)

Donnan Series

Moderately well drained and somewhat poorly drained soils of the uplands make up the Donnan series. These soils formed in loamy glacial material that is 20 to 40 inches thick. Below this loamy material is firm, gray clay. The slopes range from 2 to 5 percent.

These soils are on side slopes, downslope from Bassett, Riceville, and Racine soils in many places. They are above areas of Floyd soils and are adjacent to areas of Oran soils. The individual areas vary in size, but most of them are small.

Representative profile:

0 to 6 inches, very dark gray, friable loam.
6 to 8 inches, very dark gray and very dark grayish-brown to dark grayish-brown, friable loam.

8 to 23 inches, dark-brown to brown, friable to firm clay loam that contains some pebbles.
23 to 52 inches, gray, very firm clay; some red and reddish-brown mottles.

In many of the cultivated areas, part of the subsurface layer is mixed with the material in the plow layer. In those areas the surface layer is very dark gray or very dark grayish brown when moist and is somewhat light colored when dry.

The Donnan soils have high moisture capacity. Not all of the moisture is available for plants, however, because of the clayey texture of the subsoil and underlying material. Permeability is moderately slow above the layer of clay, and slow in that layer. Because of this difference in permeability, these soils are seepy during periods of heavy rainfall. These soils dry out slowly in spring and cannot be cultivated soon after rains. They are susceptible to water erosion when the cover of plants is sparse.

These soils are suited to row crops. They are acid, however, and crops grown on them need lime. These soils are low to medium in available nitrogen and low in available phosphorus and potassium.

Donnan loam, 2 to 5 percent slopes (DdB).—This is the only Donnan soil mapped in Winneshiek County. In areas that have been cultivated, its surface layer is very dark gray or very dark grayish brown. This soil has a somewhat distinct, light-colored subsurface layer in areas that are not eroded.

This soil is on side slopes that are nearly smooth or that are slightly concave. Included in mapped areas of this soil are a few areas that are nearly flat or that are slightly more sloping than typical.

This Donnan soil is susceptible to water erosion when the crops are small or the cover of vegetation is sparse. In places it is somewhat seepy in spring or during periods of heavy rainfall. The clayey subsoil is likely to limit the development of roots of some crops. The slow permeability and the clay near the surface make this soil unsuitable for tile drainage.

Corn or other row crops can be grown on this soil for 3 years in 5 if farming is done on the contour. Yields of corn are variable, but they are generally above average for the county. Response to fertilizer is good in years when the average amount of rainfall is received. (Capability unit IIe–5)

Dorchester Series

In the Dorchester series are light-colored, silty soils that are moderately well drained. These soils are high in content of lime and low in content of organic matter. Their slopes range from 0 to 1 percent.

The Dorchester soils are on nearly level first bottoms and on low second bottoms. They are adjacent to Caneek and Chaseburg soils and to the overwashed phase of Rowley and Lawson silt loams. They are also the major soil in the Dorchester-Chaseburg-Volney complex, which is on low foot slopes and in drainageways where the slopes are between 2 and 5 percent. In many places the individual areas are large enough to be managed separately.

Representative profile:

0 to 20 inches, dark grayish-brown, friable silt loam; calcareous.
20 to 59 inches, black, very dark brown, and very dark gray, friable silt loam.

The color of the surface layer ranges from dark grayish brown to brown, and the thickness of that layer ranges from 20 to 40 inches. Although stones or pebbles are generally absent in these soils, fragments of limestone are on the surface in some areas of the Dorchester-Chaseburg-Volney complex.

The available moisture capacity is high, and these soils are moderately permeable. Some surface sealing occurs during hard rains, however, and crusting occurs in places when the soils are dry.

In many places the Chaseburg soils need protection from overflow and from runoff from the soils upslope. Where protection is not provided, a new seeding or a young crop may be covered by recent sediments.

The Dorchester soils are suited to row crops. They are very low in available nitrogen and phosphorus, however, and only medium in available potassium.

Dorchester silt loam (0 to 1 percent slopes) (De).—This soil has a dark grayish-brown or brown surface layer consisting of recent sediments. The surface layer is much lighter colored when dry than when moist. A dark, buried soil that has a texture of silt loam to loam is commonly at a depth of 20 to 40 inches.

Included in the mapped areas of this Dorchester soil are a few areas in which the texture of the surface layer is gritty silt loam. Also included are small areas in which the light-colored material in the surface layer extends to a depth of only 8 inches.

This Dorchester soil needs protection from occasional overflow. Where it is not protected, young crops may be covered by recent sediments and surface crusting may prevent young seedlings from emerging.

This soil is suited to intensive use for corn and other row crops, but all crop residue should be returned to the soil. Also, adding manure reduces surface crusting and sealing. Yields of corn are generally above average if management is good. Response to fertilizer is very good. (Capability unit I–2)

Dorchester-Chaseburg-Volney complex, 2 to 5 percent slopes (DgB).—The soils in this complex are along narrow drainageways in the uplands and on narrow bottom lands adjacent to upland slopes. Dorchester soils make up about 60 percent of the complex, and Chaseburg and Volney soils each occupy about 20 percent. The Volney soils have a dark-colored surface layer and have fragments of limestone on the surface. The fragments are not numerous enough or large enough to hinder farm operations. Profiles that are typical of the Chaseburg and Volney soils are described under the Chaseburg and Volney series.

Runoff from the soils upslope deposits new sediments on the soils of this complex. This new material generally contains lime. It is beneficial, except when it is deposited at the time new seedlings are emerging.

Some areas of these soils are slightly wet because of seepage from the soils upslope. Wetness is generally not a hazard, however, and tile drainage is not suggested. In places diversion terraces can be built upslope to protect these soils from overflow and deposition.

Corn or other row crops can be grown if these soils are tilled on the contour and protected by diversion terraces. Yields of corn are generally above average if management is good. Response to fertilizer is good. (Capability unit IIe–2)

Dow Series

Well-drained, light-colored soils of the uplands make up the Dow series. These soils formed in loess. They have a distinctly mottled, gray subsoil, but the mottling is not related to the present drainage. The slopes range from 14 to 24 percent.

The Dow soils are on convex side slopes, mainly in small areas in and near section 25 of Washington Township. They are below areas of Fayette soils and above areas of the Dorchester-Chaseburg-Volney complex.

Representative profile:

0 to 6 inches, dark grayish-brown, friable silt loam.
6 to 72 inches, light olive-gray and olive-gray, friable silt loam; common yellowish-brown and dark reddish-brown mottles; contains lime.

Near the base of slopes or near drainageways that cut into sidehills, the color of the surface layer ranges to very dark grayish brown. In places the surface layer is mottled with olive gray.

The available moisture capacity is high, and these soils are moderately permeable. The intake of water is likely to be low, however, because of the rapid runoff and surface sealing.

The Dow soils are suitable for permanent pasture, woodland, and wildlife habitats. They are very low in available nitrogen and phosphorus and medium in potassium.

Dow silt loam, 14 to 24 percent slopes, severely eroded (DhE3).—This is the only Dow soil mapped in this county. It is on rounded side slopes that are dissected by drainageways that cut into sidehills. The plow layer is generally dark grayish brown, but it is slightly darker where this soil is near drainageways. In most places the plow layer consists of soil material that was formerly part of the subsoil.

Where the cover of plants is sparse, this soil is susceptible to further erosion. Therefore, the large areas ought to be seeded to grasses and legumes and used for pasture. The small areas can be used as wildlife habitats. Grazing ought to be controlled in the pastures.

Lime is not needed to help establish a stand of legumes on this soil. Grasses respond well to nitrogen fertilizer, however, and legumes respond well to phosphate fertilizer. (Capability unit VIe–1)

Downs Series

In the Downs series are well-drained soils of the uplands. These soils formed in loess. In areas where they have been cultivated, their surface layer is fairly light colored. The slopes range from 0 to 24 percent.

The Downs soils are on ridgetops and on the sides of ridges in the eastern part of the county. Adjacent to them in many places are Fayette and undifferentiated units of Downs and Tama soils. Most individual areas of the Downs soils are large enough to be managed separately.

Representative profile:

0 to 8 inches, very dark gray and very dark grayish-brown, friable silt loam.
8 to 10 inches, dark grayish-brown, very friable silt loam.
10 to 30 inches, brown to dark-brown, dark yellowish-brown, and yellowish-brown, friable silty clay loam; some coatings of silt on the surfaces of the peds.
30 to 50 inches, yellowish-brown, very friable silt loam.

The color of the surface layer varies, depending on the amount of erosion and the depth of plowing. In areas that are not eroded, the surface layer ranges from 4 to 8 inches in thickness and from very dark gray to very dark grayish brown in color. In those areas it is underlain by a light-colored subsurface layer. In many places part of this subsurface layer is mixed with the plow layer.

The available moisture capacity is high, and these soils are moderately permeable. The more sloping Downs soils are subject to severe erosion when the cover of plants is absent or is sparse.

Some of the Downs soils are suited to row crops. Others are suitable only for pasture, trees, and wildlife habitats.

These soils are acid, and lime is needed. The soils are low in available nitrogen, medium in available phosphorus, and medium to low in available potassium.

Downs silt loam, 0 to 2 percent slopes (DoA).—The plow layer in cultivated areas of this soil is very dark gray or very dark grayish brown, and it is low in content of organic matter. Below the plow layer is a thin, light-colored subsurface layer.

This soil is on ridgetops, upslope from areas of steeper Downs soils. In places it is also adjacent to areas of soils in the Downs and Tama undifferentiated units and to areas of Atterberry soils on wide ridges.

Included in some of the mapped areas of this soil are a few areas in which the surface layer is darker colored than typical. In many places these included soils lack a light-colored subsurface layer.

Little or no runoff takes place, because this Downs soil is nearly level and takes in water well. Erosion is not a hazard; therefore, this soil is suited to intensive use for corn or other row crops. Where tilth becomes poor, a meadow crop should be included in the rotation. Yields of corn are generally above average if good management is used. Response to fertilizer is very good. (Capability unit I–1)

Downs silt loam, 2 to 5 percent slopes (DoB).—The surface layer of this soil is very dark gray or very dark grayish brown. Beneath it is a light-colored subsurface layer.

This soil is on narrow ridgetops and is adjacent to areas of nearly level Downs soils. Downslope from it are areas of steeper Downs soils.

Included in the mapped areas of this soil are areas of soils that have a darker, thicker surface layer than typical. In many places these included soils lack a light-colored subsurface layer.

Runoff erodes this Downs soil when the cover of plants is sparse. Therefore, tillage ought to be on the contour where row crops are grown, or protection should be provided by terraces. In areas that are terraced, corn or other row crops can be grown intensively. If tilth becomes poor, a meadow crop can be included in the rotation. Yields of corn are generally above average if management is good. Response to fertilizer is very good. (Capability unit IIe–1)

Downs silt loam, 5 to 9 percent slopes (DoC).—Areas of this soil in permanent pasture or trees have a very dark gray surface layer, 4 to 8 inches thick, and a distinct, light-colored subsurface layer. In areas that are cultivated, the plow layer is very dark gray or very dark grayish brown and is somewhat light colored when dry.

This soil is on narrow ridgetops and on convex side slopes. In places it grades to areas of Nasset soils downslope. In most places, however, it lies both above and below areas of other Downs soils.

Included in mapped areas of this soil are areas of soils that have a darker, thicker surface layer than typical. In a few places, these included soils lack a distinct, light-colored subsurface layer.

When the surface is bare, this Downs soil is susceptible to erosion. Therefore, tilling on the contour, stripcropping, or terracing is necessary where row crops are grown. If this soil is terraced or stripcropped, corn or other row crops can be grown 3 years in 5. Yields of corn are generally above average if management is good. Lime is needed to help establish a stand of legumes. Response to fertilizer is very good. (Capability unit IIIe–1)

Downs silt loam, 9 to 14 percent slopes (DoD).—In areas of this soil that are in permanent pasture or wooded, the surface layer is very dark brown or very dark gray and is 4 to 8 inches thick. In cultivated areas the surface layer is very dark grayish brown.

This soil is on convex side slopes below less sloping Downs soils. It lies upslope from soils of the Otter-Lawson-Ossian and Dorchester-Chaseburg-Volney complexes, which are in drainageways.

Included in mapped areas of this soil are a few areas of soils that have a darker, thicker surface layer than typical. These included soils lack a light-colored surface layer.

This Downs soil is highly susceptible to erosion when the surface is bare. If row crops are grown, tillage can be on the contour or this soil should be terraced or stripcropped. Corn or other row crops can be grown 2 years in 6 where this soil is terraced or stripcropped. Yields of corn are generally above average if management is good, but legumes need lime. Response to fertilizer is good. (Capability unit IIIe–3)

Downs silt loam, 14 to 18 percent slopes, moderately eroded (DoE2).—This soil generally has a surface layer that is very dark grayish brown when moist and that is low in content of organic matter. Except near the base of slopes or near drainageways that cut into sidehills, the surface layer is lighter colored when dry. In many places near the base of slopes or near drainageways, however, the surface layer is darker and thicker than typical. Plowing has mixed much of the subsurface layer with the surface layer.

This soil is on convex side slopes that are dissected by waterways and gullies in some places. It is adjacent to areas of less eroded Downs soils.

Included in mapped areas of this soil are a few patches in which the surface layer is lighter colored than typical and many areas that have remained in trees and that are not eroded. Also included at the base of a few slopes are a few areas in which limestone is at a depth of only 30 to 50 inches.

Most areas of this Downs soil have been cultivated. Where the surface is bare or the cover of vegetation is sparse, however, this soil is quickly eroded by water from runoff. Corn or other row crops can be grown 1 year in 6 if this soil is stripcropped or when a pasture or meadow is renovated. The slopes are too steep for terraces to be feasible, but a diversion terrace placed at the base of a slope occupied by this soil will protect the soils downslope. The drainageways should be shaped and seeded so that gullies will not develop. Small areas of this soil can be used as wildlife habitats.

Generally, yields of corn are average for the county if this soil is well managed, but lime is needed to establish a stand of legumes. Response to fertilizer is good to moderate. (Capability unit IVe–1)

Downs silt loam, 18 to 24 percent slopes, moderately eroded (DoF2).—The surface layer of this soil is very dark gray or very dark grayish brown in most places, but it varies in color and thickness. The areas that are in permanent pasture or trees and that are not eroded have a darker surface layer than typical. Where the cover of plants is sparse and where some erosion has taken place, the subsurface layer or the subsoil is exposed in many places. In those areas this soil is light colored when dry.

This Downs soil is on convex side slopes that are cut by gullies and by drainageways. Second-growth trees or shrubs grow in some of the drainageways. In some places less sloping Downs soils are upslope and soils of the Dorchester-Chaseburg-Volney complex are downslope. The individual areas of this Downs soil are small.

This soil is easily eroded when its surface layer is bare. It is suited to permanent pasture, trees, or wildlife habitats. In the pastured areas, however, grazing must be controlled so that the cover of plants will not be destroyed. Operating farm machinery is hazardous because of the steep slopes, drainageways, and gullies. Legumes grown on this soil respond to applications of lime and fertilizer. (Capability unit VIe–3)

Downs and Tama silt loams, 2 to 5 percent slopes (DtB).—Downs silt loam is predominant in this undifferentiated unit, and its profile is like the one described for the series. The Tama soil in this complex was not mapped separately because of the pattern in which it occurs and the small size of the areas. It has a very dark brown surface layer, 8 to 12 inches thick, and it lacks a light-colored subsurface layer. A typical profile of the Tama soil is described under the Tama series.

The soils of this unit are on convex ridges that extend from watershed divides. Below them are steeper areas of Downs and Tama soils. Many of the individual areas are large enough to be managed separately.

These Downs and Tama soils are susceptible to water erosion when the cover of plants is sparse. They should be tilled on the contour or terraced if corn or other row crops are grown. Where the areas are terraced, row crops can be grown intensively. Terracing these soils protects the soils downslope. Yields of corn are generally above average if management is good. Response to fertilizer is very good. (Capability unit IIe–1)

Downs and Tama silt loams, 5 to 9 percent slopes (DtC).—The Downs soil in this undifferentiated unit has a profile like the one described as typical for the series. The Tama soil has a very dark brown surface layer that is 6 to 10 inches thick. A typical profile of the Tama soil is described under the Tama series. In places the Tama soil is on the lower parts of slopes or near drainageways.

The soils of this unit are on convex side slopes, below less sloping Downs and Tama soils. A few small drainageways are in the areas.

These soils are susceptible to erosion when the surface is bare. Therefore, it is necessary to till on the contour, terrace, or stripcrop if corn or other row crops are grown. If this soil is terraced or stripcropped, row crops can be grown 3 years in 5, and yields of corn are generally above average if management is good. Lime is needed to establish a stand of legumes. Response to fertilizer is very good. (Capability unit IIIe–1)

Downs and Tama silt loams, 5 to 9 percent slopes, moderately eroded (DtC2).—Most of this undifferentiated unit is cultivated, and in the cultivated areas the plow layer ranges from very dark brown to very dark grayish brown when moist. In some spots the plow layer is light colored when dry. The Downs soil is dominant in this unit. The Tama soil has a profile like the one described as typical for the Tama series.

The soils of this unit are on narrow, convex ridges and on the side slopes of ridges. Because of the small size of the areas of Tama soil and the pattern in which that soil occurs, the Tama soil was not mapped separately. However, the individual areas of Downs and Tama soils that make up this unit are large.

Further erosion takes place when these soils are bare or when the cover of plants is sparse. It can be satisfactorily controlled, however, by practicing contouring, terracing, or stripcropping when corn or other row crops are grown. Row crops can be grown 3 years in 5 where these soils are terraced or stripcropped.

If management is good, yields of corn are generally above average. Legumes respond well to applications of lime. Response to fertilizer is very good. (Capability unit IIIe–1)

Downs and Tama silt loams, 9 to 14 percent slopes, moderately eroded (DtD2).—In areas of these soils that are cultivated, the plow layer is very dark grayish brown. In some places near drainageways that cut into sidehills and on the lower parts of slopes, the surface layer is thicker and darker colored than typical. The surface layer in areas in permanent pasture or in wooded areas is very dark brown or very dark gray.

The Downs soil is predominant in this undifferentiated unit, and it has a light-colored subsurface layer. The Tama soil lacks a light-colored subsurface layer. Its profile is similar to the profile described for the Tama series.

These soils are on convex side slopes that are dissected by drainageways. Adjacent to them are other Downs and Tama soils. Many of the individual areas are small.

Most of the acreage is cultivated, but some of it is in permanent pasture or trees. In the cultivated areas, these soils are susceptible to further erosion when they are bare or when the plants growing on them are small. Tilling on the contour, terracing, or stripcropping is necessary if corn or other row crops are grown. Row crops can be grown 2 years in 6 if this soil is stripcropped. Yields of corn are generally above average if management is good, but legumes need lime. Response to fertilizer is good. (Capability unit IIIe–3)

Dubuque Series

In the Dubuque series are well-drained soils that have a light-colored surface layer. These soils formed in 15 to 30 inches of loess over a thin layer of reddish weathered material and hard limestone bedrock that is fractured in some places. The slopes range from 5 to 30 percent.

These Dubuque soils are on convex upland ridges and side slopes in the eastern part of the county. In many places they are downslope from Fayette, Palsgrove, and Nasset soils and upslope from Nordness soils and outcroppings of Steep rock land. Some areas of these soils are small, but the total acreage is large.

Representative profile:

0 to 6 inches, dark grayish-brown, friable silt loam.
6 to 25 inches, dark-brown to brown and yellowish-brown, friable silt loam and silty clay loam.
25 to 27 inches, dark reddish-brown and reddish-brown, firm clay or silty clay underlain by hard limestone bedrock at a depth of 27 inches.

Where these soils are not eroded or have not been cultivated, the color of their surface layer ranges from very dark gray to very dark grayish brown. The surface layer is dark grayish brown in cultivated areas. In areas that are not eroded, these soils contain a distinct, light-colored subsurface layer, but that layer is mixed into the surface layer in eroded areas.

The roots of some crops grown on these soils develop to only a limited extent because of the limestone bedrock near the surface. These soils are moderately permeable and have very low or low available moisture capacity. Lack of moisture is likely to damage crops if rains are not timely during the growing season.

The Dubuque soils are subject to erosion when they have only a sparse cover of plants. Any loss of soil material through erosion decreases the depth to limestone and definitely affects the use of these soils. The less sloping areas are suited to row crops, but the steeper areas are suitable only for pasture, trees, or wildlife habitats.

These soils are acid. Therefore, legumes grown on them respond to applications of lime. The soils are very low in available nitrogen, low in available phosphorus, and low to medium in available potassium.

Dubuque silt loam, 5 to 9 percent slopes, moderately eroded (DuC2).—The surface layer of this soil is dark grayish brown when moist and is much lighter colored when dry. It is very low in content of organic matter. Most of the acreage is cultivated, and both the surface layer and the former subsurface layer in the cultivated areas are now a part of the plow layer. Limestone bedrock is at a depth between 15 and 30 inches.

Included in mapped areas of this soil are severely eroded areas where the brown or yellowish-brown subsoil is exposed. Those areas are shown on the soil map by the symbol for severe erosion. Also included are many wooded areas where the soil is not eroded.

In cultivated areas this Dubuque soil is susceptible to erosion when the surface is bare. Therefore, tillage ought to be on the contour, or stripcropping should be practiced where corn or other row crops are grown. If this soil is stripcropped, row crops can be grown 1 year in 4. This soil is too shallow over limestone to be suitable for terraces.

Yields of corn grown on this soil are generally average if management is good. The pastures respond well to applications of manure, lime, and commercial fertilizer. (Capability unit IIIe–5)

Dubuque silt loam, 9 to 14 percent slopes, moderately eroded (DuD2).—Many areas of this soil are cultivated or were formerly cultivated, but in much of the acreage, this soil is wooded and is not eroded. The surface layer in the cultivated areas is generally dark grayish brown when moist but is much lighter colored when dry. The surface layer is brown or yellowish brown in a few places where the subsoil is exposed. It is low in content of organic matter. Limestone bedrock is at a depth of 15 to 30 inches.

This soil is on convex side slopes, below Palsgrove and Fayette soils and above Nordness soils and Steep rock land. Many of the areas are large enough to be managed separately.

This soil is suitable for pasture, or it can be used as woodland or for wildlife habitats. If stripcropping is practiced, however, corn or other row crops can be grown 1 year in 6 or when a pasture is renovated. This soil erodes quickly when the surface is bare.

If corn is grown on this soil, yields are generally below average, even if management is good. The pastures respond well to applications of manure, lime, and commercial fertilizer. (Capability unit IVe–3)

Dubuque silt loam, 9 to 14 percent slopes, severely eroded (DuD3).—This soil has a distinct, light-colored, brown or yellowish-brown surface layer that ranges from silt loam to silty clay loam in texture. The surface layer is very low in content of organic matter and is in poor tilth. It seals during rains, and a crust forms when the soil dries. Limestone bedrock is generally at a depth between 15 and 24 inches, but the depth ranges from 15 to 30 inches.

This soil is on convex side slopes adjacent to less eroded Dubuque soils and above Nordness soils and Steep rock land. The individual areas vary in size, but many of them are small.

This soil is subject to further erosion when it has only a sparse cover of plants. It is suited to permanent pasture and to use as woodland and wildlife habitats, but grazing needs to be controlled in the pastures. Where a pasture is renovated, oats can be seeded as a nurse crop. The pastures respond to applications of manure, lime, and commercial fertilizer. (Capability unit VIe–2)

Dubuque silt loam, 14 to 18 percent slopes, moderately eroded (DuE2).—This soil has a surface layer that is dark grayish brown when moist and is low in content of organic matter. The surface layer is much lighter colored when dry than when moist. Part or all of the subsurface layer is mixed with the surface layer. Limestone bedrock is at a depth of 15 to 24 inches in many places, but the depth varies.

This soil is on short, convex side slopes, both above and below areas of other Dubuque soils. Nordness soils and Steep rock land are below it in most places. The individual areas of this soil vary in size.

This soil is suited to pasture, or it can be used as woodland or for wildlife habitats. Some of the areas were formerly cultivated but are now in pasture. A large part of the acreage is wooded and is not eroded. In the pastures grazing should be controlled. The pastures respond to applications of manure, lime, and commercial fertilizer. These soils are not suitable for farm ponds. (Capability unit VIe–2)

Dubuque silt loam, 14 to 18 percent slopes, severely eroded (DuE3).—The surface layer of this soil is a distinct brown or yellowish brown. It is light colored and is very low in content of organic matter. The texture of the surface layer ranges to silty clay loam in places. The surface layer is in poor tilth. It often seals during rains, and a crust forms when the soil dries. Depth to limestone is generally between 15 and 24 inches, but it is variable.

This soil is on short, convex side slopes, above areas of Nordness soils and Steep rock land. Adjacent to it are less eroded Dubuque soils.

The cover of plants is sparse in many places, and water from rainfall continues to cause erosion. In the areas now in pasture, the bare spots ought to be reseeded and grazing should be controlled. Where a pasture is renovated, part of the present vegetation should be left and manure, lime, and commercial fertilizer ought to be applied.

This Dubuque soil is suitable for permanent pasture, or it can be used as woodland or for wildlife habitats. The small areas make excellent habitats for wildlife. Keeping the soil wooded, however, is generally better than other uses. Because of the limestone near the surface, this soil is not suitable for farm ponds. (Capability unit VIIe–1)

Dubuque silt loam, 18 to 30 percent slopes, moderately eroded (DuF2).—The surface layer of this soil varies in thickness and color. It is generally dark grayish brown when moist and is much lighter colored when dry. In a few severely eroded areas, however, the surface layer is brown or yellowish brown and the texture ranges to silty clay loam. A large acreage of this soil is wooded and is not eroded. In most places limestone bedrock is at a depth between 15 and 24 inches, but the depth varies considerably from place to place.

This soil is on short, convex side slopes, below less sloping Dubuque soils. It is above the Nordness soils and Steep rock land. Included in mapped areas of this soil are a few small areas in which limestone bedrock is at a depth of only 12 inches.

This Dubuque soil can be kept in woods or used for wildlife habitats. If it is used for permanent pasture, grazing should be controlled so that the pasture plants will have a chance to become reestablished after they are grazed. In places farm equipment cannot be safely operated. This soil is not suitable for farm ponds, because of the bedrock near the surface. (Capability unit VIIe–1)

Fayette Series

Well-drained soils of the uplands make up the Fayette series. These soils formed in loess. In cultivated areas they have a light-colored surface layer that is low in content of organic matter. Their slopes range from 0 to 35 percent.

The Fayette soils are on convex ridges and on side slopes in the eastern part of the county. In many places they are adjacent to Downs, Dow, and Palsgrove soils. Many of the individual areas are large enough to be managed separately.

Representative profile:

0 to 7 inches, dark grayish-brown, friable silt loam.
7 to 16 inches, yellowish-brown and brown to dark-brown, very friable silt loam.
16 to 39 inches, brown to dark-brown and dark yellowish-brown, friable to firm silty clay loam; some coatings of silt are on the surfaces of the peds.
39 to 80 inches, yellowish-brown, friable silt loam.

In areas that have not been cultivated, the surface layer of these soils is very dark gray or very dark grayish brown and is only 1 to 4 inches thick. A distinct, light-colored subsurface layer underlies the surface layer in those areas. The color of the surface layer ranges from dark gray to dark grayish brown where these soils are cultivated but are not severely eroded.

Even though the surface layer is low in content of organic matter and is in poor tilth, these soils are easily tilled. A seedbed can be prepared without difficulty, except in the severely eroded areas. Permeability is moderate, and the available moisture capacity is high.

The sloping Fayette soils are subject to erosion when they are only sparsely covered by plants. The less sloping Fayette soils are suited to row crops, but the steeper areas should be used for permanent pasture, as woodland, or for wildlife habitats.

These soils are acid unless they have been limed. They are very low in available nitrogen, medium to high in available phosphorus, and medium to low in available potassium.

Fayette silt loam, 0 to 2 percent slopes (FaA).—Most areas of this soil are cultivated. The plow layer in the cultivated areas is dark gray or dark grayish brown when moist, but this layer is much lighter colored when dry. Part of the light-colored subsurface layer has been mixed with the plow layer.

This soil is on convex ridges that form watershed divides. Downs soils are adjacent to it in some places, and more sloping Fayette soils are adjacent to it downslope. The individual areas are small. Therefore, this soil is generally managed with the more sloping Fayette soils.

Included in mapped areas of this soil are areas of soils in small, slight depressions. The included soils have a slightly darker surface layer than typical and a subsoil that is slightly mottled.

Because this Fayette soil is nearly level and generally takes in water well, little or no runoff takes place. A slight crust may form, however, when the surface layer dries. Applying manure reduces the surface crusting and makes the structure more nearly granular.

Where management is good, this soil is suited to intensive use for corn or other row crops. Meadow can be included in the rotation if tilth becomes poor. Where nitrogen and some phosphate and potash have been applied, yields of corn are generally above average. Lime is also required, however, for good crop response. (Capability unit I–1)

Fayette silt loam, 2 to 5 percent slopes (FaB).—In cultivated areas this soil has a dark-gray or dark grayish-brown surface layer when moist, but that layer is much lighter colored when dry. The surface layer in the few areas that are in permanent pasture or trees, however, is very dark gray or very dark grayish brown and is 1 to 4 inches thick. A thin mulch of twigs and leaves covers the surface in some wooded areas.

This soil is on ridges adjacent to nearly level watershed divides. It lies upslope from steeper Fayette soils and is adjacent to areas of Orwood soils in places.

Included in mapped areas of this soil are a few small, severely eroded spots. The surface layer in those areas ranges from dark brown to brown in color and from silt loam to silty clay loam in texture.

This Fayette soil is easily eroded when the surface layer is bare or has only a sparse cover of plants. Therefore, it ought to be tilled on the contour or terraced. Corn or other row crops can be grown intensively in areas that are terraced, and the terraces also protect the soils downslope.

If management is good, yields of corn are generally above average. Response to fertilizer is very good, but legumes need lime. (Capability unit IIe–1)

Fayette silt loam, 5 to 9 percent slopes, moderately eroded (FaC2).—This soil is cultivated in some places. The plow layer in the cultivated areas is dark gray or dark grayish brown when moist and is much lighter colored when dry. The plow layer consists not only of the surface layer but also of part of the subsurface layer. It is low in content of organic matter. The subsoil of brown or dark-brown silty clay loam is exposed in places. In the areas near drainageways in side valleys that dissect areas of this soil, the surface layer is darker and thicker than typical. Included in mapped areas of this soil is about 20,000 acres in which the soil is in pasture or trees and is not eroded. Also included are a few areas of gray variants of the Fayette series.

Further erosion is a hazard when the surface is bare or is only sparsely covered by plants. The drainageways should be shaped and reseeded to reduce the hazard of gullying. If row crops are grown, tillage should be on the contour or terracing or stripcropping is necessary. Corn or other row crops can be grown 3 years in 5 where the areas are terraced or stripcropped.

Yields of corn grown on this soil are generally above average if good management is used. Response to lime and fertilizer is very good. (Capability unit IIIe–1)

Fayette silt loam, 5 to 9 percent slopes, severely eroded (FaC3).—This soil has a surface layer of silt loam to silty clay loam. The surface layer is generally brown to dark brown when moist and is much lighter colored when dry. It is slightly darker and thicker, however, in areas of this soil near drainageways that cut into sidehills. The surface layer is very low in content of organic matter.

This soil is on convex side slopes, below less sloping Fayette soils, and it is surrounded by areas of less eroded Fayette soils in most places. The individual areas are too small to be managed separately. Included in mapped areas of this soil are a few areas of gray variants of the Fayette series.

Hard clods form if this severely eroded Fayette soil is worked when wet, but a seedbed is usually not difficult to prepare. The surface layer seals during rains, and a crust forms when the soil dries. Where the cover of plants is sparse, this soil will continue to erode. If corn or other row crops are grown, this soil can be tilled on the contour, or it can be terraced or stripcropped. Where the areas are terraced or stripcropped, row crops can be grown 2 years in 4. Adding manure and crop residue increases the intake of water. If poor tilth continues to be a problem, however, a large part of the cropping system ought to consist of meadow.

Yields of corn grown on this soil are above average if good management is used. Response to manure and commercial fertilizer is very good, but lime is needed for legumes. (Capability unit IIIe–1)

Fayette silt loam, 9 to 14 percent slopes, moderately eroded (FaD2).—In areas that are cultivated, the plow layer of this soil is generally dark grayish brown when moist and is much lighter colored when dry. It includes part of the subsurface layer and, in places, part of the subsoil. In some places near the base of slopes, however, or near drainageways that cut into sidehills, the surface layer is slightly darker.

This soil is on convex side slopes, below less sloping Fayette soils. Adjacent to it downslope in some places are areas of the Dorchester-Chaseburg-Volney complex. Many of the individual areas of this Fayette soil are large.

Included in the mapped areas of this soil is a large acreage that is wooded and is not eroded. Also included are a few areas of gray variants of the Fayette series.

Further erosion caused by runoff is a hazard on this moderately eroded Fayette soil when the cover of plants is sparse. Therefore, if corn or other row crops are grown, tillage ought to be on the contour or this soil should be terraced or stripcropped. Where the areas are terraced or stripcropped, row crops can be grown 2 years in 6. Gullying can be prevented by shaping and seeding the drainageways.

Yields of row crops grown on this soil are generally above average if management is good. Lime and fertilizer are needed, however, to establish a stand of legumes. Response to fertilizer is good. (Capability unit IIIe-3)

Fayette silt loam, 9 to 14 percent slopes, severely eroded (FaD3).—This soil has a surface layer of silt loam to silty clay loam that is very low in content of organic matter. The surface layer is generally brown or dark brown when moist but has a distinctly lighter color when dry. Near the base of slopes, however, or near drainageways that cut into sidehills, it is slightly darker.

This soil is on convex side slopes, where it is surrounded by less eroded Fayette soils in many places. Most of the areas are small, but some of them are large enough to be managed separately. Included in the mapped areas of this soil are a few areas of gray variants of the Fayette series.

The surface layer of this severely eroded soil seals during hard rains, and as a result, much of the water from rainfall runs off. Some crusting occurs when this soil dries, and clods form if the soil is worked when wet.

Corn or other row crops can be grown about 1 year in 4 when an area used for hay or pasture is renovated. Stripcropping or terracing is necessary if a row crop is grown. Also, manure and crop residue ought to be added when the seedbed is prepared. Any gullies should be shaped and seeded.

Yields of corn grown on this soil are generally average or above if good management is used. Response to manure, lime, and commercial fertilizer is good. (Capability unit IVe-2)

Fayette silt loam, 14 to 18 percent slopes, moderately eroded (FaE2).—This soil has a dark grayish-brown surface layer that is low in content of organic matter. The surface layer is much lighter colored when dry than when moist. Part of the light-colored subsurface layer is mixed with the plow layer where this soil has been cultivated. In a few areas, erosion has exposed brown or dark-brown soil material that was formerly part of the subsoil. Near the base of slopes or near drainageways that cut into sidehills, the surface layer is slightly darker and thicker than in other places. In a few small areas, limestone is at a depth of only 30 to 50 inches.

This soil is on convex side slopes, below less sloping Fayette soils. In some places it occupies an entire side slope and grades to soils of the Dorchester-Chaseburg-Volney complex downslope. In many places where this soil is on the upper part of the slope, it is above the Palsgrove and Dubuque soils or above areas of Steep rock land. The individual areas of this Fayette soil are generally large enough that they can be managed separately. Included in mapped areas of this soil is a large wooded acreage that is not eroded.

A large part of the acreage is cultivated, and when the surface is bare in those areas, this soil is easily eroded. The drainageways ought to be shaped and reseeded to prevent gullying. Diversion terraces placed in areas of this soil protect the soils downslope.

This soil is suited to hay or pasture, but it can also be used for corn or other row crops 1 year in 6 or when a pasture needs renovation. Where row crops are grown, the areas can be stripcropped. Yields of corn are generally only average, however, even though management is good. The pastures respond well to applications of manure, lime, and commercial fertilizer. (Capability unit IVe-1)

Fayette silt loam, 14 to 18 percent slopes, severely eroded (FaE3).—This soil has a surface layer of silt loam to silty clay loam that is generally brown or dark brown when moist and is lighter colored when dry. In some places near drainageways that cut into sidehills, the surface layer is slightly darker and thicker than typical. The surface layer is very low in content of organic matter and is in poor tilth.

This soil is on side slopes, where it is surrounded by less eroded Fayette soils in many places. A few areas are upslope from Palsgrove and Dubuque soils and from areas of Steep rock land. Some gullying has occurred. The areas vary in size.

This soil is suitable for permanent pastures, trees, or wildlife habitats. However, many of the small areas within areas of less sloping Fayette soils are probably more suitable for wildlife habitats than for other uses. This soil is highly susceptible to further erosion, and it should be protected by a cover of plants at all times. Grazing ought to be controlled, the brush should be removed, and the gullies need to be shaped and reseeded. Diversion terraces in some of the areas protect the soils downslope from runoff and silting. Oats can be grown as a nurse crop when a pasture is renovated. The pastures respond to applications of manure, lime, and commercial fertilizer. (Capability unit VIe-1)

Fayette silt loam, 18 to 24 percent slopes, moderately eroded (FaF2).—This soil has a surface layer that is generally dark grayish brown when moist and is much lighter colored when dry. The surface layer is low in content of organic matter and is in poor tilth. The former subsurface layer is now a part of the surface layer.

This Fayette soil is on convex side slopes that have been cut by gullies, and it is also along drainageways in side valleys. Downslope from it are other Fayette soils, Dubuque soils, and Steep rock land. The individual areas vary in size, but a few of them are large.

Included in mapped areas of this soil are a few small areas in which limestone is at a depth of only 30 to 50 inches. Also included are a few areas in which the soil is severely eroded and has a surface layer of brown or dark-brown silty clay loam. In a large part of the acreage, this soil is in trees and is not eroded.

This Fayette soil can be used for permanent pasture, as woodland, or for wildlife habitats. In the pastured areas, grazing should be controlled and the brush removed. A cover of plants must be maintained to prevent severe erosion. Ordinary farm equipment cannot be used in some places, because of the steep slopes. The pastures can be renovated where feasible. The pastures respond to applications of lime and fertilizer. (Capability unit VIe-3)

Fayette silt loam, 18 to 24 percent slopes, severely eroded (FaF3).—The surface layer of this soil is generally dark-brown or brown (moist) silt loam to silty clay loam that is very low in content of organic matter and is in poor tilth. The surface layer is lighter colored when dry than when moist. At the base of slopes or near drainageways in side valleys, the surface layer is slightly darker and thicker than typical.

This Fayette soil is on convex side slopes that are dissected by a few gullies and drainageways. Adjacent to it are less sloping Fayette soils and, in some places, Downs soils. The individual areas vary in size.

Where this soil is only sparsely covered by plants, it continues to erode. It is suitable for permanent pastures, trees, and wildlife habitats. Small patches that are adjacent to areas of less sloping soils are especially well suited to use as wildlife habitats. The gullies and steep slopes make the use of farm equipment hazardous in places. Pastures can be renovated where feasible, but the present cover of plants should not be completely destroyed. In the pastured areas, grazing needs to be controlled and the brush removed. If farm equipment can be used on this soil, the pastures should receive applications of manure, lime, and commercial fertilizer. (Capability unit VIe-3)

Fayette silt loam, 24 to 35 percent slopes (FaG).—This soil has a surface layer that varies in color and thickness. In many of the wooded or pastured areas, the surface layer is very dark gray or very dark grayish brown and is 1 to 2 inches thick. A cover of leaves and twigs is on the surface in some wooded areas. In other places the surface layer is dark grayish brown when moist and has a much lighter color when dry. In still other areas, where erosion has been severe, the color of the surface layer is dark brown to brown and the texture is silt loam to silty clay loam. The surface layer is low in content of organic matter.

This soil is on convex side slopes that are dissected by gullies and drainageways. Adjacent to it downslope are areas of Steep rock land, of Dubuque and Nordness soils, and of other soils on bottom lands and stream benches. Above it are less sloping Fayette soils. The individual areas are small.

This soil is suitable for use either as woodland or for wildlife habitats, but part of the acreage is in permanent pasture. Grazing ought to be controlled in the pastured areas. Because ordinary farm equipment cannot be used safely on this soil, controlling brush is difficult in many places. Where this soil is upslope from soils on bottom lands and stream benches, a diversion terrace can be used to protect the lower lying soils from runoff and silting. (Capability unit VIIe-1)

240-019—68——3

Festina Series

In the Festina series are well-drained soils that have a moderately dark colored surface layer. An abrupt boundary separates the surface layer from a light-colored subsurface layer. These soils formed in silty alluvium. Below a depth of 36 inches, they contain thin layers of sandy material in places. The slopes range from 0 to 5 percent.

The Festina soils are on stream benches in the eastern part of the county. In many places they are adjacent to Bertrand, Huntsville, Canoe, and Dorchester soils, and they are adjacent to more sloping Festina and Bertrand soils in other places. The individual areas are generally small.

Representative profile:

0 to 7 inches, very dark gray, friable silt loam.
7 to 12 inches, dark grayish-brown, friable silt loam.
12 to 47 inches, dark-brown to brown, dark yellowish-brown, and yellowish-brown, friable silt loam.
47 to 68 inches, yellowish-brown, friable silt loam.

The surface layer ranges from very dark gray to very dark grayish brown in color and from 5 to 10 inches in thickness.

These soils are moderately permeable and have high available moisture capacity. The intake of water is good. The sloping areas of these soils are subject to erosion when the surface is bare or is only sparsely covered by plants. Crop residue ought to be left on the surface to increase the intake of water and to reduce runoff.

Most areas of these soils are acid, and lime is needed for the optimum growth of crops. These soils are low in available nitrogen, phosphorus, and potassium.

Festina silt loam, 0 to 2 percent slopes (FeA).—The surface layer of this soil is 5 to 10 inches thick, and it generally is very dark gray. In many areas that have been cultivated, however, the color of the surface layer is very dark grayish brown. The surface layer is medium in content of organic matter. In most places it is in good tilth.

This soil is on benches adjacent to Huntsville, Dorchester, Canoe, and Bertrand soils. The individual areas are small, and much of the acreage is managed with the adjacent soils.

This soil is easily tilled, and controlling erosion is not a problem. Crop residue ought to be left on the surface, however, so that the intake of water will continue to be good. Corn and other row crops can be grown intensively. If tilth becomes poor, manure should be applied and meadow ought to be included in the rotation. Yields of corn are generally above average if this soil is well managed. Lime and fertilizer are needed for the optimum growth of crops. Response to fertilizer is very good. (Capability unit I-1)

Festina silt loam, 2 to 5 percent slopes (FeB).—This soil has a very dark gray or very dark grayish-brown surface layer that is 4 to 8 inches thick. Below the surface layer is a light-colored subsurface layer. In places part of the subsurface layer has been mixed with the plow layer.

This soil is on stream benches, and it is adjacent to Bertrand and less sloping Festina soils in many places. In some places it is above the Dorchester soils and soils of the Dorchester-Chaseburg-Volney complex that are on adjacent bottom lands. Included in the mapped areas of this soil are areas of soils that have a darker, thicker surface layer than typical.

This Festina soil is subject to water erosion when the surface is bare. If corn or other row crops are grown, tillage ought to be on the contour or the areas should be terraced. Where this soil is terraced, row crops can be grown intensively. However, terraces are difficult to lay out in some places because of the shape of the slopes. Yields of corn grown on this soil are generally above average if management is good, but lime is needed. Response to fertilizer is very good. (Capability unit IIe-1)

Floyd Series

In the Floyd series are somewhat poorly drained soils that have a dark-colored surface layer. These soils formed in loamy glacial sediments that are 30 to 40 inches thick over friable glacial till. In many places stones that are 10 to 30 inches in diameter are on the surface. The slopes range from 0 to 5 percent.

The Floyd soils are in slightly concave areas in the western part of the county. In many places they are above the Clyde soils, which are in drainageways, and below the Kenyon and other soils developed in glacial till. The individual areas vary in size.

Representative profile:

0 to 15 inches, black, friable loam to gritty silty clay loam.
15 to 29 inches, very dark grayish-brown and dark grayish-brown, friable loam; some olive-brown mottles.
29 to 42 inches, mottled yellowish-brown, strong-brown, and olive-gray, friable loam; has a thin layer of loamy sand at a depth of about 39 inches.
42 to 50 inches, mottled strong-brown and gray to light-gray, friable to firm light clay loam; contains a few stones and pebbles.

The surface layer ranges from loam to gritty silty clay loam in texture, from black to very dark gray in color, and from 12 to 18 inches in thickness. In areas that have not been cleared, the number of stones on the surface generally ranges from 10 to 300 per acre. However, as many as 1,000 stones per acre are on the surface in some areas.

These soils are moderately permeable and have high or very high available moisture capacity. Seepage water from the soils upslope drains onto these soils and causes a high, but variable, water table during rainy seasons. Tile drains function satisfactorily, and farming operations are delayed if tile drains have not been installed. The surface layer puddles if these soils are worked when wet.

Before these soils are cultivated, the stones must be removed from the surface. They must also be removed for several years after cultivation first takes place. Some areas have already been cleared. In those areas the stones are piled along fence rows or have been buried.

Where the stones have been cleared, these soils can be used for row crops. Many of the areas that are tile drained are managed with the Clyde soils.

The Floyd soils are slightly acid to neutral. Therefore, lime is generally not needed. These soils are medium in available nitrogen and low in available phosphorus and potassium.

Floyd loam, 0 to 5 percent slopes (FlB).—This soil has a black to very dark gray surface layer. The surface layer is generally 12 to 18 inches thick, but the dark color extends to a depth of 24 inches in places. Stones or boulders are common on the surface in areas that have not been cultivated.

This soil is in concave areas below Kenyon and Bassett soils. In many places it is adjacent to Clyde soils in drainageways.

Included in mapped areas of this soil are a few patches in which the surface layer is silty, and those areas lack stones or pebbles. Also included are areas in which firm glacial till is at a depth of 30 to 40 inches.

Because of the seepage water that drains from the soils upslope, and because of the high but variable water table, this Floyd soil is wet. It dries somewhat slowly and puddles if it is worked when wet. Where this soil has been tile drained, the drains work satisfactorily.

If this soil is tile drained and tilled on the contour, corn and other row crops can be grown intensively. Yields of corn are generally above average if management is good. Good response is received from applications of fertilizer. (Capability unit IIw-1)

Floyd-Clyde complex, 0 to 4 percent slopes (FmB).—The soils of this complex are in narrow drainageways in the uplands. The Floyd soil, in a narrow border around the areas of Clyde soil, makes up about 60 percent of the acreage. The Clyde soil is near the center of the drainageways, and the areas in which it occurs are dissected in some places by a small, open drainageway. The profile of the Floyd soil is similar to the one described for the Floyd series. The Clyde soil has a profile like the one described for the Clyde series.

The soils of this complex are above areas of Clyde soils that are mapped separately. They are below areas of Racine, Bassett, Kenyon, and Ostrander soils that are on side slopes in the uplands.

Because of their position in drainageways, the soils of this complex are moderately wet to very wet. They have a high water table as a result of the seepage and the runoff they receive from the slopes above. Tile drains work well, however, if a suitable outlet can be obtained. In places it may be necessary to establish a drainage ditch. These soils dry out slowly, and they puddle if worked when wet. Some areas must have the stones removed before they can be cultivated (fig. 6).

If these soils have been properly tile drained and are tilled on the contour, they are suited to intensive use for corn and other row crops. Yields of corn are generally above average if management is good. Response to fertilizer is very good. (Capability unit IIw-1)

Franklin Series, Gray Subsoil Variants

In some soil series, a variant is included. A variant has many of the characteristics of the series in which it is placed, but it differs in at least one important characteristic, which is indicated by its name. The acreage of a variant is of too small extent to justify establishing a new series. A new series may be designated and replace the variant, however, if sufficient acreage is later found.

Typical soils of the Franklin series do not occur in Winneshiek County, but gray subsoil variants that are similar to those soils in most respects have been mapped.

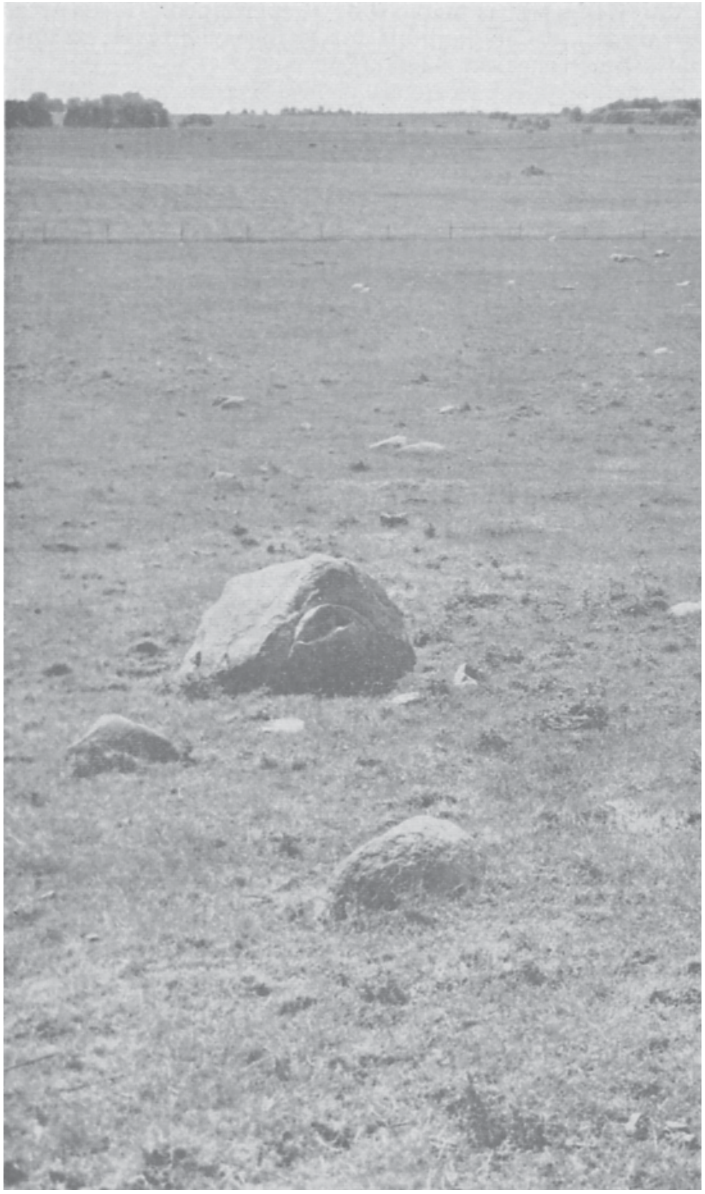

Figure 6.—A pasture made up of Floyd-Clyde complex, 0 to 4 percent slopes. The areas have not been tile drained, and the boulders and stones have not been removed.

The gray subsoil variants are somewhat poorly drained. Their surface layer is dark or moderately dark colored, and they have a distinct, light-colored subsurface layer. These soils formed in 15 to 40 inches of loess over loamy glacial sediments and glacial till. Their slopes range from 2 to 5 percent.

These soils are adjacent to drainageways in the uplands. They are downslope from Bassett soils and upslope from Clyde and Floyd soils.

Representative profile of a gray subsoil variant of the Franklin series:

0 to 6 inches, very dark gray, friable silt loam.
6 to 14 inches, dark grayish-brown, friable silt loam.
14 to 26 inches, mottled grayish-brown and yellowish-brown, friable light silty clay loam.
26 to 68 inches, mottled light-gray, strong-brown, dark-brown, and yellowish-brown, friable or friable to firm clay loam that contains some pebbles.

The surface layer ranges from black to very dark gray in color and from 4 to 8 inches in thickness. In places part of the light-colored subsurface layer is mixed with the plow layer. These soils are somewhat lighter colored when dry than when moist.

The available moisture capacity is high or very high. Permeability is moderate or moderately slow.

Runoff erodes these soils when the surface is bare or is only sparsely covered by plants. Because these soils are adjacent to upland drainageways, they receive some seepage water from the soils upslope. The water table is moderately high, but its height is variable.

Many areas of these soils are managed with the adjacent soils. The soils are suited to row crops, but they are acid and crops grown on them need lime. They are low in available nitrogen and phosphorus and medium in available potassium.

Franklin silt loam, gray subsoil variant, 2 to 5 percent slopes (FnB).—The profile of this soil is like the one just described. Most of the areas have been cultivated and have a surface layer that is very dark gray. Below the plow layer is a distinct, light-colored subsurface layer.

This soil is in and adjacent to drainageways in the uplands. It is in the western part of the county, where it is downslope from the Bassett soils. It is next to or above the Floyd and Clyde soils. The areas vary in size, but many of them are small.

This soil receives seepage water from the soils upslope. Where its surface is bare or is only sparsely covered by plants, runoff causes erosion. The water table is moderately high during some seasons of the year, but its height varies. In general, wetness is not a hazard, but farm operations are occasionally delayed because of excess moisture. This soil warms rather slowly in spring, and the surface layer puddles if it is tilled too soon after rains. Where tile drainage has been provided, field operations can be more timely than where drainage is lacking. The areas in upland drainageways need tile drains that can remove the seepage water.

In many places this soil is managed with the adjoining soils. It is suited to corn or other row crops. Tillage needs to be on the contour, however, or terraces should be constructed in areas used for corn or other row crops. Row crops can be grown intensively where terraces have been constructed. Where management is good, yields of corn are generally above average. Meadow ought to be included in the rotation if the tilth becomes poor, and lime is needed for legumes. Response to fertilizer is good. (Capability unit IIe–3)

Frankville Series

Soils that are well drained are in the Frankville series. These soils formed in 15 to 30 inches of loess over limestone bedrock. When moist, their surface layer is moderately dark colored, but it is somewhat light colored when dry. In areas that are not eroded, the profile contains a light-colored subsurface layer. The slopes range from 5 to 18 percent.

The Frankville soils are on convex ridges and on side slopes. They are mainly in the western part of the county, near the valleys of rivers and their tributaries. These soils are below Downs and Nasset soils and above Nordness soils and Steep rock land. The individual areas vary in size. Except for some of the more sloping areas, however, they are generally large enough to be managed separately.

Representative profile:

0 to 6 inches, very dark gray, friable silt loam.
6 to 23 inches, dark-brown to brown and yellowish-brown, friable silt loam and silty clay loam; some silt coatings on the surfaces of the peds.
23 to 28 inches, yellowish-brown, very firm clay underlain by hard limestone bedrock.

In general, the surface layer ranges from very dark gray to very dark grayish brown in color and from 4 to 8 inches in thickness. In places the surface layer is lighter colored, however, because it is mixed with the light-colored subsurface layer. In some areas that are not eroded, the subsurface layer is absent. In those areas an abrupt boundary separates the plow layer from the dark-brown or brown subsoil.

These soils are moderately permeable and have very low or low available moisture capacity. The root zone of some crops is limited by the limestone near the surface. Runoff causes erosion where these soils have only a sparse cover of plants. Losing additional soil material is serious because the limestone near the surface already limits the yields of many crops.

The gently sloping or sloping areas of these soils are suited to row crops if they are properly managed. The steeper areas are suited to permanent pastures, trees, and wildlife habitats.

These soils are slightly acid to medium acid. Therefore, lime is needed for legumes. The soils are low in available nitrogen and phosphorus and low to medium in available potassium.

Frankville silt loam, 5 to 9 percent slopes (FrC).—The surface layer of this soil varies in thickness and color, depending on the amount of erosion that has taken place. In some places the surface layer is very dark gray or very dark grayish brown, and it is underlain by a distinct, light-colored subsurface layer. In other places the surface layer is very dark grayish brown or grayish brown and is underlain by a dark-brown or brown subsoil. In those places the former subsurface layer is now a part of the plow layer. The underlying limestone is at a depth of 15 to 30 inches.

This Frankville soil is on narrow, convex ridges and on short side slopes, downslope from Nasset and Downs soils. Below it are steeper Frankville soils, Nordness soils, and Steep rock land. Because most of the individual areas are small, this soil is commonly managed with the steeper Frankville soils downslope.

Included in the mapped areas of this soil are severely eroded patches in which the surface layer is dark brown or brown. In those areas the surface layer is very low in content of organic matter and is in poor tilth.

Where the cover of plants is sparse, this Frankville soil is easily eroded by runoff. Tillage should be on the contour or the soil ought to be stripcropped if corn or other row crops are grown. Row crops can be grown 1 year in 4 where this soil is terraced or stripcropped. Most areas of this soil are not suitable for terraces, however, because of the limestone near the surface.

If management is good, yields of corn are generally average, but lime is needed for legumes. Response to fertilizer is good to moderate. (Capability unit IIIe-5)

Frankville silt loam, 9 to 14 percent slopes, moderately eroded (FrD2).—This soil is cultivated in most places. In the cultivated areas, the plow layer is very dark grayish brown when moist and is somewhat light colored when dry. In most places the former subsurface layer is now a part of the plow layer. In many places near drainageways that cut into sidehills, the surface layer of this soil is dark colored below plow depth. Limestone is at a depth between 15 and 30 inches, but it is generally at a greater depth upslope than downslope.

This soil is on the convex side slopes of ridges, below less sloping Frankville, Downs, and Nasset soils and above Nordness soils and Steep rock land. Many of the individual areas are small. Therefore, this soil is often managed with the soils on the adjacent side slopes.

This soil is easily eroded when the surface is bare or has only a sparse cover of plants. Because the growth of some crops is already limited by the limestone near the surface, loss of additional soil material would be critical.

This soil is suitable for pasture. Corn or some other row crop can be grown 1 year in 6, however, if the area is stripcropped or when a pasture is renovated. This soil is not suitable for terraces, because of the limestone near the surface.

Even if management is good, yields of corn grown on this soil are generally only average or below for this county. Pastures that have been seeded respond to applications of manure, lime, and commercial fertilizer. (Capability unit IVe-3)

Frankville silt loam, 14 to 18 percent slopes, moderately eroded (FrE2).—The surface layer of this soil varies in thickness and color. The surface layer in areas that are wooded or in permanent pasture is 4 to 6 inches thick and is very dark gray or very dark grayish brown. In many of those areas, the surface layer is underlain by a distinct, light-colored subsurface layer. In cultivated areas the surface layer is slightly lighter colored because it is mixed with the subsurface layer. Limestone bedrock is at a depth between 15 and 24 inches in most places, but in general, the depth ranges from 15 to 30 inches. Included in the mapped areas of this soil are a few small areas in which limestone is at a depth of only 12 to 20 inches.

This soil is on convex side slopes. It is above Nordness soils and Steep rock land and below Nasset and other Frankville soils. The individual areas vary in size, but many of them are small.

Runoff erodes this Frankville soil when the surface is bare or is only sparsely covered by plants. Grazing should be controlled in the areas in pasture so that this soil has a cover of plants at all times. When a pasture is renovated, not all of the cover of plants should be destroyed. Control of brush is needed in some of the areas that are pastured.

This soil is suited to permanent pastures, trees, and wildlife habitats. In the pastures, manure, lime, and commercial fertilizer are needed to help establish the stand. (Capability unit VIe-2)

Hagener Series

In the Hagener series are excessively drained, dark-colored soils of the uplands. These soils formed in loamy sand and sand. Their slopes range from 0 to 14 percent.

The Hagener soils are on benches, ridges, and side slopes in the western part of the county. In most places they occur as small islands, adjacent to such medium-textured soils as the Ostrander and Kenyon. Most of the individual areas are small.

Representative profile:

0 to 18 inches, very dark brown and very dark grayish-brown, loose loamy sand.
18 to 25 inches, very dark grayish-brown and brown to dark-brown, loose sand.
25 to 60 inches, yellowish-brown and yellow, loose sand.

The surface layer ranges from 6 to 18 inches in thickness. In some places, however, the soil is moderately dark colored to a depth of 25 inches.

The intake of water is rapid, but permeability is very rapid and the available moisture capacity is very low. Much of the moisture is lost through deep percolation. Where the cover of plants is sparse, wind erosion is a hazard, and water erosion is also a hazard in bare sloping areas. These soils do not supply enough moisture for plants to make good growth. Adding manure or other organic residue does not greatly improve their moisture-holding capacity. Crop residue should be left on the surface to give protection from wind erosion.

These soils are easily tilled. They warm up quickly in spring, and they can be worked soon after rains. The soils can be used for row crops if they are properly managed, but yields of all crops are below average, even if management is good.

These soils are acid. Therefore, lime is needed if a stand of legumes is to be established. These soils are very low in available nitrogen, phosphorus, and potassium.

Hagener loamy sand, 0 to 2 percent slopes (HaA).—This soil has a very dark brown or very dark gray surface layer. The surface layer is 10 to 18 inches thick in places.

This soil is on stream benches and ridges. On the benches it is adjacent to Dickinson soils in many places. In many areas of the uplands, this soil occurs as a small island of sandy material adjacent to medium-textured soils. The individual areas are small. Therefore, this soil is generally managed with the adjoining soils. Included in the mapped areas of this soil are a few small patches in which the texture of the surface layer is sandy loam.

When the surface is bare during periods of little rainfall, this Hagener soil is susceptible to wind erosion. Therefore, crop residue ought to be left on the surface.

Corn or other row crops can be grown 2 years in 4 on this soil. Yields that are only average or below are generally to be expected because of the limited supply of moisture. Nevertheless, in years when rainfall is timely, yields can be above average. Most of the acreage is cultivated and is farmed with the Dickinson soils.

Lime is needed where a stand of legumes is to be established on this soil. Response to fertilizer is moderate to poor. (Capability unit IVs–1)

Hagener loamy sand, 2 to 5 percent slopes (HaB).—This soil has a surface layer that is very dark brown. The surface layer is 8 to 12 inches thick.

This soil is mainly on convex ridges and on side slopes, but in a few places it is on slopes that border stream benches. In many places it occurs as a small island of sandy material, adjacent to medium-textured soils. Most of the individual areas are small, and many of them are managed with the adjoining soils. Included in the mapped areas of this soil are a few spots in which the texture of the surface layer is sandy loam.

Wind and runoff erode this soil where the cover of plants is sparse. Tillage should be on the contour when a row crop is grown, and crop residue ought to be left on the surface to give protection from wind erosion. This soil is not suitable for terraces; the sand in the subsoil is infertile, and the sandy material in the back slopes has poor stability.

If this soil is farmed on the contour, corn or other row crops can be grown 2 years in 4. The amount of moisture in the subsoil is limited, however, and yields of corn are generally below average, even if management is good. Nevertheless, these yields can be above average when rainfall is especially timely.

Lime is needed for legumes grown on this soil. The moisture-holding capacity is not improved by adding manure. Response to commercial fertilizer is moderate to poor. (Capability unit IVs–1)

Hagener loamy sand, 5 to 14 percent slopes (HaD).—The surface layer of this soil varies in color and thickness. In most places it is 6 to 12 inches thick and is very dark brown to very dark grayish brown. In some places at the base of slopes, the surface layer is as thick as 18 inches and the moderately dark color extends to a depth of 24 inches.

In some places this soil is on narrow, convex ridges. It is mainly on convex side slopes, however, and is below less sloping Hagener soils in many places. Downslope from it in most places are medium-textured Floyd and Clyde soils in drainageways. The individual areas are small.

Included in mapped areas of this soil are severely eroded spots in which the surface layer is brown or dark brown. In those places the texture of the surface layer is sand.

Runoff erodes this Hagener soil easily when the surface is bare or is only sparsely covered by plants. Wind erosion is also a hazard when the surface is bare. Therefore, crop residue ought to be left on the surface and this soil should be farmed on the contour or stripcropped when corn or other row crops are grown. If the areas are stripcropped, row crops can be grown 2 years in 5. This soil is not suitable for terraces, because of the unstable, sandy material in the back slopes and the infertile, sandy subsoil near the surface. The amount of subsoil moisture is not adequate for the good growth of crops. Therefore, yields are generally below average, although they may be much better in years when rainfall is timely.

Lime is needed for legumes grown on this soil. Response to fertilizer is poor. (Capability unit IVs–2)

Hayfield Series

In the Hayfield series are somewhat poorly drained soils that have a dark-colored surface layer and a light-colored subsurface layer. These soils formed in loamy material that is 24 to 45 inches thick over leached sand and gravel. No stones or pebbles are on the surface, but some are in the subsoil in places. An abrupt boundary separates the surface layer from a distinct, light-colored subsurface layer. The slopes range from 0 to 4 percent.

These soils are on stream benches and in a few broad drainageways in the uplands. Where they are on benches, they are adjacent to Kato and Sattre soils. In upland drainageways they are downslope from areas of Oran, Floyd, and Clyde soils. Both Hayfield soils that are moderately deep over sand and gravel and Hayfield soils that are deep over sand and gravel are mapped in Winneshiek County.

Representative profile of Hayfield loam, deep:

0 to 7 inches, very dark brown, friable loam.
7 to 11 inches, dark grayish-brown to grayish-brown, friable loam.
11 to 40 inches, mottled grayish-brown, brown, yellowish-brown, strong-brown, and light brownish-gray, friable loam, light clay loam, and sandy loam; some gravel at a depth of 29 inches and below.
40 to 45 inches, strong-brown and grayish-brown to light brownish-gray, loose sand and gravel.

The thickness of the surface layer ranges from 4 to 10 inches. The color of the surface layer ranges from black to very dark brown or very dark gray.

The available moisture capacity of the deep Hayfield soils is medium to high, but the available moisture capacity of the moderately deep Hayfield soils is only medium. Permeability is moderate in the loamy material, but it is rapid in the underlying sand and gravel. In most places the intake of water is good. The moderately deep Hayfield soils are slightly droughty. In places they lose some moisture from the subsoil through deep percolation. The deep Hayfield soils are occasionally wet because the water table rises into the sand and gravel in some seasons.

Row crops can be grown on these soils under proper management. Rains must be timely, however, for yields to be good on the moderately deep Hayfield soils. Also, the roots of some crops make only limited growth in dry years because of the underlying sand and gravel. In some years tile drainage is needed in some areas of the deep Hayfield soils.

The Hayfield soils are medium acid, and lime is needed for the optimum growth of crops. These soils are low in available nitrogen, phosphorus, and potassium.

Hayfield loam, deep, 0 to 3 percent slopes (HdA).—The surface layer of this soil ranges from 6 to 10 inches in thickness and from very dark gray to black in color. Beneath the surface layer is a distinct, light-colored subsurface layer. No stones or pebbles are on the surface. Depth to sand and gravel ranges from 36 to 45 inches.

This soil is on benches and in upland drainageways. It is adjacent to Sattre soils on benches and below Floyd, Clyde, and Oran soils in drainageways. Included in the mapped areas of this soil are a few places where sandy or silty material has been deposited on the surface.

This Hayfield soil is slightly wet because the water table is generally within the layer of sand and gravel in spring. The water table usually drops during the growing season. Therefore, wetness does not affect the yields of crops in most places. Tile drainage is needed in years when the amount of rainfall is above normal.

Corn and other row crops can be grown intensively on this soil. Yields of corn that are above average are obtained if management is good. Response to fertilizer is good, but for optimum yields, lime should be applied. (Capability unit I-3)

Hayfield loam, moderately deep, 0 to 4 percent slopes (HmA).—The surface layer of this soil is 4 to 8 inches thick and is very dark brown or very dark gray. Below the surface layer is a distinct, light-colored subsurface layer. No stones or pebbles are on the surface, but sand and gravel are at a depth of 24 to 36 inches.

This soil is on stream benches and in a few places in upland drainageways. It is adjacent to Kato and Sattre soils. The individual areas are small, and much of the acreage is managed with the adjoining soils.

The available moisture capacity is medium, and this soil is droughty in years when rainfall is average. The water table is usually low during the growing season, but a seasonal high water table may delay fieldwork in spring. The underlying sand and gravel limit the root growth of some crops.

Corn or other row crops can be grown intensively on this soil, but yields are variable and depend on the timeliness of rains. In years when the average amount of rainfall is received, yields of corn are generally above average for the county if management is good.

Lime is needed for the optimum growth of crops grown on this soil. Response to fertilizer is good. (Capability unit IIs-1)

Huntsville Series

In the Huntsville series are well-drained soils that formed in silty alluvium. These soils have a dark-colored surface layer that is high in content of organic matter, and they are free of stones or pebbles. The slopes range from 0 to 6 percent.

These soils are at the base of upland slopes and at the mouths of drainageways that fan out onto bottom lands and low stream benches. On the bottom lands, they grade to Kennebec, Lawson, and Otter soils. On the benches, they are adjacent to Rowley soils. Most of the areas are small, but a few are large enough to be managed separately.

Representative profile:

0 to 31 inches, black, friable silt loam.
31 to 52 inches, very dark grayish-brown and dark-brown, friable silt loam.
52 to 64 inches, dark-brown to brown, friable silt loam.

The color of the surface layer ranges from black to very dark brown or very dark gray. The thickness of the surface layer ranges from 20 to 30 inches.

These soils have high or very high available moisture capacity. Permeability is moderate.

These soils are suitable for cultivated crops, but the sloping areas are likely to erode when the surface is bare. Soil material from the soils upslope is deposited on their surface by runoff.

These soils are in good tilth and are easily cultivated. Wetness is usually not a problem, but occasionally these soils receive some water from overflow. The soils are medium in available nitrogen and potassium but are low in available phosphorus. In most places lime is not needed for legumes.

Huntsville silt loam, 0 to 2 percent slopes (HuA).—This soil has a very dark brown or black surface layer that is 20 to 30 inches thick. The surface layer is high in content of organic matter, has granular structure, and is in good tilth.

This soil is at the mouths of upland drainageways that fan out onto bottom lands and stream benches. Adjacent to it are Lawson, Kennebec, and Otter soils.

In some places runoff from the soils upslope has deposited about 6 inches of light-colored, silty material on the surface of this soil. Diversion terraces placed upslope can be used to control runoff and to prevent further silting. Protection from overflow is also needed.

Corn or other row crops can be grown intensively on this soil, and yields of corn are generally above average if good management is used. Response to fertilizer is very good. (Capability unit I–2)

Huntsville silt loam, 2 to 6 percent slopes (HuB).—The surface layer of this soil is very dark brown and is 20 to 24 inches thick. In places about 6 inches of light-colored, recent silty sediment is on the surface. In a few other places, spots where 6 to 18 inches of light-colored silty material has been deposited on the surface are included in the mapped areas of this soil.

This Huntsville soil is at the base of upland slopes that grade to bottom lands or stream benches. It is below soils derived from loess and above Lawson, Kennebec, and Otter soils on bottom lands. Adjacent to it on stream benches are Rowley and Festina soils.

This Huntsville soil receives some runoff from higher lying areas. It can be protected from overflow and from deposition and gullying by placing diversion terraces upslope.

Corn or other row crops can be grown intensively on this soil if farming is on the contour. Yields of corn are generally above average if management is good. Response to fertilizer is very good. (Capability unit IIe–2)

Jacwin Series

In the Jacwin series are somewhat poorly drained soils that have a dark-colored surface layer. These soils are on the uplands, where they formed in 15 to 30 inches of loamy glacial material over fine-textured shale. Above the shale in many places is a layer of sandy material that is 2 to 6 inches thick. The slopes range from 0 to 14 percent.

These soils are on structural benches and side slopes in the western part of the county. They are adjacent to Marlean soils and to soils of the deep, clay shale substratum phases of the Kato series. Steep rock land is either upslope or downslope from them. Many of the individual areas are small.

Representative profile:

- 0 to 19 inches, black, friable loam.
- 19 to 27 inches, very dark grayish-brown, light olive-brown, and yellowish-brown, friable loam and sandy clay loam.
- 27 to 48 inches, yellowish-brown and greenish-gray, very firm silty clay loam or silty clay shale.

The color of the surface layer ranges from black to very dark gray, and the thickness of that layer ranges from 8 to 20 inches. In places the texture of the surface layer is silt loam instead of loam. Stones and pebbles are on the surface or in the subsoil in some places.

These soils have high available moisture capacity, but because of the high content of clay, not all of the moisture is available for plants. Permeability is moderate above the underlying shale and slow or very slow in the shale.

During wet seasons, seepage causes a temporary perched water table that makes these soils wet. These soils dry out slowly, and the surface layer puddles if it is worked when wet. Tile drainage is needed, but the tile drains must be placed correctly and the backfilling done properly for them to work well. The soils should be checked in the field to determine the correct spacing and depth needed for the tile. The sloping areas are subject to water erosion when their surface is only sparsely covered by plants.

These soils are suited to row crops if they are properly managed. The root growth of some plants is slightly limited, however, by the shale near the surface. These soils are neutral or slightly acid. Therefore, lime is needed only occasionally. The soils are medium in available nitrogen and are low in available phosphorus and potassium.

Jacwin loam, 0 to 2 percent slopes (JaA).—This soil has a black surface layer that is 16 to 20 inches thick. The surface layer is high in content of organic matter and is generally in good tilth.

This soil is mainly on high structural benches and on low foot slopes, but it occupies a few areas in or adjacent to upland drainageways. Both upslope and downslope from it are other Jacwin soils and Steep rock land. In places this soil is adjacent to Calamine soils and to deep, clay shale substratum phases of the Kato series. Included in mapped areas of this soil are places in which the surface layer is thinner than typical and that contain an indistinct subsurface layer.

This Jacwin soil receives seepage water from the soils upslope. The water table is moderately high during wet seasons, but its height varies. Farming is often delayed unless tile drains have been installed. Placing interceptor tile drains properly in this soil is important because of the shale near the surface. The tile drains must not be placed too deep in the clay shale, and the backfill should be made of porous material.

Where this soil is tile drained, corn or other row crops can be grown 3 years in 5. Yields of corn are generally above average if good management is used. Meadow should be included in the rotation if tilth becomes poor. Response to fertilizer is moderate to good. (Capability unit IIw–4)

Jacwin loam, 2 to 5 percent slopes (JaB).—The surface layer of this soil is black to very dark gray and is 12 to 18 inches thick. Where this soil is near the base of steep slopes, as much as 6 inches of lighter colored silty material has been deposited on the surface.

This soil is on high structural benches and on foot slopes, both upslope and downslope from Marlean soils and Steep rock land. A few areas are in or adjacent to upland drainageways and are adjacent to Calamine soils and to deep, clay shale substratum phases of the Kato series.

Included in mapped areas of this soil are areas of a soil that has had 6 to 18 inches of light-colored material deposited on the surface. Also included are a few small areas in which the surface layer is thinner than typical and that contain an indistinct subsurface layer.

Runoff from the soils upslope causes erosion when the cover of plants is sparse. This soil is wet as a result of the seepage in the sandy material above the clay shale. The surface layer puddles easily if it is worked when wet.

Corn or other row crops can be grown 3 years in 5 if this soil is tile drained and tilled on the contour. Correct placement of the tile drains is important, however, because of the clay shale in the subsoil and substratum. The tile drains must not be placed too deep in the shale. The backfill ought to be made of porous material.

If management is good, yields of corn are generally average or above. Legumes normally do not need lime. Response to fertilizer is moderate to good. (Capability unit IIe–5)

Jacwin loam, 5 to 9 percent slopes (JaC).—This soil has a black or very dark gray surface layer that is 8 to 16 inches thick. In places as much as 6 inches of lighter colored silty material has been deposited on the surface.

This soil is on sloping, high structural benches and on foot slopes. In many places it is downslope from Calamine and less sloping Jacwin soils. Both upslope and downslope from it in many places are Marlean soils and Steep rock land.

Included in the mapped areas of this soil are areas in which 6 to 18 inches of light-colored material has been deposited on the surface. Also included are eroded spots where only 3 to 8 inches of the dark-colored surface layer remains. Other inclusions consist of small areas, mainly in the northern and eastern parts of the county, where the profile contains an indistinct subsurface layer. In those areas the soil material is silty above the shale.

Runoff, both from higher areas of this soil and from other soils upslope, causes erosion when the cover of plants is sparse. In some seasons this soil is also wet because of seepage that occurs above the clay shale.

This soil can be tilled on the contour or stripcropped, and it ought to be tile drained. It is not suitable for terraces, because of the very firm shale near the surface. The correct spacing and the depth needed for the tile drains should be checked in the field.

If this soil is stripcropped and artificially drained, corn or other row crops can be grown 2 years in 5. Meadow crops should make up a larger part of the rotation, however, if tilth becomes poor. Where good management is used, yields of corn are generally about average for the county. In most places legumes do not need lime. Response to fertilizer is moderate. (Capability unit IIIe–6)

Jacwin loam, 9 to 14 percent slopes (JaD).—This soil generally has a black to very dark gray surface layer that is 12 to 18 inches thick. In a few places, however, only 3 to 8 inches of the surface layer remains. Stones and pebbles are in the subsoil, but the surface layer is free of them in many places.

This soil is on high foot slopes, below Marlean and other Jacwin soils. In a few places, it is upslope from Rockton soils and Steep rock land. The individual areas are rather small.

Included in mapped areas of this soil are a few patches, mainly in the northern and eastern parts of the county, in which a layer of silty material overlies the shale. Also included are areas of soils that are underlain by shale at a depth of 30 to 40 inches. Other inclusions consist of a few small spots in which the shale is underlain by limestone at a depth of 30 to 50 inches.

This Jacwin soil is susceptible to water erosion when it is only sparsely covered by plants. Seepage from the soils upslope make it wet.

This soil is suited both to hay and pasture. It is mainly in permanent pasture, however, because the individual areas are small and because the adjoining soils are better suited to that use. If the areas are large enough, they can be planted to a row crop when a pasture is renovated. Also, corn or other row crops can be grown 1 year in 6 if this soil is stripcropped.

If corn is grown, yields are below average, even if management is good. The pastures respond to applications of nitrogen and phosphate. Legumes may benefit from applications of lime. (Capability unit IVe–5)

Kato Series

Somewhat poorly drained soils are in the Kato series. These soils formed in 24 to 42 inches of loamy glacial sediments that are underlain by loamy sand and sand. The slopes range from 0 to 9 percent.

In Winneshiek County a moderately deep phase, a deep phase, and a deep, clay shale substratum phase of these soils are mapped. In the moderately deep phase, sandy material is at a depth of 24 to 36 inches. In the deep soil that lacks a clay shale substratum, sandy material is at a depth of 36 to 42 inches. In the other deep Kato soil, sandy material is also at a depth of 36 to 42 inches and this material grades to clay shale below that depth.

In most places the Kato soils are on stream benches or on high structural benches, but they are in broad upland drainageways in a few places. The individual areas vary in size.

Representative profile of a moderately deep Kato soil:

0 to 15 inches, black, friable loam.
15 to 27 inches, very dark grayish-brown, grayish-brown, and olive, friable loam, grading to sandy loam; some yellowish-brown mottles.
27 to 42 inches, yellowish-brown, brownish-yellow, light yellowish-brown, light-gray, and gray, very friable and loose loamy sand and sand.

The surface layer ranges from 12 to 20 inches in thickness, and its texture is silt loam in some places. Depth to sandy material ranges from 24 to 42 inches.

These soils vary in available moisture capacity. In the deep Kato soils, the available moisture capacity is medium to high, but it is medium in the moderately deep Kato soil. Permeability is moderate in the loamy subsoil but rapid in the sandy substratum. It is very slow in the shale underlying the deep Kato soils that have a clay shale substratum. Seepage water that drains to the Kato soils that have a clay shale substratum causes a temporary perched water table because of the underlying shale.

The sloping areas are susceptible to erosion when the surface is bare or is only sparsely covered by plants. Because the moderately deep Kato soil is slightly droughty, rains must be timely for good yields on that soil. The Kato soils that are underlain by clay shale should be tile drained.

These soils are slightly acid to neutral. They are medium in available nitrogen and low in available phosphorus and potassium.

Kato loam, moderately deep, 0 to 4 percent slopes (KaA).—This soil has the profile that is described for the series. Its surface layer is black and is 12 to 16 inches thick. In places the soil material is moderately dark colored to a depth of 24 inches. Loamy sand and sand are at a depth of 24 to 36 inches.

This soil is on stream benches and in upland drainageways. It is adjacent to Kato loam, deep, 0 to 4 percent slopes, and to Waukegan soils. The individual areas are small. Therefore, this soil is commonly managed with the adjoining soils.

Included in mapped areas of this soil are a few areas of soils that have a distinctly mottled and slightly grayer subsoil than typical. Also included are areas of soils that have had 6 to 12 inches of light-colored material deposited on their surface.

The root zone is limited, and crop yields vary according to the timeliness of rains. Except where the water table is high, this soil warms up quickly in spring, and it can be worked soon after rains. During wet seasons, water saturates the underlying sand. This wetness is seasonal, and tile drainage is beneficial in some years in the early part of the growing season. Because the intake of water is good and this soil is nearly level, only a small amount of water runs off.

If proper management is used, corn and other row crops can be grown intensively on this soil. Yields of corn are generally above average, but they vary, depending on the timeliness of rains. Response to fertilizer is good. (Capability unit IIs–1)

Kato loam, deep, 0 to 4 percent slopes (KdA).—The surface layer of this soil is 16 to 20 inches thick. It is black or very dark gray and is high in content of organic matter. Loamy sand or sand is at a depth of 36 to 42 inches.

This soil is mainly on stream benches. A few tracts, however, are in upland drainageways, adjacent to the moderately deep Kato soil and to Clyde, Floyd, and Waukegan soils. In some places the areas are large enough to be managed separately.

The underlying sandy substratum is saturated during wet seasons, but it is dry in summer. Tile drains can make farming more timely in spring. These drains function well, and outlets can be obtained in most places.

This soil is suited to intensive use for corn and other row crops. Yields of corn are generally above average if proper management is used. Response to fertilizer is very good. (Capability unit IIw–1)

Kato loam, deep, clay shale substratum, 1 to 5 percent slopes (KsB).—This soil has a black or very dark gray surface layer, and the dark color extends to a depth of about 24 inches in places. In most places the surface layer is between 16 and 20 inches thick. Loamy sand or sand is at a depth of 36 to 42 inches. Beneath the sandy material is silty clay shale.

This soil is on high structural benches, adjacent to Calamine and Jacwin soils. It is also in upland drainageways and at the base of slopes, below Marlean and Rockton soils and Steep rock land. The areas are small, and many of them are managed with the adjoining soils. Included in mapped areas of this soil are patches of a soil that has had 6 to 18 inches of light-colored material deposited on its surface.

A moderately high water table makes this Kato soil wet, and water seeps into the sandy layer above the shale. Farming is often delayed in areas that are not tile drained. Proper placement of the tile drains is important because of variations in the depth and thickness of the layer of sand and of the underlying shale.

Corn and other row crops can be grown intensively on this soil. Tile drains are needed, however, to help to improve yields and to allow farming to be more timely. Yields of corn are generally above average if good management is used. Response to fertilizer is good. (Capability unit IIw–4)

Kato loam, deep, clay shale substratum, 5 to 9 percent slopes (KsC).—This soil generally has a black or very dark gray surface layer that is 8 to 12 inches thick. In some areas, however, the surface layer is only 3 to 8 inches thick. Depth to loamy sand or sand ranges from 36 to 42 inches. Below the sand is clay shale.

This soil is on convex slopes that are adjacent to structural benches. In places it is downslope from Rockton and Marlean soils and Steep rock land. In many other places, it is also downslope from less sloping Kato soils and adjacent to Calamine and Jacwin soils. The individual areas are rather small. Therefore, this soil is often managed with the less sloping Kato soils that have a substratum of clay shale. Included in mapped areas of this soil are a few spots in which the shale contains several fragments of limestone.

This soil is subject to erosion when it is only sparsely covered by plants. Crops can be tilled on the contour or grown in contour strips. During some parts of the year, the water table is moderately high as a result of seepage, but its height varies. If tile drains are installed, increased yields are feasible and farming can be more timely. Correct placement of the tile drains is critical, however, because of variations in the thickness of the sand and in the depth to clay shale.

Where this soil is tile drained and stripcropped, corn and other row crops can be grown 2 years in 5. If management is good, yields of corn are generally average or above. Response to fertilizer is moderate to good. (Capability unit IIIe–6)

Kennebec Series

Moderately well drained soils that formed in friable, silty alluvium are in the Kennebec series. The surface layer of these soils is thick, and it is dark colored both when moist and when dry. The dark color extends to a depth of 3 feet or more. These soils do not contain stones or pebbles. Their slopes range from 0 to 2 percent.

The Kennebec soils are adjacent to Lawson soils on first bottoms and low stream benches. In places they are near the Rowley, Otter, and Huntsville soils. Because the areas of Kennebec soils in Winneshiek County are intermingled with areas of Lawson soils, the Kennebec soils are mapped and managed with those soils.

Representative profile:

0 to 26 inches, very dark brown, friable silt loam.
26 to 47 inches, black, friable silt loam.

In places the soil material below a depth of 30 inches consists of very dark gray silt loam to light silty clay loam. If loam material is present, it is generally below 40 inches.

These soils have a high available moisture capacity and moderate permeability. In most places the water

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table is below a depth of 4 feet, but its height is variable. The Kennebec soils are flooded during periods when a large amount of rainfall is received.

These soils are suited to intensive use for row crops. Their supply of available nitrogen is low, and their supply of available phosphorus and potassium is medium. They are neutral to slightly acid; lime is generally not needed.

Kenyon Series

In the Kenyon series are moderately well drained soils that have a dark-colored surface layer. These soils formed in 14 to 24 inches of loamy material over glacial till. The loamy material is separated from the till by a slight concentration of stones and pebbles. The slopes range from 2 to 5 percent.

The Kenyon soils are on convex ridges and on side slopes of uplands in the western part of the county. They are adjacent to Ostrander soils and, in places, to Bassett and Racine soils. Below them are Floyd and Clyde soils. Many of the individual areas are large enough to be managed separately.

Representative profile:

0 to 12 inches, black and very dark grayish-brown, friable loam.

12 to 55 inches, dark-brown to brown, dark yellowish-brown, and yellowish-brown, friable loam; some stones and pebbles at a depth of 16 inches and below; a few grayish-brown coatings and mottles in the lower part.

55 to 65 inches, mottled yellowish-brown and gray, friable loam that contains some pebbles.

Where these soils are slightly eroded, the color of the surface layer ranges from black to very dark grayish brown. In many places these soils are free of stones to a depth of 14 to 24 inches, but most areas contain a few pebbles. Stones and pebbles are noticeable below the loamy material.

These soils are easily eroded by runoff when they are only sparsely covered by plants. They have a seasonal perched water table, and they dry out slowly in spring. The available moisture capacity is high, and permeability is moderate to moderately slow. A system of random tile drains has been installed in some areas.

These soils are suited to row crops. They are acid, however, and are low in available nitrogen, phosphorus, and potassium. Crops grown on them respond to applications of lime.

Kenyon loam, 2 to 5 percent slopes (KyB).—This is the only Kenyon soil mapped in the county. Its surface layer is black or very dark brown, but the color grades to very dark grayish brown with increasing depth. A few stones or pebbles are below a depth of 14 to 24 inches.

This soil is on convex ridges and side slopes, adjacent to Ostrander soils and upslope from Floyd and Clyde soils. In places it is at the base of steeper slopes occupied by Ostrander, Bassett, Racine, and Atkinson soils.

Runoff causes erosion when this soil is protected by only a sparse cover of plants. Therefore, tillage ought to be on the contour, or this soil should be terraced if a row crop is grown. Corn and other row crops can be grown intensively where this soil is terraced, but the channels of the terraces contain stones and pebbles. Manure or crop residue is needed in the channels to improve the tilth and the intake of water. This soil dries out more slowly than the adjacent Ostrander soils, but wetness is normally a seasonal problem.

Yields of corn are generally above average if good management is used. Response to lime and fertilizer is good. (Capability unit IIe-1)

Lamont Series

In the Lamont series are well-drained to excessively drained soils that have a light-colored surface layer low in content of organic matter. These soils formed in 24 to 48 inches of sandy and loamy material that is free of gravel. In many places sand or loamy sand is below a depth of 48 inches. The slopes range from 1 to 14 percent.

The Lamont soils are on convex ridges and on side slopes of uplands in the western part of the county. They are also on stream benches in the valleys of the major rivers. The Lamont soils are adjacent to Dickinson soils and to the till subsoil variant of the Lamont series. In many places they occur as islands within larger areas of Coggon, Renova, and other medium-textured soils. The individual areas of Lamont soils are generally small, but they vary in size.

Representative profile:

0 to 7 inches, dark grayish-brown and very dark grayish-brown, very friable sandy loam.

7 to 12 inches, dark grayish-brown, very friable sandy loam.

12 to 47 inches, brown to dark-brown and dark yellowish-brown, friable sandy loam and loam.

47 to 54 inches, yellowish-brown, loose sand that contains some fine gravel.

In areas that have not been cultivated, the surface layer is 2 to 4 inches thick and is very dark gray or very dark grayish brown. In those areas there is a distinct, light-colored subsurface layer. Where this soil has been cultivated, part of the subsurface layer is included in the plow layer. The surface layer in cultivated areas is dark grayish brown when moist, but it is much lighter colored when dry.

These soils have low available moisture capacity and rapid permeability. They take in water well, but the root growth of many plants is limited by the sandy substratum.

The sloping Lamont soils are subject to erosion by water. All of the Lamont soils are also subject to erosion by wind when the surface is bare. These soils are easily tilled. They warm up quickly in spring and can be tilled soon after rains.

If these soils are properly managed, they can be used for row crops. They are medium acid, however, and are very low in available nitrogen, phosphorus, and potassium.

Lamont sandy loam, 1 to 5 percent slopes (LaB).—The surface layer of this soil is generally dark grayish brown when moist. It is very dark grayish brown in some places, but even in those areas, it is lighter colored when dry. The surface layer is low in content of organic matter. Its texture is silt loam or loamy sand in a few spots. No stones or pebbles are on the surface.

This soil is on stream benches adjacent to areas of Dickinson and other Lamont soils. It is also on ridges and side slopes adjacent to sandy Chelsea soils and to medium-textured soils, such as the Coggon and Renova. The individual areas are generally less than 12 acres in size. Therefore, this soil is often managed with the adjoining soils.

This soil is subject to erosion by wind or water when it is only sparsely covered by plants. Therefore, crop residue ought to be left on the surface. Where row crops are grown, tillage ought to be on the contour or this soil should be terraced or stripcropped. Corn and other row crops can be grown intensively where terracing or stripcropping is practiced. The yields are related mainly however, to the timeliness of rains. Yields of corn are generally about average for the county if good management is used. Other crops also are likely to make only average yields because the sandy or gravelly substratum is dry during part of the growing season.

Lime and fertilizer are needed where a seeding of legumes is to be established. Response to fertilizer is moderate if rainfall is timely. (Capability unit IIIe-7)

Lamont sandy loam, 5 to 9 percent slopes (LaC).—Where this soil is cultivated, its surface layer is generally 3 to 7 inches thick and is dark grayish brown when moist. The surface layer is much lighter colored when dry. Near drainageways that cut into sidehills, the surface layer is slightly darker than in other places. In a few areas that are in permanent pasture or trees, the surface layer is very dark gray or very grayish brown and is 2 to 4 inches thick. In those places this soil contains a distinct, light-colored subsurface layer that is 4 to 6 inches thick. The texture of the surface layer is silt loam or loamy sand in a few minor spots. The surface is free of stones or pebbles.

This Lamont soil is on ridges and side slopes, adjacent to other Lamont soils. In many places it is adjacent to Coggon, Renova, and other medium-textured soils. Most of the individual areas are small.

The intake of water is good, but some runoff occurs when the surface layer is bare. This soil is also subject to wind erosion. Consequently, crop residue ought to be left on the surface. The substratum is usually dry; therefore, crop yields depend on the timeliness of rains.

If row crops are grown, tillage ought to be on the contour or this soil should be stripcropped or terraced. Where this soil is stripcropped or terraced, corn and other row crops can be grown 2 years in 4. Many of the areas are not suitable for terraces, however, because of the infertile sand near the surface.

Yields of corn are generally below average on this soil, even when management is good. Nevertheless, if rains are timely, yields may be greatly increased. Response to fertilizer is moderate to poor, depending on the supply of moisture. Both lime and fertilizer are needed for legumes. (Capability unit IIIe-7)

Lamont sandy loam, 9 to 14 percent slopes (LaD).—The surface layer of this soil is generally dark grayish brown when moist, and it is 3 to 7 inches thick. When dry, the surface layer is much lighter colored. It is slightly darker where this soil occurs at the base of slopes or near drainageways that cut into sidehills. No stones or pebbles are on the surface. In many places loamy sand or sand is at a depth of 24 to 30 inches.

This soil is on convex side slopes below less sloping Lamont soils. In a few places, it is adjacent to sandy Chelsea soils and to medium-textured soils, such as the Orwood and Fayette. Most of the individual areas are small.

Included in the mapped areas of this soil are a few small eroded areas in which the surface layer consists of dark-brown to brown loam. Also included are a few patches in which the texture is loamy sand, sand, or silt loam at a depth of 20 to 40 inches.

The intake of water is good, but this soil is susceptible to water erosion when the surface is bare. Crop residue ought to be left on the surface, so that this soil will not also be eroded by wind. This soil is easily tilled and can be worked soon after rains. The sandy substratum is usually dry, however, during the growing season. The growth of some crops is limited by this dry layer.

Because field crops make only low yields on this soil, the areas are better used for hay and pasture. Corn and other row crops can be grown 1 year in 5, however, if this soil is terraced or stripcropped. Yields are below average for this county. Many areas are not suitable for terraces, because of the infertile sand in the substratum. Grain sorghum is occasionally substituted for corn in the rotation. Lime and fertilizer are needed to establish a stand of hay or pasture, but the areas used for hay or pasture are often not plowed unless the stand is poor. Response to fertilizer is poor because of the low available moisture capacity of this soil. (Capability unit IVe-4)

Lamont Series, Till Subsoil Variants

The Lamont, till subsoil variants, in this county are represented by well-drained soils of the uplands that formed in 15 to 36 inches of sandy loam over glacial till. The surface layer is dark colored when moist but light colored when dry. The slopes range from 2 to 9 percent.

These soils are on convex ridges and side slopes. In many places they are downslope from Lamont soils. The individual areas are small.

Representative profile:

0 to 7 inches, very dark gray, very friable sandy loam.
7 to 12 inches, dark grayish-brown, very friable sandy loam.
12 to 25 inches, brown to dark-brown and dark yellowish-brown, friable sandy loam and loam to sandy loam.
25 to 54 inches, brown, yellowish-brown, and strong-brown loam that contains some pebbles and has some light brownish-gray coatings on the surfaces of the peds. This layer is underlain by light brownish-gray and strong-brown light clay loam.

The color of the surface layer is generally between a very dark gray and a very dark brown, and the thickness of that layer ranges from 4 to 8 inches. In small areas, however, the surface layer is darker colored and thicker. Most areas of this soil contain a light-colored subsurface layer, but the former subsurface layer is part of the plow layer in some places.

The available moisture capacity is medium. Permeability is moderately rapid in the sandy loam and moderate in the loam glacial till.

The Lamont, till subsoil variants, are medium acid to strongly acid, and lime is needed for crops to grow well. These soils are low in available nitrogen, phosphorus, and potassium.

Lamont sandy loam, till subsoil variant, 2 to 9 percent slopes (LdB).—The profile of this soil is the one described in the preceding paragraphs. The surface layer is generally very dark gray to very dark brown when moist and light colored when dry, but it is darker colored and thicker in a few small areas. The surface layer ranges from 4 to 8 inches in thickness. It is low in content of organic matter.

This soil is on narrow ridges and on convex side slopes, in many places below and adjacent to areas of other Lamont soils. In many places it is above Backbone soils. It is above Racine and Bassett soils or adjacent to Kenyon and Dickinson soils in other places.

Even though this soil takes in water well, it is subject to both wind and water erosion when the surface is bare or is only sparsely covered by plants. It is easily tilled. If row crops are grown, this soil can be tilled on the contour or terraced and crop residue can be left on the surface. This soil warms up quickly in spring and can be worked soon after rains. Near the place where the sandy loam is underlain by glacial till, this soil on side slopes is seepy in spring and after periods of heavy rainfall.

If tillage is on the contour, corn and other row crops can be grown 3 years in 4. Yields of corn are generally average or above if management is good, but the yields depend on the timeliness of rains.

Lime and fertilizer are needed if a stand of legumes is to be established. Response to fertilizer is moderate. (Capability unit IIe-6)

Lawson Series

In the Lawson series are somewhat poorly drained soils that formed in silty alluvium. The surface layer of these soils is dark colored, and it does not contain stones or pebbles. The slopes range from 0 to 5 percent.

The Lawson soils are on first bottoms and at the base of the upland slopes that grade to bottom lands or low benches. They are adjacent to areas of Rowley, Kennebec, Huntsville, and Dorchester soils. Some of the areas are large enough to be managed separately.

Representative profile:

0 to 29 inches, black, friable silt loam.
29 to 50 inches, dark grayish-brown, very dark grayish-brown, and light olive-brown, friable silt loam.

The surface layer ranges from 20 to 36 inches in thickness.

These soils have high or very high available moisture capacity and are moderately permeable. In places they receive some overflow. The water table is normally moderately high, but its height is variable. Therefore, these soils are slightly wet. Field operations can be more timely if the soils are tile drained and protected from overflow.

These soils are suited to row crops. When the surface is bare, however, the sloping areas are easily eroded by runoff from the soils upslope.

Lime is not needed, because these soils are slightly acid to moderately alkaline. The soils are medium in available nitrogen and potassium and low in available phosphorus.

Lawson and Kennebec silt loams, 0 to 2 percent slopes (LkA).—In this undifferentiated unit, the soils have a black surface layer that is high in content of organic matter. The surface layer is 30 to 36 inches thick, but the dark color extends to a depth of 40 inches or more in the Kennebec soil. In a few places, as much as 6 inches of light-colored material has been deposited on the surface. Also, in a few areas of these soils, the surface layer is dark grayish brown and the subsoil is grayer than typical.

The soils of this unit are on bottom lands and low benches. Where they are near a drainageway or near the channel of a stream, they are in the same general areas as the Dorchester soils. These soils are adjacent to Rowley, Huntsville, and Otter soils. The individual areas are small. Therefore, these soils are generally farmed with the adjacent soils.

The Lawson soil of this unit is slightly wet. Tile drainage makes field operations more timely, and outlets for the drains are not difficult to establish. A few areas need protection from overflow.

If the soils of this unit are properly managed, corn and other row crops can be grown intensively. Meadow needs to be included in the rotation, however, if tilth becomes poor. Yields are generally above average if good management is used. Response to fertilizer is good. (Capability unit I-2)

Lawson silt loam, 2 to 5 percent slopes (LmB).—The surface layer of this soil is 20 to 24 inches thick and is generally black or very dark gray. In most places moderately dark colors extend below the surface layer to a depth of about 30 inches. In a few places, as much as 6 inches of light-colored material has been deposited on the surface. Also, in some areas the surface layer is very dark grayish brown and the subsoil is somewhat grayer than typical.

This soil is at the base of upland slopes that grade to areas of bottom lands and low benches. It is downslope from Nordness soils and Steep rock land and adjacent to Rowley, Huntsville, and Kennebec soils. The individual areas vary in size, but some are large enough to be managed separately. Included in mapped areas of these soils are a few patches in which the slopes are slightly steeper than 5 percent.

Runoff from the soils upslope erodes this soil or deposits soil material on the surface. Tile drainage is needed in places, so that field operations can be more timely. If this soil is tile drained and tilled on the contour, it can be used for corn and other row crops 3 years in 4. The small areas are managed with the adjacent soils.

Yields of corn grown on this soil are generally above average if management is good. Meadow, rather than a catch crop of oats, can be included in the rotation if tilth becomes poor. Lime is normally not needed. Response to fertilizer is good. (Capability unit IIe-2)

Loamy Colluvial Land

This miscellaneous land type consists of well-drained loamy material that is more than 40 inches thick. The soil material near the surface is dark colored or moderately dark colored, and the same coloring extends to various depths. The slopes range from 9 to 24 percent.

Areas of this miscellaneous land type are on high foot slopes. They are mainly in the eastern part of the county, at the base of areas of Steep rock land or of steep Nordness soils. Some areas, however, are in the western part of the county.

In most places a distinct soil profile is lacking, but there is a profile similar to those of the Orwood, Huntsville, Dickinson, and Backbone soils in some places. Profiles of these soils can be found under their respective series.

Permeability is moderate, and the available moisture capacity is high. Where this land type receives runoff from soils upslope, soil material is usually deposited on the surface. The intake of water is good.

This land is suited to pasture, trees, and wildlife habitats. The less sloping areas can be used infrequently for row crops, but this land generally occurs with areas of soils that are not used for crops.

In most of the acreage, lime is not needed to establish a stand of legumes. This land is low in available nitrogen and phosphorus and medium in available potassium.

Loamy colluvial land, 9 to 18 percent slopes (LnE).—Near the surface this miscellaneous land type consists of dark to moderately dark colored material that varies in thickness. It does not have stones or pebbles on the surface.

This land type is on high foot slopes, below and parallel to areas of Steep rock land and the Nordness soils. It lies upslope from soils of the bottom lands and stream benches. Included in mapped areas of this land type are a few spots occupied by a soil that has a surface layer of sandy loam and a subsoil of loamy sand.

This land type receives runoff and deposition from the soils upslope, and gullies form where water concentrates. A few gullies that have already formed need to be shaped and seeded.

Generally, this land type occurs with soils that are not used for crops. It should be stripcropped if row crops are grown. A diversion terrace, constructed at the base of areas of this land, will protect the soils downslope.

This land is suited to permanent pasture, and much of the acreage is used for that purpose. The land can be used for corn and other row crops 1 year in 6 if stripcropping is practical. As a rule, however, a row crop is not grown until the pastures need renovation. If corn is included in the rotation, the yields are generally only average, even if management is good. Manure and commercial fertilizer are needed to establish a stand of legumes. Lime is normally not needed. Response to fertilizer is moderate. (Capability unit IVe-1)

Loamy colluvial land, 18 to 24 percent slopes (LnF).—The soil material near the surface of this land type is dark colored and has a texture of loam. No stones or pebbles are on the surface.

This land type is on high foot slopes below areas of Steep rock land and Nordness soils. It is upslope from soils of bottom lands and stream benches. Included in mapped areas of this land type are areas of a soil that is silty and that has a thick, dark-colored surface layer.

This land type receives deposition from higher lying soils, and where water concentrates, gullies form. Farm equipment cannot be used safely on some of the areas, and access to some areas is difficult. The land is suitable for permanent pasture, trees, and wildlife habitats. Grazing needs to be controlled in the pastured areas, however, so that the cover of plants will not be lost. Diversion terraces are needed in places to protect the soils downslope. The areas that are good for timber ought to be managed as woodland. (Capability unit VIe-3)

Loamy Terrace Escarpments

Loamy terrace escarpments, 16 to 30 percent slopes (LoF) consists of well-drained loamy material that is extremely variable in color. The texture is generally loam to a depth of 20 inches or more, but thin layers of coarser textured material occur in places. Loamy sand or sand is below a depth of 20 inches in most places.

This land type forms a border along some stream benches, below areas of Waukegan, Camden, Sattre, Festina, and other silty and loamy soils on benches. In many places it is upslope from soils of the bottom lands.

Geologic erosion has truncated areas of this land type so that a particular soil profile is hard to identify. The land is extremely susceptible to further erosion when the surface is bare or is protected by only a sparse cover of plants. Some gullies occur on hillsides. The soil material near the surface ranges from dark to light in color, depending on the amount of recent erosion that has taken place.

The land is suitable for permanent pasture, trees, or wildlife habitats, but many of the areas are better used as woodland or for wildlife habitats than for pasture. Grazing needs to be controlled in the pastured areas, so that the cover of plants will not be lost. In most places farm machinery cannot be operated safely. Diversion terraces placed at the base of some of the areas will protect the soils downslope from runoff and silting. Trees and shrubs should be planted in the gullied areas.

This land type is very low in available nitrogen, phosphorus and potassium. The need for lime varies. Applying lime and fertilizer is often not justified, because farm machinery generally cannot be operated safely. (Capability unit VIe-3)

Marlean Series

In the Marlean series are well-drained to excessively drained soils that formed in 5 to 15 inches of loamy glacial material over fragmented limestone. Some soil material lies between the fragments of limestone and extends to a depth of 48 inches or more. The slopes range from 2 to 24 percent.

These soils are on convex ridges and side slopes on uplands in the western part of the county. Where they occur on side slopes, they are between outcrops of limestone and areas of Steep rock land. On the ridges, they are above Atkinson and Waucoma soils in many places and above areas of the deep Kato soils that have a substratum of clay shale. The individual areas vary in size.

Representative profile:

0 to 9 inches, very dark brown, friable loam.
9 to 12 inches, very dark grayish-brown, dark-brown, and brown, friable loam.
12 to 48 inches, very dark grayish-brown, dark-brown, brown, and dusky-red, friable, loamy material between fragments of shaly limestone.

The surface layer ranges from 3 to 12 inches in thickness. In areas that have not been cultivated, the color of the surface layer ranges from very dark brown to black, but the surface layer is only moderately dark colored in cultivated areas. Fragments of limestone are on the surface in some places.

These soils have very low available moisture capacity and are moderately permeable. Subsoil moisture is often lost through leaching. The root zone is generally thin, but it varies in thickness. Roots can extend into the soil material, however, between the fragments of limestone.

The Marlean soils are subject to erosion, but the fragments of shaly limestone on the surface protect them to some extent. Because these soils are shallow over limestone and are subject to erosion, they are more suitable for pastures, trees, and wildlife habitats than for row crops. The less sloping areas can be used for row crops, however, if these soils are properly managed.

These soils are low in nitrogen and are very low in phosphorus and potassium. Lime is not needed.

Marlean loam, 2 to 5 percent slopes (MaB).—This soil has a black to very dark brown surface layer that is 8 to 12 inches thick. It has fragments of limestone on the surface. Fragmented limestone is at a depth ranging from 5 to 15 inches, but it is between 10 and 15 inches in most places.

This soil is on ridges above areas of more sloping Marlean soils. On the wider ridges, it is nearly level in places. Included in mapped areas of this soil are a few spots in which the surface layer is very dark grayish brown and is only 3 to 6 inches thick.

The intake of water is generally good, but some runoff takes place because of the gentle slopes. The amount of moisture in the subsoil is not adequate for most row crops, but this soil is suited to hay and pasture. Hayfields or pastures are generally not renovated unless the stand becomes poor. If stripcropping is practical, however, corn or other crops can be grown 2 years in 5.

Yields of corn grown on this soil are generally below average, even if good management is used. The yields are directly related to the timeliness of rains. Pasture seedings respond to applications of fertilizer, especially to applications of phosphate. (Capability unit IVs–3)

Marlean loam, 5 to 9 percent slopes (MaC).—Most areas of this soil are not cultivated, and in those areas the surface layer is very dark brown or very dark gray and is 6 to 10 inches thick. In places the surface layer contains fragments of limestone. Fragmented limestone is at a depth ranging from 5 to 15 inches, but it is generally between 10 and 15 inches.

This soil is on side slopes, both above and below other Marlean soils. In places it is upslope from Waucoma, Atkinson, and Jacwin soils and from the deep Kato soils that have a substratum of clay shale.

Water erosion is a hazard when the surface of this soil is bare or is only sparsely covered by plants. The coarse fragments on the surface, however, help to control erosion to some extent. Grazing ought to be controlled to prevent losing a seeding in pastured areas.

This soil is suited to hay or pasture. If the stand becomes poor in the pastures, corn or other row crops can be grown when a pasture is renovated. Even when stripcropping is practiced, a row crop should be grown only 1 year in 6. Many areas of this soil are idle, even though adjoining soils are cropped.

If corn is grown, yields are generally below average, even though management is good. The yields depend on the timeliness of rains and on the amount of moisture received. Pasture seedings respond to applications of fertilizer, especially to applications of phosphate. (Capability unit IVs–3)

Marlean loam, 5 to 9 percent slopes, moderately eroded (MaC2).—The surface layer of this soil varies in color and thickness, but it is very dark grayish brown and is 3 to 6 inches thick in most places. In a few severely eroded areas, however, the surface layer is dark brown. Fragments of limestone are on the surface, and limestone bedrock is generally at a depth of only 5 to 10 inches.

This Marlean soil is on side slopes adjacent to other Marlean soils. In places it is upslope from Steep rock land. Many of the areas are small and are managed with the adjoining soils.

When the surface is bare, this soil is subject to further water erosion. The large number of coarse fragments on the surface, however, tend to curtail erosion to some extent. Rain quickly saturates the thin layer of soil material, and then runoff takes place. This soil does not store enough water for crops to grow well.

Much of the acreage is cultivated, but this soil should be used for hay and pasture instead of for corn or other row crops. A row crop can be grown as often as 1 year in 6, however, if stripcropping is practiced. The pastures are usually not renovated until the stand becomes poor. Many areas of this soil are idle. The small areas can be used for wildlife habitats.

If corn is grown on this soil, yields are generally very low, even if management is good. Grazing ought to be controlled in the pastured areas. Fertilizer is needed to establish pasture seedings. (Capability unit IVs–3)

Marlean loam, 9 to 14 percent slopes, moderately eroded (MaD2).—The surface layer of this soil varies in color and thickness because of differences in the amount of erosion that has taken place. The color ranges from black to very dark grayish brown, and the thickness ranges from 3 to 10 inches. Fragments of limestone are on the surface. The loamy material ranges from 5 to 15 inches in thickness over fragmented limestone, but it is only 5 to 10 inches thick in most places.

This soil is generally on short side slopes in escarpment areas, downslope from other Marlean soils. In places it is either upslope or downslope from Steep rock land.

When this soil is only sparsely covered by plants, it is subject to erosion. Therefore, where practical, grazing ought to be controlled in the pastured areas. This soil is suitable for use as permanent pasture, as woodland, and for wildlife habitats. The pasture plants do not grow much in summer, however, because of the small supply of moisture in the subsoil.

The present cover of plants should not be destroyed when a pasture is renovated. Adapted grasses can be used for seeding. Also, although response to fertilizer is poor, fertilizer should be applied. (Capability unit VIs–1)

Marlean loam, 9 to 14 percent slopes, severely eroded (MaD3).—The surface layer of this soil is dark brown when moist, and it is very low in content of organic matter. It is lighter colored when dry. Fragments of limestone are common. The loamy material is generally only 5 to 10 inches thick over fragmented limestone.

This soil is on short side slopes and escarpments, adjacent to less eroded Marlean soils. In places it is upslope from Steep rock land. Many of the individual areas are small.

In many places this soil is only sparsely covered by plants, and as a result, it continues to erode. The coarse fragments of limestone, however, curtail erosion to some extent.

This soil is often left idle while the adjoining soils are used for crops. It is suitable for permanent pasture, trees, or wildlife habitats. The carrying capacity of the pastures is low, and many areas of this soil are better suited to trees or wildlife habitats than to pasture. The pastures need protection from overgrazing. They should not be grazed in midsummer, because the supply of subsoil moisture is limited and the plants cannot make good growth. Response to fertilizer is poor. (Capability unit VIIs-1)

Marlean loam, 14 to 24 percent slopes, moderately eroded (MaE2).—This soil has a surface layer that is 3 to 8 inches thick and is very dark brown or very dark grayish brown. On the surface it has pieces of limestone. The loamy material is generally only 5 to 15 inches thick, and it is underlain by fragmented limestone.

This soil is on short side slopes and escarpments, downslope from other Marlean soils. It is upslope from Steep rock land. The individual areas vary in size, but some of them are large.

Erosion is a serious hazard when the surface of this soil is bare or only sparsely covered by plants. The surface needs to be protected by growing plants or by plant residue at all times. The supply of moisture is too limited for pasture plants to make good growth.

This soil is suited to permanent pastures, or it can be used as woodland or for wildlife habitats. The carrying capacity of the pastures is low, and use as woodland or for wildlife habitats is probably better than for pastures. Grazing should be controlled in the pastures. Response to fertilizer is very poor. (Capability unit VIIs-1)

Marlean loam, 14 to 24 percent slopes, severely eroded (MaE3).—The surface layer of this soil is dark brown when moist and is lighter colored when dry. It contains fragments of limestone. Only 5 to 10 inches of loamy material overlies the substratum of fragmented limestone.

This soil is on short side slopes and escarpments, upslope from Steep rock land. Adjacent to it are less sloping or eroded Marlean soils.

The cover of plants is sparse in most places, and there is a large amount of runoff. The small amount of moisture in the subsoil limits the growth of plants.

This soil can be used as woodland or for wildlife habitats. It is also suitable for limited grazing of permanent pasture. Operating farm machinery is difficult, and the pastures are rarely renovated. Many areas are idle or are not renovated with the adjoining areas. Control of grazing is necessary. (Capability unit VIIs-1)

Nasset Series

In the Nasset series are well-drained soils that formed in 30 to 50 inches of loess on the uplands. Below the loess is limestone bedrock or a thin layer of material weathered from bedrock over limestone. These soils have a moderately dark colored surface layer. A distinct subsurface layer underlies the surface layer and is mixed with the plow layer in some places. The subsurface layer is lighter colored than the surface layer. In cultivated areas the surface layer is light colored when dry. The slopes range from 5 to 18 percent.

The Nasset soils are on side slopes, generally downslope from Downs soils and upslope from Frankville soils. The individual areas are small.

Representative profile:

0 to 8 inches, very dark gray, friable silt loam.
8 to 15 inches, very dark grayish-brown and dark grayish-brown, friable silt loam.
15 to 37 inches, yellowish-brown, dark yellowish-brown, and dark-brown to brown, friable or friable to firm silt loam and light silty clay loam.
37 to 42 inches, yellowish-brown and reddish-yellow, very firm clay underlain by hard limestone bedrock.

In areas that are not cultivated, the surface layer is very dark brown or very dark gray and ranges from 4 to 8 inches in thickness. In cultivated or eroded areas, the surface layer is very dark grayish brown when moist and has a somewhat lighter color when dry.

These soils have medium available moisture capacity and are moderately permeable. They have a somewhat limited root zone for a few crops. Erosion is a serious hazard. Loss of additional soil material will limit the future use of these soils.

These soils are easily tilled and can be used for row crops. The steeper areas are more suitable for hay or pasture.

The Nasset soils are medium acid to strongly acid, and crops grown on them need lime. These soils are low in available nitrogen and phosphorus and low to medium in available potassium.

Nasset silt loam, 5 to 9 percent slopes, moderately eroded (NaC2).—In a large part of the acreage, this soil is cultivated. The surface layer in the cultivated areas includes part of the subsurface layer; it is very dark gray or very dark grayish brown when moist and has a somewhat lighter color when dry. The surface layer is low in content of organic matter. In the few areas in woods or permanent pasture, the surface layer is dark colored, is 4 to 8 inches thick, and is underlain by a distinct, light-colored subsurface layer. No stones or pebbles are on the surface or in the subsoil. Limestone bedrock is at a depth of about 40 inches in most places, but the depth ranges from 30 to 50 inches.

This Nasset soil is on narrow convex ridges or side slopes, downslope from Downs soils and upslope from Frankville and more sloping Nasset soils. Many of the individual areas are small and narrow. Therefore, this soil is generally managed with the adjacent soils. Included with mapped areas of this soil on ridges are areas in which the slopes are less than 5 percent.

This Nasset soil is easily eroded by runoff. Therefore, tillage needs to be on the contour or this soil should be terraced or stripcropped. Because of the limestone near the surface, terrace layouts ought to be planned so that cuts and fills are held to a minimum.

Corn and other row crops can be grown 2 years in 4 if terracing or stripcropping is used and if crop residue is left on the surface. Yields of corn are generally above average if management is good, but lime is needed for legumes. Response to fertilizer is good. (Capability unit IIIe-2)

Nasset silt loam, 9 to 14 percent slopes, moderately eroded (NaD2).—This soil has a very dark brown or very dark grayish-brown surface layer that is generally low in content of organic matter. The subsurface layer is lighter colored than the surface layer and is a part of the surface layer in places. Neither the surface layer nor the subsoil contains stones or pebbles. The underlying limestone is at a depth ranging from 30 to 50 inches, but it is at a depth of less than 40 inches in many places.

This soil is on convex side slopes, below Downs and other Nasset soils. In many places it is upslope from Frankville soils or Steep rock land. The individual areas are small, and most of the acreage is managed with the adjacent soils.

Included in mapped areas of this soil are a few tracts in which the surface layer is dark colored and is 8 to 16 inches thick. Also included are a few uneroded areas in woods or permanent pasture. In those areas the surface layer is also dark colored, and there is a distinct subsurface layer that is lighter colored than the surface layer.

When the surface is bare or is only sparsely covered by plants, this Nasset soil is easily eroded by runoff. Crop residue can be left on the surface to increase the intake of water. Corn and other row crops can be grown 1 year in 5 if this soil is terraced or stripcropped. Because of the underlying limestone, terraces ought to be planned so that cuts and fills are held to a minimum.

Even if this soil is well managed, yields of corn are generally only average. Lime is needed if legumes are to be established. Response to fertilizer is moderate to good. (Capability unit IIIe-4)

Nasset silt loam, 14 to 18 percent slopes, moderately eroded (NaE2).—The surface layer of this soil is very dark grayish brown when moist, but it is lighter colored when dry. In many places the former light-colored subsurface layer is now a part of the surface layer. No stones or pebbles are on the surface or in the profile. The underlying limestone is generally at a depth between 30 and 50 inches, and it is at a depth of 36 inches in many places.

This Nasset soil is on convex side slopes, downslope from other Nasset soils and upslope from Frankville soils and Steep rock land. Most of the individual areas are small. Therefore, this soil is often managed with the adjoining soils.

Included in mapped areas of this soil are patches that are wooded or in permanent pasture. In those places the surface layer is darker colored than in the cultivated areas and there is a distinct subsurface layer.

Runoff easily erodes this Nasset soil when the surface is only sparsely covered by plants. Therefore, crop residue ought to be left on the surface.

This soil is suited to hay or pasture. If it is stripcropped, however, it can be used for corn or other row crops 1 year in 6, or a row crop can be grown when a pasture needs to be renovated. Usually, the pastures are not renovated until the stand becomes poor.

Even if this soil is well managed, yields are generally below average. Pasture seedings respond to applications of lime and phosphate fertilizer. (Capability unit IVe-1)

Nordness Series

Well-drained soils of the uplands are in the Nordness series. These soils formed in 5 to 15 inches of loamy material. Beneath the loamy overburden is limestone bedrock or a thin layer of silty clay loam or silty clay and bedrock. Stones or pebbles are not common on the surface, but pieces of limestone are typical. The slopes range from 5 to 24 percent.

The Nordness soils are on narrow ridges and side slopes. In many places they are below Dubuque and Palsgrove soils and above Steep rock land and other Nordness soils.

Representative profile:

0 to 2 inches, very dark gray and dark grayish-brown, friable silt loam.
2 to 5 inches, dark grayish-brown friable silt loam .
5 to 9 inches, dark-brown to brown, friable silt loam.
9 to 12 inches, dark-brown, friable silty clay loam; underlain by limestone bedrock and some soil material.

In areas that are not eroded, the surface layer ranges from very dark gray to very dark grayish brown in color and from 2 to 3 inches in thickness. In those areas the subsurface layer is light colored.

The fractured limestone near the surface limits the amount of moisture that can be stored in these soils, and it limits the development of roots. Therefore, the available moisture capacity is very low. Permeability is moderate in the loamy material above the limestone, and it is generally rapid in the fractured limestone.

The Nordness soils are subject to erosion when they are only sparsely covered by plants. The less sloping areas are suited to hay and pasture. The steeper areas are better used as woodland or for wildlife habitats.

These soils are very low in available nitrogen and phosphorus and low in available potassium. Lime is generally not needed, although the soils are acid.

Nordness silt loam, 5 to 14 percent slopes (NoD).—This soil has a thin surface layer that is generally very dark gray or dark grayish brown. The surface layer is low in content of organic matter. In a few areas that are severely eroded, the surface layer is dark brown. Fragments of limestone are on the surface in places. Limestone is at a depth of about 5 inches in the severely eroded areas, but it is normally at a depth of 5 to 15 inches.

This soil is on side slopes below Dubuque and other Nordness soils and above Steep rock land in many places. In places this soil occurs with Rockton and Marlean soils. The individual areas are small, and this soil is commonly managed with the adjacent soils.

Included in the mapped areas of this soil in the southwestern part of the county are areas of a soil that has a dark-colored surface layer. The texture of the surface layer in those areas is loam.

Water quickly runs off the surface of this Nordness soil. Therefore, erosion is a hazard if the surface is bare. Grazing needs to be controlled in the pastured areas, especially in midsummer when the cover of plants is poor. Except in spring, the small amount of moisture in the soil limits the growth of plants. This soil is suited to trees, and a few areas are wooded. Some areas are idle and make a satisfactory habitat for wildlife. Renovating pastures is often difficult because of the limestone near the surface. If a pasture is renovated, the present cover of plants should not be completely destroyed. Pasture seedings show some response to applications of phosphate. (Capability unit VIs-1)

Nordness silt loam, 14 to 24 percent slopes (NoE).—In moist areas that are not wooded, the surface layer of this soil ranges from very dark gray to brown in color, but it is much lighter colored when dry. In wooded areas the surface layer is very dark gray and is 2 to 3 inches thick. Beneath the surface layer in wooded areas is a distinct, light-colored subsurface layer. The surface layer is dark grayish brown to brown in eroded areas that are pastured. A few fragments of limestone are on the surface in places. Limestone is at a depth that is generally between 5 and 15 inches, but it is at a depth of less than 10 inches in a large part of the acreage. Limestone crops out on the surface in a few small areas that are less than one-fourth of an acre in size.

This Nordness soil is on side slopes and escarpments below Frankville and less sloping Nordness soils. In many places it is upslope from areas of Steep rock land.

Runoff is rapid on this soil, and it causes erosion when the surface is bare. The growth of plants is limited because of the low available moisture capacity. Therefore, grazing ought to be controlled in the pastured areas, especially in midsummer.

This soil can be used for permanent pasture, trees, or wildlife habitats, but it is better used for trees or wildlife habitats than for pasture. The wooded areas need proper management.

On much of the acreage, farm machinery cannot be operated safely. The use of fertilizer is generally not worth while, because of the poor response and hazards related to operating equipment. (Capability unit VIIs–1)

Oran Series

In the Oran series are soils of the uplands that are somewhat poorly drained. These soils formed in 14 to 24 inches of loamy material over loam glacial till. The loamy material is separated from the glacial till by a concentration of stones or pebbles. The slopes range from 0 to 5 percent.

The Oran soils are in areas adjacent to drainageways and on side slopes in the uplands in the western part of the county. Adjacent to them are Bassett, Racine, Coggon, and Renova soils. In many places they are upslope from Floyd and Clyde soils.

Representative profile:

0 to 8 inches, very dark gray, friable loam.
8 to 14 inches, dark grayish-brown, friable loam.
14 to 42 inches, dark grayish-brown, grayish-brown, and yellowish-brown, friable loam that grades to friable to firm loam; contains some stones and pebbles and very fine sand or coatings of silt.
42 to 50 inches, yellowish-brown, firm loam; contains some stones and pebbles and common grayish-brown mottles.

In areas of Oran soils that are not eroded, the surface layer ranges from black to very dark gray in color and from 4 to 8 inches in thickness. Below the surface layer in those areas is a distinct, light-colored subsurface layer. In areas where the surface layer was originally only 4 inches thick, the present plow layer is very dark grayish brown in many places.

These soils have high or very high available moisture capacity and moderately slow permeability. They are slightly wet because of the moderately high, but fluctuating, water table. Field operations can be more timely where these soils are tile drained. Tile drainage is generally needed if use of the soils for crops is to be profitable. These soils are easily tilled.

The Oran soils are suited to row crops. The sloping areas are subject to erosion, however, when the surface is bare or is only sparsely covered by plants.

These soils are acid; crops grown on them respond to applications of lime. The soils are low in available nitrogen, phosphorus, and potassium.

Oran loam, 0 to 2 percent slopes (OrA).—This soil has a black or very dark gray surface layer that is 6 to 8 inches thick. The surface layer is low to medium in content of organic matter and is somewhat light colored when dry. Stones and pebbles are absent from the surface but are in the subsoil.

This soil is in moderately wide areas near drainageways. In some places it is adjacent to sloping Oran, Racine, or Bassett soils. Some of the individual areas are large enough to be managed separately.

A moderately high water table makes this soil wet, and no runoff takes place. If tile drainage is provided, farming can be more timely. Tile drainage is generally needed if crops are to be grown profitably.

This soil is suited to intensive use for corn and other row crops, and yields of corn are generally above average if management is good. This soil is easily tilled, but the surface layer puddles if it is worked when wet. Where tilth is poor, meadow ought to be included in the rotation.

Lime is needed for crops to grow well on this soil. Response to fertilizer is good. (Capability unit IIw–1)

Oran loam, 2 to 5 percent slopes (OrB).—The surface layer of this soil is generally very dark gray when moist, but the color is black to very dark grayish brown in places. When the surface layer is dry, it is somewhat lighter colored than when it is moist. The subsurface layer is light colored. Part of it has been mixed with the plow layer in some places. In many places near the base of slopes or near drainageways in side valleys, the surface layer is darker and thicker than typical. In most places stones and pebbles are absent from the surface layer but are in the subsoil.

This soil is on side slopes, downslope from Bassett, Racine, Coggon, Renova, or less sloping Oran soils. It is upslope from Clyde soils.

Some runoff occurs on this soil, but erosion is generally not a serious hazard. Also, this soil is wet and tile drainage is needed so that field operations can be more timely. Graded terraces improve the drainage in some places. If this soil is terraced, it is suited to intensive use for corn and other row crops. Near drainageways in side valleys, however, tile drainage is needed to control the seepage.

Yields of corn grown on this soil are generally above average if management is good. Good response is obtained from fertilizer, and the crops also respond to applications of lime. (Capability unit IIe–3)

Orwood Series

In the Orwood series are well-drained soils of the uplands. These soils formed in more than 40 inches of windblown material that has a texture of loam or silt loam. No stones or pebbles are on the surface or in the subsoil. The slopes range from 2 to 30 percent.

The Orwood soils are on convex ridges and on side slopes in areas that border the Upper Iowa River and its tributaries. In many places they are adjacent to Fayette, Downs, and Lamont soils. Many of the areas are large enough to be managed separately.

Representative profile:

0 to 8 inches, very dark grayish-brown, friable silt loam to loam.
8 to 50 inches, dark-brown and dark yellowish-brown, friable silt loam to loam.
50 to 60 inches, yellowish-brown, friable silt loam.

Because of differences in the amount of erosion, the surface layer varies in color and thickness. In areas that are not eroded, the surface layer ranges from very dark brown to very dark gray in color and from 4 to 8 inches in thickness. Also in areas that are not eroded, there is a distinct, light-colored subsurface layer. In many of the areas that are eroded or that have been cultivated, part of the subsurface layer has been mixed with the plow layer. In many of those areas, the surface layer directly overlies the subsoil and is very dark grayish brown.

These soils have high available moisture capacity. They are moderately permeable.

Erosion is a hazard on all of these soils. The less sloping Orwood soils are suitable for row crops, and the steeper areas are suitable for pasture or can be used as woodland or for wildlife habitats. These soils are easily tilled, although in many places the surface layer is low in content of organic matter and is in poor tilth. The surface layer of the eroded soils is likely to seal during hard rains, and a crust forms when the soil dries.

Lime is needed because the Orwood soils are acid. These soils are low in available nitrogen and phosphorus and medium in available potassium.

Orwood silt loam, 2 to 5 percent slopes (OsB).—This soil has a surface layer that is very dark brown or very dark gray and is 4 to 8 inches thick. The surface layer ranges from silt loam to loam in texture. Below it is a distinct, light-colored subsurface layer.

This soil is on convex ridges. It is upslope from Downs, Fayette, and other Orwood soils.

This soil can be managed separately from the adjoining soils, and much of the acreage is cultivated. Some runoff occurs, however, because of the gentle slopes. Therefore, tillage ought to be on the contour or terraces should be constructed. Corn or other row crops can be grown intensively if this soil is terraced.

This soil is easily tilled, and a seedbed is not difficult to prepare. Crop residue ought to be left on the surface, however, and manure should be applied. The crop residue and manure reduce runoff and insure that a good intake of water will be maintained.

If management is good, yields of corn are generally above average, but lime is needed for the optimum growth of crops. Response to fertilizer is very good. (Capability unit IIe–1)

Orwood silt loam, 5 to 9 percent slopes, moderately eroded (OsC2).—Much of the acreage of this soil is cultivated, and the surface layer in the cultivated areas is very dark grayish brown when moist and is somewhat lighter colored when dry. The surface layer ranges from silt loam to loam in texture. The former subsurface layer is now a part of the plow layer in many places. Near drainageways that cut into sidehills, the surface layer is slightly darker and thicker than in other places. Many areas of this soil that are in pasture or wooded are not eroded.

This soil is on convex side slopes, in most places above or below other Orwood soils. Downslope from it in some places are Downs and Fayette soils.

Included in mapped areas of this soil are a few severely eroded patches in which the dark-brown subsoil is exposed. Also included are a few minor spots in which the texture of the surface layer is sandy loam.

This Orwood soil is subject to further erosion when the surface is bare or is only sparsely covered by plants. Crop residue ought to be left on the surface. If row crops are grown, tillage ought to be on the contour or this soil should be terraced or stripcropped. Terraces can be constructed with little or no difficulty, and the drainageways should be shaped and reseeded.

During hard rains, the surface layer of this soil may seal over, and a crust forms when the soil dries. Adding manure and leaving crop residue on the surface improve the intake of water.

Where this soil is terraced or stripcropped, corn or other row crops can be grown 3 years in 5. Meadow should be included in the rotation for an additional year, however, if the tilth is poor. Yields of corn are generally above average if management is good, but lime is needed for establishing meadow or pasture. Response to fertilizer is good. (Capability unit IIIe–1)

Orwood silt loam, 9 to 14 percent slopes, moderately eroded (OsD2).—Cultivated crops are grown on a large part of the acreage of this soil. In the cultivated areas, the surface layer is very dark grayish brown and is underlain by a brown subsoil. In many of the cultivated areas, the subsurface layer is absent or is part of the plow layer. The texture of the surface layer is silt loam to loam in the areas at the base of slopes or near drainageways that cut into sidehills. In those areas the surface layer is slightly darker and thicker than in other places.

This soil is on convex side slopes. In some places it is below less sloping Orwood soils, and in others it occupies an entire side slope. Near it on the adjoining side slopes are Downs and Fayette soils and some areas of Lamont soils. Included in the mapped areas of this soil are a few small, severely eroded spots where the former subsoil of brown silt loam to loam is exposed. These severely eroded spots are indicated on the soil map by the symbol for severe erosion.

Water quickly runs off this Orwood soil. The surface sometimes seals during rains, and a crust forms when the soil dries. Crop residue ought to be left on the surface, and manure should be applied to increase the intake of water. The bare areas are subject to erosion. Therefore, where a row crop is grown, tillage ought to be on the contour or terracing or stripcropping should be practiced. The uniform slopes and the medium texture of the surface layer are well suited to the construction of terraces. In some places drainageways in the side valleys need to be shaped and seeded.

Corn or other row crops can be grown 1 year in 4 if this soil is terraced or stripcropped. Yields of corn are generally above average if management is good, but both lime and fertilizer are needed for legumes. Response to fertilizer is good. (Capability unit IIIe–3)

Orwood silt loam, 14 to 18 percent slopes, moderately eroded (OsE2).—This soil has a surface layer that is very dark brown to very dark grayish brown when moist, but the surface layer is somewhat light colored when dry. In many places near drainageways in side valleys and at the base of slopes, the surface layer is darker and thicker than in other areas. The surface layer ranges from silt loam to loam in texture and is low in content of organic matter.

This soil is on convex side slopes below other Orwood soils. In places it is upslope from Frankville and Nordness soils or from Steep rock land. Near it on the adjacent slopes are Downs and Fayette soils.

Included in mapped areas of this soil are a few patches on the side slopes of benches where the surface layer is darker colored or lighter colored than typical. In those areas sand or gravel is at a depth of 24 inches or below.

Runoff is rapid, and this Orwood soil erodes when its surface is bare or is only sparsely covered by plants. If this soil is stripcropped, corn or other row crops can be grown 1 year in 6, or a row crop can be grown when a hayfield or pasture is renovated. This soil is generally too steep to be suitable for terraces, but diversion terraces constructed in some of the areas will protect the soils downslope. Some of the drainageways need to be shaped and seeded.

Yields of corn are only average, even if this soil is well managed. Seeded pastures respond to applications of manure, lime, and commercial fertilizer. (Capability unit IVe–1)

Orwood silt loam, 14 to 18 percent slopes, severely eroded (OsE3).—In this soil, erosion has exposed the former subsoil. As a result, the present surface layer in most places is dark-brown silt loam to loam, but it is somewhat lighter colored when dry. Near drainageways that cut into sidehills, however, the surface layer is darker colored than in other areas. The surface layer is in poor tilth and is very low in content of organic matter.

This soil is on convex side slopes where it is surrounded in many places by areas of less eroded Orwood soils. In a few places, it is upslope from Dubuque and Nordness soils or from Steep rock land. The individual areas vary in size, but many of them are small.

Included in the mapped areas of this soil are a few small patches on the side slopes of benches. In those areas sand or gravel is at a depth of 24 inches or below.

The surface layer of this Orwood soil seals during rains, and a crust forms as the soil dries. Tillage is usually not difficult, but the seedbed is cloddy and hard after the soil dries.

This soil is easily eroded when it is only sparsely covered by plants. Oats can be used as a nurse crop when a pasture is renovated, but manure should be added and lime and fertilizer applied to newly seeded pastures. Many of the small areas are more suitable for trees or for wildlife habitats than for field crops. (Capability unit VIe–1).

Orwood silt loam, 18 to 30 percent slopes, moderately eroded (OsF2).—The surface layer of this soil ranges from silt loam to loam in texture and from very dark brown to dark brown in color. Many of the areas are in pasture or wooded, and this soil is not eroded in those areas. In the moderately eroded spots, the surface layer is somewhat lighter colored than in the uneroded areas and the boundary is abrupt between the surface layer and the subsoil.

This soil is on convex side slopes below less sloping Orwood soils. In some places it is upslope from Dubuque and Nordness soils or from Steep rock land. Many of the individual areas are small. Included in the mapped areas of this soil are patches in which the subsoil is exposed at the surface. These severely eroded spots are indicated on the soil map by the symbol for severe erosion.

Runoff is very rapid on this steep soil, and it causes further erosion when the surface is bare. A cover of plants ought to be kept on the surface to increase the intake of water and to reduce erosion.

This soil is suitable for permanent pasture, or it can be used as woodland. Also, some small areas are excellent for wildlife habitats. The brush should be removed, and the waterways in side valleys ought to be shaped and seeded. Also, grazing needs to be controlled in the pastures. The few areas that are wooded need good management. Manure ought to be added when a pasture is renovated, and lime and commercial fertilizer should be applied. (Capability unit VIe–3)

Ossian Series

In the Ossian series are poorly drained soils that formed in silty alluvium. These soils have a moderately thick, dark-colored surface layer that is underlain by a distinct, gray, mottled subsoil. The slopes range from 0 to 3 percent.

These soils are mainly on bottom lands, but a few areas are in moderately wide drainageways in uplands in the eastern part of the county. In many places these soils are adjacent to areas of Colo, Otter, and Rowley soils.

Representative profile:

0 to 15 inches, black, friable silt loam.
15 to 42 inches, dark-gray, olive-gray, and light olive-gray, friable and very friable silt loam; some yellowish-brown mottles.
42 to 50 inches, olive-gray and yellowish-brown, very friable silt loam.

The surface layer ranges from black to very dark gray in color and from 10 to 20 inches in thickness.

These soils have high or very high available moisture capacity. They are moderately permeable but are occasionally flooded and are very wet. The water table is high because seepage is received from the soils upslope. These soils are easily puddled if worked when wet. They warm up slowly in spring, and as a result, field operations are sometimes delayed.

Unless drainage has been improved, these soils are suitable only for pasture. They can be used for row crops if they are tile drained.

Lime is not needed, because these soils are only slightly acid or are neutral. They are medium in available nitrogen and potassium and low in available phosphorus.

Ossian silt loam (0 to 3 percent slopes) (Of).—This is the only Ossian soil mapped separately in this county. Its surface layer is black or very dark gray and is 10 to 20 inches thick. No stones or pebbles are on the surface or in the subsoil.

This soil is on bottom lands and in drainageways in the uplands. It is adjacent to Colo, Otter, and Rowley soils.

Many of the individual areas are small and are managed with the adjoining soils.

This soil is very wet. Tile drains should be placed where they will intercept seepage water and lower the water table. In some places, however, outlets for these drains are difficult to establish.

Where this soil has been tile drained, it is suited to intensive use for corn or other row crops. Yields of corn are above average if management is good, and small grains also yield well. Response to fertilizer is good. (Capability unit IIw–2)

Ostrander Series

Well-drained soils that have a distinct, dark-colored surface layer and that are in the uplands are in the Ostrander series. These soils formed in loamy glacial sediment over friable, glacial till. A thin band of stones and pebbles separates the sediment from the underlying till. Stones and pebbles are common in the subsoil. The slopes range from 0 to 9 percent.

These soils are on convex ridges and side slopes in the western part of the county. In some places they are adjacent to Kenyon and Racine soils, and upslope from Floyd, Clyde, and Atkinson soils. Many of the areas are small and are farmed with the adjoining soils.

Representative profile:

0 to 18 inches, very dark brown and very dark grayish-brown, friable loam.

18 to 55 inches, brown to dark-brown, dark yellowish-brown, and yellowish-brown, friable loam that contains some stones and pebbles at a depth of 22 inches and below.

55 inches, yellowish-brown, friable loam that contains some pebbles.

The surface layer ranges from black to very dark brown in color and from 8 to 15 inches in thickness. In places these soils are moderately dark colored to a depth of 20 inches. The thickness of the loamy overburden, or sediment, varies considerably, but this material is about 20 inches thick in many places.

These soils have high available moisture capacity and are moderately permeable. The sloping areas are easily eroded, however, when the surface is bare or is only sparsely covered by plants.

These soils are suited to row crops. They are easily tilled, and most of the acreage is cultivated. The surface layer is high in content of organic matter, is in good tilth, and takes in water well.

These soils are medium acid, and crops grown on them need lime. The soils are medium in available nitrogen and low in available phosphorus and potassium.

Ostrander loam, 0 to 2 percent slopes (OuA).—This soil has a black to very dark brown surface layer that is 12 to 15 inches thick. No stones are on the surface, but stones and pebbles are in the subsoil.

This soil is on slightly convex, moderately wide ridges where it is bordered downslope by Kenyon and other Ostrander soils. Adjacent to it in a few places are areas of Racine and Bassett soils.

The surface layer is friable and in good tilth. Therefore, the intake of water is good. Little or no runoff occurs, but water does not pond on the surface, and wetness is not a problem.

Corn or other row crops can be grown intensively on this soil. Because of the small size of the areas, however, row crops should be grown less frequently than on the adjoining soils. Lime is needed for crops to make good growth, but yields of corn are above average if management is good. Response to fertilizer is very good. (Capability unit I–1)

Ostrander loam, 2 to 5 percent slopes (OuB).—The surface layer of this soil is very dark brown and is 8 to 15 inches thick. The texture is generally loam, but in a few places it is silt loam. The surface layer is high in content of organic matter, is in good tilth, and in most places is free of stones. A few stones and pebbles are in the subsoil.

This soil is on convex ridges and on a few side slopes upslope from Kenyon, Floyd, Clyde, and Atkinson soils. In places it is adjacent to areas of Racine and Bassett soils.

Some water runs off this soil. Therefore, erosion is a hazard when the surface is bare. Tillage should be on the contour or this soil ought to be terraced if a row crop is grown. Where terraces are constructed, small stones and pebbles are exposed in the channel of the terrace in many places. Applying manure and commercial fertilizer in the channel not only increases the supply of plant nutrients but also increases the intake of water.

Where this soil is terraced, it is suited to intensive use for corn or other row crops. Yields of corn are generally above average if management is good. Good response is obtained if lime and fertilizer are applied. (Capability unit IIe–1)

Ostrander loam, 5 to 9 percent slopes (OuC).—This soil has a very dark brown to very dark grayish-brown surface layer that is generally 8 to 12 inches thick. In a few small areas, however, the surface layer is only 3 to 6 inches thick. A few stones and pebbles are in the subsoil and in a few places on the surface.

This soil is on narrow, convex ridges and on the side slopes of ridges below areas of less sloping Ostrander soils. It is above areas of Kenyon, Floyd, and Clyde soils, and it is above areas of Atkinson and Rockton soils in some places.

This soil is easily eroded by runoff. Therefore, tillage ought to be on the contour, or this soil should be terraced or stripcropped. Where this soil is terraced or stripcropped, corn or other row crops can be grown 3 years in 5. Where terraces are constructed, some stones and pebbles are exposed in the channels. In these channels manure and commercial fertilizer should be applied. Some of the drainageways that cut into sidehills may need to be shaped and seeded.

Yields of corn grown on this soil are generally above average if management is good, but legumes need lime for optimum growth. Response to fertilizer is good. (Capability unit IIIe–1)

Otter Series

The soils of the Otter series are poorly drained and are flooded occasionally. They formed in silty alluvium. Their surface layer is dark colored, and the dark color commonly extends to a depth of 3 feet.

The Otter soils occur with the Colo soils on wide bottom lands and are mapped with those soils. On narrow bottom lands and in upland drainageways, they also occur with Lawson and Ossian soils and are mapped with those soils.

Representative profile:

0 to 37 inches, black, friable silt loam.
37 to 58 inches, dark-gray and olive-gray to light olive-gray, friable silt loam mottled with yellowish brown.

The Otter soils have high available moisture capacity and moderate permeability. The water table is high, but the height is variable.

These soils are suited to extensive use for row crops, and tile drains work well in them. The supply of available nitrogen and potassium is medium, but the supply of available phosphorus is low. These soils are slightly acid to neutral, and they generally do not need lime.

Otter-Lawson-Ossian complex, 1 to 4 percent slopes (OvB).—In this soil complex are dark-colored, somewhat poorly drained and poorly drained soils in areas too narrow for the soils to be mapped separately. These soils formed in silty alluvium. Their surface layer is black to very dark gray, and it is high in content of organic matter. No stones or pebbles are on the surface. The profile of the Otter soil is like the profile described for the Otter series. Profiles that are typical of the Ossian and Lawson soils are described under the Ossian and Lawson series.

These soils are on narrow bottom lands and in upland drainageways in the eastern part of the county. On bottom lands they are adjacent to Huntsville and other Otter soils, and in upland drainageways they are downslope from Downs and Fayette soils.

The soils of this complex are moderately permeable and have high or very high available moisture capacity. Their surface layer puddles if it is worked when wet. Runoff is received from the soils upslope that formed in loess, and these soils also receive seepage water from the adjoining soils. As a result, the height of the water table varies. These soils are often too wet in spring or after rains to be crossed with farm equipment unless they are tile drained. Tile drains work well, however, and an outlet can be established in most places. The drainageways in a few areas can be shaped and reseeded.

Corn or other row crops can be grown intensively where these soils are tile drained. Some small areas are cropped with the adjoining soils. If tilth is poor, meadow should be included in the rotation.

Yields of corn grown on these soils are generally above average if management is good. Response to fertilizer is good where drainage has been improved.

These soils are neutral or slightly acid. They are medium in available nitrogen and low in available phosphorus and potassium. (Capability unit IIw–2)

Otter-Ossian complex (0 to 2 percent slopes) (Ow).—The soils of this complex are poorly drained, and they formed in silty alluvium. Both of the soils have a black surface layer, but the black color extends to a greater depth in the Otter than in the Ossian soil. The profile of the Otter soil is like the one described for the Otter series. A profile that is typical for the Ossian soil is described under the Ossian series.

These soils are on bottom lands and in upland drainageways. They are subject to flooding, but the floodwaters remain for only short periods. A thin layer of lighter colored sediments has been deposited on the surface in some places.

These soils have a seasonal high water table. Tile drainage is needed if crops are to grow satisfactorily. Where drainage is provided, corn or other row crops can be grown intensively and yields of corn are above average if management is good. Lime is not needed in most places, but response to fertilizer is good. (Capability unit IIw–2)

Otter and Ossian silt loams, overwashed (0 to 3 percent slopes) (Ox).—Soils that are poorly drained and that formed in silty alluvium are in this undifferentiated unit. A layer of silt loam that is 6 to 20 inches thick and that contains lime has been deposited on their surface. The present surface layer is dark grayish brown. No stones or pebbles are on the surface. The profile of the Otter soil is similar to the one described for the Otter series. A profile considered typical of the Ossian soils is described under the Ossian series.

These soils are on bottom lands adjacent to Dorchester, Caneek, and other Otter soils. In places they are separated from the stream channel by areas of Dorchester soils. Because of the thick layer of overwash and the similar colors and textures in the surface layer, these two soils were identified in mapping but were not mapped separately. In most places beneath the layer of silty overwash, the soil profile is similar to that of the Ossian soils.

Included in mapped areas of these soils are a few spots in which about 30 inches of light-colored material has been deposited on the surface. Also included are a few areas in which the subsoil is loamy and there is a buried soil.

The soils of this unit have high or very high available moisture capacity and are moderately permeable. The soils are wet, however, because little or no water runs off. Also, the water table is high and the areas are occasionally to frequently flooded.

These soils are suited to intensive use for corn or other row crops if they are protected from overflow and if tile drains have been installed to lower the water table. Outlets for tile drains can be established in most places.

Yields of corn are generally above average if management is good. Crops grown on these soils respond well to fertilizer, but lime is not needed. These soils are very low in available nitrogen and phosphorus and medium in available potassium. (Capability unit IIw–2)

Palsgrove Series

In the Palsgrove series are well-drained soils of uplands that have a light-colored surface layer. These soils formed in a layer of loess that is 30 to 50 inches thick. Beneath the loess is a thin layer of clayey material weathered from bedrock. That material, in turn, is underlain by limestone bedrock. No stones or pebbles are in the surface layer or the subsoil. The slopes range from 2 to 24 percent.

The Palsgrove soils are on narrow, convex ridges and on side slopes. They are downslope from Fayette soils. In many places they are upslope from Dubuque and Nordness soils and from Steep rock land. Some of the areas are small.

Representative profile:

0 to 6 inches, dark grayish-brown, friable silt loam.
6 to 40 inches, brown to dark-brown, yellowish-brown, and dark yellowish-brown, friable silty clay loam and silt loam.
40 to 42 inches, dark-brown to brown, firm gritty silty clay; contains some yellowish-brown and grayish-brown mottles; underlain by fractured hard limestone.

In areas where these soils have not been cultivated and are not eroded, the surface layer ranges from very dark gray to very dark grayish brown in color and from 2 to 4 inches in thickness. In those areas the surface layer is underlain by a distinct, light-colored subsurface layer. In eroded or cultivated areas, the surface layer is dark gray or dark grayish brown, and the subsurface layer is now a part of the surface layer.

The available moisture capacity is medium, and the loessal soil material is moderately permeable above the limestone. The underlying limestone is fractured, but it limits the root growth of some plants. The surface layer is low in content of organic matter and is commonly in poor tilth. It often seals during rains, and a crust forms when the soil dries. As a result, a large amount of the water from rainfall usually runs off because of the strong slopes and the slightly restricted intake of water in some places. The surface layer is subject to erosion where it is bare or is only sparsely covered by plants.

The less sloping Palsgrove soils are suited to row crops if they are properly managed. The steeper areas are suitable for pasture, trees, and wildlife habitats.

These soils are acid, and they are very low in available nitrogen, low in available phosphorus, and low to medium in available potassium. Lime is needed for the optimum growth of crops.

Palsgrove silt loam, 5 to 9 percent slopes, moderately eroded (PaC2).—A large part of the acreage of this soil is cultivated. Generally, the surface layer in the cultivated areas is dark gray or dark grayish brown when moist and is much lighter colored when dry. It is slightly darker and thicker in some places near drainageways that cut into sidehills. In most places the subsurface layer is now a part of the plow layer. Depth to the underlying bedrock or to material weathered from limestone bedrock ranges from 30 to 50 inches, but it is about 40 inches in many areas.

This soil is on convex side slopes adjacent to less sloping Palsgrove soils. In some places it is above Dubuque or other Palsgrove soils.

Where the surface is bare or is only sparsely covered by plants, runoff erodes this soil. During hard rains, the surface is likely to seal, and a crust forms when the soil dries. Manure can be applied and crop residue can be left on the surface to improve the intake of water. If row crops are grown, tillage should be on the contour and this soil ought to be terraced or stripcropped. Because of the underlying limestone near the surface, cuts and fills need to be held to a minimum where terraces are built. In places the drainageways need shaping and reseeding.

Corn or other row crops can be grown 2 years in 5 if this soil is terraced or stripcropped. Yields of corn are generally only average, however, even if good management is used. Lime and fertilizer are needed to establish a stand of legumes. Response to fertilizer is good to moderate. (Capability unit IIIe-2)

Palsgrove silt loam, 9 to 14 percent slopes, moderately eroded (PaD2).—Most areas of this soil are cultivated, and the surface layer in most of the cultivated areas is dark gray or dark grayish brown when moist and is much lighter colored when dry. In most places near drainageways that cut into sidehills, however, the surface layer is generally darker and thicker than in other areas. The surface layer is low in content of organic matter, and the subsurface layer in most areas is now a part of the surface layer. Depth to limestone bedrock or to material weathered from bedrock ranges from 30 to 50 inches. It is less than 40 inches in much of the acreage.

This soil is on convex side slopes, downslope from tracts occupied by Fayette soils and less sloping Palsgrove soils. It is upslope from Dubuque, Nordness, and steeper Palsgrove soils. In places this soil is on the lower parts of side slopes that grade to areas of Chaseburg soils that are downslope. Included in mapped areas of this soil is a rather large acreage in which the soil is wooded and is not eroded.

Cultivated areas of this Palsgrove soil are subject to further erosion where row crops are grown and the soil is not terraced or stripcropped. During hard rains, the surface layer often seals, and a crust forms when the soil dries. Crop residue can be left on the surface and manure can be applied to increase the intake of water and to reduce runoff. Also, some of the drainageways in side valleys need to be shaped and seeded. The number of cuts and fills needs to be kept to a minimum where terraces are constructed. Enough soil material should be left to cover the limestone in the channels.

If this soil is terraced or stripcropped, it can be used for corn or other row crops 1 year in 5. Meadows are generally left for more than 3 years, and a row crop is then grown when the area is renovated. Yields of corn are variable, but they are generally only about average for the county, even if management is good. Manure, lime, and commercial fertilizer are needed to help establish a good stand of meadow or pasture. (Capability unit IIIe-4)

Palsgrove silt loam, 9 to 14 percent slopes, severely eroded (PaD3).—In this soil the present surface layer was formerly the subsoil. Its color is dark brown to brown when moist, and it is somewhat lighter colored when dry. In most places the texture of the surface layer is silt loam, but the texture grades to silty clay loam in places. The surface layer is very low in content of organic matter and is in poor tilth. Depth to limestone bedrock or to material weathered from bedrock ranges from 30 to 40 inches.

In many places this soil is on convex knobs on side slopes between the drainageways that cut into sidehills. In most places it is surrounded by less eroded Palsgrove and Nasset soils. The individual areas are small, and as a result, much of the acreage is managed with the adjacent soils. Included in mapped areas of this soil are a few spots in which limestone bedrock and material weathered from limestone are at a depth between 24 and 30 inches.

Where the surface is bare or is only sparsely covered by plants, this soil is subject to further erosion. Crop residue can be left on the surface and manure can be applied to increase the intake of water. The surface tends to seal during rains, and a crust forms when the soil dries.

This soil is suited to pasture, but it can be used for corn or other row crops 1 year in 6 if it is terraced or stripcropped. Because of the location and small size of the areas, however, this soil is usually farmed with less eroded Palsgrove soils.

Yields of corn are below average on this soil, even if management is good. When pastures are seeded, manure, lime, and commercial fertilizer ought to be applied to help establish the stand. (Capability unit IVe-2)

Palsgrove silt loam, 14 to 18 percent slopes, moderately eroded (PaE2).—This soil generally has a dark-gray to dark grayish-brown surface layer that is 3 to 6 inches thick. In many places near drainageways that cut into sidehills, however, the surface layer is darker and thicker than in other areas. The surface layer is much lighter colored when dry than when moist. Brown material from the subsoil is mixed with the surface soil in some places. Limestone bedrock or material weathered from bedrock is generally at a depth of less than 40 inches, but the depth ranges from 30 to 50 inches. Nearly half of the acreage is wooded, and the soil in those areas is not eroded.

This soil is on convex side slopes, below Fayette and less sloping Palsgrove soils. It is upslope from Dubuque and Nordness soils and from areas of Steep rock land. In some places where this soil is on the lower parts of side slopes, it is upslope from the Chaseburg soils.

Where the surface of this soil is bare or is only sparsely covered by plants, runoff causes further erosion. Crop residue can be left on the surface and manure can be applied to increase the intake of water. The surface may seal during rains, and a crust forms when the soil dries.

This soil is suited to hay or pasture, but corn or other row crops can be grown 1 year in 6 when a pasture is renovated. A good stand of pasture is generally left for more than 4 years before the area is plowed.

Some drainageways that cut into sidehills need to be shaped and seeded. Scattered trees and shrubs ought to be removed from the pastures, but a good stand of timber should be managed as woodland.

If corn is grown when a pasture is renovated, the yields are below average, even if management is good. When a pasture is seeded, lime, manure, and commercial fertilizer help to establish the stand. (Capability unit IVe-1)

Palsgrove silt loam, 14 to 18 percent slopes, severely eroded (PaE3).—In this soil, erosion has exposed the subsoil. As a result, the present surface layer is dark brown or brown when moist, and it has a texture that ranges to silty clay loam in some places. The surface layer is somewhat lighter colored when dry. It is very low in content of organic matter and is in poor tilth. Depth to limestone bedrock or to material weathered from bedrock is generally between 30 and 40 inches. It is between 24 and 30 inches in a few small areas.

This soil is on convex knobs on side slopes between the drainageways that cut into sidehills. The areas are small, and this soil is generally surrounded by areas of less eroded Palsgrove and Nasset soils.

Crop residue can be left on the surface and manure can be applied to increase the intake of water. Control of grazing is necessary, for erosion continues where this soil is only sparsely covered by plants. This soil is suited to permanent pasture, or it can be used as woodland or as a habitat for wildlife. If a pasture is renovated, oats can be seeded as a nurse crop. Where a pasture is seeded, lime, manure, and commercial fertilizer help to establish the stand. (Capability unit VIe-1)

Palsgrove silt loam, 18 to 24 percent slopes, moderately eroded (PaF2).—The surface layer of this soil is generally dark gray or dark grayish brown when moist and is 3 to 6 inches thick. It is slightly darker and thicker, however, near drainageways that cut into sidehills. This layer is much lighter colored when dry. The subsurface layer is absent in many places, and in some areas it is a part of the surface layer. Limestone bedrock or material weathered from bedrock is at a depth between 30 and 40 inches in many places.

This soil is on convex side slopes that are dissected by drainageways that cut into sidehills. It is below Nasset and less sloping Palsgrove soils and above Steep rock land and Dubuque, Frankville, and Nordness soils. In places this soil is on the lower parts of side slopes that grade downslope to the Chaseburg soils or to soils on benches.

Included in mapped areas of this soil are a few severely eroded patches in which the subsoil is exposed and the present surface layer is dark brown or brown. Also, in more than half of the acreage, this soil is wooded and is not eroded.

Much of the acreage is in pasture. Grazing should be controlled in the pastured areas so that a good cover of plants is maintained. Where the surface is bare, this soil is easily eroded by runoff.

This soil is suited to permanent pasture, or it can be used as woodland. Also, the small areas make excellent habitats for wildlife.

Farm machinery must be operated with care on this soil. Lime, manure, and commercial fertilizer are needed to improve the stands of pasture. (Capability unit VIe-3)

Peaty Muck

Peaty muck consists of accumulations of partly decomposed plant material. This organic material is 10 inches or more thick and is underlain by gray silty or loamy material. It is very poorly drained and seepy.

Peaty muck occurs in broad drainageways and on bottom lands. It is in slight depressions or in slightly elevated areas, mostly in the western part of the county. Most of the individual areas are small.

Representative profile:

0 to 37 inches, black, very friable peaty muck and muck.
37 to 46 inches, very dark gray, very friable silty clay loam.

These soils have very high available moisture capacity. Permeability is rapid in the organic material, but seepage and a high water table make these soils very wet. Where these soils are in depressions, water is often ponded on the surface.

These soils are difficult to drain. Open ditches are used to drain them where the layer of organic material is thick, and tile drains can be used to drain them where that layer is thinner. Considerable settling takes place after these soils are drained.

Unless adequate drainage has been provided, these soils are generally considered to be wasteland. After the areas are drained, however, row crops can be grown.

Lime is not needed, because these soils are neutral. These soils are high in available nitrogen but very low in available phosphorus and potassium.

Peaty muck (0 to 12 percent slopes) (Pk).—This soil has a black surface layer consisting of organic material that is 10 to 48 inches thick. The surface layer has a soft, spongy feel. In the areas that have not been drained, the hoofs of animals cut the surface and this soil will not support the weight of farm equipment.

This soil is in slight depressions or in slightly elevated areas on bottom lands and in broad drainageways. In most places it occurs within larger areas of Floyd, Clyde, Ossian, or Otter soils or it is adjacent to those soils.

Peaty muck is very wet because it receives seepage water from the surrounding soils and has a high water table. The excess water should be controlled by installing tile or surface drainage. Each area ought to be checked carefully, however, before tile drains are installed. Outlets are difficult to obtain in some places.

Where this soil is drained, corn and other row crops can be grown intensively, but many crops do not mature properly. The corn that is grown is often used for silage. Only average yields are obtained from corn that is grown for grain, and the grain often needs to be dried before it is stored. Applications of phosphate and potassium are needed. (Capability unit IIIw–3)

Peaty muck, overwashed (0 to 12 percent slopes) (Pw).—This soil consists of dark-colored peaty muck over which 6 to 20 inches of light-colored silty material has generally been deposited. The thickness of the silty material varies considerably within short distances. Some areas have received as much as 40 inches.

This soil is on bottom lands and in broad drainageways in the uplands, mainly in the eastern part of the county. Adjacent to it in many places are Dorchester, Ossian, and Otter soils and complexes of those soils. The individual areas are small and are managed with the adjoining soils.

This soil is wet, but the areas that have only a thin deposit of silty material on the surface need drainage more than the areas where the deposit is thick. Tile drains are difficult to install and to maintain. The organic material is unstable, and the tile drains ought to be placed in the underlying soil material. Corn or other row crops can be grown intensively if this soil is drained. Average yields of corn are generally obtained if management is good.

Lime is not needed on this soil. Good response is received, however, if fertilizer is applied. (Capability unit IIw–3)

Racine Series

In the Racine series are well-drained soils of the uplands. These soils have a moderately dark colored surface layer and a light-colored subsurface layer. They formed in a thin layer of loamy material over friable glacial till. Some pebbles are in the subsoil, and a few are on the surface. The slopes range from 0 to 14 percent.

These soils are on ridges and side slopes in the western part of the county, adjacent to Bassett, Coggon, Renova, and Oran soils in many places. They are upslope from areas of Waucoma, Winneshiek, or Floyd soils in some places.

Representative profile:

0 to 8 inches, very dark gray, friable loam.
8 to 12 inches, dark grayish-brown, friable loam.
12 to 34 inches, dark-brown to brown and yellowish-brown, friable loam that contains some stones and pebbles; few coatings of silt.
34 to 44 inches, yellowish-brown and some grayish-brown, friable sandy clay loam that contains some stones and pebbles.

The surface layer ranges from black to very dark gray in color and from 4 to 8 inches in thickness. The subsurface layer ranges from 2 to 6 inches in thickness.

These soils have high available moisture capacity and are moderately permeable. The sloping areas erode, however, when the surface layer is bare or is only sparsely covered by plants. Crop residue can be left on the surface and manure can be added to increase the intake of water.

These soils are suited to row crops, but the steep Racine soils are better suited to hay or pasture. The soils are acid. Therefore, lime is needed for the good growth of crops. These soils are low in available nitrogen, phosphorus, and potassium.

Racine loam, 0 to 2 percent slopes (RaA).—This soil has a surface layer that ranges from 4 to 8 inches in thickness. The surface layer is black to very dark gray when moist, but it is somewhat lighter colored when dry. The content of organic matter is moderately low. In most places the surface layer is free of stones, but stones and pebbles are in the subsoil.

This soil is on moderately wide convex ridges within larger areas of more sloping Racine soils. The individual areas are small. Therefore, this soil is managed with the adjoining soils.

Little or no runoff takes place, but water does not pond on the surface. Crop residue can be left on the surface to maintain a good intake of water.

This soil is suited to intensive use for corn and other row crops. If tilth becomes poor, a meadow crop can be included in the rotation. Yields of corn are generally above average if management is good. Applying lime, manure, and commercial fertilizer helps the growth of crops. Response to fertilizer is very good. (Capability unit I–1)

Racine loam, 2 to 5 percent slopes (RaB).—This soil has a surface layer that is very dark gray when moist but that is somewhat lighter colored when dry. The surface layer is 4 to 8 inches thick. Beneath it is a distinct, light-colored subsurface layer. No stones are on the surface, but some stones and pebbles are in the subsoil. In some wooded areas, this soil has a thin cover of twigs and leaves on the surface.

This soil is on convex ridges, above Oran and other Racine soils. It is upslope from Floyd soils and is adjacent to Ostrander or Renova soils in places.

Generally, the intake of water is good. However, crop residue can be kept on the surface and manure can be applied to maintain a good intake of water. Runoff erodes this soil when the surface is bare. Therefore, tillage should be on the contour or this soil ought to be terraced if row crops are grown. Where this soil is terraced, corn or other row crops can be grown intensively. If tilth is poor, meadow can be included in the rotation. Yields of corn are generally above average if management is good, but lime is needed for above-average yields of crops. Response to fertilizer is good. (Capability unit IIe–1)

Racine loam, 5 to 9 percent slopes (RaC).—Some areas of this soil are wooded or in permanent pasture. In those areas the surface layer is very dark gray when moist, is 4 to 8 inches thick, and is underlain by a distinct, light-colored subsurface layer. In the wooded areas, twigs and leaves cover the surface in some places. The surface layer is moderately low in content of organic matter and is somewhat light colored when dry. No stones are on the surface, but some are in the subsoil.

This soil is on side slopes below Ostrander and less sloping Racine soils. In some places it is upslope from Bassett, Oran, Waucoma, Winneshiek, and Floyd soils.

Runoff erodes this soil when the surface is bare or is only sparsely covered by plants. Crop residue can be left on the surface to maintain a good intake of water. The drainageways that cut into sidehills ought to be kept seeded at all times, and any scattered trees and shrubs should be removed.

If corn or other row crops are grown, tillage should be on the contour or this soil ought to be terraced or stripcropped. Row crops can be grown 3 years in 5 where this soil is terraced or stripcropped. Yields of corn are generally above average if management is good.

Lime and fertilizer are needed to establish a stand of legumes on this soil. Response to fertilizer is good. (Capability unit IIIe-1)

Racine loam, 5 to 9 percent slopes, moderately eroded (RaC2).—A large part of the acreage of this soil is cultivated. In the cultivated areas, the surface layer is very dark grayish brown or very dark gray when moist but is somewhat lighter colored when dry. Also, the subsurface layer is part of the plow layer. In some places the dark-brown subsoil is exposed, and those areas are shown on the soil map by a symbol for severe erosion. A few stones or pebbles are on the surface.

This soil is on convex side slopes below Ostrander and less sloping Racine soils and upslope from Oran, Bassett, and Floyd soils. In a few places, it is also upslope from Waucoma and Winneshiek soils.

In some areas of this soil, tilth is poor. In those places crop residue can be kept on the surface and manure can be applied to increase the intake of water. Sometimes the surface seals during hard rains, and this sealing causes an increase in runoff. As a result, this soil is easily eroded when the surface is bare. Where improvement is needed, the drainageways that cut into sidehills should be shaped and reseeded.

If corn and other row crops are grown, tillage can be on the contour, but the soil really should be terraced or stripcropped. Row crops can be grown 3 years in 5 where terracing or stripcropping is practiced. Where tilth is poor, the rotation ought to include meadow for an additional year.

Yields of corn are generally above average if management is good, but lime, manure, and commercial fertilizer are needed to help in establishing legumes. Response to fertilizer is good. (Capability unit IIIe-1)

Racine loam, 9 to 14 percent slopes, moderately eroded (RaD2).—The surface layer of this soil ranges widely in thickness and color. In most of the cultivated areas, the surface layer is very dark grayish brown and is underlain by a dark-brown to brown subsoil. Some areas are severely eroded, and in those areas the present surface layer is dark brown or brown. The severely eroded areas are shown on the soil map by the symbol for severe erosion. In places some stones or pebbles are on the surface and in the subsoil.

This soil is on convex side slopes that are dissected, to some extent, by drainageways in side valleys. They are below Ostrander and less sloping Racine soils and above Waucoma, Winneshiek, and Floyd soils. The individual areas are not large. Therefore, much of the acreage is managed with the adjoining soils.

Included in mapped areas of this soil are some soils that have a surface layer of very dark gray loam or silt loam and a distinct, light-colored subsurface layer. Also included are a few areas in which the surface layer is light colored.

The surface of this Racine soil tends to seal during hard rains, and a crust forms when the soil dries. Crop residue ought to be left on the surface, and manure should be applied to increase the intake of water. Some drainageways in side valleys need to be shaped and reseeded, and scattered trees and shrubs ought to be removed where necessary. Water from runoff erodes this soil when the cover of plants is sparse. Therefore, tillage should be on the contour if row crops are grown, or this soil needs to be terraced or stripcropped. Corn or other row crops can be grown 1 year in 4 where this soil is terraced or stripcropped.

Yields of corn are only average on this soil, even if management is good. Lime, manure, and commercial fertilizer are needed if a stand of legumes is to be established. Response to fertilizer is moderate. (Capability unit IIIe-3)

Renova Series

In the Renova series are well-drained soils of the uplands that have a light-colored surface layer. These soils formed in a thin layer of loamy sediment over friable loam glacial till. A layer of stones or pebbles separates the glacial sediment from the till. The slopes range from 2 to 18 percent.

These soils are on convex ridges and side slopes in the western part of the county, adjacent to Racine, Coggon, and Oran soils in many places. They are upslope from Whalan, Nordness, Marlean, and Floyd soils and from Steep rock land in some places. Some of the individual areas are large.

Representative profile:

0 to 7 inches, dark grayish-brown, friable loam.
7 to 11 inches, brown to dark-brown, friable loam.
11 to 35 inches, brown to dark-brown, dark yellowish-brown, and yellowish-brown, friable loam and sandy clay loam; contains some pebbles at a depth of 14 inches and below; very few strong-brown mottles in the lower part.
35 to 50 inches, dark yellowish-brown and strong-brown, friable sandy clay loam and loam that contain some pebbles; few grayish-brown mottles.

In areas that are eroded, the surface layer of these soils is 2 to 4 inches thick. In those areas the surface layer is grayish brown when moist but is much lighter colored when dry. Also in those areas, a distinct, light-colored subsurface layer is beneath the surface layer. The plow layer in cultivated areas is dark gray or dark grayish brown.

These soils are moderately permeable and have high available moisture capacity. They are subject to erosion when the surface is bare or is only sparsely covered by plants. Therefore, crop residue ought to be left on the surface in cultivated areas. If the less sloping Renova soils are properly managed, they are suited to row crops. The steep areas are suited to permanent pasture, or they can be used as woodland or for wildlife habitats.

These soils are acid, and crops grown on them need lime. These soils are very low in available nitrogen and low in available phosphorus and potassium.

Renova loam, 2 to 5 percent slopes (ReB).—This soil has a dark-gray or dark grayish-brown surface layer. The surface layer in cultivated areas is much lighter colored when dry than when moist. It is underlain by a distinct, light-colored subsurface layer. The surface soil is generally free of stones and pebbles, but some stones or pebbles are in the subsoil.

This soil is on convex ridges that are nearly level in places. It is upslope from more sloping Renova or Coggon soils. Adjacent to it in a few places are Racine soils.

When the surface layer is bare in cultivated areas of this soil, erosion is a hazard. Crop residue can be left on the surface to increase the intake of water. During rains, the surface layer may seal, and a slight crust then forms as the soil dries.

If corn or other row crops are grown, this soil ought to be tilled on the contour or terraced. Row crops can be grown intensively where this soil is terraced, and yields of corn are above average if management is good. Lime is needed, however, for the optimum growth of crops. Response to fertilizer is good. (Capability unit IIe-1)

Renova loam, 5 to 9 percent slopes (ReC).—Most areas of this soil are used for permanent pasture or trees, and the surface layer in those areas is very dark gray or dark grayish brown and is 2 to 4 inches thick. Below the surface layer is a distinct, light-colored subsurface layer. In places the wooded areas have twigs and leaves on the surface. Stones and pebbles are generally in the subsoil, but the surface layer is free of them in most places.

This soil is on side slopes, adjacent to less sloping Renova soils. Downslope from it are Oran and Floyd soils.

Water from runoff erodes this soil when the surface is bare or is only sparsely covered by plants. Tillage can be on the contour, or this soil can be terraced or stripcropped where row crops are grown. In some places the drainageways that cut into sidehills ought to be shaped and seeded. Scattered trees and shrubs need to be removed if this soil is to be easily farmed, but good stands of timber ought to be managed as woodland.

If this soil is terraced or stripcropped, corn or other row crops can be grown 3 years in 5. Yields of corn are generally high if management is good. Lime, commercial fertilizer, and manure should be applied to help establish a good stand of crops. Response to fertilizer is moderate to good. (Capability unit IIIe-1)

Renova loam, 5 to 9 percent slopes, moderately eroded (ReC2).—This soil has a surface layer that is generally dark gray or dark grayish brown, but that layer is much lighter colored when dry. The surface layer is darker and thicker than typical near drainageways that cut into sidehills. This soil lacks a subsurface layer. Dark-brown to brown soil material that was formerly part of the subsoil is mixed with the plow layer in some cultivated areas. In a few small spots, the subsoil is exposed. Those areas are indicated on the soil map by the symbol for severe erosion. Some stones or pebbles are in the subsoil and on the surface.

This soil is on narrow, convex ridges and on the side slopes of ridges below less sloping Renova soils. Downslope from it are Oran, Floyd, or steep Renova soils.

Much of the acreage is cultivated, and the surface layer in the cultivated areas is low in content of organic matter and is in poor tilth. During rains, the surface layer may seal, and then a crust forms as the soil dries. Crop residue can be left on the surface, and manure can be applied to improve the intake of water.

This soil is subject to further erosion when the surface is bare. Therefore, tillage should be on the contour or the soil should be terraced or stripcropped. If the areas are terraced or stripcropped, corn or other row crops can be grown 2 years in 4. Where this soil is in poor tilth, meadow should be included in the rotation for a longer time than normal.

Yields of corn grown on this soil are generally above average if management is good. Lime, manure, and commercial fertilizer are needed to help establish a stand of legumes. Response to fertilizer is moderate to good. (Capability unit IIIe-1)

Renova loam, 9 to 14 percent slopes, moderately eroded (ReD2).—Much of the acreage of this soil is cultivated. The surface layer in the cultivated areas is generally dark gray or dark grayish brown when moist and has a much lighter color when dry. It is slightly darker and thicker near drainageways that cut into sidehills, however, than in other places. Also, in a few places, the surface layer is dark brown or brown and consists of soil material that was formerly part of the subsoil. Some stones or pebbles are in the subsoil, and they are also on the surface in a few places.

This soil is on convex side slopes. It occupies an entire slope in a few places. It is generally above areas of Floyd soils and downslope from Racine or Coggon soils, but it is downslope from Fayette soils in some places.

Included in mapped areas of this soil are small patches in which the soil has not been cultivated and is not eroded. In those spots the surface layer is thin and dark colored, and there is a distinct, light-colored subsurface layer.

Runoff causes this Renova soil to erode still further when the cover of plants is sparse. Therefore, if a row crop is grown, tillage should be on the contour or this soil ought to be terraced or stripcropped. The surface layer is low in content of organic matter and is in poor tilth. During hard rains, it may seal, and a crust then forms when the soil dries. Manure can be applied and crop residue can be left on the surface to increase the intake of water.

Where this soil is terraced or stripcropped, corn or other row crops can be grown 1 year in 4. Yields of corn are generally about average, even if management is good, but lime, manure, and commercial fertilizer are needed if a stand of legumes is to be established. Response to fertilizer is moderate. (Capability unit IIIe-3)

Renova loam, 9 to 14 percent slopes, severely eroded (ReD3).—In this soil dark-brown or brown soil material that was formerly part of the subsoil is exposed on the surface. The present surface layer is very low in content of organic matter. It has a brownish color when moist but is somewhat lighter colored when dry. Stones and pebbles are on the surface and in the subsoil in many places.

This soil is on convex knobs that occur on slopes, generally between drainageways that cut into sidehills. As a rule, it occurs within larger areas of less eroded Renova and Coggon soils.

The surface layer is in poor tilth. It seals during rains, and a crust forms when the soil dries. Crop residue can be left on the surface and manure can be applied to increase the intake of water. When the surface is bare, this soil quickly erodes. Therefore, the areas should be terraced or stripcropped.

Because the individual areas are small, this soil is often managed with the adjoining soils. Corn or other row crops can be grown 1 year in 6 where stripcropping is practiced. Yields of corn are only average, however, even though management is good. Lime, manure, and commercial fertilizer are needed to establish a stand of pasture. Response to fertilizer is moderate. (Capability unit IVe–2)

Renova loam, 14 to 18 percent slopes, moderately eroded (ReE2).—This soil has a surface layer that is 3 to 6 inches thick. The surface layer is generally dark gray or dark grayish brown when moist. In some places near drainageways that cut into sidehills, however, the surface layer is slightly darker and thicker. The surface layer is much lighter colored when dry than when moist. Part of the subsoil has been mixed with the plow layer in some areas. A few stones and pebbles are in the subsoil, and a few are on the surface.

This soil is on convex side slopes, below less sloping Renova and Coggon soils. In a few places, it is downslope from Fayette soils, and it is upslope from Whalan soils in many places.

The surface layer is low in content of organic matter, and it is in poor tilth in many of the areas. The amount of water taken in is reduced by surface sealing during hard rains. Therefore, this soil erodes quickly when it is only sparsely covered by plants.

This soil is suited to hay or pasture, but corn or other row crops can be grown 1 year in 6 if stripcropping is practiced. As a rule, a good stand of meadow is left more than 4 years before the area is renovated. Where corn is grown when a pasture is renovated, the yields are generally average if management is good. Lime, manure, and commercial fertilizer ought to be applied to help in establishing a good stand of hay or pasture. Response to fertilizer is moderate. (Capability unit IVe–1)

Renova loam, 14 to 18 percent slopes, severely eroded (ReE3).—In this soil dark-brown to brown soil material that contains stones and pebbles makes up the present surface layer. This material was formerly part of the subsoil. It has a somewhat lighter color when dry than when moist.

This soil is mainly on knobs that occur on slopes between drainageways that cut into sidehills. It is generally downslope from less sloping Renova and Coggon soils, and it is also downslope from Fayette soils in a few places. In a few areas, it is upslope from Whalan and steeper Renova soils.

The surface layer is very low in content of organic matter and is in poor tilth. It is likely to seal during rains. Crop residue can be left on the surface and manure can be applied to increase the intake of water. This soil ought to be kept in permanent pasture, because it is highly susceptible to further erosion when the surface is bare. Also, it can be used as woodland or as habitats for wildlife. Small areas that are surrounded by soils more suitable for crops are especially suitable for use as habitats for wildlife.

Grazing ought to be controlled to prevent losing a seeding of pasture. Oats are often used as a nurse crop when a pasture is renovated. Lime, manure, and commercial fertilizer should be applied to help establish a good stand of pasture plants. (Capability unit VIe–1)

Riceville Series

In the Riceville series are moderately well drained soils of the uplands. These soils formed in 15 to 24 inches of loamy glacial material over clay loam till. They have a firm or very firm subsoil. In their subsoil the color on the exterior of the peds contrasts with the color in the interior. The slopes range from 2 to 7 percent.

These soils are on convex ridges and on the side slopes of ridges in the western part of the county. In many places they are adjacent to Kenyon and Bassett soils and upslope from Floyd soils.

Representative profile:

0 to 8 inches, black, friable loam.
8 to 12 inches, dark grayish-brown and brown to dark-brown, friable loam.
12 to 16 inches, brown to dark-brown, friable loam.
16 to 56 inches, dark-brown to strong-brown and olive-gray to gray, firm and very firm clay loam that contains some pebbles.

The surface layer ranges from black to very dark gray in color, and it is underlain by a distinct, light-colored subsurface layer. A band of stones or pebbles is at depths ranging from 14 to 24 inches.

These soils have high available moisture capacity and moderately slow permeability. The height of the water table varies, but excess moisture usually does not limit the growth of crops.

When the surface is bare or is only sparsely covered by plants, runoff is likely to erode these soils. Crop residue can be left on the surface to increase the intake of water and to reduce the amount of runoff.

These soils are suited to row crops. They are strongly acid, however, and crops grown on them need lime. These soils are low in available nitrogen, phosphorus, and potassium.

Riceville loam, 2 to 7 percent slopes (RfB).—This is the only Riceville soil mapped in this county. Its surface layer is 4 to 8 inches thick and is generally black or very dark gray. Below the surface layer, in most places, is a distinct, light-colored subsurface layer. In a few places, the former subsurface layer is now a part of the plow layer. When the soil is dry, the surface layer in those areas is somewhat lighter colored than typical. In most places friable, loamy material is 15 to 24 inches thick over firm glacial till.

This Riceville soil is on convex side slopes and on some ridges in the western part of the county. It is adjacent to Bassett, Kenyon, and Floyd soils.

Included in mapped areas of this soil are small patches of sloping to moderately steep soils. Also included are spots in which the loamy material is as much as 30 to 40 inches thick over firm glacial till.

Permeability is moderately slow in the subsoil. The water table is moderately high during part of the year, but its height varies. Some tile drainage makes farming more timely.

Runoff erodes this soil. Therefore, when row crops are grown, tillage should be on the contour or this soil ought to be terraced or stripcropped. Corn or other row crops can be grown intensively where this soil is terraced or stripcropped. The cuts and fills necessary for constructing terraces expose the firm subsoil. Therefore, manure ought to be applied to improve tilth in the channels of the terraces. Yields of corn are above average if good management is used. Response to fertilizer is good. Also, newly seeded legumes are benefited by lime. (Capability unit IIe–3)

Rockton Series

Soils of the uplands that are dark colored and well drained make up the Rockton series. These soils formed in 15 to 30 inches of loamy glacial material. The thin layer of underlying material was weathered from limestone bedrock and is underlain by bedrock. The slopes range from 0 to 14 percent.

These soils are on convex ridges, structural benches, and side slopes in the western part of the county. Both upslope and downslope from them are Atkinson, Marlean, Winneshiek, and Jacwin soils. The individual areas vary in size.

Representative profile:

0 to 18 inches, black, friable loam.
18 to 29 inches, dark yellowish-brown, friable or firm clay loam that contains some pebbles.
29 to 31 inches, reddish-brown, very firm clay underlain by hard limestone bedrock.

The surface layer ranges from black to very dark gray in color and from loam to gritty silt loam in texture. In places a few stones and pebbles are on the surface, and some are in the subsoil.

The available moisture capacity is low or very low. Permeability is moderate in the material above the limestone.

These soils have a somewhat restricted root zone because of the limestone near the surface. If soil material is lost through erosion, the root zone becomes even more limiting. The sloping Rockton soils erode easily when the surface is bare or is only sparsely covered by plants.

All of the Rockton soils are suited to row crops if they are well managed, but many of the steeper areas are used for pasture. Yields of crops are variable. They depend on the timeliness of rainfall during the growing season.

These soils are slightly acid to medium acid, and as a result, legumes generally respond to applications of lime. These soils are low in available nitrogen, phosphorus, and potassium.

Rockton loam, 0 to 2 percent slopes (RkA).—The surface layer of this soil ranges from black to very dark gray in color, from 12 to 18 inches in thickness, and from loam to gritty silt loam in texture. In many places the surface layer lacks pebbles, but the subsoil contains stones and pebbles in some places. Limestone bedrock is generally at a depth between 20 and 30 inches, but it is at a depth between 30 and 40 inches in a few areas.

This soil is on convex ridges and structural benches, adjacent to Atkinson and Winneshiek soils. Above or below it are Marlean, Jacwin, and other Rockton soils. Some of the areas are large enough to be managed separately.

This soil takes in water well. Because of the limestone near the surface, however, only a limited amount of water can be stored for the use of crops.

This soil is suited to intensive use for corn and other row crops. Yields of corn are variable, but they are generally above average if good management is used. Response to fertilizer is moderate to good. (Capability unit IIs–1)

Rockton loam, 2 to 5 percent slopes (RkB).—This soil has a black to very dark gray surface layer. The surface layer is generally between 8 and 12 inches thick, but it is only 3 to 8 inches thick in some places. In places it contains pebbles. Depth to limestone ranges from 15 to 30 inches.

This Rockton soil is on convex ridges or on structural benches below Atkinson and less sloping Rockton soils. It lies both above and below Marlean, Jacwin, and other Rockton soils. Some of the areas are large enough to be farmed separately, but this soil is often managed with the adjoining soils.

This soil is easily eroded by runoff when the surface is bare or is only sparsely covered by plants. Therefore, tillage ought to be on the contour if row crops are grown. Erosion needs to be controlled, so that the limestone near the surface does not become more limiting for the growth of roots. The limestone near the surface makes this soil unsuitable for terraces.

If tillage is on the contour, corn and other row crops can be grown on this soil 2 years in 4. Yields of corn are generally above average if management is good. In places lime is needed to establish a stand of legumes. Response to fertilizer is moderate to good. (Capability unit IIe–6)

Rockton loam, 5 to 9 percent slopes (RkC).—The surface layer of this soil is generally very dark gray or black and is 8 to 12 inches thick. In a few places, however, it is very dark brown to very dark grayish brown and is only 3 to 8 inches thick. The surface layer contains a few pebbles. Depth to limestone ranges from 15 to 30 inches, but the depth is between 20 and 24 inches in many places.

This Rockton soil is on convex side slopes in the uplands and on structural benches below Ostrander, Atkinson, and less sloping Rockton soils. In places it is either upslope or downslope from Winneshiek or Jacwin soils. This soil generally occurs in small areas and is managed with the adjoining soils.

Where the cover of plants is sparse, runoff erodes this soil. Therefore, tillage needs to be on the contour, or this soil should be stripcropped. The development of roots of some crops is limited by the limestone near the surface, and loss of soil material through erosion makes this limitation even more serious. Because of the limestone near the surface, this soil is not suitable for terraces.

If this soil is stripcropped, it can be used for corn or other row crops 1 year in 4. Yields of corn are only average, however, even if management is good. In places lime and fertilizer are needed to establish a stand of legumes. Response to fertilizer is moderate. (Capability unit IIIe–5)

Rockton loam, 9 to 14 percent slopes (RkD).—This soil is largely in permanent pasture, and the surface layer in the pastured areas is black to very dark gray and is 8 to 12 inches thick. In a few places, pebbles are on the surface. Depth to limestone ranges from 15 to 30 inches, but it is between 15 and 20 inches in much of the acreage.

This soil is on convex side slopes or at the base of side slopes, below Ostrander, Atkinson, or other Rockton soils. In many places it is adjacent to and either above or below Winneshiek, Marlean, or Jacwin soils. Most of the individual areas are too small to be managed separately.

This soil is subject to erosion when it is used for row crops and the surface is bare. It also erodes if pastures are overgrazed and the cover of plants becomes sparse. The root zone is already shallow enough to limit the root growth of some plants. Therefore, preventing additional losses of soil material is important.

This soil is suitable for hay or pasture. If it is stripcropped, however, it can be used for corn or other row crops 1 year in 6. A row crop is generally not grown until a pasture needs renovation.

Yields of corn are generally only average on this soil, even though management is good. Lime and fertilizer are needed to establish a stand of hay or pasture. (Capability unit IVe–3)

Rowley Series

In the Rowley series are somewhat poorly drained soils that formed in silty alluvium. The surface layer is dark colored. The slopes range from 0 to 4 percent. These soils are mainly on low stream benches adjacent to Canoe and Huntsville soils. Some areas, however, are on or near soils of bottom lands. In those areas the Rowley soils have been mapped with Lawson soils. Light-colored soil material has been deposited on the surface of both of these soils.

Representative profile:

0 to 13 inches, black and very dark brown, friable silt loam.
13 to 30 inches, dark grayish-brown, grayish-brown, and light olive-brown, friable silt loam; some light olive-brown and yellowish-brown mottles.
30 to 46 inches, mottled grayish-brown, light olive-brown, and olive-gray, friable silt loam.

The surface layer ranges from 8 to 15 inches in thickness and from black or very dark gray to very dark brown in color. The thickness of the light-colored material that has been deposited on the surface in the overwashed phase of these soils ranges from 5 to 20 inches.

The surface layer is high in content of organic matter and is in good tilth. The soils are easily tilled. The available moisture capacity is high or very high, and these soils take in water well and are moderately permeable. The water table is variable, but it is low enough during the growing season that crops are not seriously affected by excess moisture. Some areas of Rowley soils receive occasional overflow. Farming can be more timely if the excess moisture is removed by tile drains.

The Rowley soils are suited to row crops. They are slightly acid to medium acid, however, and lime is generally needed for crops to grow well. These soils are low in available nitrogen, phosphorus, and potassium.

Rowley silt loam, 0 to 4 percent slopes (RoA).—This soil has a black surface layer that is 8 to 15 inches thick. The surface layer is friable and well granulated.

This soil is on stream benches, adjacent to Canoe and Huntsville soils. In most places it is on the nearly level parts of the benches.

The intake of water is good, and no water ponds on the surface. The surface layer dries out somewhat slowly after rains, however, and as a result, farming is delayed in some years.

Corn or other row crops can be grown intensively on this soil. If the tilth becomes poor, meadow should be included in the rotation. Yields of corn are above average if management is good.

Lime is needed for good yields. Response to fertilizer is very good. (Capability unit I–3)

Rowley and Lawson silt loams, overwashed (0 to 3 percent slopes) (Rw).—On both of the soils of this unit, a layer of dark grayish-brown or brown silt loam that is 5 to 20 inches thick has been deposited on the surface. These soils were not mapped separately, because the layer of overwash is similar on both and the texture and drainage are similar. The profile of the Rowley soil is similar to the one described for the Rowley series. A profile of the Lawson soil is described under the Lawson series.

These soils are on bottom lands or on low benches. They are adjacent to areas of Dorchester, Caneek, and Ossian soils.

Because of a variable, but moderately deep, water table, these soils are seasonally wet. The water table is generally low during the growing season, but at times, these soils are flooded in spring when there is a large amount of runoff. Farming can be more timely if tile drainage is provided.

If these soils are protected from occasional overflow, they are suited to intensive use for corn and other row crops. Yields of corn are above average if management is good. The light-colored overwash material is neutral; therefore, lime is generally not needed. Response to fertilizer is good. (Capability unit I–5)

Sattre Series

In the Sattre series are soils that are well drained. These soils have a moderately dark colored surface layer and a light-colored subsurface layer. The surface layer and subsurface layer are separated by an abrupt boundary. These soils formed in 24 to 45 inches of loamy material over sand and gravel, but neither the surface layer nor the upper part of the subsoil contains gravel. The slopes range from 0 to 14 percent.

The Sattre soils are mainly on stream benches and on the escarpments of benches, but a few areas are on ridges in the uplands. Adjacent to them are Waukegan, Kato, Hayfield, and Camden soils.

In Winneshiek County moderately deep and deep phases of the Sattre soils are mapped. In the moderately deep phases, sand and gravel are at a depth of 24 to 36 inches. In the deep phases, they are at a depth of 36 to 45 inches.

Representative profile of Sattre loam, deep:

0 to 8 inches, very dark brown, friable silt loam.
8 to 11 inches, brown to dark-brown and dark grayish-brown, friable silt loam.

11 to 44 inches, brown to dark-brown, dark yellowish-brown, and strong-brown, friable loam, heavy sandy loam, and light sandy clay loam; some stones and pebbles are at a depth of 22 to 38 inches.
44 to 56 inches, yellowish-brown, loose sand.

The surface layer ranges from 4 to 8 inches in thickness and from black or very dark gray to very dark brown in color. The texture of the surface layer ranges from loam to gritty silt loam.

The available moisture capacity of these soils is low to medium, depending upon the thickness of the layer of soil material over sand and gravel. Permeability is moderate in the loamy material and rapid in the sand and gravel. The moderately deep Sattre soils have low to medium available moisture capacity and are somewhat droughty. In the deep Sattre soils, some water may be lost from the subsoil through deep percolation, and those soils have medium available moisture capacity. The Sattre soils usually warm up quickly in spring and can be worked soon after rains.

If these soils are properly managed, they are suited to corn and other row crops. Yields are variable and depend on the depth to sand and gravel and on the timeliness of rains. Runoff causes erosion in the sloping areas when the surface is bare or is only sparsely covered by plants.

In most places lime is needed for the optimum growth of crops because the Sattre soils are acid. These soils are low in available nitrogen, phosphorus, and potassium.

Sattre loam, moderately deep, 0 to 2 percent slopes (SdA).—The surface layer of this soil is very dark gray and is 4 to 8 inches thick. It is underlain by a distinct, light-colored subsurface layer. Depth to sand and gravel ranges from 24 to 36 inches, but it is between 30 and 36 inches in much of the acreage.

This soil is on benches and on moderately wide ridges in the uplands. On the benches it is adjacent to Waukegan and Bixby soils. On the uplands it is near areas of Waukegan, Racine, and other Sattre soils.

In most places the intake of water is good. No runoff takes place, and water does not pond on the surface. This soil is easily tilled and can be worked soon after rains. It is somewhat droughty because of the limited available moisture capacity.

Corn and other row crops can be grown intensively on this soil. Yields of corn are generally above average if management is good, and if the amount of rainfall is average. However, crops more resistant to drought should be substituted for corn in dry years. Crop residue ought to be left on the surface, and manure should be added.

Lime is needed for the optimum growth of crops on this soil. Response to fertilizer is good to moderate. (Capability unit IIs–1)

Sattre loam, moderately deep, 2 to 5 percent slopes (SdB).—In much of the acreage, this soil is cultivated, and the plow layer in those areas is very dark gray or very dark grayish brown. In places the plow layer contains part of the light-colored subsurface layer. In other places it contains all of the subsurface layer and part of the subsoil. The underlying sand and gravel are at a depth of 24 to 36 inches.

This soil is on stream benches, adjacent to Waukegan and Bixby soils and in places adjacent to Hayfield soils. It is also on ridges in the uplands, near Waukegan and Bixby soils.

The intake of water is good, but even so, runoff erodes this soil when the surface is bare. Tillage needs to be on the contour, and crop residue can be left on the surface if a row crop is grown.

This soil is easily tilled, warms up quickly in spring, and can be worked soon after rains. It is slightly droughty because of the underlying sand and gravel.

Where farming is on the contour, corn or other row crops can be grown on this soil 3 years in 4. If the amount of rainfall is average and if management is good, yields of corn are above average. Crops that are more resistant to drought can be grown, however, instead of corn. Lime, manure, and commercial fertilizer are needed for the optimum growth of crops. Response to fertilizer is good to moderate. (Capability unit IIe–6)

Sattre loam, moderately deep, 5 to 9 percent slopes, moderately eroded (SdC2).—The surface layer of this soil is 3 to 6 inches thick. It is very dark grayish brown when moist but is somewhat lighter colored when dry. The former subsurface layer is now a part of the plow layer. Also, a few inches of the former subsoil is now a part of the plow layer in a few areas. The underlying sand and gravel are at a depth of 24 to 30 inches in most places.

This soil is on the escarpments of benches and on side slopes in the uplands. It is adjacent to Waukegan, Bixby, Dickinson, and other Sattre soils. It is also adjacent to areas of Racine soils in some places in the uplands.

Included in mapped areas of this soil are a few spots occupied by soils that have a darker surface layer than typical. Also included are small areas in which the soil is severely eroded. Those areas are indicated on the soil map by the symbol for severe erosion.

Where the surface is bare, this Sattre soil is easily eroded by runoff. Therefore, tillage should be on the contour if a row crop is grown, or this soil ought to be stripcropped. Because of the sand and gravel near the surface, this soil is not suitable for terraces.

The surface layer of this soil is moderately low in content of organic matter. Crop residue can be left on the surface and manure can be applied to increase the intake of water and improve tilth. This soil warms up quickly in spring and can be worked soon after rains. It is droughty, however, because of its limited moisture-holding capacity.

If this soil is stripcropped, corn or other row crops can be grown 2 years in 4. In places, however, row crops are grown only when a meadow is renovated. Yields of corn are generally about average if the average amount of rainfall is received and if management is good. Crops that resist drought may be substituted for corn in the rotation.

Lime, manure, and commercial fertilizer are needed to help establish a good stand of crops. Response to fertilizer is moderate. (Capability unit IIIe–5)

Sattre loam, moderately deep, 9 to 14 percent slopes, moderately eroded (SdD2).—Most areas of this soil are cultivated, and the plow layer in the cultivated areas is very dark grayish brown. This layer is somewhat lighter colored when dry. The former subsurface layer is now a part of the plow layer in most places. There is a distinct, light-colored subsurface layer in some areas. Depth to sand and gravel is generally between 24 and 30 inches.

This soil is on the escarpments of benches and on side slopes in the uplands. Both on the benches and on the side slopes, it is adjacent to Bixby and Lamont soils. On the benches it is downslope from Waukegan soils.

Included in mapped areas of this soil are a few small spots where the subsurface layer is absent and the surface layer is darker and thicker than typical. Also included are a few severely eroded areas. Those are indicated on the soil map by the symbol for severe erosion.

Where the cover of plants is sparse, this Sattre soil is easily eroded by runoff. Therefore, the areas should be stripcropped if row crops are grown. This soil is not suitable for terraces, because of the sand and gravel near the surface.

This soil warms up quickly in spring and can be worked soon after rains. The intake of water is generally good, but the available moisture capacity is limiting. Crop residue can be left on the surface and manure can be applied to increase the intake of water and to improve tilth.

This soil is suited to hay and pasture, but corn or other row crops can be grown 1 year in 5 if the soil is stripcropped. If a stand of hay or pasture is good, it is often left more than 4 years before the area is renovated.

If corn is grown, yields are often below average for the county, even though management is good. More drought-resistant crops can be substituted for corn in the rotation. Lime, manure, and commercial fertilizer are needed for the optimum yields of crops, but response to fertilizer is only moderate to poor. (Capability unit IVe–3)

Sattre loam, deep, 0 to 2 percent slopes (SbA).—The surface layer of this soil is very dark brown and is 6 to 8 inches thick. It is underlain by a distinct, light-colored subsurface layer. Sand and gravel are at a depth ranging from 36 to 45 inches, but they are below a depth of 40 inches in much of the acreage.

This soil is on benches and on moderately wide ridges in the uplands. On the benches it is adjacent to Waukegan and Camden soils. On the ridges in the uplands, it is adjacent to Racine soils.

Included in mapped areas of this soil are areas of soils in slight depressions and on flats. The profile of these included soils is similar to that of the Hayfield soils.

The intake of water is good, and little or no runoff takes place. In dry years, however, the subsoil generally contains only a small amount of moisture and that supply is quickly depleted by growing crops.

This soil is suited to intensive use for corn and other row crops. Crop residue can be left on the surface and manure can be added to maintain good tilth. Yields of corn are above average if management is good.

On this soil, lime, manure, and commercial fertilizer are needed to help crops make good growth. Response to fertilizer is good. (Capability unit I–4)

Sattre loam, deep, 2 to 5 percent slopes (SbB).—The surface layer of this soil is very dark brown to very dark gray and is 4 to 8 inches thick. Below the surface layer is a distinct, light-colored subsurface layer. The underlying sand and gravel are at a depth of 36 to 45 inches.

This soil is on stream benches, adjacent to Hayfield soils in many places. It is also on convex ridges in the uplands, near Racine soils.

Some runoff takes place; therefore, this soil erodes easily when the surface is bare. Crop residue can be left on the surface and manure can be added to increase the intake of water and to maintain good tilth. Tillage should be on the contour or this soil ought to be terraced if row crops are grown. Constructing terraces is difficult, however, where this soil is on benches, because of the shape and pattern of the areas. Corn or other row crops can be grown intensively if this soil is terraced.

If proper management is used, yields of corn that are above average are obtained in years when the amount of rainfall is average. Where the supply of subsoil moisture is low, crops that are more drought resistant should be substituted for corn in the rotation. Lime is needed for the optimum growth of crops. Response to fertilizer is good. (Capability unit IIe–4)

Sattre loam, deep, 5 to 9 percent slopes, moderately eroded (SbC2).—This soil has a surface layer that is 4 to 6 inches thick. The surface layer is very dark brown to very dark gray when moist and is somewhat lighter colored when dry. Sand and gravel are at a depth of 36 to 45 inches, and they are at a depth of less than 40 inches in much of the acreage.

This soil is on the side slopes of benches or escarpments, downslope from Camden, Waukegan, and other Sattre soils. In a few places, it is on side slopes in the uplands, adjacent to Racine and moderately deep Sattre soils. The individual areas are small; therefore, this soil is generally managed with the adjoining soils.

Included in mapped areas of this soil are a few minor patches of a soil that is not underlain by sand or gravel. Also included are areas of soils that have a darker and thicker surface layer than typical. Other inclusions consist of severely eroded spots that are indicated on the soil map by the symbol for severe erosion.

This Sattre soil is subject to erosion when the surface is bare or is only sparsely covered by plants. If row crops are grown, tillage ought to be on the contour or this soil should be terraced or stripcropped. Terraces may be difficult to lay out, however, where these soils are on benches.

If this soil is terraced or stripcropped, corn and other row crops can be grown 2 years in 4. Yields of corn are above average if management is good. Lime, manure, and commercial fertilizer are needed to establish a stand of legumes. Response to fertilizer is good. (Capability unit IIIe–2)

Spillville Series

In the Spillville series are moderately well drained, nearly level soils that have a thick, dark-colored surface layer. The surface layer is high in content of organic matter and is in good tilth. These soils formed in loamy alluvium. No stones or pebbles are on the surface or in the subsoil.

These soils are on bottom lands along streams in the western part of the county. They are adjacent to Turlin and Otter soils, to areas of Alluvial land, and in some places to areas of Terril soils.

Representative profile:

0 to 36 inches, black, very friable loam.
36 to 54 inches, black and very dark brown, friable loam.
54 to 60 inches, very dark grayish-brown, friable loam; common, dark yellowish-brown and very dark gray mottles.

The color of the surface layer ranges from black to very dark brown. In some places the surface layer is 40 or more inches thick.

These soils are moderately permeable. They are high or very high in available moisture capacity and take in water well, but they are occasionally flooded. If flooding occurs, it usually takes place early in spring before crops are planted.

These soils are suited to row crops. They are slightly acid in many places, however, and lime is needed in some places for the optimum growth of crops. These soils are medium in available nitrogen and potassium and low in available phosphorus.

Spillville loam (0 to 1 percent slopes) (Sp).—This is the only Spillville soil mapped in the county. It has no stones or pebbles on the surface and has a thick, black surface layer that is high in content of organic matter. In some places this soil contains thin layers of sandy material at a depth of 30 inches or below. A large stream that cannot be crossed with farm machinery dissects the areas in a few places.

This soil is on bottom lands, adjacent to Turlin and Otter soils. In a few places, it is adjacent to areas of Terril soils.

No runoff takes place on this soil. The intake of water is good; therefore, water does not pond on the surface. This soil is generally not wet, but it is flooded occasionally in some years.

Corn or other row crops can be grown intensively if this soil is protected from occasional flooding. If management is good, yields of corn are above average. Response to fertilizer is good. (Capability unit I–2)

Steep Rock Land

Steep rock land (3 to 40 percent slopes) (Sr) consists of outcrops of limestone bedrock and of areas where a few inches of silty or loamy material overlies the bedrock (fig. 7). The limestone is hard but is fractured in most places. The slopes are irregular and are as steep as 30 percent or more.

This land type is on escarpments between two levels of soils of the uplands. Soils formed in loess or glacial till are upslope from it, and Loamy colluvial land, Volney soils, and other soils of the bottom lands are downslope. In places this land type is on ledges or side slopes between soils formed in loess and soils formed in till. In many places the areas in which it occurs extend back along drainageways in the uplands. Included in mapped areas of this land type are a few patches in which about 12 inches of silty or loamy material overlies the bedrock.

This land type has only slight agricultural value, and in many of the areas it supports a poor stand of hardwood trees. It is suitable for trees, wildlife habitats, or permanent pastures, but the carrying capacity of the pastures is very low. Farm equipment cannot be used on this land.

Woodland is probably a better use for this land type than permanent pasture, and selected cuttings can be made in some places. Replanting of trees must be done by hand. (Capability unit VIIs–1)

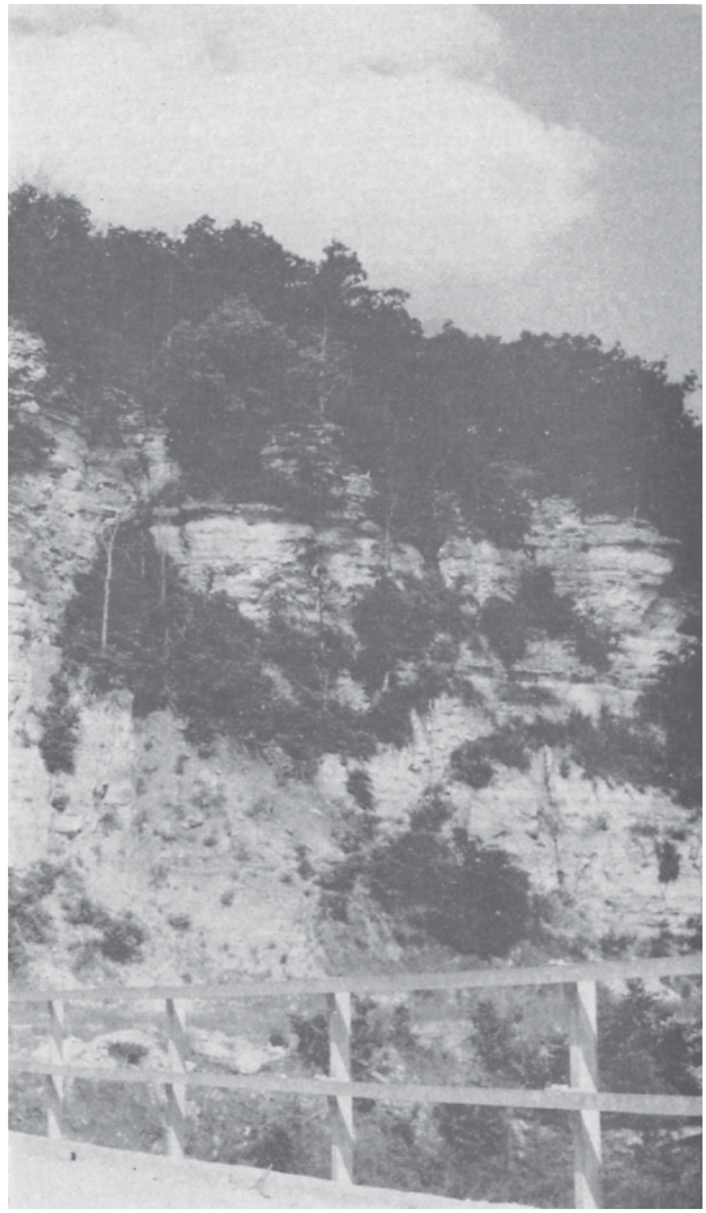

***Figure 7.*—A typical scenic area occupied by Steep rock land along the Upper Iowa River. The limestone walls extend upward from 200 to 300 feet.**

Steep Sandy Land

Steep sandy land, 14 to 30 percent slopes (SsF) consists of a layer of sandy loam or of coarser textured material that is more than 40 inches thick. This material is variable in color, texture, and thickness. The color ranges from very dark gray to brown, and the texture ranges from sandy loam to loamy sand. No gravel is on the surface.

This land type generally occupies small areas on convex side slopes and on bench escarpments. It is downslope from Hagener, Chelsea, Lamont, and Dickinson soils. It is similar to a mixture of those soils or to Loamy colluvial land in some places. Typical profiles of the Hagener, Chelsea, Lamont, and Dickinson soils are described under their respective series.

Steep sandy land has very low available moisture capacity and is rapidly permeable. Where the surface is bare, this land is subject to erosion caused by runoff or wind. It is droughty and supports only a limited growth of plants.

This land type is suitable for trees, wildlife habitats, or permanent pasture, but farm equipment cannot be safely used on some of the areas. The land is medium acid in most places and is very low in available nitrogen, phosphorus, and potassium. In most places lime and fertilizer are not applied, however, because of the poor response. (Capability unit VIIs-2)

Tama Series

Well-drained soils of the uplands make up the Tama series. These soils formed in loess. They have a dark-colored, friable surface layer that is in good tilth. Their surface layer and subsoil are free of stones and pebbles. The slopes range from 2 to 14 percent.

The Tama soils are on convex ridges and side slopes, and the areas are intermingled with areas of Downs soils. Therefore, the Tama soils are mapped and managed with the Downs soils.

Representative profile:

0 to 15 inches, very dark brown, grading to very dark gray and very dark grayish-brown, friable silt loam.
15 to 33 inches, dark yellowish-brown, friable light silty clay loam.
33 to 47 inches, yellowish-brown, friable silt loam.

In most places the surface layer is very dark brown, but the color ranges from black to very dark grayish brown in places.

These soils have high available moisture capacity and are moderately permeable. The more sloping Tama soils are subject to severe erosion when the cover of plants is absent or is sparse.

The Tama soils are suited to row crops, but the sloping areas ought to be terraced or stripcropped if row crops are grown.

Lime is needed on these acid soils. The soils are low to medium in available nitrogen and phosphorus and are medium in available potassium.

Terril Series

Well drained or moderately well drained soils that formed in loamy alluvium are in the Terril series. These soils have a thick, dark-colored surface layer. The slopes range from 0 to 5 percent.

The Terril soils are on first bottoms along small drainageways, on low benches, and at the base of upland slopes. In many places they are adjacent to Turlin and Spillville soils, and they are near areas of Waukegan soils in some places.

Representative profile:

0 to 32 inches, very dark brown and black, friable loam.
32 to 40 inches, very dark grayish-brown and brown to dark-brown, friable loam.
40 to 48 inches, brown to dark-brown, friable loam.

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The surface layer ranges from very dark brown to black in color. Its thickness ranges from 20 to 40 inches.

The Terril soils have high available moisture capacity and are moderately permeable. They are not wet, but infrequently they receive runoff from the soils upslope. Drainageways dissect the areas in some places. Controlling the water is necessary to prevent small drainageways from developing into gullies.

These soils are suited to row crops. They are medium in available nitrogen and potassium and low in available phosphorus.

Terril loam, 0 to 2 percent slopes (TeA).—This soil has a black or very dark brown surface layer that is high in content of organic matter. The surface layer is friable and is in good tilth.

This soil is on first bottoms along upland drainageways and on stream benches. It is adjacent to Spillville, Turlin, Dorchester, and Waukegan soils and below Nordness soils and Steep rock land in many places. The individual areas vary in size, but many of them are small. Therefore, this soil is managed with the adjoining soils in many places.

Included in mapped areas of this soil are a few spots occupied by a soil that has a dark-colored surface layer that is only 16 to 20 inches thick. In these included areas, the texture of the surface layer is silt loam.

This Terril soil is well drained or moderately well drained, but occasionally it receives runoff from the soils upslope. It can be protected from overflow by placing diversion terraces in the areas upslope. The drainageways need to be improved in a few places.

Corn or other row crops can be grown intensively on this soil, and yields of corn are above average if good management is used. Response to fertilizer is very good. (Capability unit I–2)

Terril loam, 2 to 5 percent slopes (TeB).—This soil generally has a very dark brown or black surface layer that is 20 to 40 inches thick. In some places on the surface, however, it has a deposit of lighter colored soil material that is less than 6 inches thick and is low in content of organic matter. In a few other areas, the surface is covered by a deposit consisting of about 4 inches of sandy loam.

This Terril soil is on stream benches at the base of slopes in the uplands. It is also near the junction between the uplands and drainageways. It is adjacent to less sloping Terril, Turlin, Spillville, Waukegan, and Dorchester soils. Many of the individual areas are small, and many of them are managed with the adjacent, less sloping soils.

Included in mapped areas of this soil are areas of a soil in which the surface layer is silt loam 6 to 12 inches thick. Also included are areas in which loamy sand is at a depth of only 36 inches. Other inclusions consist of soils that have slopes of 5 to 9 percent.

Runoff from the uplands deposits sediment on this Terril soil. Placing diversion terraces upslope gives protection from occasional overflow.

Tilling this soil on the contour helps to prevent rilling and development of gullies. In some places improvement is needed in the drainageways. Where the soil is tilled on the contour, corn or other row crops can be grown intensively. Yields of corn are above average if management is good. Response to fertilizer is very good. (Capability unit IIe–2)

Turlin Series

In the Turlin series are somewhat poorly drained soils formed in loamy alluvium. These soils have no stones or pebbles on the surface, and they have a thick surface layer that is dark colored. The slopes range from 0 to 5 percent.

These soils are near the place where the bottom lands are adjacent to upland slopes. They also are on low benches that consist of the first bottoms of side streams. In adjoining areas are Colo, Otter, Kato, Terril, and Spillville soils.

Representative profile:

0 to 34 inches, very dark brown and black, friable gritty silt loam and loam.
34 to 41 inches, very dark grayish-brown, friable loam; common, dark yellowish-brown and dark-brown to brown mottles.
41 to 52 inches, very dark grayish-brown and dark grayish-brown, friable loam; common, strong-brown and dark yellowish-brown mottles.

The surface layer ranges from black or very dark gray to very dark brown in color, from silt loam to loam in texture, and from 20 to 36 inches in thickness. In many places the moderately dark color extends to a depth of about 40 inches.

The available moisture capacity is high or very high, and permeability is moderate. These soils generally take in water well. They are slightly wet, however, because of a moderately high but variable water table and occasional flooding. Wetness usually does not limit the growth of crops, but tile drainage allows farming to be more timely. In years when rainfall is above average, wetness reduces yields in fields that have not been tile drained.

These soils are suited to row crops. They are neutral or slightly acid, and lime is generally not needed for crops to make good growth. These soils are medium in available nitrogen and potassium and low in available phosphorus.

Turlin gritty silt loam, 0 to 2 percent slopes (TgA).—This soil has a black to very dark brown surface layer of silt loam to loam. The surface layer is 24 to 36 inches thick. It is high in content of organic matter and is generally in good tilth.

This soil is on bottom lands, adjacent to Colo, Otter, Terril, Spillville, and more sloping Turlin soils. Included in mapped areas of this soil are areas on low benches that have a moderately dark colored deposit of soil material on their surface.

No runoff takes place on this Turlin soil. The intake of water is generally good. Therefore, water does not pond on the surface. The water table is moderately high, but its height is variable. Flooding occurs at times during periods when there is a large amount of rainfall and when this soil receives runoff. During the growing season, however, the water table is low enough that the growth of crops is not affected. Some tile drainage allows farming to be more timely. In years when rainfall is above normal, wetness reduces yields in areas that are not tile drained.

Corn or other row crops can be grown intensively on this soil, and yields of corn are above average if management is good. Good response is received from applications of fertilizer. (Capability unit I–2)

Turlin gritty silt loam, 2 to 5 percent slopes (TgB).—This soil has a black to very dark gray surface layer that is 20 to 36 inches thick. The surface layer ranges from silt loam to loam in texture. It is high in content of organic matter and is in good tilth.

This soil is on bottom lands at the foot of upland slopes. Adjacent to it are Terril, Spillville, Colo, Otter, and Dorchester soils.

Occasional flooding and a water table that is moderately high make this soil slightly wet. In most years, however, wetness does not affect yields of crops. Some tile drainage allows farming to be more timely. It reduces wetness caused by seasonal seepage.

Runoff occurs on this soil to some extent. Where the surface is bare or is only sparsely covered by plants, some erosion takes place. Therefore, tillage should be on the contour if row crops are grown. Row crops can be grown 3 years in 4 if tillage is on the contour. Where tilth is poor, 1 year of meadow can be substituted in the rotation for a catch crop and oats.

Yields of corn are above average on this soil if management is good. Lime is generally not needed for crops to grow well. Response to fertilizer is good. (Capability unit IIe–2)

Volney Series

The Volney series consists of soils that are well drained and that have a dark-colored, silty surface layer high in content of lime. These soils formed in medium-textured material. They have many fragments of limestone on their surface, and they contain many fragments of limestone. The proportion of fragments increases with increasing depth. The material is predominantly limestone at a depth of 24 to 36 inches. The slopes range from 0 to 5 percent.

These soils are on alluvial fans and on bottom lands, mainly in the eastern part of the county. They are downslope from Fayette and Nordness soils and Steep rock land. They are above or adjacent to Dorchester soils and to soils of the Dorchester-Chaseburg-Volney complex.

Representative profile:

0 to 30 inches, very dark gray, friable silt loam; contains many fragments of limestone.
30 to 50 inches, fragments of limestone and some silt loam.

In the typical Volney soils, the color of the surface layer ranges from very dark gray to very dark brown. In the overwashed phases, however, the color of the surface layer ranges from dark grayish brown to brown.

The Volney soils have medium available moisture capacity and are moderately permeable. In places they lose some subsoil moisture through deep percolation. The numerous fragments of limestone on the surface make preparation of a seedbed difficult in places, and they may damage farm machinery.

The sloping Volney soils are subject to erosion and also receive sediments and fragments of limestone from the soils upslope. Gullies form in the areas where water concentrates. Diversion terraces can be placed in areas of the more sloping Volney soils at the base of upland slopes.

If they are properly managed, the Volney soils are suited to row crops. In many places, however, their use is determined by the use of the adjoining soils, now used mainly for crops. The Volney soils are low in available nitrogen, very low in available phosphorus, and medium in available potassium.

Volney channery silt loam, 0 to 1 percent slopes (VcA).—This soil has a very dark gray surface layer that is 24 to 36 inches thick. The surface layer contains lime and fragments of limestone. In places 6 inches or less of light-colored material has been deposited on the surface.

This soil is on bottom lands, below foot slopes occupied by more sloping Volney soils. In many places it is adjacent to Dorchester soils or to areas of soils of the Dorchester-Chaseburg-Volney complex.

Little runoff takes place on this soil, but a large amount of runoff is received from higher lying soils. In places silty material and fragments of limestone that have washed or fallen from the areas upslope have been deposited on the surface. Removing the large fragments of limestone may be necessary before this soil can be cultivated.

This soil can be used intensively for corn or other row crops, but its use is likely to be determined by the use of the adjoining soils. If the amount of rainfall is average and if management is good, yields of corn are average or above. Lime is not needed, because this soil already contains excessive lime. Response to fertilizer is good, especially response to applications of phosphorus. (Capability unit IIs–1)

Volney channery silt loam, 2 to 5 percent slopes (VcB).—This soil has a very dark brown or very dark gray surface layer that is 20 to 30 inches thick. The surface layer contains lime and fragments of limestone. In a few places, 6 inches or less of light-colored material has been deposited on the surface.

This soil is on low foot slopes, below Fayette and Nordness soils and Steep rock land. Downslope from it are Dorchester and less sloping Volney soils or soils of the Dorchester-Chaseburg-Volney complex.

Runoff erodes this soil. Therefore, tillage ought to be on the contour where a row crop is grown. In places deposits of silty material and fragments of limestone eroded from the soils upslope are still received. Diversion terraces placed in areas of this soil protect the soils downslope.

If this soil is tilled on the contour, corn or other row crops can be grown 3 years in 4. The use of this soil, however, is likely to be determined by the use of the adjoining soils. Crop residue can be left on the surface to help maintain a good intake of water. In years when the average amount of rainfall is received, yields of corn are average if management is good. Lime is not needed. Fertilizer, but not lime, is needed for optimum crop yields on this soil. (Capability unit IIe–2)

Volney silt loam, overwashed, 0 to 1 percent slopes (VoA).—About 6 to 20 inches of dark grayish-brown or brown silt loam has been deposited on the surface of this soil. The deposited material contains lime, but in most places it contains no fragments of limestone. Below a depth of 36 inches, however, the underlying material is dominantly fragments of limestone.

This soil is on bottom lands, below foot slopes occupied by other Volney soils. In many places it is adjacent to areas of Dorchester soils or to soils of the Dorchester-Chaseburg-Volney complex.

Runoff from the soils upslope continues to deposit silty sediment on the surface of this soil. Young crops are sometimes covered by the sediment, and replanting may be necessary. This soil can be protected from overflow by placing diversion terraces in areas of the soils upslope.

The use of this soil is likely to be determined by the use of the adjoining soils, but corn or other row crops can be grown intensively. If management is good, yields of corn are above average. Fertilizer should be applied, but lime is not needed for optimum crop yields on this soil. (Capability unit I–5)

Volney silt loam, overwashed, 2 to 5 percent slopes (VoB).—A layer of dark grayish-brown or brown silt loam that contains lime covers the surface of this soil to a depth of 6 to 20 inches. Below this deposition is a dark-colored surface layer that has a texture of silt loam and is 20 to 30 inches thick. In this buried soil, fragments of limestone increase in number with increasing depth. At a depth of 30 inches or more, the material is dominantly fragments of limestone.

This soil is on foot slopes, below Fayette and Nordness soils and Steep rock land. It is adjacent to Dorchester soils, to soils of the Dorchester-Chaseburg-Volney complex, and to areas of less sloping Volney soils downslope. Included in mapped areas of this soil are a few minor areas where the slopes are greater than 5 percent.

In most places silty material, eroded from the soils upslope, has been deposited on this soil. Gullies form where water concentrates. Also, young crops that are emerging may be covered by sediment. Diversion terraces are needed in areas of this soil near the base of upland slopes.

Where tillage is on the contour and this soil is protected from overflow, corn or other row crops can be grown 4 years in 5. Yields of corn are above average if management is good. This soil contains abundant lime. Response to fertilizer is good. (Capability unit IIe–2)

Waucoma Series

In the Waucoma series are well-drained soils that formed in 30 to 50 inches of loamy material. Generally, beneath this loamy material is a thin layer of material weathered from limestone, with limestone bedrock below. In a few places, the weathered material is absent. An abrupt boundary separates the surface layer from a light-colored subsurface layer. In many places stones or pebbles are absent from the surface layer, but a few are in the subsoil. The slopes range from 0 to 14 percent.

These soils are on ridges, on side slopes, and on high structural benches in the uplands. They are downslope from Racine or Bassett soils and upslope from Winneshiek soils. Adjacent to them in places are Atkinson, Whalan, and Jacwin soils.

Representative profile:

0 to 7 inches, very dark gray, friable loam to silt loam.
7 to 18 inches, very dark gray, dark grayish-brown, and dark-brown to brown, friable loam to silt loam.
18 to 36 inches, dark-brown to brown, dark yellowish-brown, and yellowish-brown, friable loam and sandy clay loam that contain some pebbles.
36 to 39 inches, dark-brown to brown, firm clay underlain by hard limestone bedrock.

The surface layer ranges from 5 to 9 inches in thickness.

These soils have medium available moisture capacity, and the loamy material is moderately permeable. In places bedrock limits the root growth of some plants.

Runoff erodes the sloping Waucoma soils if the surface is bare or is only sparsely covered by plants. Crop residue can be left on the surface to increase the intake of water and to reduce runoff.

These soils are medium acid in most places, and lime is needed for the optimum growth of crops. The soils are low in available nitrogen, phosphorus, and potassium.

Waucoma loam, 0 to 2 percent slopes (WcA).—This soil has a surface layer of very dark gray or dark grayish-brown loam to silt loam that is 6 to 9 inches thick. In cultivated areas the surface layer is underlain by a distinct, light-colored subsurface layer. No stones or pebbles are on the surface, but some are in the subsoil. Limestone bedrock is at a depth ranging from 30 to 50 inches. It is below a depth of 40 inches in many places.

This soil is on convex ridges in the uplands and on high structural benches. It is below Racine or Bassett soils and upslope from Winneshiek and more sloping Waucoma soils. The individual areas are small. Therefore, much of this soil is often managed with the adjoining sloping soils.

Because of the nearly level relief and good intake of water, little or no runoff takes place on this soil. Corn and other row crops can be grown intensively, but crop residue should be left on the surface. If tilth becomes poor, meadow can be included in the rotation and manure can be applied.

If management is good, yields of corn grown on this soil are above average. Lime and fertilizer are needed, however, for optimum yields of crops. Response to fertilizer is good. (Capability unit I–4)

Waucoma loam, 2 to 5 percent slopes (WcB).—In areas that are not cultivated, this soil has a surface layer of very dark gray or very dark brown silt loam to loam that is 5 to 9 inches thick. In cultivated areas the surface layer is very dark grayish brown and part of the light-colored subsurface layer has been mixed into it. The subsoil contains some stones or pebbles. Limestone is at a depth of 30 to 50 inches.

This soil is on narrow convex ridges and on high structural benches below Racine, Bassett, or less sloping Waucoma soils. In places it is near Atkinson, Whalan, and Jacwin soils that are on the adjacent slopes. Included in mapped areas of this soil are patches of eroded soils that have a surface layer only 3 to 6 inches thick.

The surface layer of this Waucoma soil erodes easily when it is bare or is only sparsely covered by plants. Therefore, tillage ought to be on the contour or this soil should be terraced where row crops are grown. The terraces need to be laid out in such a way that the underlying bedrock is not exposed in the channel of the terraces. Crop residue can be left on the surface and manure can be added in these channels.

Corn or other row crops can be grown intensively if this soil is terraced. Yields of corn are above average if management is good. Lime is needed for the optimum growth of crops. Response to fertilizer is good. (Capability unit IIe–4)

Waucoma loam, 5 to 9 percent slopes (WcC).—Much of the acreage of this soil is used for purposes other than for cultivated crops. The surface layer in the areas that are not cultivated is very dark gray to very dark brown loam or silt loam, and it is 5 to 8 inches thick. In the cultivated areas, the surface layer is 3 to 6 inches thick and is very dark grayish brown. Most of the subsurface layer has been mixed into the surface layer in many of the cultivated areas. Limestone is at a depth ranging from 30 to 50 inches. It is between 30 and 40 inches in much of the acreage. The subsoil contains some stones or pebbles.

This soil is on convex side slopes, both below and above other Waucoma soils. It is upslope from Winneshiek soils, and it is adjacent to Atkinson, Whalan, or Jacwin soils in a few places.

Where the surface is bare or is only sparsely covered by plants, runoff erodes this soil. If row crops are grown, crop residue can be left on the surface or this soil should be tilled on the contour or terraced. The terraces must be laid out in such a way that the underlying bedrock is not exposed.

If this soil is terraced or stripcropped, corn or other row crops can be grown 2 years in 4. Lime is needed, however, if a stand of legumes is to be established. Yields of corn are average or above if management is good. Response to fertilizer is good. (Capability unit IIIe–2)

Waucoma loam, 9 to 14 percent slopes (WcD).—This soil has a surface layer of very dark gray or very dark grayish-brown loam or silt loam. Below the surface layer is a distinct, light-colored subsurface layer. Some stones and pebbles are on the surface, but they are more numerous in the subsoil than on the surface. Limestone is generally at a depth between 30 and 50 inches. It is at a depth between 30 and 40 inches in much of the acreage.

This soil is on convex side slopes and on high foot slopes below Racine, Bassett, or less sloping Waucoma or Atkinson soils. It is upslope from Rockton and Winneshiek soils and from areas of Steep rock land. In many places it is adjacent to slopes occupied by Marlean and Jacwin soils.

Included in mapped areas of this soil are a few places in which the surface layer is thicker and darker than typical and in which there is no light-colored subsurface layer. Also included are a few moderately eroded areas in which the surface layer is only 3 to 6 inches thick. Other inclusions consist of a few severely eroded areas indicated on the soil map by the symbol for severe erosion.

The surface layer of this Waucoma soil erodes when it is bare or is only sparsely covered by plants. Therefore, crop residue ought to be left on the surface, or this soil should be terraced or stripcropped. The terraces must be laid out in such a way that the bedrock is not exposed. If bedrock is at a depth of less than 30 inches, it may interfere with the construction of the terraces. Where this soil is terraced or stripcropped, corn or other row crops can be grown 1 year in 5. A stand of meadow is seldom left for more than 3 years.

Yields of corn are only average on this soil, even when management is good. Lime and fertilizer are needed to help establish a stand. Response to fertilizer is moderate. (Capability unit IIIe–4)

Waukegan Series

In the Waukegan series are well-drained soils that have a dark-colored surface layer. These soils formed in 24 to 45 inches of loam to silt loam over leached sand and gravel. They do not have stones or pebbles on the surface or in the subsoil. The slopes range from 0 to 5 percent.

These soils are mainly on stream benches, and they are also on convex ridges or on the side slopes of uplands in a few places. On the benches they are adjacent to Kato, Sattre, Bixby, and Camden soils. Near them on the adjacent uplands are Ostrander and Atkinson soils.

Two depth phases of Waukegan soils are mapped in this county. In the deep phase, sand and gravel are at a depth of 36 to 45 inches. In the moderately deep phase, they are at a depth of 24 to 36 inches.

Representative profile of a moderately deep Waukegan soil:

0 to 14 inches, black and very dark grayish-brown, friable loam.
14 to 25 inches, dark-brown and dark yellowish-brown, friable loam.
25 to 50 inches, yellowish-brown and dark yellowish-brown, loose fine gravel.

The surface layer ranges from 6 to 15 inches in thickness and from loam to silt loam in texture. The color of the surface layer ranges from black to very dark brown. In places this soil is moderately dark colored to a depth of 24 inches.

The surface layer is high in content of organic matter and is in good tilth. The deep Waukegan soils have medium to moderately high available moisture capacity. The moderately deep Waukegan soils have medium available moisture capacity. The intake of water is good, and these soils are moderately permeable.

The moderately deep Waukegan soils warm up quickly in spring and can be worked soon after rains. They may lose some moisture from the subsoil, however, as a result of deep percolation.

These soils are suited to row crops, but the sloping areas erode unless they are protected by a good cover of plants. These soils are slightly acid to medium acid, and lime is generally needed for the optimum growth of crops. The soils are low in available nitrogen and phosphorus and very low in available potassium.

Waukegan loam, deep, 0 to 2 percent slopes (WdA).—The surface layer of this soil ranges from loam to silt loam in texture, from 12 to 15 inches in thickness, and from black to very dark brown in color. No stones or pebbles are on the surface. The underlying sand and gravel are at a depth ranging from 36 to 45 inches, but they are at a depth between 36 and 42 inches in much of the acreage.

This soil is on stream benches, and it is on upland ridges in a few places. In places it is adjacent to nearly level Kato soils, and it is adjacent to Sattre soils in some places. Where this soil occurs in the uplands, it is near areas of Ostrander or Atkinson soils, which are on the adjoining slopes.

This soil is easily tilled, and little or no runoff takes place, because of the nearly level slopes and good intake of water. The available moisture capacity is only medium to moderately high, and as a result, the growth of crops is limited in some years.

Corn or other row crops can be grown intensively on this soil. The surface needs to be protected, however, by a cover of crop residue. Yields of corn are above average if management is good, but some lime is needed for optimum yields. Response to fertilizer is good. (Capability unit I–4)

Waukegan loam, deep, 2 to 5 percent slopes (WdB).—In most places this soil has a surface layer of very dark brown loam to silt loam that is 8 to 12 inches thick. In a few areas, however, 6 to 18 inches of light-colored sandy material has been deposited on the surface. The underlying sand and gravel are at a depth of 36 to 45 inches. They are at a depth of less than 42 inches in much of the acreage. The surface is free of stones and pebbles.

This soil is mainly on stream benches, but it is on upland ridges in places. It is adjacent to less sloping Waukegan soils, and in some places it is also adjacent to Kato and Sattre soils. In many places this soil is near areas of Ostrander and Atkinson soils, which are on the adjoining upland slopes.

Some runoff takes place and causes erosion on this soil when the surface is bare. Therefore, row crops ought to be tilled on the contour or this soil should be terraced. Terracing is somewhat difficult because of the shape or size of the areas. If terraces are constructed, however, corn or other row crops can be grown intensively. Crop residue ought to be left on the surface.

Yields of corn are generally above average if this soil is well managed. The growth of crops is limited in some years, however, by the medium to moderately high available moisture capacity. Lime and fertilizer are needed for optimum yields. Response to fertilizer is good. (Capability unit IIe–4)

Waukegan loam, moderately deep, 0 to 2 percent slopes (WgA).—This soil has a very dark brown surface layer that is 8 to 14 inches thick. It has no stones or pebbles on the surface. Depth to the underlying sand and gravel ranges from 24 to 36 inches.

This soil is mainly on stream benches, but in a few places it is on ridges in the uplands. In places it is near Sattre and Bixby soils, which are on adjacent benches. Also in some places it is near Ostrander, Sattre, or Bixby soils of the uplands.

This soil is easily tilled, but it is slightly droughty in years when the amount of rainfall is only average. It warms up quickly in spring and can be worked soon after rains. Although the intake of water is good and no runoff takes place, some water may be lost through deep percolation.

Corn and other row crops can be grown intensively on this soil. Yields of corn are generally above average if rains are timely and if management is good. The surface needs to be protected by crop residue, and the crops need lime and fertilizer. Response to fertilizer is good to moderate. (Capability unit IIs–1)

Waukegan loam, moderately deep, 2 to 5 percent slopes (WgB).—This soil has a surface layer that is generally very dark brown and is 6 to 12 inches thick. No stones or pebbles are on the surface. Sand and gravel are at a depth ranging from 24 to 36 inches. They are at a depth of less than 30 inches in much of the acreage.

This soil is on stream benches and on ridges in the uplands. In most places it is adjacent to other Waukegan soils. In a few places, it is near Sattre and Bixby soils on adjacent benches. In the uplands this soil is near Ostrander, Sattre, and Bixby soils.

This soil warms up quickly in spring and can be worked soon after rains. It is droughty, however, and is easily eroded by runoff when it is only sparsely covered by plants. Tillage can be on the contour when a row crop is grown, but this soil is generally too shallow for terraces.

If crop residue is left on the surface and if this soil is farmed on the contour, corn or other row crops can be grown 3 years in 4. Where moisture is adequate in the soil and good management is used, yields are generally above average. Lime and fertilizer are needed, however, to help in establishing a stand. Response to fertilizer is good to moderate. (Capability unit IIe–6)

Whalan Series

In the Whalan series are well-drained soils that have a distinct, light-colored subsurface layer. These soils formed in 15 to 30 inches of loamy glacial material. The glacial material is underlain by a thin layer of material weathered from limestone bedrock that, in turn, overlies bedrock. In areas that are cultivated or that are eroded, the surface layer is light colored. A few stones or pebbles are in the subsoil and are on the surface in some places. The slopes range from 2 to 24 percent.

The Whalan soils are on convex ridges, on side slopes, and on high foot slopes and structural benches. They are mainly in the western part of the county, but some areas are in the eastern part near the valleys of the major streams. These soils are downslope from Renova and Coggon soils and upslope from Jacwin and Marlean soils and Steep rock land.

Representative profile:

0 to 2 inches, black, very friable loam to silt loam.
2 to 7 inches, dark grayish-brown, very friable loam to silt loam.
7 to 28 inches, brown, dark-brown, dark yellowish-brown, and yellowish-brown, friable loam and light clay loam that contain some pebbles.
28 to 30 inches, dark-brown and brown, firm gritty clay that is underlain by hard limestone bedrock.

The surface layer ranges from 2 to 4 inches in thickness and from very dark gray to black in color. Its texture ranges from loam to gritty silt loam. The subsurface layer ranges from 4 to 8 inches in thickness.

The loamy material is moderately permeable, and the available moisture capacity is very low or low. The small amount of subsoil moisture limits the growth of crops in most years.

Runoff erodes these soils when the surface is bare or is only sparsely covered by plants. The less sloping Whalan soils are suited to row crops. The steep areas are suitable for permanent pasture, trees, and wildlife habitats.

These soils are acid, and crops grown on them need lime for optimum growth. The soils are very low in available nitrogen and low in available phosphorus and potassium.

Whalan loam, 2 to 5 percent slopes (WhB).—In areas that have never been cultivated, this soil has a black to very dark gray surface layer that is 2 to 4 inches thick. Beneath the surface layer is a distinct, light-colored subsurface layer. The plow layer in cultivated areas is dark gray or dark grayish brown when moist and is much lighter colored when dry. In most places stones or pebbles are absent from the surface layer but are in the subsoil. Depth to limestone or to material weathered from limestone ranges from 15 to 30 inches.

This soil is on convex ridges in the uplands and on structural benches below Renova and Coggon soils. In most places it is upslope from other Whalan soils.

Where the ridges are moderately wide, tracts of nearly level Whalan soils are included in mapped areas of this soil. Also included are patches of Roseville soils in which the depth to limestone is 30 to 50 inches. Roseville soils are not mapped separately in this county.

Some water runs off this Whalan soil, and it causes erosion when the surface is bare. Corn and other row crops can be grown 2 years in 4 if they are planted and tilled on the contour. Limestone is too near the surface for terraces to be practical.

Unless rains are timely throughout the growing season, crops grown on this soil make low yields. The underlying limestone limits the root growth of some plants. If corn is included in the rotation, yields are variable. They are often above average or may be only average. Response to fertilizer is moderate. Lime is needed for the optimum growth of crops. (Capability unit IIe–6)

Whalan loam, 5 to 9 percent slopes, moderately eroded (WhC2).—The surface layer of this soil is dark gray or dark grayish brown when moist and has a texture of loam to silt loam. The surface layer is much lighter colored when dry, and it is low in content of organic matter. Where this soil has been cultivated, the plow layer contains the former subsurface layer and in some places 2 to 3 inches of material from the subsoil. Some areas are severely eroded, but more than half of the acreage is in trees and is not eroded. The severely eroded areas are indicated on the soil map by the symbol for severe erosion. Stones and pebbles are in the subsoil, and a few are on the surface. In a large part of the acreage, depth to limestone bedrock or to material weathered from bedrock is less than 24 inches. Depth to bedrock ranges from 15 to 30 inches.

This soil is on convex side slopes, surrounded by areas of other Whalan soils. In many places it is downslope from Renova and Coggon soils. Included in mapped areas of this soil are a few small areas of Roseville soils in which depth to limestone or to material weathered from limestone is 30 to 40 inches.

The capacity of this soil to store moisture is low enough that it limits the growth of crops. Rains must be timely, or the growth of crops is poor during dry periods. The limestone near the surface also limits the root growth of some plants. The surface layer sometimes seals during hard rains, and it is low in content of organic matter and is in poor tilth. Crop residue ought to be left on the surface.

In much of the acreage, this soil is cultivated. It is susceptible to further erosion when the surface is bare or is only sparsely covered by plants. Row crops can be tilled on the contour or this soil should be stripcropped if row crops are grown. Where this soil is stripcropped, corn or other row crops can be grown 1 year in 4. Pastures are seldom left longer than 3 years before they are renovated. A row crop can be grown when the pastures are renovated.

In years when rainfall is average, yields of corn grown on this soil are generally about average if management is good. More drought-resistant crops are often grown in place of corn. Lime, manure, and commercial fertilizer are needed if a stand of legumes is to be established. Moderate response is received from fertilizer. (Capability unit IIIe-5)

Whalan loam, 9 to 14 percent slopes, moderately eroded (WhD2).—Trees or permanent pasture occupy about two-thirds of the acreage of this soil. In the wooded or pastured areas, this soil is not eroded. The surface layer in those areas is very dark gray loam to silt loam and is 2 to 4 inches thick. It is underlain by a light-colored subsurface layer. In wooded areas a thin layer of leaf litter is on the surface. The plow layer in cultivated areas is dark gray or dark grayish brown when moist and is much lighter colored when dry. No stones or pebbles are on the surface, but some are in the subsoil. Depth to material weathered from limestone or to the underlying limestone is 15 to 30 inches. Included in mapped areas of this soil are a few areas of Roseville soils that are underlain by limestone at a depth of about 30 to 40 inches.

This Whalan soil is on convex side slopes and on high foot slopes below other Whalan soils. It is upslope from areas of Steep rock land and from soils on stream benches.

This soil is easily eroded when the surface is bare or is only sparsely covered by plants. Grazing needs to be controlled in the pastured areas to keep from losing the cover of plants. Selective cutting and planting are necessary in the wooded areas.

If stripcropping is practiced, corn or other row crops can be grown on this soil 1 year in 6. Pastures are seldom left longer than 4 years, and a row crop can be grown when a pasture is renovated.

Yields of corn are variable on this soil, but they are often below average for the county, even when management is good. Lime, manure, and commercial fertilizer are needed to obtain a good stand of pasture. However, response to fertilizer is only moderate to poor (Capability unit IVe-3)

Whalan loam, 14 to 24 percent slopes, moderately eroded (WhE2).—This soil generally has a surface layer of dark-gray or dark grayish-brown loam to silt loam that is 3 to 6 inches thick. In most places the surface layer is light colored both when moist and when dry. In places, near the base of slopes, however, the surface layer is thicker and darker. In still other places, the surface layer is only 1 to 3 inches thick and is very dark gray. In those places it is underlain by a light-colored subsurface layer. Some stones and pebbles are in the subsoil, but they are generally absent from the surface layer. Depth to the underlying limestone ranges from 15 to 30 inches.

This soil is on side slopes and on high foot slopes below Renova, Coggon, and other Whalan soils. In places it is upslope from areas of Steep rock land on stream benches. Included in the mapped areas of this soil are a few small areas of Roseville soils in which depth to material weathered from limestone and depth to limestone bedrock is 30 to 40 inches.

Much of the acreage of this Whalan soil is in permanent pasture, but some areas are in trees. A good cover of plants needs to be kept on the surface so that runoff will not cause erosion. Grazing ought to be controlled in the pastures. Cutting should be done selectively in the wooded areas, and trees ought to be replanted. Small areas of this soil are excellent for wildlife habitats.

Farm equipment can be used on this soil. Therefore, pastures can be renovated when the stand becomes poor. Lime, manure, and commercial fertilizer are needed to help establish a stand of pasture. (Capability unit VIe-2)

Whalan loam, 14 to 18 percent slopes, severely eroded (WhE3).—The present surface layer of this soil consists of brown loam to silt loam that was formerly part of the subsoil. The surface layer has a somewhat lighter color when dry than when moist. It is very low in content of organic matter and is in poor tilth. A few stones and pebbles are on the surface and in the subsoil. In most places depth to the underlying limestone is between 15 and 24 inches.

This soil is on side slopes and on escarpments, below Winneshiek, Waucoma, or other Whalan soils. In places it is upslope from Nordness soils or Steep rock land. Included in mapped areas of this soil are small areas in which depth to material weathered from limestone and depth to limestone bedrock is between 30 and 40 inches.

Runoff quickly erodes this soil when the surface is only sparsely protected by plants. Crop residue can be added to the surface layer to increase the intake of water.

This soil is more suitable for trees or for wildlife habitats than for permanent pasture, but it can be used for permanent pasture. Grazing must be controlled in the pastured areas. (Capability unit VIIe-1)

Winneshiek Series

In the Winneshiek series are well-drained soils of the uplands. These soils formed in 15 to 30 inches of loamy glacial material over a thin layer of material weathered from limestone. They contain a distinct, light-colored subsurface layer. Some pebbles are in the subsoil, and pebbles are on the surface in places. The slopes range from 0 to 18 percent.

These soils are on rather high structural benches and on convex ridges and side slopes. They are mainly in the western part of the county, but some areas are adjacent to major streams in the eastern part of the county. The Winneshiek soils are below Waucoma, Racine, and Bassett soils, and they are adjacent to Whalan, Atkinson, Marlean, and Rockton soils in many places. In places they are upslope from areas of Steep rock land.

Representative profile:

0 to 7 inches, very dark gray, friable loam.
7 to 11 inches, brown to dark-brown, friable loam.
11 to 21 inches, dark-brown and dark yellowish-brown, friable or friable to firm loam and clay loam that contain some pebbles.
21 to 24 inches, dark-brown, firm clay that is underlain by fragmented, rather soft limestone.

The surface layer ranges from very dark brown to very dark gray in color and from 4 to 9 inches in thickness. The subsurface layer ranges from 3 to 6 inches in thickness.

These soils have very low or low available moisture capacity: Permeability is moderate above the material weathered from bedrock. The intake of water is generally good until the soil is saturated to a depth of 15 to 30 inches.

These soils are susceptible to erosion when the surface is bare or is only sparsely covered by plants. The less sloping Winneshiek soils are suited to row crops. The steep areas are suited to permanent pasture, trees, and wildlife habitats.

For some plants, the limestone near the surface limits the growth of roots. Unless rains are timely during summer, crops lack adequate moisture for good growth.

These soils vary in reaction, but legumes that are grown on them generally need lime. The soils are low in available nitrogen, phosphorus, and potassium.

Winneshiek loam, 0 to 2 percent slopes (WkA).—The surface layer of this soil is very dark gray when moist, but it is somewhat lighter colored when dry. The surface layer is 6 to 9 inches thick and is underlain by a distinct, light-colored subsurface layer. Stones and pebbles are in the subsoil, but the surface is free of them in some places. Depth to limestone ranges from 20 to 30 inches.

This soil is on convex ridges and on high, nearly level structural benches. It is upslope from steeper Winneshiek soils, and it is adjacent to Rockton, Marlean, and Whalan soils in places. The individual areas are small. Therefore, much of the acreage is managed with the adjoining soils.

Little or no runoff takes places on this soil. Because of the limestone near the surface, not enough moisture is stored for some crops. Suitable crops for planting are those that tolerate slight drought.

Corn and other row crops can be grown intensively on this soil, but yields are not high unless rains are timely. Lime and fertilizer are required for the optimum growth of crops. Response to fertilizer is moderate to good. (Capability unit IIs–1)

Winneshiek loam, 2 to 5 percent slopes (WkB).—This soil has a surface layer that is 4 to 8 inches thick. The surface layer is very dark gray or very dark brown when moist, but it is somewhat lighter colored when dry. It is underlain by a distinct, light-colored subsurface layer. Stones and pebbles are in the subsoil and in a few places on the surface. In most places depth to limestone is between 15 and 30 inches. Limestone is at a depth of 36 inches in some places.

This soil is on convex ridges and on structural benches, both above and below areas of other Winneshiek soils. In many places it is downslope from Waucoma, Bassett, or Racine soils.

This soil is somewhat droughty in years when the amount of rainfall is only average. The root zone is limited by the limestone near the surface. Some crops will not grow well because not enough moisture can be stored.

Runoff erodes this soil when the surface is bare or is only sparsely covered by plants. Tillage ought to be on the contour when row crops are grown, but this soil is too shallow for terraces. Corn or other row crops can be grown 2 years in 4 if they are planted and tilled on the contour. Where corn is grown, the yields are generally above average if rains are timely and if management is good. Lime, manure, and commercial fertilizer are needed, however, to help to establish the stand. Response to fertilizer is moderate. (Capability unit IIe–6)

Winneshiek loam, 5 to 9 percent slopes (WkC).—Much of the acreage of this soil is wooded or in pasture. The surface layer in the wooded or pastured areas is very dark gray and is 4 to 8 inches thick. It is underlain by a light-colored subsurface layer. The surface is free of stones and pebbles in some places, but a few stones or pebbles are in the subsoil. In wooded areas a thin layer of leaf litter covers the surface in some places. Limestone is generally at a depth between 15 and 30 inches, but it is mainly below a depth of 20 inches. The depth is as much as 36 inches in some places.

This soil is on convex side slopes in the uplands, and it is also on structural benches. It is downslope from Waucoma, Bassett, and other Winneshiek soils and is commonly adjacent to Rockton, Marlean, and Whalan soils.

The intake of water is good in most places, but this soil is easily eroded when the surface is bare. If row crops are grown, this soil ought to be tilled on the contour or stripcropped. It is too shallow over limestone to be suitable for terraces.

Lack of moisture limits the growth of crops on this soil in years when rainfall is only average. Corn or other row crops can be grown 1 year in 4, however, if this soil is stripcropped. Yields of corn are variable but are usually about average for the county. Meadows are generally renovated after about 3 years.

Areas where the timber is good should not be cleared but ought to be managed as woodland. The pastures respond to applications of lime, manure, and commercial fertilizer. (Capability unit IIIe–5)

Winneshiek loam, 5 to 9 percent slopes, moderately eroded (WkC2).—The surface layer of this soil is 3 to 6 inches thick. It is very dark grayish brown when moist but is somewhat lighter colored when dry. Stones or pebbles are in the subsoil and in a few places on the surface. In much of the acreage, the underlying limestone is at a depth of less than 24 inches, but the depth ranges from 15 to 30 inches. In some spots this soil is severely eroded. Those spots are indicated on the soil map by the symbol for severe erosion.

This soil is on structural benches or on convex side slopes in the uplands. It is below Bassett and Waucoma soils and both above and below areas of other Winneshiek soils.

In much of the acreage, this soil is cultivated or was formerly cultivated. In most places it takes in water well, but the moisture-storing capacity is limited. As a result, this soil is quickly saturated, and then runoff occurs. Crop residue can be left on the surface, and this soil can be tilled on the contour or stripcropped if corn or other row crops are grown. Limestone is too near the surface for this soil to be suitable for terraces.

Where stripcropping is practiced, corn or other row crops can be grown 1 year in 4. Meadows or pastures are seldom left for more than 3 years, and a row crop is grown when they are renovated. The yield of corn is variable. It is usually about average, however, if rainfall is timely and if management is good. Lime, manure, and commercial fertilizer are needed to help establish a stand of legumes. (Capability unit IIIe–5)

Winneshiek loam, 9 to 14 percent slopes (WkD).—This soil has a very dark gray surface layer that is 4 to 6 inches thick. Beneath the surface layer is a light-colored subsurface layer that is about 3 to 6 inches thick. Stones and pebbles are on the surface in places and are in the subsoil. In a few wooded areas, a thin layer of leaf litter is on the surface. Limestone is at a depth between 15 and 30 inches, but it is below a depth of 24 inches in much of the acreage.

This soil is on convex side slopes and on high foot slopes, below Waucoma and other Winneshiek soils. In places it is adjacent to Whalan and Marlean soils and upslope from Sattre soils and areas of Steep rock land. Included in mapped areas of this soil are patches in which the surface layer is dark grayish brown and is only 3 to 6 inches thick.

If this Winneshiek soil is cultivated, it is subject to erosion unless it is protected. This soil is too shallow over limestone to be suitable for terraces.

Corn or other row crops can be grown 1 year in 6 or when a pasture is renovated. Pastures are seldom left more than 4 years before they are renovated. If corn is grown, the yields are average or below average, depending on the amount of rainfall and the kind of management. Good stands of timber ought to be managed as woodland. Because of the small size of the areas and the characteristics of the adjacent soils, some of the areas are better used as permanent pasture, woodland, or wildlife habitats than for field crops. Lime, manure, and commercial fertilizer are needed to help establish a stand of pasture or field crops. (Capability unit IVe-3)

Winneshiek loam, 14 to 18 percent slopes (WkE).—Much of the acreage of this soil is in permanent pasture or trees. In the pastured or wooded areas, the surface layer is generally 4 to 6 inches thick and is very dark gray. Below the surface layer is a distinct, light-colored subsurface layer. Some stones or pebbles are on the surface and in the subsoil in places. In some wooded areas, a thin layer of leaf litter covers the surface. Limestone is generally at a depth between 15 and 30 inches, but the depth is less than 24 inches in much of the acreage. In a few areas, limestone is at a depth of 30 to 50 inches.

This Winneshiek soil is on convex side slopes, below Racine, Bassett, Waucoma, Rockton, and other Winneshiek soils. It is also on high foot slopes, above areas of Sattre soils. Included in mapped areas of this soil are a few areas in which the surface layer is darker and thicker than typical.

Grazing must be controlled in the pastured areas to protect the cover of plants. Crop residue should be left on the surface, for this soil quickly erodes when the surface is bare. Oats are ordinarily used as a nurse crop when a pasture is renovated.

Good stands of timber that grow on this soil ought to be managed as woodland. Small tracts, within areas more suitable for crops, can be used as wildlife habitats. Lime, commercial fertilizer, and manure are needed when a pasture is renovated. (Capability unit VIe-2)

Use and Management of Soils

This section briefly describes the use and management of the soils in the county for crops and pasture; describes the system of capability classification used by the Soil Conservation Service; discusses the use and management of groups of soils, or capability units; and gives a table showing management and yield data for all of the soils in the county. In addition, it discusses woodland and names trees suitable for planting on each of the soils in the county, briefly discusses wildlife, and gives facts about the soils that affect suitability for engineering practices.

The information given in this section is not a substitute for the detailed advice that can be provided by a local representative of the Soil Conservation Service or by the county extension director. It may, however, help the farmer or others plan suitable management for the soils.

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Use and Management of the Soils for Crops and Pasture

Farming in Winneshiek County consists mainly of producing corn, small grains, hay, and pasture. These products are marketed mainly through the sale of hogs, cattle, and dairy products. Fertilizer and lime are needed for optimum yields on many of the soils, however, and water control is needed in many places. Also, the permanent pastures require regular renovation. Some facts about fertilizer and lime, water control, and permanent pastures are given in the following paragraphs. More specific information is given in the descriptions of the capability units.

Fertilizer and lime.—The soils of this county furnish different amounts and kinds of nutrients to plants. Fertilizer and lime are applied to balance and supplement the natural supply of nutrients. Applying fertilizer and lime according to the needs indicated by the results of soil tests is a necessary part of good management.

Examples of soils that contain a fairly large amount of available phosphorus in their subsoil are the Fayette. Those soils contain more available phosphorus than the Kenyon and Bassett soils. Therefore, they need less phosphate than do those soils. The Tama, Kenyon, and other dark-colored soils that formed under prairie have a somewhat larger supply of available nitrogen in their plow layer than do the Fayette and Coggon soils that formed under forest. Potassium is needed on most of the soils. Below the plow layer, the supply of available potassium generally decreases rapidly with increasing depth. The Dorchester and Caneek soils contain an excess of lime, but lime is needed on many of the other soils of the county.

Water control.—Water control consists of slowing and channeling runoff to protect the soils from erosion. It also entails protecting the soils from flooding and of removing the excess water so that plants will have a favorable environment for optimum growth. Methods of protection include the use of terraces, stripcropping (fig. 8), contouring, and close-growing crops.

Many of the soils of bottom lands and colluvial fans, and some soils of stream terraces, need protection from flooding. Methods of protection include the use of levees or dikes, diversion terraces, open ditches, and water retention dams. They also include treatment of the uplands in the watershed to reduce and slow down runoff. More than one of these practices may be necessary.

Many soils that are not well drained can be cultivated without artificial drainage, but yields are generally below optimum. Some kind of drainage system is necessary to remove the excess water in the Clyde, Floyd, and other soils that are not well drained. The excess water can be removed by installing tile drains, open ditches, grassed waterways, spillways, or diversion terraces. More than one of these practices may be required.

Permanent pastures.—For the soils used for permanent pastures, regular renovation, if feasible, is needed when

***Figure 8.*—An aerial view of a field where stripcropping has been used to protect the soils from erosion.**

production declines. Renovation consists of applying lime and fertilizer according to the results of soil tests, controlling erosion, preparing a good seedbed, using a combination of adapted legumes and grasses for seeding, controlling weeds, and controlling grazing.

The soils in capability classes I, II, III, and IV are generally not used for permanent pastures but are used for field crops. When those soils are used for permanent pastures, and when the pastures are renovated and well managed, good yields are generally obtained.

If renovation is practical, the soils in capability classes V, VI, and VII can be used for permanent pastures. Where complete renovation is not feasible, those practices that are feasible can be used, or the area should be kept in trees or used for wildlife.

Capability Groups of Soils

Capability classification is the grouping of soils to show, in a general way, their suitability for most kinds of farming. It is a practical classification based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The soils are classified according to degree and kind of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible but unlikely major reclamation projects.

In the capability system all kinds of soils are grouped at three levels, the capability class, subclass, and unit. These are discussed in the following paragraphs.

Capability Classes, the broadest grouping, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I. Soils that have few limitations that restrict their use.

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

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

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V. Soils subject to little or no erosion but that have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover. (None in Winneshiek County)

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and that limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial plant production and that restrict their use to recreation, wildlife, water supply, or esthetic purposes. (None in Winneshiek County)

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with the growth of plants or with cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited, mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

Capability Units are soil groups within the subclass. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraphs. The Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages, the capability units of Winneshiek County are described and suggestions for the use and management of the soils are given. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all the soils of a given series appear in the unit. To find the names of all of the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I-1

In this capability unit are level or nearly level, dark-colored or light-colored, well-drained soils of the Bertrand, Downs, Fayette, Festina, Ostrander, and Racine series. These soils are on uplands and stream benches. They have a friable, medium-textured surface layer and a friable, medium-textured or moderately fine textured subsoil.

These soils are moderately permeable and have high water-holding capacity. They are well aerated, warm up quickly in spring, and can be worked soon after rains. The content of organic matter ranges from low to high in the surface layer, but all of these soils are in good tilth. Areas of these soils that have not been limed are acid. Except for the Ostrander soils, which are medium in available nitrogen, all of the soils are low or very low in available nitrogen. These soils are also low in available phosphorus, and they range from low to medium in available potassium.

The soils of this unit are suited to cultivated crops. They are not susceptible to erosion, and drought or poor drainage is not a hazard. Water does not pond on the surface, although the soils are nearly level.

These soils are used for corn, soybeans, oats, hay, and pasture, and trees grow well on them. Most of the acreage is used for cultivated crops, however, and corn is the major crop. These are among the most productive soils in the county, and corn and other row crops can be grown intensively if management is good. Soybeans are often substituted for corn in the rotation.

Lime is needed for optimum yields, and corn that is not preceded by a legume responds well to applications of nitrogen and phosphate fertilizer. Applications of potash are also desirable.

CAPABILITY UNIT I-2

In this capability unit are level or nearly level, dark-colored or light-colored, well-drained or somewhat poorly drained soils of the flood plains. These soils are in the Arenzville, Chaseburg, Dorchester, Huntsville, Kennebec, Lawson, Spillville, Terrill, and Turlin series. They have a friable, medium-textured surface layer and subsoil.

These soils are moderately permeable and have high or very high water-holding capacity. They are occasionally wet because of infrequent flooding or a moderately high, but variable, water table. All of these soils, except the Lawson and Turlin, are well aerated, and the Lawson and Turlin soils are moderately well aerated. The soils of this unit dry out somewhat more slowly in spring and after heavy rains than the soils of capability unit I-1.

The content of organic matter is high or very high, except in the Chaseburg, Dorchester, and Arenzville soils. In those soils the content of organic matter is very low. The soils of this unit are medium to very low in available nitrogen, low in available phosphorus, and only medium in available potassium. The Dorchester soils contain abundant lime, but the other soils are slightly acid to medium acid.

These are among the most productive soils in the county. All of them are suitable for cultivated crops, and they are also suitable for pasture and trees. They are not droughty and are not subject to erosion, but the Lawson and Turlin soils need some artificial drainage so that field operations can be more timely. The other soils need protection from occasional flooding.

The soils of this unit are used for corn, soybeans, oats, hay, and pasture, but corn is the crop grown most extensively. The small areas adjacent to areas less suitable for cultivation are used for permanent pasture.

Row crops can be grown intensively on these soils if good management is used. A suitable rotation if good management is used consists of 3 successive years of row crops followed by a crop of oats and a crop grown as green manure. Soybeans are sometimes substituted for corn in this rotation.

For optimum yields, lime is needed on all of these soils, except the Dorchester. Corn that is not preceded by a legume responds well to application of a fertilizer that contains nitrogen and phosphate. Where a high rate of fertilization is used, potash is also suggested.

CAPABILITY UNIT I-3

This capability unit is made up of nearly level and gently sloping, dark colored or moderately dark colored, somewhat poorly drained or moderately well drained soils of the Atterberry, Bassett, Canoe, Hayfield, and Rowley series. These soils are on uplands and stream benches. They have a friable, medium-textured surface layer, and all of them, except the Bassett, have a friable, medium-textured or moderately fine textured subsoil. The Bassett soil has a friable to firm subsoil.

Permeability is moderate in all of these soils, except the Bassett, and it is moderately slow in that soil. All of the soils, except the Hayfield, have high or very high water-holding capacity, but the water-holding capacity of the Hayfield soil is medium to high. The soils are moderately well aerated, but they are wet in some seasons because of the moderately high, but variable, water table. During wet seasons, farm operations are delayed, to some extent, by the excess moisture.

The content of organic matter is medium to high, and most areas of these soils are in good tilth. The reaction ranges from medium acid to strongly acid. All but the Atterberry soil, which is medium in available potassium, are low in available nitrogen, phosphorus, and potassium.

The soils of this unit are suitable for cultivated crops, and droughtiness is a minor hazard only in the Hayfield soil. Erosion is not a hazard in most areas, although water runs off the gently sloping areas. Water sometimes collects on the surface of the nearly level places for a short period of time. Because the soils are slightly wet, some artificial drainage will improve them so that field operations can be more timely.

These are among the most productive soils in the county if they are well managed. They not only are suited to field crops and pasture, but trees also grow well on them. Most of the acreage is in cultivated crops, and corn is the major crop. Soybeans are also grown, however, and part of the acreage is used for oats, hay, and pasture.

Row crops can be grown intensively on these soils. Because some areas are small, however, they are managed with the adjoining soils. A satisfactory rotation is one in which row crops are grown for 3 years and are followed by a crop of oats and a crop grown as green manure.

Lime is needed on all of these soils for optimum yields. Corn that is not preceded by a legume responds well to applications of nitrogen, phosphate, and potash. Oats and legumes respond well to applications of phosphate and potash fertilizer.

CAPABILITY UNIT I-4

In this capability unit are level or nearly level, dark-colored or light-colored, well-drained soils of the Camden, Sattre, Waucoma, and Waukegan series. These soils are on uplands and stream benches, and they are deep over limestone bedrock or coarse-textured material. They have a friable, medium-textured surface layer and a friable, medium-textured or moderately fine textured subsoil. All of these soils, except the Waucoma, are underlain by coarse-textured material at a depth of about 36 to 45 inches. The Waucoma soil is underlain by bedrock at a depth of 30 to 50 inches.

The surface layer and the subsoil of these soils are moderately permeable, but permeability is rapid in the underlying sand and gravel and in the fractured bedrock. The water-holding capacity is medium to high. All of these soils are well aerated.

The content of organic matter is medium to low in the surface layer of all of the soils except the Waukegan, but it is high in many areas of that soil. These soils are generally in good tilth. All of them are acid. Except for the Sattre and Waukegan soils, all of them are low in available nitrogen, phosphorus, and potassium. The Sattre soil is medium in available potassium, and the Waukegan soil is very low in available potassium.

These soils are suited to cultivated crops, but the bedrock or coarse-textured material in the substratum limits the root development of some crops. Water that falls on the surface is quickly absorbed, and the soils are slightly droughty in years when rainfall is below average. These soils are easily tilled and can be worked soon after rains. In many places they are managed with the soils of capability unit IIe-4.

The soils of this unit are productive. The large areas are generally used for row crops, but some of the small areas are in trees or pasture. Corn is the major crop, but soybeans, oats, and hay are also grown. Grain sorghum can be substituted for corn if the subsoil contains only a small amount of moisture and if the preceding crop was a legume. Corn and other row crops can be grown intensively if good management is used. A suitable cropping system is one in which row crops are grown successively for 3 years and are followed by a crop of oats and a crop grown as green manure.

Lime and fertilizer are needed on these soils for optimum yields, but the Waukegan soil requires less nitrogen than the other soils. Corn that is not preceded by a legume responds well to nitrogen, phosphate, and potash.

CAPABILITY UNIT I-5

In this capability unit are level or nearly level, somewhat poorly drained or moderately well drained soils of the Lawson, Rowley, and Volney series. These soils are on flood plains, and they have an overwash of friable, light-colored, medium-textured sediments on their surface. The soil material beneath the overwash is dark colored, and it is also friable and medium textured. The subsoil of the Volney soil contains fragments of limestone that increase in number with increasing depth.

The water-holding capacity of these soils varies, but it is generally medium to high. Permeability is moderate. These soils are normally not wet, but they are flooded occasionally or receive runoff from the soils upslope. In some places the overwash makes the soils more suitable for row crops, but it is low in content of organic matter. The overwash is generally neutral, but it contains lime in some places. All of the soils of this group are very low in available nitrogen and low in available phosphorus and potassium. The former surface layer that has been buried by sediments is medium to low in available nitrogen.

These soils are suitable for row crops if they are protected from flooding. Artificial drainage is needed in some of the nearly level areas, but the intake of water is generally good. Many areas of these soils are managed with the soils of capability unit I-2.

These soils are used for corn, soybeans, oats, hay, and pasture, and they are also suitable for trees. Most of the areas are cultivated. The soils are productive, but yields are more variable than on soils in units I-1, I-2, and I-3. If management is good, row crops can be grown intensively. A suitable rotation is 3 consecutive years of row crops followed by a crop of oats and a green-manure crop. Soybeans are often substituted for corn in the rotation.

Lime is generally not needed on the soils of this group, but the soils respond well to applications of fertilizer. For optimum yields, corn that is not preceded by a legume should be fertilized with nitrogen, phosphate, and potash.

CAPABILITY UNIT IIe-1

This capability unit consists of gently sloping, dark-colored or light-colored soils of the uplands. These soils are well drained or moderately well drained. They are in the Bassett, Bertrand, Coggon, Downs, Fayette, Festina, Kenyon, Orwood, Ostrander, Racine, Renova, and Tama series. The surface layer is friable and medium textured. The subsoil is friable to firm and is medium textured or moderately fine textured.

All of these soils have high water-holding capacity. All except the Bassett, Coggon, and Kenyon soils are moderately permeable, but permeability is moderately slow in the subsoil of the Bassett, Coggon, and Kenyon soils. The soils take in water well. They absorb much of the water from rainfall, although some water runs off. The surface layer of the Bertrand, Fayette, Coggon, and Renova soils tends to seal during hard rains, and a crust is likely to form as the surface layer dries.

The soils of this unit vary greatly in content of organic matter, but most of them have a medium amount of organic matter in the surface layer. Unless they have been limed, they are acid. Except for the Ostrander and Tama soils, which are low to medium in available nitrogen, these soils are low or very low in available nitrogen. The Downs and Fayette soils are low to medium in available potassium and medium to high in available phosphorus. All of the other soils, except the Tama, are low in these elements. The Tama soil is low to medium in available phosphorus and medium in available potassium.

These soils are suitable for row crops, but they are subject to some sheet erosion because of their gentle slopes. Droughtiness and wetness are not hazards. The soils are subject to water erosion when the surface is bare or when the cover of plants is sparse.

If these soils are terraced, row crops can be grown intensively. Where they are not terraced but are tilled on the contour, a rotation that will help to control erosion consists of row crops grown for 3 consecutive years and followed by a crop of oats and a crop of meadow. If practices are not used to control erosion, growing row crops only 2 years in 4 protects the soils.

If good management is used, these are among the most productive soils in the county. They are suited to corn, soybeans, oats, hay, and pasture, and trees also grow well on them. Nearly all of the acreage is cultivated, and corn is the main crop.

Lime is needed on all of the soils for optimum yields, and corn that is not preceded by a legume responds well to nitrogen. Corn, soybeans, and legumes respond well to applications of phosphate and potash. Many areas of the Fayette and Downs soils, however, may not need phosphate, except where a high level of fertilization is used.

CAPABILITY UNIT IIe–2

Gently sloping, dark-colored or light-colored, well-drained or somewhat poorly drained soils make up this capability unit. These soils are at the base of slopes or in drainageways in the uplands. They are in the Chaseburg, Dorchester, Huntsville, Lawson, Terril, Turlin, and Volney series. The surface layer and subsoil of these soils are friable and medium textured, but the subsoil of the Volney soils contains fragments of limestone that increase in number with increasing depth.

The soils of this unit are moderately permeable. All of them, except the Volney, have high or very high water-holding capacity, but the Volney soils have medium water-holding capacity. The Lawson and Turlin soils are only moderately well aerated, but the rest of the soils are well aerated. The soils receive runoff from the soils upslope. The Lawson and Turlin soils dry somewhat more slowly in spring and after heavy rains than do the other soils.

In general, these soils are in good tilth, even though the content of organic matter in their surface layer ranges from very low to high. The Chaseburg and Volney soils are medium acid, but the rest of the soils are slightly acid or neutral. The Terril, Lawson, and Turlin soils are medium in available nitrogen, but the other soils are low or very low in that element. All of the soils, except the Volney, are low in available phosphorus, and the Volney soils are very low. The soils are medium in available potassium.

These soils are suited to cultivated crops, but they are subject to occasional overflow and to some sheet erosion. Because the soils are at the base of slopes, they receive about as much soil material through runoff from the slopes above as they lose through erosion. Artificial drainage is needed in some areas of the Lawson and Turlin soils, which are slightly wet. Many areas of these soils are managed with the soils of capability units I–2 and I–5.

If these soils are well managed, they are productive. They are used for corn, soybeans, hay, and pasture, and trees grow well on them. Most of the acreage is used for cultivated crops, but a smaller proportion of the Volney acreage is cultivated than of other soils in the unit. Corn is the main crop, but soybeans can be substituted for corn in the rotation.

These soils can be used intensively for row crops if they are tilled on the contour and diversion terraces are placed upslope. A suitable cropping system is one in which row crops are grown successively for 3 years and are followed by a crop of oats and a crop grown as green manure. Tile drainage is needed in some areas of the Lawson and Turlin soils so that field operations can be more timely.

Lime is not needed, except on the Chaseburg and Terril soils. For optimum yields, corn that is not preceded by a legume should receive nitrogen and phosphate. Less nitrogen fertilizer is needed on the Terril, Lawson, Huntsville, and Turlin soils, however, than on the other soils. The Volney soils need more phosphate than do the other soils. Potash is likely to be needed where the level of fertilization is high.

CAPABILITY UNIT IIe–3

Gently sloping, dark colored or moderately dark colored soils that are somewhat poorly drained or moderately well drained are in this capability unit. These soils are in the Franklin, Oran, and Riceville series. They have a medium-textured surface layer and a medium-textured to moderately fine textured subsoil that is firm or friable to firm. Permeability is moderately slow in the subsoil, and the movement of water and air is somewhat restricted in these soils.

These soils have high or very high water-holding capacity. The water table varies in height. Normally, it is moderately high, which somewhat limits the intake of water. These soils absorb most of the water from rainfall, however, if the amount is moderate. Because of the gentle slopes, some runoff takes place.

The soils of this unit have a moderately high content of organic matter and are medium acid to strongly acid. Except for the Franklin soil, which is medium in available potassium, the soils are low in available nitrogen, phosphorus, and potassium.

These soils are suited to cultivated crops, but they are slightly wet and are slightly susceptible to sheet erosion. Wetness is more of a problem in spring than during the growing season. Therefore, artificial drainage can be used to make field operations more timely.

Cultivated crops are grown on the soils of this unit. Corn and soybeans are the major crops, but corn is grown more extensively than soybeans. The soils not only are suited to corn and soybeans, but they are also suited to oats, hay, and pasture. They are productive under good management.

If these soils are terraced, and if tile drains are installed in some places, row crops can be grown intensively. Row crops can be grown 3 years in 5 if these soils are tilled on the contour. Where practices are not used to control erosion, row crops should be grown only 2 years in 5.

Lime is needed on all of these soils for optimum yields; legumes are difficult to establish unless these soils receive lime and fertilizer. Corn that is not preceded by a legume needs nitrogen, and corn, soybeans, oats, and legumes need phosphate and potash. Less potash is required on the Franklin soil, however, than on the other soils.

CAPABILITY UNIT IIe-4

In this capability unit are gently sloping, dark-colored or light-colored soils that are well drained. These soils are on uplands and stream benches and are deep over bedrock or coarse-textured material. They are in the Atkinson, Calmar, Camden, Sattre, Waucoma, and Waukegan series. Except for the Calmar soil, which has a moderately fine textured surface layer, all of the soils have a friable, medium-textured surface layer and a friable, medium-textured to moderately fine textured subsoil. The Camden, Sattre, and Waukegan soils are underlain by coarse-textured material at a depth of about 36 to 45 inches. The other soils of the unit, except the Calmar, are underlain either by limestone or by material weathered from limestone at a depth of 30 to 50 inches. In the Calmar soil, limestone mixed with some soil material is at a depth between 24 and 40 inches.

Permeability is moderate in the surface layer and subsoil of these soils, but it is rapid in the underlying fractured limestone and in the sand and gravel. The Calmar soil has low to medium water-holding capacity, but the water-holding capacity is generally medium in the other soils.

The intake of water is generally good in these soils, and the movement of air and water is good in the profile. The surface layer of most of these soils tends to seal during hard rains, however, and a crust forms as the soils dry. The surface layer of the Calmar soil is likely to puddle if it is worked when wet. Because of the gentle slopes, some runoff takes place on these soils.

Except for the Atkinson, Calmar, and Waukegan soils, which have a high content of organic matter, all of the soils of this unit are low to very low in content of organic matter. The Calmar is low to medium in available nitrogen, but the other soils are low or very low in available nitrogen. All of the soils are low in available phosphorus. The Sattre soils are medium and the other soils are low or very low in available potassium. These soils are acid. Lime is needed for optimum yields.

The soils of this unit are suitable for cultivated crops but are subject to erosion. Also, the underlying limestone bedrock or sand and gravel limit, to some extent, the root development of some crops. The soils are slightly droughty in years when rainfall is below average. Some areas of these soils are in poor tilth. The surface layer of all but the Calmar soil, however, is generally easy to work. A seedbed may be difficult to prepare in the Calmar soil in years when rainfall is above average. A few areas of these soils are managed with the soils of capability units I-4 and IIIe-2.

These soils are used for corn, soybeans, oats, hay, and pasture, and they are also suited to trees. Nearly all of the acreage is in cultivated crops. Where the subsoil moisture is low and the preceding crop was a legume, grain sorghum can be substituted for corn in the cropping system.

Row crops can be grown intensively if these soils are terraced. When the terraces are constructed, cuts and fills should be held to a minimum so that bedrock or coarse-textured material will not be exposed in the channel of the terrace. If the Camden, Sattre, and Waukegan soils are tilled on the contour, a suitable rotation is 3 successive years of row crops followed by a crop of oats and a green-manure crop. On the other soils, tillage should be on the contour and a meadow crop ought to be grown 1 year in 5. Where practices that control erosion are not used, row crops can be grown on the Camden, Sattre, and Waukegan soils 2 years in 4. One additional year of meadow is desirable on the other soils.

Response is good to applications of lime and fertilizer on these soils. Corn that is not preceded by a legume needs nitrogen, and all the crops respond to applications of phosphate.

CAPABILITY UNIT IIe-5

In this capability unit are gently sloping, dark colored or moderately dark colored soils that are moderately well drained or somewhat poorly drained. These soils are in the Donnan and Jacwin series. They are on uplands and benches and are moderately deep or deep over shale or fine-textured material. The surface layer of these soils is fine textured and friable. The subsoil is also fine textured and is firm or very firm.

These soils have high water-holding capacity. Because of their high content of clay, however, not all of this moisture is available for plants. The subsoil is slowly or very slowly permeable. The movement of water and air is somewhat restricted in the subsoil. Where these soils are in good tilth, the intake of water is generally good, but the surface layer puddles easily if the soils are worked when wet. Some runoff takes place.

These soils are low in available phosphorus and potassium. The Donnan soil is low to medium and the Jacwin soil is medium in available phosphorus. The Donnan soil is medium acid to strongly acid, and the Jacwin soil is slightly acid or neutral in reaction.

The soils of this unit are slightly wet and are slightly susceptible to erosion. If they are protected from erosion and the excess water is removed, they are suited to row crops. Artificial drainage is needed in the Jacwin soil so that field operations can be more timely. Tile drains do not function properly in some places, however, because of the slowly permeable clayey material in the subsoil and substratum. In spring the soils contain a perched water table, but the water table is lower during the growing season.

These soils are moderately productive if they are well managed. They are suited to corn, soybeans, oats, hay, and pasture, and adapted species of trees also grow well. Most of the acreage is used for cultivated crops.

If these soils are tilled on the contour and tile drained where feasible, row crops can be grown for 3 consecutive years. They should be followed by a crop of oats and a crop of meadow. Where erosion control practices are not used but where wetness is controlled, the soils can be used for row crops 2 years in 5. If the soils are in poor tilth, meadow should make up a larger part of the rotation. These soils are generally not suitable for terraces, because of their clayey subsoil.

These soils are low in available phosphorus and potassium. The Donnan soil is low to medium and the Jacwin soil is medium in available phosphorus. The Donnan soil is medium acid to strongly acid, and the Jacwin soil is slightly acid or neutral.

For optimum yields, corn that is not preceded by a legume needs nitrogen. Corn, soybeans, oats, and meadow crops grown on these soils respond to applications of phosphate and potash. Lime is generally not needed on the Jacwin soil, but crops grown on the Donnan soil respond to applications of lime.

CAPABILITY UNIT IIe-6

In this capability unit are gently sloping, dark-colored or light-colored, well-drained soils of the Bixby, Rockton, Sattre, Waukegan, Whalan, and Winneshiek series. It also includes the till subsoil variant of the Lamont series. These soils are on uplands and stream benches. The Lamont variant is moderately coarse textured and is underlain by glacial material. The other soils are medium textured and are moderately deep over bedrock or coarse-textured material.

All of these soils, except the Lamont variant, have a friable, medium-textured surface layer and a friable, medium-textured or moderately fine textured subsoil. The Lamont variant has a very friable, moderately coarse textured surface layer and subsoil, and it is underlain by loamy glacial material at a depth of 15 to 36 inches. The Rockton, Whalan, and Winneshiek soils are underlain by limestone bedrock at a depth of 15 to 30 inches. The Bixby, Sattre, and Waukegan soils are underlain by sand and gravel at a depth of about 24 to 36 inches.

All of the soils of this unit, except the Lamont variant, have a moderately permeable surface layer and subsoil and are underlain by rapidly permeable coarse-textured material or fractured bedrock. The Lamont variant, however, has moderately rapid permeability in the upper part of the profile and moderate permeability in the lower part of the subsoil and in the substratum. The water-holding capacity of the Waukegan and Lamont variant is medium. It is very low or low in the other soils. All of these soils are well aerated. They absorb much of the rain that falls on the surface, but part of this water is lost through deep percolation. Because of the gentle slopes, some water is also lost through runoff.

These soils are in good tilth, even though the content of organic matter is medium to very low. They are acid. The supply of available nitrogen is low or very low, and the supply of available phosphorus is low.

The soils of this unit are suitable for cultivated crops, but they are slightly droughty. They are also subject to erosion when the surface is bare or the cover of vegetation is sparse. In years when rainfall is average or below, crops do not have enough moisture to make good growth. These soils are easily tilled and can be worked soon after rains. They are often managed with the soils of capability unit IIs-1.

These soils are productive if they are well managed. They are suited to corn, soybeans, oats, hay, and pasture, and they are also suitable for trees. Most of the acreage is cultivated.

If the Bixby, Lamont variant, Sattre, and Waukegan soils of this unit are tilled on the contour, row crops can be grown successively for 3 years but should be followed by a crop of oats and a green-manure crop. Row crops ought to be grown on the other soils only 2 years in 4 where those soils are tilled on the contour. If no practices are used to control erosion, the Bixby, Lamont variant, Sattre, and Waukegan soils should be used for row crops only 2 years in 4, and the other soils, only 1 year in 4. Many of the areas are not suitable for terraces, because of the bedrock or coarse-textured material near the surface. The Lamont variant can be terraced, however, because it is underlain by glacial till.

Lime and fertilizer are needed on these soils for optimum yields. Corn that is not preceded by a legume responds well to nitrogen, and corn, soybeans, oats, and legumes respond well to applications of phosphate and potash. Less potash is needed on the Sattre than on the other soils.

CAPABILITY UNIT IIs-1

In this capability unit are level or nearly level, dark-colored or light-colored soils that are well drained or somewhat poorly drained. These soils are on uplands and stream benches and are moderately deep over bedrock or coarse-textured material. They are in the Bixby, Hayfield, Kato, Rockton, Sattre, Volney, Waukegan, and Winneshiek series.

The surface layer of these soils is medium textured and is friable or very friable. The subsoil is also friable and is medium textured or moderately fine textured. The Rockton, Winneshiek, and Volney soils are underlain by limestone bedrock at a depth of about 15 to 30 inches. The bedrock underlying the Volney soil is more fragmented, however, than that underlying the Rockton and Winneshiek soils, and it contains some soil material. The Bixby, Hayfield, Kato, Sattre, and Waukegan soils are underlain by sand and gravel at a depth of about 24 to 36 inches.

The soils of this unit have a moderately permeable surface layer and subsoil and are underlain by rapidly permeable material. The Rockton and Winneshiek soils have very low or low water-holding capacity, but the water-holding capacity of the other soils is medium. The movement of water and air is good in these soils. All of the water that falls on the surface is absorbed, but some is lost through deep percolation. No water stands on the surface. The Kato soil has a fluctuating water table that is moderately high in spring. This water table drops rapidly during the growing season.

The Kato soil of this unit is slightly acid to neutral, and the Volney soil contains abundant lime. All of the other soils are acid. All of these soils are low in available nitrogen, except the Bixby and Kato soils. The Bixby soil is very low and the Kato is medium in available nitrogen. The Volney soil is very low in available phosphorus, and the other soils are low in that element. All of the soils are very low to medium in available potassium.

The soils of this unit are suited to cultivated crops, but they are slightly droughty. Droughtiness is a hazard, especially in years of average or below-average rainfall. The soils are generally in good tilth and are easily tilled. They also warm up quickly in spring and can usually be worked soon after rains. The Kato soil, however, may be slightly wet during seasons when rainfall is above average. Nearly all of the acreage of soils in this unit is managed with the soils of capability unit IIe-6.

The soils of this unit are productive, but the yields depend on the amount and timeliness of rainfall. Most of the acreage is cultivated, and corn is the main crop. The soils are also suited to soybeans, oats, hay, and pasture, however, and they are suitable for trees. Grain sorghum can be substituted for corn in the rotation if the supply of subsoil moisture is low or if the preceding crop was a legume.

Row crops can be grown intensively on these soils if good management is used. A commonly used rotation is 3 years of row crops grown consecutively, followed by a crop of oats and a green-manure crop.

Except on the Volney and Kato soils, lime is needed on these soils for optimum yields. Corn that is not preceded by a legume responds well to applications of nitrogen. Corn, oats, and legumes need phosphate and potash. Little or no potash is needed on the Sattre and Volney soils unless a high rate of fertilization is used.

CAPABILITY UNIT IIw-1

Soils that are nearly level or gently sloping, dark colored or light colored, and very poorly drained or somewhat poorly drained make up this capability unit. These soils are on uplands and stream benches. They are in the Clyde, Floyd, Kato, and Oran series. Their surface layer is friable and medium textured, and their subsoil is friable or friable to firm and is medium textured or moderately fine textured.

All of these soils have high water-holding capacity. Permeability is moderate in the Clyde, Floyd, and Kato soils and moderately slow in the Oran soil. A high water table slightly restricts aeration in these soils, and water ponds on the surface of the Clyde soils for short periods of time. The soils dry out somewhat slowly in spring and cannot be worked soon after rains. The Clyde and Floyd soils have some stones and boulders on the surface.

Except for the Oran soil, which is low in available nitrogen, the soils are medium in available nitrogen. All of them are low in available phosphorus and potassium. The Clyde and Floyd soils are nearly neutral, but the other soils are slightly acid to medium acid. The content of organic matter is medium to high in the surface layer of most of the soils, but it is low in the surface layer of the Oran soil.

The soils of this unit are wet, but they are suited to corn, soybeans, oats, and legumes after they have been drained. Many of the areas have been artificially drained in recent years, but drainage still needs to be improved in many of the areas. These soils puddle easily if worked when wet, and some runoff takes place in the sloping areas. Plowing in fall is often desirable to prevent planting from being delayed in spring.

These soils are highly productive if they are well managed. The areas that have been drained are used for row crops, but the undrained areas are in permanent pasture. Adapted species of trees grow well.

Where tile drains have been installed, these soils can be used intensively for row crops. The gently sloping areas should be tile drained and tilled on the contour. In those areas a suitable rotation is one in which row crops are grown for 3 years and are followed by a crop of oats and a green-manure crop. In some places tile outlets are difficult to establish in the Clyde and Floyd soils. The drainageways need improvement in some places.

Lime and fertilizer are needed for optimum yields on these soils. Corn that is not preceded by a legume needs nitrogen, and corn, soybeans, oats, and legumes need phosphate and potash.

CAPABILITY UNIT IIw-2

In this capability unit are level or nearly level, dark-colored or light-colored soils that are poorly drained or somewhat poorly drained. These soils are on flood plains and are in the Caneek, Colo, Lawson, Ossian, and Otter series. All of these soils, but the Colo, have a friable, medium-textured surface layer and subsoil. The Colo soil has a moderately fine textured, friable to firm surface layer and subsoil.

Permeability is moderately slow in the Colo soil, but it is moderate in the other soils. The water-holding capacity is high or very high. The high water table, occasional flooding, and slow surface runoff make these soils wet. The movement of air and water is somewhat restricted in the profile; therefore, these soils dry out slowly in spring, and they cannot be worked soon after rains. In general, tilth is good, but the surface layer puddles if the soils are worked when wet. All of the soils, except the Caneek, are high in content of organic matter.

The Caneek soil contains abundant lime, but the other soils of this unit are slightly acid to neutral. Except for the Caneek soil, the soils are medium in available nitrogen and low in available phosphorus. The Caneek soil is very low in available nitrogen and phosphorus. All of the soils are medium in available potassium.

These soils are well suited to cultivation, but artificial drainage and protection from overflow are required. Where areas of these soils have not been protected from overflow, water from runoff collects and runs across them. In places crops are damaged by sediment and excess water. Some of the areas have been drained and are used for row crops. Corn, soybeans, oats, and legumes are the crops commonly grown. The areas that have not been drained are used for pasture or are idle.

If these soils have been drained and protected from overflow, they are suited to intensive use for row crops. A suitable rotation is one in which row crops are grown for 3 successive years and are followed by a crop of oats and a green-manure crop.

Tile drains are generally used to remove the excess water, and outlets can be established in most areas of these soils. The development of drainageways is needed in some places. Where these soils are near the base of upland slopes, diversion terraces should be placed upslope to protect them from runoff from the higher lying soils. Some fields are plowed in spring, especially where planting is delayed because the soils are wet.

If these soils are used intensively for row crops, fertilizer is needed for continued optimum yields. Lime is generally not needed. Corn that is not preceded by a legume responds well to applications of nitrogen. Corn, soybeans, oats, and legumes need phosphate. Potash is needed on the Otter soils, and it is needed on all of the soils if a high level of fertilization is used.

CAPABILITY UNIT IIw-3

A nearly level, poorly drained organic soil, Peaty muck, overwashed, is in this capability unit. This soil is in upland drainageways and on flood plains. It generally consists of 6 to 20 inches of light-colored, medium-textured overwash that is underlain by dark-colored, spongy organic material. In some areas, however, the overwash is as much as 40 inches thick.

Permeability is moderate in the overwash material, but it is rapid in the organic material where this soil has been artificially drained. The intake of water is generally slow because this soil is saturated. The water-holding capacity is very high.

This soil is wet because of the high water table and occasional overflow. Areas in which the overwash is only about 20 inches thick are less wet, however, than those in which it is only about 6 inches thick. This soil dries out slowly in spring and cannot be worked soon after rains. The organic material settles unevenly in some places where this soil has been artificially drained.

In areas where the layer of overwash is recent, this material is very low in content of organic matter and puddles if it is worked when wet. This soil is neutral in reaction. It is medium in available nitrogen but very low in available phosphorus and potassium.

If this soil is artificially drained, it is suited to corn, soybeans, oats, and legumes, although oats may lodge in places. Some protection from overflow is needed, or new seedlings may be covered with sediment. The areas that have not been drained are left idle or used for pasture. Varieties of crops that mature early should be used for planting. This is because crops grown on this soil are more susceptible to damage from frost than are crops grown in most other areas in the county. This soil is productive if good management is used.

This soil is suited to intensive use for row crops if it is tile drained and protected from overflow. The tile lines should be placed in the underlying soil material. If they are placed in the organic material, their alinement may be altered when the peaty muck shrinks. Then, the tile will not drain properly.

A large amount of phosphate and potash are required on this soil for optimum yields, but lime is not needed. Corn that is not preceded by a legume needs nitrogen.

CAPABILITY UNIT IIw-4

Level or nearly level, dark-colored, somewhat poorly drained soils that are on uplands and benches and that are moderately deep or deep over shale are in this capability unit. These soils are in the Jacwin and Kato series. They have a surface layer that is friable and medium textured. The Jacwin soil has a subsoil that is fine textured and very firm. The Kato soil has a subsoil that is friable, but is has a fine-textured, very firm substratum.

Permeability is moderate in the loamy material and slow or very slow in the underlying shaly material. Both soils have high water-holding capacity, but not all of the moisture is available to plants. Seepage and a temporary perched water table make these soils wet, and aeration is somewhat restricted. Surface runoff is slow, and water is ponded on the surface in some places after heavy rains. These soils dry out slowly in spring. If they are worked when wet, the surface layer puddles easily.

These soils are slightly acid to neutral. The content of organic matter is medium to high, but these soils are in poor tilth in places. They are medium in available nitrogen and low in available phosphorus and potassium.

These soils are suited to cultivated crops, but farming can be more timely if drainage is provided. The soils have a perched water table in spring, but this water table recedes during the growing season. In years when rainfall is above average, management of these soils is difficult. Some of the fields in which these soils occur are plowed in fall, so that planting will not be delayed in spring.

These soils are often managed with the soils of capability unit IIe-5, which are gently sloping, and most of the acreage is used for cultivated crops. The soils are suited to corn, soybeans, oats, and hay or pasture. Corn is the major crop, and yields are favorable under good management.

The Kato soil is suited to intensive use for row crops. If some areas are tile drained, the Jacwin soil is suited to row crops 3 years in 5. Placement of tile drains is important in these soils because of the slowly permeable clay near the surface. Interceptor tile drains are generally used.

Fertilizer is needed for optimum yields, but lime is generally not needed. Corn that is not preceded by a legume responds to applications of nitrogen. Corn, soybeans, oats, and hay respond well to phosphate and potash.

CAPABILITY UNIT IIIe-1

Moderately sloping, dark-colored or light-colored, well drained or moderately well drained soils of the uplands make up this capability unit. These soils are in the Bassett, Coggon, Downs, Fayette, Orwood, Ostrander, Racine, Renova, and Tama series. Some of them are moderately or severely eroded. These soils have a friable, medium-textured surface layer. In most places their subsoil is also friable and is medium textured or moderately fine textured.

All of these soils have high water-holding capacity. In the Bassett, Coggon, and Racine soils, permeability is moderately slow, but the other soils are moderately permeable. These soils are well aerated, and all of them, except the severely eroded Fayette soil, are in good tilth. The content of organic matter ranges from high to very low. All of these soils are easily tilled. It may be necessary to remove some stones from the surface of all but the Downs, Fayette, Orwood, and Tama soils. The intake of water is generally good, but some runoff takes place because of the moderate slopes.

The soils of this group are acid. Except for the Ostrander soil, which is medium in available nitrogen, they are low or very low in available nitrogen. All but the Downs and Fayette soils are low in available phosphorus, but the supply of available phosphorus is medium or medium to high in those soils. All of the soils are low or medium to low in available potassium.

These soils are moderately well suited to cultivated crops. The hazard of further erosion is severe, but these soils are not wet or droughty. Runoff causes erosion when the surface is bare or is only sparsely covered by plants. Many of these soils are managed with the soils of capability units IIe–1 and IIIe–3.

The soils of this unit are productive if they are well managed. They are suited to corn, soybeans, oats, hay, and pasture, and they are also suitable for trees. Cultivated crops are grown on most of the acreage, and corn is the major crop.

If they are terraced or stripcropped, the moderately eroded Bassett, Coggon, and Renova soils and the severely eroded Fayette soil can be used for row crops 2 years in 4. The other soils can be used for row crops 3 years in 5 if they are terraced or stripcropped. Row crops can be grown on all of the soils 2 years in 5 if tillage is on the contour. They can be grown only 1 year in 4 or 5 if no practices are used to control erosion. Soybeans can be substituted for corn in the rotation. In places the drainageways in side valleys need to be shaped and reseeded.

Lime and fertilizer are needed for optimum yields on these soils. In the severely eroded areas and in the channels of the terraces, manure should be applied. On most of the soils, except the Fayette and Downs, phosphate is needed. If a large amount of nitrogen is applied, however, some phosphate and potash is required on all of the soils.

CAPABILITY UNIT IIIe–2

In this capability unit are moderately sloping, dark-colored or light-colored, well-drained soils of uplands and stream benches. These soils are in the Camden, Nasset, Palsgrove, Sattre, and Waucoma series. They are deep over bedrock or coarse-textured material. Their surface layer is friable and medium textured, and their subsoil is also friable and is medium textured or moderately fine textured. The Palsgrove and Waucoma soils are underlain by limestone bedrock at a depth between 30 and 50 inches. The other soils are underlain by sand and gravel at a depth between 36 and 45 inches. Some of these soils are moderately eroded.

The soils of this unit are moderately permeable, but the underlying fractured limestone, sand, and gravel are rapidly permeable. The Sattre soil has medium to high water-holding capacity, but the other soils have medium water-holding capacity.

Air and water move freely through these soils. In most places the intake of water is good, but some runoff takes place. The surface layer in the Sattre and Palsgrove soils tends to seal during hard rains, and a crust forms when these soils dry. All of these soils are easily tilled, warm up quickly in spring, and can be worked soon after rains.

These soils are acid. In general, they are low in available nitrogen and phosphorus, but the Palsgrove soil is very low in available nitrogen. The Nasset, Palsgrove, and Sattre soils are medium to low in available potassium, but the other soils are low in that element.

The soils of this unit are moderately well suited to cultivated crops, but the hazard of further erosion is severe. Bedrock or the underlying droughty sand and gravel limit the growth of roots of some plants. These soils are somewhat droughty in years when the amount of rainfall is below average. Some of the areas are managed with the soils of units IIe–4 or IIIe–4. If these soils are well managed, they are productive. They are suited to corn, soybeans, oats, hay, and pasture, and they are also suitable for trees. Cultivated crops are grown on more than half of the acreage, but some areas are in permanent pasture or trees. In the cultivated areas, corn is the major crop.

All of the soils, but the Palsgrove, are suited to row crops 2 years in 4 if they are terraced or stripcropped, or they can be used for row crops 2 years in 6 if they are tilled on the contour. The Palsgrove soil is suited to row crops 2 years in 5 if it is terraced or stripcropped. It is suited to row crops 1 year in 4 if it is tilled on the contour. If practices are not used to control erosion, these soils should be kept in long-term meadow. A row crop can be grown for 1 year, however, when a meadow is renovated. The surface needs to be protected by crop residue. Because of the bedrock or sand and gravel near the surface, the cuts and fills required in constructing terraces ought to be held to a minimum. Manure should be applied, especially in the channels of the terraces.

Lime and fertilizer are necessary for optimum yields on these soils. Corn that is not preceded by a legume needs nitrogen, and corn, soybeans, oats, and legumes need phosphate and potash. Less potash is required on the Nasset, Palsgrove, and Sattre than on the other soils.

CAPABILITY UNIT IIIe–3

Strongly sloping, moderately dark colored or light-colored, well-drained soils of the uplands are in this capability unit. These soils are in the Downs, Tama, Fayette, Orwood, Racine, and Renova series. The surface layer of these soils is friable and medium textured. The subsoil is friable and medium textured or moderately fine textured. Most of these soils are moderately eroded.

These soils have high water-holding capacity. They are moderately permeable, and air and water move freely through the profile. Because of the steep slopes and the somewhat poor granulation of the surface soil, however, all of these soils are susceptible to severe erosion. In the soils that are already moderately eroded, the surface layer tends to seal during heavy rains and a crust forms when the soil dries. The soils can be easily tilled, even though tilth is fair to poor in places. They warm up quickly in spring and can be worked soon after rains. Removing a few stones from the surface of the Racine and Renova soils may be necessary.

All of the soils of this unit are acid. All of them are very low or low in available nitrogen. All but the Downs, Fayette, and Orwood are low in available phosphorus and potassium. The Downs and Fayette soils are medium to high in available phosphorus and medium to low in available potassium. The Orwood soil is low in available phosphorus and medium in available potassium.

The use of these soils is seriously limited by erosion, but the soils are moderately well suited to cultivated crops if erosion is controlled. Wetness or drought are not hazards. Leaving crop residue on the surface increases the intake of water and reduces runoff. In many places these soils are managed with the soils of capability unit IIIe–1.

The soils of this unit are moderately productive if they are well managed. All of the moderately eroded soils are used for cultivated crops, and the slightly eroded areas are used for cultivated crops to some extent. A few areas are in permanent pasture or trees. These soils are suited to corn, oats, hay, and pasture, and they are also suitable for trees. Soybeans are usually not grown.

All of these soils, except the Racine and Renova, can be used for row crops 2 years in 6 if they are terraced or stripcropped. If the same soils are tilled on the contour, they can be used for row crops 1 year in 5. Row crops can be grown 1 year in 4 if the Racine and Renova soils are terraced or stripcropped, and they can be grown 1 year in 6 if those soils are tilled on the contour. The soils of this unit should be used for long-term meadow, unless practices are used to control erosion. In places the drainageways that cut into sidehills need to be shaped and reseeded.

Lime and fertilizer are necessary for optimum yields on these soils. Manure should be applied, especially in the channels of the terraces. Nitrogen is needed for corn that is not preceded by a legume. Corn, oats, and legumes respond to applications of phosphate and potash. Less phosphate is needed on the Downs and Fayette soils, however, than on the other soils.

CAPABILITY UNIT IIIe–4

In this capability unit are strongly sloping, moderately dark colored or light-colored, well-drained soils of uplands and stream benches. These soils are in the Calmar, Nasset, Palsgrove, and Waucoma series. They are deep over bedrock or coarse-textured material. The Calmar soil has a moderately fine textured surface layer, but the surface layer of the other soils is friable and medium textured. In most places all of these soils have a friable, medium-textured or moderately fine textured subsoil. All of these soils, except the Calmar, are underlain by limestone bedrock at a depth between 30 and 50 inches. The Calmar soil is underlain by limestone and by some soil material at a depth between 24 and 40 inches. Some of these soils are moderately eroded.

All of these soils are moderately permeable, but the underlying fractured limestone is rapidly permeable. The Calmar soil has low to medium water-holding capacity, but the water-holding capacity of the other soils is medium to high.

These soils are well aerated. In cultivated areas, however, the surface layer is somewhat poorly granulated. In those areas the surface layer tends to seal during hard rains, and a crust forms when the soil dries. Therefore, crop residue ought to be left on the surface. All of these soils, except the Calmar, are easily tilled, even though the soil tilth is fair to poor in places. The Calmar soil is sometimes difficult to till in years when the amount of rainfall is above average. The soils of this unit warm up quickly in spring and can be worked soon after rains. All of these soils are highly susceptible to severe erosion.

The Calmar soil of this unit is neutral in reaction, but the other soils are acid. Most of the soils are low or very low in available nitrogen and low in available phosphorus. The Calmar soil, however, is low to medium in available nitrogen. The Waucoma soil is low in available potassium, but the supply of that element is medium to low in the other soils.

The use of these soils is seriously limited by erosion, but the soils are moderately well suited to cultivated crops if erosion is controlled. Wetness is not a hazard, but these soils are somewhat droughty in years when rainfall is below average. The underlying limestone bedrock limits the growth of roots of some plants. In places these soils are managed with the soils of capability unit IIIe–2.

The soils of this unit are moderately productive if they are properly managed. Although much of the acreage is in permanent pasture or trees, all of the moderately eroded soils and some areas of the soils that are not eroded are used for cultivated crops. The soils are suited to corn, oats, hay, and pasture, and they are also suited to trees. Corn is the major row crop grown. Soybeans are generally not grown.

If these soils are terraced or stripcropped, a suitable rotation is 1 year of corn, 1 year of oats, and 3 years of meadow. If tillage is on the contour, a row crop can be grown for 1 year when a long-term meadow is renovated. Because of the bedrock or sand and gravel near the surface, terraces should be constructed so that the cuts and fills are held to a minimum. Manure is needed in the channels of the terraces.

Lime and fertilizer are needed for optimum yields on these soils, and corn that is not preceded by a legume also needs nitrogen. Corn, oats, and legumes respond well to applications of phosphate and potash. Less potash is generally needed on the Nasset and Palsgrove than on the other soils.

CAPABILITY UNIT IIIe–5

Moderately sloping, dark-colored or light-colored, well-drained soils of the Bixby, Dubuque, Frankville, Rockton, Sattre, Whalan, and Winneshiek series are in this capability unit. These soils are on uplands and stream benches, and they are moderately deep over bedrock or coarse-textured material. All of these soils have a friable, medium-textured surface layer and a friable, medium-textured or moderately fine textured subsoil. The Bixby and Sattre soils are underlain by sand and gravel at a depth of about 24 to 36 inches. The other soils are underlain by limestone bedrock at a depth of 15 to 30 inches. All of these soils but the Frankville, Rockton, and Winneshiek are moderately eroded.

The upper part of the profile of these soils is moderately permeable, and the lower part is rapidly permeable. The water-holding capacity is very low to medium. The movement of air and water is good, and the intake of water is generally good. Because of the moderate slopes, however, runoff takes places. The surface layer of the moderately eroded soils tends to seal during hard rains, and a slight crust forms when the soil dries. Crop residue can be left on the surface to increase the intake of water and to prevent sealing of the surface soil.

The content of organic matter is medium to high in the surface layer of the Rockton soil, but it is medium to low in the surface layers of the other soils. These soils are acid. They are low or very low in available nitrogen and low in available phosphorus. The supply of available potassium is low to medium in the Dubuque, Sattre, and Frankville soils. It is low in the other soils.

These soils are moderately well suited to cultivated crops. They are susceptible to severe erosion, however, and there is also a slight hazard of drought. In years when rainfall is average or below, crops do not have enough moisture to grow well. All of these soils are easily tilled, warm up quickly in spring, and can be worked soon after rains. Some of the areas are managed with the soils in unit IIe–6. All of the moderately eroded soils and some areas of the soils that are not eroded are used for cultivated crops, but a few areas are wooded or in permanent pasture. Corn is the major row crop, but soybeans, oats, and hay are also grown. Good management is needed if moderate yields are to be obtained.

Except for the Sattre and Bixby soils, a suitable rotation for these soils consists of growing row crops 1 year in 4 if the areas are stripcropped or terraced, or 1 year in 5 if tillage is on the contour. Row crops can be grown for 1 additional year on the Sattre and Bixby soils. If no practices are used to control erosion, the soils ought to be used for long-term meadow. Most areas of these soils are not suitable for terraces, because of the bedrock or coarse-textured material near the surface.

Lime and fertilizer are needed for optimum yields on these soils. Corn that is not preceded by a legume responds to applications of nitrogen. Corn, soybeans, oats, and legumes respond to applications of phosphate and potash. However, less potash is needed on the Dubuque, Frankville, and Sattre soils of this unit than on the other soils.

CAPABILITY UNIT IIIe–6

Soils that are gently sloping to strongly sloping, dark colored or moderately dark colored, and somewhat poorly drained make up this capability unit. These soils are in the Jacwin and Kato series. They are on uplands and benches and are moderately deep or deep over shale. Their surface layer is friable and medium textured, and their subsoil is firm or very firm and fine textured.

These soils have slow or very slow permeability and high water-holding capacity. Because of the high content of clay, however, not all of the moisture is available for plants. Movement of air and water through the profile is somewhat restricted. The soils take in water well when their subsoil is not saturated. They dry out somewhat slowly in spring and cannot be worked soon after rains. The slopes are strong enough that much of the water runs off. The soils are slightly acid to neutral. They are low in available phosphorus and potassium and medium to low in available nitrogen.

The soils of this capability unit are moderately well suited to cultivation, but they are susceptible to erosion. Wetness is also a slight hazard because of the perched water table. The water table is generally lower during the growing season than it is in winter and early in spring. Tile drainage is needed in some places, so that farming can be more timely. Tile drains do not function properly in some areas, because of the slowly permeable clay near the surface.

These soils are suited to corn, soybeans, oats, hay, and pasture, and nearly all of the acreage is used for cultivated crops. The soils are moderately productive under good management.

If these soils are stripcropped, and if tile drainage is installed where needed, a suitable cropping system consists of 2 years of row crops, 1 year of oats, and 2 years of meadow. Where tillage is on the contour and some tile drainage is provided, a cropping system in which row crops are grown 1 year in 4 is satisfactory. The Jacwin soil is generally not suitable for terraces, because of the clay in the subsoil and substratum. The Kato soil could be used because it is deep over clay.

Lime is generally not needed on these soils, but fertilizer usually improves yields. Corn that is not preceded by a legume needs nitrogen. Corn, oats, and soybeans and other legumes respond to applications of phosphate and potash.

CAPABILITY UNIT IIIe–7

In this capability unit are gently sloping or moderately sloping, dark-colored or light-colored, well-drained to excessively drained soils of uplands and stream benches. These soils are in the Dickinson and Lamont series. Their surface layer is moderately coarse textured, and the upper part of their subsoil is moderately coarse textured. The soil material grades to coarse textured, however, with increasing depth.

All of these soils have low water-holding capacity and are rapidly permeable. They readily absorb rainfall, but they hold little moisture available for plants. Some water is lost through deep percolation, and some water runs off. The soils are easily tilled, warm up early in spring, and can be worked soon after rains.

The soils of this unit are acid. They are very low in available nitrogen and low in available phosphorus and potassium. The surface layer is medium to very low in content of organic matter, but soil tilth is not a problem.

Use of these soils is limited by their slopes and droughtiness. In places blowing sand is likely to damage young crops. Crop residue can be left on the surface to reduce erosion caused by wind and water.

The productivity of these soils is variable and depends on the amount of rainfall. In years when rainfall is average, average yields can be obtained if management is good. The soils are suited to corn, soybeans, oats, hay, and pasture, and they are also suitable for trees. Cultivated crops are grown on most of the acreage, and corn is the main crop.

If the gently sloping areas of these soils are terraced or stripcropped, row crops can be grown intensively. Where these soils are tilled on the contour, they are suited to 3 years of row crops, followed by a crop of oats and a crop grown for green manure. For the moderately sloping areas, a good rotation where the soils are terraced or stripcropped is 2 years of row crops in 4. If tillage is on the contour, the more sloping areas are also suited to row crops grown 1 year in 3.

Lime and fertilizer are needed on these soils for optimum yields. Corn that is not preceded by a legume needs nitrogen. Corn, soybeans, oats, and legumes need phosphate and potash.

CAPABILITY UNIT IIIs-1

Only Dickinson sandy loam, 0 to 2 percent slopes, which is on uplands and benches, is in this capability unit. This soil is dark colored to light colored, is well drained to excessively drained, and is moderately deep over coarse-textured material. The surface layer is moderately coarse textured and is very friable. The subsoil, like the surface layer, is moderately coarse textured, but it grades to coarse-textured material with increasing depth.

The water-holding capacity is low, and this soil is rapidly permeable. Moisture is lost through deep percolation, but the intake of water is good and no runoff occurs. This soil is easily tilled, warms up quickly in spring, and can be worked soon after rains.

This soil is medium acid to strongly acid. It is very low in available nitrogen and low in available phosphorus and potassium. The content of organic matter is medium.

Droughtiness limits the use of this soil for crops, and wind erosion is also a hazard when the surface is bare or is only sparsely covered by plants. Blowing sand sometimes damages newly seeded crops. However, crop residue left on the surface will provide protection.

Although the yields are variable, this soil is moderately productive in years when rainfall is average. It is suited to corn, soybeans, oats, hay, and pasture, and it is also suitable for trees. Row crops are grown on most of the acreage. Corn and soybeans are the major crops.

This soil can be used intensively for row crops. It is well suited to irrigation, but in many places an ample supply of water is not available.

Lime and fertilizer are needed for optimum yields. If row crops are grown intensively, large amounts of nitrogen, phosphate, and potash are required.

CAPABILITY UNIT IIIw-1

Nearly level or gently sloping, dark-colored Calamine soils that are poorly drained are in this capability unit. These soils occur at the base of upland slopes and benches and are moderately deep over shale. They have a friable, moderately fine textured surface layer and a firm, fine-textured subsoil. The subsoil grades to very firm, moderately fine textured shaly material with increasing depth.

These soils have medium water-holding capacity. Not all of the moisture is available for plants, however, because of the high content of clay. Permeability is slow or very slow in the subsoil. Some runoff takes place in the gently sloping areas, but no runoff occurs in the nearly level areas.

The intake of water is moderate. The movement of air and water is restricted in the soil profile, and the fine-textured subsoil limits the development of roots of some plants. These soils are seepy because they have a high, perched water table. They are slow to warm up in spring and cannot be worked soon after rains. The surface layer puddles easily if the soils are worked when wet.

These soils are neutral. They are medium in available nitrogen and low in available phosphorus and potassium. The surface layer is medium to high in content of organic matter, but the soil tilth is only fair in most cultivated areas.

Wetness limits the use of these soils, but the soils are moderately well suited to cultivated crops if they are artificially drained. The placement of tile drains and the kind of material used for backfill are important because of the slow permeability of the clay subsoil. Tile drains will not function properly in some places. In years when rainfall is above average, these soils are difficult to manage. Some fields are plowed in fall to prevent delay of spring planting.

Part of the acreage is used for cultivated crops, and part is in permanent pasture. The areas that have been drained are suited to corn, soybeans, oats, hay, and pasture, but corn is the major cultivated crop. The areas that have not been drained should be used for pasture. These soils are moderately productive if they are well managed.

If tile drains have been installed in these soils, a suitable rotation for the nearly level areas is 3 consecutive years of row crops, followed by a crop of oats and a crop grown for green manure. If the gently sloping areas are tile drained and tilled on the contour, they are suited to row crops 2 years in 4. The soils are not well suited to alfalfa or to similar legumes, because those crops may drown out or winterkill in places.

Fertilizer is needed for optimum yields. Corn that is not preceded by a legume needs nitrogen. Corn, soybeans, oats, and legumes respond to applications of phosphate and potash.

CAPABILITY UNIT IIIw-2

Only the miscellaneous land type, Alluvial land, which is nearly level or undulating, is in this capability unit. This land type is on flood plains of streams where it is frequently flooded. It varies in color. The texture ranges from coarse to fine, but it is generally moderately coarse or medium. The water-holding capacity and permeability are also variable.

This land type is frequently flooded. In many places new, infertile sediments are deposited on the surface every year. In most places the areas contain old, meandering channels or oxbows. In many places water is ponded during part of the year, and the water table is high in many of the areas.

This land type is slightly acid to neutral in reaction. The supply of plant nutrients varies, but the supply of available nitrogen is very low in most places. In most areas the content of organic matter is very low.

Because of frequent flooding, wetness is a severe limitation, but it can be controlled in some places by improving the channel and building dikes. Land leveling or surface drainage is needed in many places if cultivated crops are grown.

Most areas of this land type are in permanent pasture or in second-growth stands of trees. In a few small areas, the land is cultivated with areas of adjacent soils. If this land type is protected from frequent flooding, it is suited to the same cultivated crops as are grown on the adjacent soils. The areas that are not protected from flooding are not suitable for cultivated crops and are poorly suited to pasture. The trees that grow in some places have little value, for they are generally small and are of undesirable species.

In the areas used for cultivated crops, the same kinds and amounts of fertilizer are applied as are applied on the adjoining soils. Adding fertilizer to the unimproved pastures, however, is not considered worth while.

CAPABILITY UNIT IIIw-3

In this capability unit is a nearly level, dark-colored, very poorly drained organic soil, Peaty muck, on flood plains and in upland drainageways. This soil has a thick, spongy surface layer that consists mainly of organic matter. Beneath the surface layer is soil material that is very friable and that is medium textured or moderately fine textured.

This soil has very high water-holding capacity. Its surface layer is rapidly permeable, however, if this soil is artificially drained.

Seepage and a high water table make this soil very wet. The areas that have not been drained are wet all year, for the water table remains high during the growing season. Because the surface is irregular, water stands in places. If this soil is artificially drained, the organic material settles.

This soil is neutral. It is medium in available nitrogen but very low in available phosphorus and potassium.

This soil is moderately productive if it is well managed, but its use is limited by wetness, by the hazard of frost, and by low fertility. Where the areas are artificially drained, cultivated crops can be grown. The areas that have not been drained are poorly suited to plants, even to plants grown for pasture. Where the excess moisture is controlled, this soil is suitable for corn, soybeans, and vegetables. It is also suitable for oats, but the oats are subject to lodging. Early maturing varieties of crops should be grown because of the hazard of frost.

Where tile drains have been installed and where this soil has been fertilized, it can be used intensively for row crops. The tile drains should be placed in the underlying mineral soil material, however, below the organic material. If the tile are placed above the mineral soil material, shrinkage of the organic material alters the alinement and the tile drains will not function properly. Unless these soils are artificially drained, they are poorly suited to pasture and are generally left idle. The spongy material in the undrained areas will not withstand the traffic of grazing livestock.

Lime is not needed on this soil, but large amounts of phosphate and potash are necessary for optimum yields. Nitrogen is needed for corn that is not preceded by a legume or by a crop grown as green manure.

CAPABILITY UNIT IVe-1

Moderately steep, moderately dark colored or light-colored, well-drained soils of the uplands are in this capability unit. The unit consists of soils of the Downs, Fayette, Nasset, Orwood, Palsgrove, and Renova series and of Loamy colluvial land. Most of the soils are moderately eroded. Their surface layer is friable and medium textured, and their subsoil is friable and medium textured or moderately fine textured. The Nasset and Palsgrove soils are underlain by limestone bedrock at a depth between 30 and 50 inches. The other soils are generally deeper.

All of the soils of this unit are moderately permeable; water and air move readily through them. Except for the Nasset and Palsgrove soils, which have medium water-holding capacity, all of the soils have high water-holding capacity. The content of organic matter is very low or low. Soil tilth is somewhat poor in many of the moderately eroded areas, but in general, the soils are easily tilled. Runoff causes further erosion when the surface is bare or is only sparsely covered by plants.

The soils of this unit are acid and are low or very low in available nitrogen. The Downs and Fayette soils are medium to high in available phosphorus, but all of the other soils are low in that element. The Renova soil is low and the other soils are medium to low in available potassium.

These soils are poorly suited to cultivated crops. The hazard of further erosion is very severe, and drainageways or gullies have already dissected the areas in places. Also, because of the bedrock near the surface, the Nasset and Palsgrove soils are likely to be somewhat droughty in years when rainfall is below average.

The soils of this unit are moderately productive if they are well managed. Part of the acreage is still cultivated. Many of the moderately eroded areas that were formerly used for row crops are now in hay or pasture. The areas that have always been used for permanent pasture or trees are not eroded.

These soils are suited to oats, hay, and pasture, and they are also suitable for trees. Semipermanent hay or pasture is a good use. A row crop can be grown 1 year in 6 if the field is stripcropped. These soils are generally used for row crops, however, only when a pasture or meadow needs renovation. Corn, instead of soybeans, is the usual row crop grown. Diversion terraces have been placed in a few of the areas to protect the soils downslope. The gullies and the drainageways that have cut into sidehills need to be shaped and reseeded in places.

Manure, lime, and commercial fertilizer are needed if a meadow is to be established. Mixtures of grasses and legumes respond well to applications of phosphate and potash, but less phosphate is needed on the Downs and Fayette than on the other soils. Pastures that consist mainly of grass respond well to the applications of nitrogen.

CAPABILITY UNIT IVe-2

Strongly sloping, severely eroded, light-colored soils of the uplands are in this capability unit. These soils are well drained. They are in the Fayette, Palsgrove, and Renova series. Their surface layer is friable and medium textured, and their subsoil is friable and medium textured or moderately fine textured. The Palsgrove soil is underlain by limestone bedrock at a depth between 30 and 50 inches, but the other soils are deeper.

The soils of this unit are moderately permeable. The Fayette and Renova soils have high water-holding capacity, but the water-holding capacity of the Palsgrove soil is only medium. The soils are in poor tilth, but they generally are not difficult to till. The surface layer tends to seal during rains, and a crust forms when the soil dries. The surface sealing and steep slopes restrict the intake of water to some extent. Therefore, much of the water is lost through runoff. The content of organic matter is very low.

These soils are medium acid to strongly acid and are very low in available nitrogen. The Fayette soil is medium and the Palsgrove and Renova soils are low in available phosphorus. The Renova soil is low in available potassium, but the other soils are generally medium to low in that element.

Additional very severe erosion is a hazard on the soils of this unit. The Palsgrove soil is likely to be somewhat droughty in years when rainfall is below average. In the Palsgrove soil, the root growth of some plants is limited by the bedrock near the surface.

The soils of this unit are poorly suited to cultivation, but cultivated crops have been grown on most of the acreage. The soils are suitable for hay or pasture, and trees grow well on them. They are also suitable for oats.

If these soils are terraced or stripcropped, a row crop can be grown on the Palsgrove and Renova soils 1 year in 6 and on the Fayette soil 1 year in 4. A row crop is often grown, however, when a pasture is renovated, or about once in 4 to 8 years. When a row crop is grown, crop residue should be left on the surface and manure ought to be applied.

Lime, manure, and commercial fertilizer are needed when a meadow is to be established. Legumes respond well to applications of lime and phosphate, and grasses respond well to nitrogen and lime.

CAPABILITY UNIT IVe-3

Strongly sloping, dark-colored or light-colored, well-drained soils of uplands and stream benches are in this capability unit. These soils are moderately deep over bedrock or coarse-textured material. They belong to the Dubuque, Frankville, Rockton, Sattre, Whalan, and Winneshiek series. Most of the soils are moderately eroded. Their surface layer is friable and medium textured, and their subsoil is friable and medium textured or moderately fine textured. The Sattre soil is underlain by sand and gravel at a depth between 24 and 36 inches. The other soils are underlain by limestone bedrock at a depth between 15 and 30 inches.

The water-holding capacity is very low or low. Permeability is moderate in the surface layer and subsoil. It is rapid in the underlying fractured limestone, sand, and gravel.

The intake of water is generally good, but runoff takes place because of the strong slopes. Also, some moisture may be lost through deep percolation. These soils warm up quickly in spring, and farm equipment can be moved over them fairly soon after rains.

These soils are acid. They are low or very low in available nitrogen and low in available phosphorus. The Sattre, Dubuque, and Frankville soils are low to medium and the Rockton, Whalan, and Winneshiek soils are low in available potassium.

The soils of this unit are susceptible to additional very severe erosion, and they are somewhat droughty. In years when the amount of rainfall is average or below, crops grown on them do not get enough moisture for good growth. These soils are moderate to low in productivity.

Most areas of the moderately eroded Dubuque, Frankville, Sattre, and Whalan soils of this unit have been cultivated, although the soils are not well suited to cultivated crops. The other soils are in permanent pasture or trees. Corn, oats, legumes, and grasses can be grown, and these soils are also suitable for trees. Soybeans are usually not substituted for corn in the rotation where cultivated crops are grown.

If the Sattre soil is stripcropped, a suitable rotation is 1 year of corn, 1 year of oats, and 2 years of meadow. If the other soils are stripcropped, row crops can be grown 1 year in 6. A row crop is usually grown, however, only when a pasture needs renovation. The soils are suitable for long-term hay or pasture, but it may be necessary to limit grazing during the dry parts of the year. Limestone bedrock or sand and gravel are too near the surface for these soils to be suitable for terraces.

Lime and fertilizer are needed for optimum yields on these soils. Mixtures of grasses and legumes respond well to applications of phosphate, lime, and potash, and grasses also need nitrogen.

CAPABILITY UNIT IVe-4

In this capability unit are strongly sloping, dark-colored or light-colored, well-drained to excessively drained soils of uplands and stream benches. These soils are in the Dickinson and Lamont series. They have a very friable, moderately coarse textured surface layer and subsoil. The material in the subsoil grades to coarse-textured material with increasing depth.

The water-holding capacity of these soils is low, and permeability is rapid. The soils are well aerated. They take in water well, but part of the moisture that is absorbed is lost through deep percolation. Because of the strong slopes, runoff is moderate. These soils are easily eroded by wind and water when their surface is bare or is only sparsely covered by plants. Blowing sand damages crops in some places. The soils are easily tilled, however, warm up quickly in spring, and can be worked soon after rains. The content of organic matter ranges from medium to very low, but the soils are in good tilth.

The soils of this unit are acid. They are very low in available nitrogen and low in available phosphorus and potassium.

These soils are not well suited to cultivation, because they are subject to erosion and are droughty. In years when rainfall is only average, crops grown on them lack moisture for adequate growth. The soils can be used for corn, oats, hay, or pasture, however, and some kinds of trees do well. Grain sorghum can be substituted for corn in years when the subsoil contains only a small amount of moisture. Part of the acreage is used for cultivated crops, and part is in permanent pasture or trees. If cultivated crops are grown, crop residue ought to be left on the surface to reduce erosion by wind and water. The soils are moderate to low in productivity. Yields are variable and depend on the amount of rainfall and on the level of fertilization.

Although these soils are more suitable for long-term meadow than for row crops, a rotation consisting of 1 year of row crops followed by a crop of oats and then by 3 years of meadow is suitable if the soils are terraced or stripcropped. The soils are generally not suitable for terraces, however, because of the loamy sand and sand near the surface. Good stands of legumes or of grasses and legumes are often left for 3 to 8 years before the area is renovated. Gophers are harmful to old seedings.

Lime and fertilizer are needed for optimum yields on these soils. Corn, oats, and legumes respond to applications of phosphate or potash. Pastures that consist mainly of grass respond to nitrogen, phosphate, and potash.

CAPABILITY UNIT IVe-5

In this capability unit is only one soil, Jacwin loam, 9 to 14 percent slopes, which is dark colored or moderately dark colored and is somewhat poorly drained. This soil is on the uplands, where it is underlain by shaly material at a moderate depth. It has a friable, medium-textured surface layer and a firm or very firm, fine-textured subsoil.

The water-holding capacity of this soil is medium to high. Because of the high content of clay, however, not all of the moisture is available to plants. This soil contains a perched water table. The permeability of the subsoil is slow or very slow.

The intake of water is somewhat limited in this soil because of the slow movement of air and water through the profile and because of the large amount of runoff. This soil is likely to be seepy in spring or when the amount of rainfall is higher than average. The water table is variable. The surface layer dries slowly, and farm equipment cannot be moved over these soils soon after rains. The surface layer puddles easily if it is worked when wet.

This soil is only slightly acid. It is low in available phosphorus and potassium and only medium in available nitrogen.

This soil is poorly suited to cultivated crops. It is slightly wet, and there is a severe hazard of erosion. The water table is usually high in spring, but it is lower during the growing season. Artificial drainage is needed if field crops are grown.

Most of the acreage is in permanent pasture, but a few areas are cultivated. This soil can be used for corn, oats, hay, or pasture, and it is suited to some species of trees. Productivity is moderate to low, even if management is good.

This soil is suitable for hay or pasture. A row crop can be grown 1 year in 6 if stripcropping is practiced and tile drains are installed. As a rule, however, the returns from tile drainage generally do not justify the cost. When a meadow is renovated, a crop of oats can be grown, even though the soil has not been drained.

Legumes grown on this soil respond to applications of phosphate and potash. Pastures that consist mainly of grass respond to applications of nitrogen, phosphate, and potash.

CAPABILITY UNIT IVs-1

In this capability unit are nearly level or gently sloping, dark-colored or light-colored, excessively drained soils of uplands and stream benches. These soils are shallow over bedrock or coarse-textured material. They are in the Backbone, Burkhardt, Chelsea, and Hagener series.

These soils have a loose or very friable, moderately coarse textured or coarse textured surface layer and subsoil. The Backbone soil is underlain by limestone bedrock at a depth between 20 and 40 inches, and the Burkhardt soils are underlain by gravelly sand at a depth between 15 and 24 inches. The other soils have a subsoil that grades to sand with increasing depth.

The water-holding capacity is low or very low. Permeability is very rapid.

These soils absorb moisture readily. They hold only a small amount of moisture available for plants, however, and much of the moisture is lost through deep percolation. In years when only the average amount of rainfall is received, the soil generally does not hold enough moisture for a crop to grow well. Sheet erosion is generally not a problem on these soils. Wind erosion is a hazard when the surface is bare or is only sparsely covered by plants. The soils of this unit warm up quickly in spring and can be worked soon after rains.

These soils are acid. The Backbone soil is low in available nitrogen, phosphorus, and potassium, but the other soils are very low in those elements.

Droughtiness and susceptibility to erosion limit the use of these soils. Wind erosion is a more serious hazard on the Chelsea and Hagener soils than on the other soils. Blowing sand is likely to damage newly seeded crops on these and on adjacent soils. These soils need to have crop residue left on the surface to reduce wind erosion. They are too porous for it to be practical to try to build up the content of organic matter. Manure or other residue decomposes rapidly in these soils. In the Backbone soil, the root growth of some plants is limited by the bedrock near the surface. Productivity is only moderate to low, even if management is good. The yields obtained depend on the kinds and amounts of fertilizer applied and on the timeliness of rains during the growing season.

Part of the acreage is in cultivated crops, and some areas are in pasture. Corn, soybeans, oats, and hay can be grown, and these soils are suitable for pasture.

If the gently sloping areas are tilled on the contour, a suitable rotation is one in which corn is grown for 2 years and is followed by a crop of oats and by a crop of meadow. Where these gently sloping areas are not tilled on the contour, a row crop can be grown 1 year in 3 or 4. Row crops can be grown more intensively, however, on the nearly level Hagener soil than on the other soils. The soils of this unit are suited to irrigation, but an ample supply of water is usually not available. A few of the areas are kept in hay or pasture and are not used for row crops.

Crops grown on these soils need large amounts of fertilizer and lime. Corn that is not preceded by a legume is likely to need nitrogen, and all crops need lime, phosphate, and potash. Because these soils are droughty, however, large applications of fertilizer generally are not worth while.

CAPABILITY UNIT IVs-2

Moderately sloping to strongly sloping, dark-colored or light-colored, excessively drained soils of uplands and stream benches make up this capability unit. These soils are shallow over bedrock or coarse-textured material. They are in the Backbone, Burkhardt, Chelsea, and Hagener series. The soils have a loose or very friable surface layer and subsoil of moderately coarse textured or coarse textured material. Limestone bedrock underlies the Backbone soil at a depth between 20 and 40 inches, and gravelly sand underlies the Burkhardt soils at a depth between 15 and 24 inches. The soil material in the other soils grades to sand with increasing depth.

The water-holding capacity of these soils is low or very low. Permeability is very rapid.

The intake of water is good, but these soils hold only a small amount of moisture for the use of plants. Much of the moisture is lost through deep percolation, and part of it is lost through runoff. These soils are subject to both sheet erosion and wind erosion when their surface is bare or is only sparsely covered by plants. They are easily tilled, warm up quickly in spring, and can be worked soon after rains.

These soils are medium acid to strongly acid. They are very low in available nitrogen, phosphorus, and potassium.

Droughtiness and susceptibility to erosion are very severe limitations to use of these soils. During years when rainfall is only average, the soils generally do not contain enough moisture for crops to grow well. Both sheet erosion and wind erosion are hazards; newly seeded crops on these and on adjoining soils are often damaged by blowing sand. The soils need to have crop residue left on the surface to reduce erosion. They are too porous for it to be practical to try to build up the content of organic matter. The limestone bedrock underlying the Backbone soil limits the development of roots of some plants.

The soils of this unit can be used for corn, oats, hay, or pasture, and they are suitable for some kinds of trees. Part of the acreage is used for cultivated crops, and other areas are in pasture or trees. Corn is the major row crop grown. These soils are low in productivity.

If these soils are stripcropped, a suitable rotation is one in which row crops are grown only 2 years in 5. If practices are not used to control erosion, the soils are used for hay or pasture. A row crop can be grown for 1 year when a pasture is renovated. Terraces are generally not built on these sandy soils.

Lime and fertilizer are needed on the soils of this unit. Adding a large amount of fertilizer is generally not worth while, however, because these soils are droughty. Lime, nitrogen, phosphate, and potash are needed for corn, oats, and grass. Manure is likely to be needed to help establish a stand of legumes. Trying to build up the content of organic matter is impractical; the soils are too porous, and the organic residue decomposes readily.

CAPABILITY UNIT IVs-3

In this capability unit are gently sloping or moderately sloping, dark colored or moderately dark colored, excessively drained soils of the Marlean series. These soils are on uplands and are shallow or very shallow over fragmented material or hard bedrock. They have a friable, medium-textured surface layer and subsoil and are underlain by soft limestone bedrock. In the areas where these soils are underlain by fragmented material, the fragments of limestone have some soil material between them.

The water-holding capacity is very low. Permeability is moderate, but the underlying fragmented or fractured bedrock is rapidly permeable in most places.

These soils are well aerated. The intake of water is generally good, but much of the moisture is lost through runoff and deep percolation. In most places the soils are easily tilled, but cultivation turns up fragments of limestone. These soils warm up quickly in spring and can be worked soon after rains.

Lime is abundant in many of the areas. These soils are generally very low in available nitrogen, phosphorus, and potassium, but the uneroded Marlean soils are medium in available nitrogen.

The fragmented material or bedrock near the surface and the susceptibility to erosion are very severe limitations to the use of these soils. The soils are very droughty, and they do not store enough moisture for plants to grow well. Bedrock near the surface limits the root growth of nearly all crops.

In some places these soils are used for cultivated crops, and they are cultivated with the adjoining soils in many places. Corn, oats, legumes, and grasses are grown, and trees also grow in some areas. These soils are not very productive, but the gently sloping areas are more productive than the others.

If the gently sloping areas of Marlean soils are stripcropped, they can be used for row crops 2 years in 5. If these same areas are tilled on the contour, a row crop can be grown 1 year in 5. Where the more sloping areas are stripcropped, a row crop can be grown 1 year in 6. A row crop is usually grown when a meadow or pasture needs renovation. Corn is the main row crop. The limestone near the surface makes these soils unsuitable for terraces.

Lime is generally not needed to establish a stand of legumes on these soils. Corn, oats, and grass need nitrogen, phosphate, and potash, and legumes respond to applications of phosphate and potash. However, large applications of fertilizer are generally not worth while.

CAPABILITY UNIT VIe-1

In this capability unit are moderately steep, light-colored, well-drained, severely eroded soils of the uplands. These soils are in the Dow, Fayette, Orwood, Palsgrove, and Renova series. Their surface layer is friable and medium textured, and their subsoil is friable and is medium textured or moderately fine textured. The Palsgrove soil is underlain by limestone bedrock at a depth between 30 and 50 inches.

The water-holding capacity of the Palsgrove soil is medium, but the water-holding capacity of the other soils is high. Permeability is moderate.

Although air and water move readily through these soils, tilth is poor. Also, the surface of these soils sometimes seals during hard rains. Because of the surface sealing and the large amount of runoff, the soils are extremely erodible. They warm up quickly in spring, and farm equipment can be moved over them fairly soon after rains. The content of organic matter is very low.

All of these soils, but the Dow, are acid. The soils are very low in available nitrogen. The Fayette soil is medium to high in available phosphorus, but the other soils are low to medium in that element. The Renova soil is low in available potassium, but the other soils are medium to low.

The soils of this unit are generally not suitable for cultivated crops. They are moderately well suited to permanent pasture and trees, however, and they can be used for wildlife habitats. The soils are subject to additional very severe erosion, and they are generally low in fertility. The Palsgrove soil is somewhat droughty in places during years when rainfall is below average.

Most areas of these soils were formerly cultivated, but the present trend is to seed the soils to permanent pasture. A crop of oats can be grown when the pastures are renovated. In most places farm machinery can be operated safely. Some gullies and drainageways that have cut into sidehills need to be shaped and reseeded. Diversion terraces are needed in areas of these soils to protect other soils downslope.

Lime, manure, and commercial fertilizer are needed where a stand of grasses and legumes is to be established. Legumes grown on these soils generally respond well to applications of lime and phosphate, but little or no phosphate is needed on the Fayette soil. Oats and grass pastures respond to applications of lime, nitrogen, and phosphate.

CAPABILITY UNIT VIe-2

In this capability unit are strongly sloping and moderately steep, moderately dark colored or light-colored soils of the uplands. These soils are well drained and are moderately deep over bedrock. They are in the Dubuque, Frankville, Whalan, and Winneshiek series. Most of these soils are moderately or severely eroded. They have a medium-textured surface layer that is friable in most places, and a medium-textured or moderately fine textured subsoil. Limestone bedrock is at a depth between 15 and 30 inches.

The water-holding capacity of these soils is very low or low. Permeability is moderate in the soil material above the limestone.

These soils are well aerated. The intake of water is somewhat restricted in the severely eroded Dubuque soil, however, because of surface sealing during heavy rains. A large amount of moisture runs off these soils, and some moisture is lost through deep percolation. The soils warm up quickly in spring, and farm equipment can be moved over them soon after rains. The severely eroded Dubuque soil is very low in content of organic matter and is in poor tilth. Also in poor tilth are some of the moderately eroded soils.

All of the soils of this unit are acid. The soils are low or very low in available nitrogen and low to medium in available phosphorus.

These soils are highly susceptible to further erosion and are very droughty. They are not suited to cultivated crops, but a crop of oats can be grown when a pasture is renovated. The bedrock near the surface limits the root growth of some crops. In years when the amount of rainfall is only average, these soils lack sufficient moisture for crops to make satisfactory growth.

The severely eroded Dubuque soil was formerly cultivated, but the present trend is toward using these soils for pasture. Many of the areas that are not eroded are in permanent pasture or are wooded. In those places these soils are moderately well suited to pasture, trees, and wildlife habitats.

Farm machinery can be used safely on the soils of this unit. Therefore, bluegrass pastures ought to be renovated and the areas should be seeded to more productive grasses and legumes. Oats can be grown as a cover crop. The pastures need to be clipped or grazed lightly the first year, and they should have grazing limited during dry seasons, or about midsummer. Lime, manure, and commercial fertilizer are required to help establish a stand of pasture.

CAPABILITY UNIT VIe-3

In this capability unit are steep, moderately dark colored or light-colored, well-drained soils of uplands and stream benches. The unit consists of Downs, Fayette, Orwood, and Palsgrove soils and of Loamy terrace escarpments and Loamy colluvial land. The surface layer of these soils is friable and medium textured, and their subsoil is friable and medium textured or moderately fine textured. The soils are moderately or severely eroded. The Palsgrove soil is underlain by limestone bedrock at a depth between 30 and 50 inches.

These soils are moderately permeable. The Palsgrove soil has only medium water-holding capacity, but the water-holding capacity of the other soils is high.

Runoff quickly erodes these soils, and gullies form in places when the surface is bare or is only sparsely covered by plants. The soils are porous. Only a small amount of moisture is absorbed, however, because much of the water runs off. The severely eroded Fayette soil and some of the moderately eroded soils are in poor tilth. The surface tends to seal during hard rains when it is not protected by crop residue or by a cover of plants. The steep slopes and the drainageways make the operation of farm machinery difficult on these soils.

These soils are acid. Except for the Downs, Fayette, and Palsgrove soils, they are generally low or very low in available nitrogen, phosphorus, and potassium. The Downs, Fayette, and Palsgrove soils are medium to high in available phosphorus.

The soils of this unit are not suited to cultivation and are only moderately well suited to pasture. If a pasture is renovated, the old seeding should not be destroyed. In areas where farm machinery can be used safely, the pastures need to be clipped or sprayed to destroy the weeds. The pastures need to have grazing controlled to prevent losing the cover of plants. Diversion terraces placed in some areas of these soils will protect the soils downslope.

The soils of this unit can be used for permanent pasture, as woodland, or as habitats for wildlife. Small areas that occur with soils more suitable for cultivation are excellent for wildlife habitats. The areas in trees need good management.

Lime and some fertilizer are needed on the permanent pastures. Applying a large amount of fertilizer, however, seldom pays.

CAPABILITY UNIT VIs-1

Strongly sloping, dark colored or moderately dark colored, excessively drained soils of the uplands are in this capability unit. These soils are in the Backbone, Marlean, and Nordness series, and they are shallow or very shallow over bedrock or coarse-textured material. The Marlean soil is moderately eroded. The Backbone soil has a very friable, coarse-textured surface layer, and the Marlean and Nordness soils have a medium-textured surface layer. All of these soils are underlain by fragmented or fractured limestone bedrock.

The water-holding capacity of these soils is low or very low. Permeability is moderate in the soil material above the fractured limestone or coarse-textured material, but it is generally rapid in those materials.

A large part of the moisture received through rainfall runs off these soils. Most of the water that is absorbed is lost through deep percolation. These soils warm up quickly in spring, and farm machinery can be moved over them soon after rains.

The Backbone soil is acid, but lime is not needed on the Marlean and Nordness soils. All of these soils are very low in fertility, but applying fertilizer generally does not pay.

The soils of this unit are very severely limited by droughtiness and by the strong slopes. They do not store enough moisture for crops to make satisfactory growth. The bedrock near the surface limits the growth of roots of most plants. Soil material lies between the fragments of limestone, however, in the bedrock underlying the Marlean soil. Therefore, that soil is more suitable for plants than are the other soils.

The soils of this unit are not suited to cultivation and are not well suited to pasture or trees. In places, however, adapted species of trees grow moderately well. Small areas are often left idle or are used as habitats for wildlife. Also, part of the acreage is in permanent pasture and part is wooded. In the pastures, grazing needs to be controlled and weeds and brush should be clipped or sprayed. The wooded areas need protection from grazing.

Fertilizer is needed on these soils. The soils are generally too droughty, however, for a large amount of fertilizer to be worth while.

CAPABILITY UNIT VIIe-1

Moderately steep to very steep, light-colored, well-drained soils of the uplands are in this unit. These soils are in the Dubuque, Fayette, and Whalan series. The Dubuque and Whalan soils are moderately or severely eroded. In places the soils contain gullies, and deep drainageways have cut into sidehills in places. The surface layer of these soils is friable and medium textured, and their subsoil is friable and medium textured or moderately fine textured. The Dubuque soils are underlain by limestone bedrock at a depth of only 15 to 30 inches.

The Fayette soil has high water-holding capacity. The water-holding capacity of the Dubuque and Whalan soils, however, is very low or low.

Much of the water from rainfall runs off the soils of this unit, and some surface sealing takes place in the severely eroded Dubuque and Whalan soils. Therefore, the intake of water is somewhat low. Farm equipment cannot be used safely in many of the areas.

These soils are acid and are somewhat low in fertility. Because of the difficulty of using equipment on the steep slopes and because applying fertilizer normally does not pay, lime and fertilizer generally, are not applied.

These soils are poorly suited to pasture but are suitable for trees and for wildlife habitats. The wooded areas should not be grazed. The pastured areas need to have the brush cleared and the weeds controlled. Also, grazing should be limited. Many areas of these soils are left idle and make excellent habitats for wildlife.

CAPABILITY UNIT VIIs-1

Strongly sloping or very steep soils of the uplands are in this capability unit. These soils are very shallow or shallow over bedrock. They are in the Marlean and Nordness series and include a large acreage of Steep rock land. The surface layer of the Marlean and Nordness soils is thin and is friable and medium textured. Beneath the surface layer is fragmented or fractured limestone bedrock. Little soil material is on the surface of Steep rock land, but soil material is between the fragments of limestone and in the fractures in the bedrock. In the soils of this unit, the layer of soil material is so thin that only a small amount of water is held for the use of plants.

Because of the steep slopes and shallow soil material, nearly all of the water that falls on the surface of these soils runs off. More water is absorbed by the Marlean soils, however, than is absorbed by the Nordness soil or by Steep rock land. The steep slopes restrict the size of fields and the accessibility of adjacent areas of soils. Some of the very steep areas cannot be grazed by livestock.

Use of these soils for agriculture is extremely limited. Where the pastures can be improved, however, yields of forage are fair to good. The soils are less well suited to trees than are deeper soils. The north-facing slopes and other areas of Nordness and Marlean soils have some woodland cover, and in those places the growth of timber is surprisingly good. Steep rock land has some scenic value, and an increasing number of tourists are visiting those areas each year. Some limestone quarries are located in the areas of Steep rock land and in the areas of Nordness soil. A description of typical areas of the soils of this unit is given in the description of association 6 near the front of the survey, as well as in the soil descriptions.

CAPABILITY UNIT VIIs-2

Only a miscellaneous land type, Steep sandy land, 14 to 30 percent slopes, is in this capability unit. This land type is on uplands and benches. It is coarse textured, is very rapidly permeable, and has very low water-holding capacity.

This land type is extremely droughty and low in fertility, and it is easily eroded. In many places it limits the size and use of areas of adjacent soils. In some of the areas, farm machinery cannot be safely operated.

This land type is of little value as permanent pasture, but a few areas are in trees. Grazing needs to be controlled in the pastured areas. There are a few sand pits, but the commercial value of the sand is likely to be low because the particles are too fine. Small areas of this land type are generally idle.

Predicted Yields

Table 2 gives the estimated yields of the principal crops grown in the county under a high level of management. For all estimates of yields, it is assumed that this level of management has been used for at least 10 years, and that the yields reflect the major effects of good management practices. A high level of management includes the following practices:

1. Draining wet soils adequately with tile or surface drainage.
2. Using suitable varieties of crops.
3. Effectively controlling weeds, diseases, and insects.
4. Controlling erosion.
5. Planting the amount of seed that will produce a plant population no greater than the available moisture will support.
6. Applying the kinds and amounts of fertilizer indicated by the results of soil tests so that the soil reaches the levels of fertilization and reaction approaching those suggested by the soil testing laboratory of the Iowa State University.
7. Planting, cultivating, and harvesting at the proper time.
8. Planting alfalfa and bromegrass or orchardgrass for hay on suitable soils, to obtain three cuttings a year.

TABLE 2.—*Management and yield data for soils*

[Dashed lines indicate that the crop is not suited to the soil or is not generally grown on it]

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Ab	Alluvial land	Very wet and subject to frequent flooding and some ponding and channeling; has a high water table; slow runoff.	Row crops where feasible or long-term meadow.[2]	Protection from flooding.	62	22	47	2.5	125
Ar	Arenzville silt loam	Occasional flooding	Intensive row cropping.[3]	Protection from flooding.	85	30	64	3.4	170
AtB	Atkinson loam, 2 to 5 percent slopes.	Slightly erodible: somewhat limited root zone.	RROMM [4]	None	82	29	62	3.3	165
			RRROM	Contouring	82	29	62	3.3	165
			Intensive row cropping.	Terracing	82	29	62	3.3	165
AyA	Atterberry silt loam, 1 to 4 percent slopes.	Slightly wet; has a water table at variable depths.	Intensive row cropping.	Some tile drainage.	96	34	72	3.8	190
BaB	Backbone loamy sand, 2 to 5 percent slopes.	Very droughty; slightly erodible; limited root zone; low in fertility.	ROMM	Mulch tillage	50	18	37	2.0	100
			RROM	Contouring and mulch tillage.	50	18	37	2.0	100
BaC	Backbone loamy sand, 5 to 9 percent slopes.	Very droughty; moderately erodible; limited root zone; low in fertility.	Hay or pasture	None	----	----	----	1.7	89
			ROMMM	Contouring and mulch tillage.	42	15	32	1.7	89
			RROMM	Stripcropping and mulch tillage.	42	15	32	1.7	89
BaD	Backbone loamy sand, 9 to 14 percent slopes.	Very droughty; highly erodible; limited root zone; low in fertility.	Permanent pasture.[5]	Controlled grazing.	----	----	----	1.2	60
BeA	Bassett loam, 0 to 2 percent slopes.	Slightly wet in some years.	Intensive row cropping.	Some tile drainage.	91	32	68	3.6	180

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
BeB	Bassett loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	86	30	65	3.4	170
			RRROM	Contouring	86	30	65	3.4	170
			Intensive row cropping.	Terracing	86	30	65	3.4	170
BeC	Bassett loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	78	27	58	3.1	155
			RROMM	Contouring	78	27	58	3.1	155
			RRROM	Terracing or stripcropping.	78	27	58	3.1	155
BeC2	Bassett loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	73	25	55	2.9	145
			RROMM	Contouring	73	25	55	2.9	145
			RROM [6]	Terracing or stripcropping.	73	25	55	2.9	145
BlB	Bassett silt loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	88	31	66	3.5	175
			RRROM	Contouring	88	31	66	3.5	175
			Intensive row cropping.	Terracing	88	31	66	3.5	175
BlC	Bassett silt loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	80	28	60	3.2	160
			RROMM	Contouring	80	28	60	3.2	160
			RRROM	Terracing or stripcropping.	80	28	60	3.2	160
BnA	Bertrand silt loam, 0 to 2 percent slopes.	None	Intensive row cropping.	None	94	33	71	3.8	190
BnB	Bertrand silt loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	89	31	67	3.5	175
			RRROM	Contouring	89	31	67	3.5	175
			Intensive row cropping.	Terracing	89	31	67	3.5	175
BoA	Bixby loam, 0 to 2 percent slopes.	Limited root zone; slightly droughty.	Intensive row cropping.	None	77	27	58	3.1	155
BoB	Bixby loam, 2 to 5 percent slopes.	Slightly erodible; limited root zone; slightly droughty.	RROM	None	72	25	54	2.9	145
			RRROx	Contouring	72	25	54	2.9	145
BoC2	Bixby loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	----	----	---	2.4	120
			RROMMM	Contouring	60	21	45	2.4	120
			RROM [6]	Terracing or stripcropping.	60	21	45	2.4	120
BuB	Burkhardt soils, 0 to 5 percent slopes.	Very droughty; slightly erodible; low in fertility.	ROMM	Mulch tillage	42	15	32	1.7	89
			RROMM	Contouring and mulch tillage.	42	15	32	1.7	89
BuC2	Burkhardt soils, 5 to 14 percent slopes, moderately eroded.	Very droughty; moderately erodible; low in fertility.	Hay or pasture	None	----	----	---	1.3	65
			ROMMM	Contouring and mulch tillage.	32	11	24	1.3	65
			RROMMM	Stripcropping and mulch tillage.	32	11	24	1.3	65
CaA	Calamine silty clay loam, 0 to 2 percent slopes.	Very wet; seepy; has a high perched water table; somewhat limited root zone.	RRROx	Tile drainage in places.	66	23	49	2.6	130
CaB	Calamine silty clay loam, 2 to 5 percent slopes.	Very wet; seepy; has a high perched water table; slightly erodible; somewhat limited root zone.	RROM	Tile drainage in places.	64	22	48	2.6	130
			RRROx	Contouring and drainage.	64	22	48	2.6	130

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
CcB	Calmar clay loam, 2 to 5 percent slopes.	Slightly erodible	RROMM RRROM Intensive row cropping.	None Contouring Terracing	80 80 80	28 28 28	60 60 60	3.2 3.2 3.2	160 160 160
CcC	Calmar clay loam, 5 to 14 percent slopes.	Moderately erodible	Long-term meadow. ROMMM	None Terracing or stripcropping.	---- 68	---- 24	---- 51	2.7 2.7	135 135
CdA	Camden silt loam, 0 to 2 percent slopes.	Somewhat limited root zone.	Intensive row cropping.	None	82	29	61	3.3	165
CdB	Camden silt loam, 2 to 5 percent slopes.	Slightly erodible; somewhat limited root zone.	RROM RRROx Intensive row cropping.	None Contouring Terracing	76 76 76	27 27 27	57 57 57	3.0 3.0 3.0	150 150 150
CdC	Camden silt loam, 5 to 9 percent slopes.	Moderately erodible; somewhat limited root zone.	ROMMM RROMMM RROM [6]	None Contouring Terracing or stripcropping.	70 70 70	24 24 24	52 52 52	2.8 2.8 2.8	140 140 140
Ce	Caneek silt loam	Moderately wet; has a variable water table; occasionally flooded; slow runoff.	Intensive row cropping.	Some tile drainage; protection from overflow.	84	30	63	3.4	170
Cf	Canoe silt loam (0 to 3 percent slopes).	Slightly wet; has a variable water table.	Intensive row cropping.	Some tile drainage.	93	33	70	3.7	185
ChA	Chaseburg silt loam, 0 to 2 percent slopes.	Occasionally flooded	Intensive row cropping.	Some diversion terraces.	82	29	61	3.3	165
ChB	Chaseburg silt loam, 2 to 5 percent slopes.	Slightly erodible; occasionally flooded.	RRROM RRROx Intensive row cropping.	None Contouring Some diversion terraces.	80 80 80	28 28 28	60 60 60	3.2 3.2 3.2	160 160 160
ClB	Chelsea loamy fine sand, 1 to 5 percent slopes.	Very droughty; slightly erodible; low in fertility.	ROM RROM	Mulch tillage Contouring and mulch tillage.	45 45	15 15	33 33	1.8 1.8	90 90
ClD	Chelsea loamy fine sand, 5 to 14 percent slopes.	Very droughty; moderately erodible; low in fertility.	Hay or pasture ROMMM RROMM	None Contouring and mulch tillage. Stripcropping and mulch tillage.	---- 30 30	---- ---- ----	---- 23 23	1.2 1.2 1.2	60 60 60
CmB	Clyde silt loam, 0 to 4 percent slopes.	Very wet; has a high water table; contains some stones.	Intensive row cropping.	Tile drainage	78	27	58	3.1	155
CoB	Coggon loam, 2 to 5 percent slopes.	Slightly erodible	RROM RRROM Intensive row cropping.	None Contouring Terracing	78 78 78	27 27 27	58 58 58	3.1 3.1 3.1	155 155 155
CoC2	Coggon loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMMM RROMM RROM [6]	None Contouring Terracing or stripcropping.	68 68 68	24 24 24	51 51 51	2.7 2.7 2.7	135 135 135

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Cs	Colo and Otter silt loams	Very wet; has a high water table; occasionally flooded; slow runoff.	Intensive row cropping.	Tile drainage; protection from overflow.	80	28	60	3. 2	160
Ct	Colo-Otter-Ossian complex (0 to 4 percent slopes).	Very wet; occasionally flooded; has a high water table.	Intensive row cropping.	Tile drainage; protection from flooding.	85	30	64	3. 4	170
DcA	Dickinson sandy loam, 0 to 2 percent slopes.	Moderately droughty	Intensive row cropping.	Mulch tillage	70	24	52	2. 8	140
DcB	Dickinson sandy loam, 2 to 5 percent slopes.	Slightly erodible; moderately droughty.	ROMM	Mulch tillage	65	23	48	2. 6	130
			RRROx	Contouring and mulch tillage.	65	23	48	2. 6	130
			Intensive row cropping.	Terracing and mulch tillage.	65	23	48	2. 6	130
DcC	Dickinson sandy loam, 5 to 9 percent slopes.	Moderately erodible; moderately droughty.	ROMMM	Mulch tillage	58	20	43	2. 3	115
			ROM	Contouring and mulch tillage.	58	20	43	2. 3	115
			RROM [6]	Terracing or stripcropping and mulch tillage.	58	20	43	2. 3	115
DcD	Dickinson sandy loam, 9 to 14 percent slopes.	Very erodible; moderately droughty.	Hay or pasture	None	----	----	----	2. 0	100
			ROMMM	Terracing or stripcropping and mulch tillage.	50	----	37	2. 0	100
DdB	Donnan loam, 2 to 5 percent slopes.	Slightly erodible; slightly wet in some years.	RROMM	None	70	24	52	2. 8	140
			RRROM	Contouring	70	24	52	2. 8	140
De	Dorchester silt loam	Occasionally flooded	Intensive row cropping.	Protection from overflow.	86	30	65	3. 4	170
DgB	Dorchester-Chaseburg-Volney complex, 2 to 5 percent slopes.	Occasionally flooded	RRROM	None	78	27	58	3. 1	155
			RRROx	Contouring	78	27	58	3. 1	155
			Intensive row cropping.	Some diversion terraces.	78	27	58	3. 1	155
DhE3	Dow silt loam, 14 to 24 percent slopes, severely eroded.	Extremely erodible; in poor tilth; low in fertility.	Permanent pasture.[5]	Controlled grazing.	----	----	----	2. 0	100
DoA	Downs silt loam, 0 to 2 percent slopes.	None	Intensive row cropping.	None	98	34	73	3. 9	195
DoB	Downs silt loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	93	33	70	3. 7	185
			RRROM	Contouring	93	33	70	3. 7	185
			Intensive row cropping.	Terracing	93	33	70	3. 7	185
DoC	Downs silt loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	88	31	66	3. 5	175
			RROMM	Contouring	88	31	66	3. 5	175
			RRROM	Terracing or stripcropping.	88	31	66	3. 5	175
DoD	Downs silt loam, 9 to 14 percent slopes.	Highly erodible	Long-term meadow.	None	----	----	----	3. 2	160
			ROMMM	Contouring	80	----	60	3. 2	160
			RROMMM	Terracing or stripcropping.	80	----	60	3. 2	160

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
DoE2	Downs silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	----	----	----	2. 7	135
			ROMMM	Stripcropping	68	----	51	2. 7	135
DoF2	Downs silt loam, 18 to 24 percent slopes, moderately eroded.	Extremely erodible	Permanent pasture.[5]	Controlled grazing	----	----	----	2. 0	100
DtB	Downs and Tama silt loams, 2 to 5 percent slopes.	Slightly erodible	RROM	None	95	33	72	3. 8	190
			RRROM	Contouring	95	33	72	3. 8	190
			Intensive row cropping.	Terracing	95	33	72	3. 8	190
DtC	Downs and Tama silt loams, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	90	31	67	3. 6	180
			RROMM	Contouring	90	31	67	3. 6	180
			RRROM	Terracing or stripcropping.	90	31	67	3. 6	180
DtC2	Downs and Tama silt loams, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	88	31	66	3. 5	175
			RROMM	Contouring	88	31	66	3. 5	175
			RRROM	Terracing or stripcropping.	88	31	66	3. 5	175
DtD2	Downs and Tama silt loams, 9 to 14 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	----	----	----	3. 3	165
			ROMMM	Contouring	82	----	61	3. 3	165
			ROM	Terracing	82	----	61	3. 3	165
			RROMMM	Stripcropping	82	----	61	3. 3	165
DuC2	Dubuque silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	----	----	----	2. 4	120
			ROMM	Contouring	60	21	45	2. 4	120
			ROMM [6]	Terracing or stripcropping.	60	21	45	2. 4	120
DuD2	Dubuque silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture	None	----	----	----	2. 1	105
			ROMMMM	Stripcropping	52	----	39	2. 1	105
DuD3	Dubuque silt loam, 9 to 14 percent slopes, severely eroded.	Highly erodible; limited root zone; in poor tilth; low in fertility; slightly droughty.	Permanent pasture.[5]	Controlled grazing.	----	----	----	1. 4	70
DuE2	Dubuque silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Permanent pasture.[5]	Controlled grazing.	----	----	----	1. 8	90
DuE3	Dubuque silt loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; in poor tilth; low in fertility; limited root zone; slightly droughty.	Permanent pasture.[5]	Limited grazing	----	----	----	1. 2	60
DuF2	Dubuque silt loam, 18 to 30 percent slopes, moderately eroded.	Extremely erodible; limited root zone; slightly droughty.	Permanent pasture.[5]	Limited grazing	----	----	----	1. 2	60
FaA	Fayette silt loam, 0 to 2 percent slopes.	None	Intensive row cropping.	None	96	34	72	3. 8	190
FaB	Fayette silt loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	91	32	68	3. 6	180
			RRROM	Contouring	91	32	68	3. 6	180
			Intensive row cropping.	Terracing	91	32	68	3. 6	180

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
FaC2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	82	29	61	3.2	160
			RROMM	Contouring	82	29	61	3.2	160
			RRROM	Terracing or stripcropping.	82	29	61	3.2	160
FaC3	Fayette silt loam, 5 to 9 percent slopes, severely eroded.	Moderately erodible; in poor tilth; low in fertility.	ROMMM	None	78	27	58	3.1	155
			RROMM	Contouring	78	27	58	3.1	155
			RROM [6]	Terracing or stripcropping.	78	27	58	3.1	155
FaD2	Fayette silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	-----	-----	-----	3.0	150
			ROMMM	Contouring	74	-----	56	3.0	150
			RROMMM	Terracing or stripcropping.	74	-----	56	3.0	150
FaD3	Fayette silt loam, 9 to 14 percent slopes, severely eroded.	Highly erodible; in poor tilth; low in fertility.	Long-term meadow.	None	-----	-----	-----	2.8	140
			ROMM	Terracing or stripcropping.	70	-----	52	2.8	140
FaE2	Fayette silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	-----	-----	-----	2.6	130
			ROMMMM	Stripcropping	66	-----	49	2.6	130
FaE3	Fayette silt loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; in poor tilth; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	-----	2.3	115
FaF2	Fayette silt loam, 18 to 24 percent slopes, moderately eroded.	Extremely erodible	Permanent pasture.[5]	Controlled grazing.	-----	-----	-----	1.6	80
FaF3	Fayette silt loam, 18 to 24 percent slopes, severely eroded.	Extremely erodible; in poor tilth; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	-----	1.5	75
FaG	Fayette silt loam, 24 to 35 percent slopes.	Extremely erodible	Permanent pasture.[5]	Limited grazing	-----	-----	-----	1.4	70
FeA	Festina silt loam, 0 to 2 percent slopes.	None	Intensive row cropping.	None	98	34	73	3.9	195
FeB	Festina silt loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	93	33	70	3.7	185
			RRROM	Contouring	93	33	70	3.7	185
			Intensive row cropping.	Terracing	93	33	70	3.7	185
FlB	Floyd loam, 0 to 5 percent slopes.	Moderately wet; has a variable water table.	Intensive row cropping.	Tile drainage and contouring.	86	30	65	3.4	170
FmB	Floyd-Clyde complex, 0 to 4 percent slopes.	Moderately wet to very wet; has a high water table; contains stones in places.	Intensive row cropping.	Tile drainage and removal of stones in places.	82	29	61	3.3	165
FnB	Franklin silt loam, gray subsoil variant, 2 to 5 percent slopes.	Slightly erodible; slightly wet; has a variable water table.	RROMM	Some tile drainage	80	28	60	3.2	160
			RRROM	Contouring and drainage.	80	28	60	3.2	160
			Intensive row cropping.	Terracing and drainage.	80	28	60	3.2	160

See footnotes at end of table.

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TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
FrC	Frankville silt loam, 5 to 9 percent slopes.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	----	----	----	2.7	135
			ROMMM	Contouring	67	24	50	2.7	135
			ROMM [6]	Terracing or stripcropping.	67	24	50	2.7	135
FrD2	Frankville silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture	None	----	----	----	2.2	110
			ROMMMM	Stripcropping	55	----	41	2.2	110
FrE2	Frankville silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Permanent pasture.[5]	Controlled grazing	----	----	30	1.9	95
HaA	Hagener loamy sand, 0 to 2 percent slopes.	Very droughty; low in fertility.	RROMM	Mulch tillage	55	19	41	2.2	110
HaB	Hagener loamy sand, 2 to 5 percent slopes.	Very droughty; slightly erodible; low in fertility.	ROM	Mulch tillage	50	18	37	2.0	100
			RROM	Contouring and mulch tillage.	50	18	37	2.0	100
HaD	Hagener loamy sand, 5 to 14 percent slopes.	Very droughty; slightly erodible; low in fertility.	Hay or pasture	None	----	----	----	1.6	80
			ROMMM	Contouring and mulch tillage.	40	----	30	1.6	80
			RROMM	Stripcropping and mulch tillage.	40	----	30	1.6	80
HdA	Hayfield loam, deep, 0 to 3 percent slopes.	Slightly wet; has a variable water table.	Intensive row cropping.	Some tile drainage	88	31	66	3.5	175
HmA	Hayfield loam, moderately deep, 0 to 4 percent slopes.	Limited root zone; occasionally droughty; has a variable water table.	Intensive row cropping.	None	80	28	60	3.2	160
HuA	Huntsville silt loam, 0 to 2 percent slopes.	Occasionally flooded	Intensive row cropping.	Protection from overflow.	92	32	69	3.7	185
HuB	Huntsville silt loam, 2 to 6 percent slopes.	Slightly erodible; occasionally flooded.	RROM	Protection from overflow.	89	31	67	3.5	175
			RRROx	Contouring and protection from overflow; some diversion terraces.	89	31	67	3.5	175
JaA	Jacwin loam, 0 to 2 percent slopes.	Moderately wet; has a perched water table; seepy in places.	Intensive row cropping.	Some tile drainage	72	25	54	2.9	145
			RRROM	Some tile drainage	72	25	54	2.9	145
JaB	Jacwin loam, 2 to 5 percent slopes.	Slightly erodible; slightly wet; has a perched table; seepy in places.	RROMM	Some tile drainage	68	24	52	2.7	135
			RRROM	Contouring and tile drainage.	68	24	52	2.7	135
JaC	Jacwin loam, 5 to 9 percent slopes.	Moderately erodible; slightly wet; has a perched water table; seepy in places.	ROMMMM	Some tile drainage	62	22	47	2.5	125
			ROMM	Contouring and tile drainage.	62	22	47	2.5	125
			RROMM	Terracing or stripcropping and tile drainage.	62	22	47	2.5	125
JaD	Jacwin loam, 9 to 14 percent slopes.	Highly erodible; slightly wet; has a perched water table; seepy in places.	Hay or pasture	None	----	----	----	2.2	110
			ROMMMM	Stripcropping and tile drainage.	54	----	40	2.2	110

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
KaA	Kato loam, moderately deep, 0 to 4 percent slopes.	Limited root zone; slightly droughty; has a variable water table.	Intensive row cropping.	None	82	29	61	3.3	165
KdA	Kato loam, deep, 0 to 4 percent slopes.	Moderately wet; has a variable water table.	Intensive row cropping.	Some tile drainage	90	31	67	3.6	180
KsB	Kato loam, deep, clay shale substratum, 1 to 5 percent slopes.	Moderately wet; has a variable water table.	Intensive row cropping.	Some tile drainage	86	30	65	3.4	170
KsC	Kato loam, deep, clay shale substratum, 5 to 9 percent slopes.	Moderately erodible; slightly wet; has a variable water table.	ROMMMM	Some tile drainage	70	24	52	2.8	140
			ROMM	Contouring and tile drainage.	70	24	52	2.8	140
			RROMM	Terracing or stripcropping and tile drainage.	70	24	52	2.8	140
KyB	Kenyon loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	88	31	66	3.5	175
			RRROM	Contouring	88	31	66	3.5	175
			Intensive row cropping.	Terracing	88	31	66	3.5	175
LaB	Lamont sandy loam, 1 to 5 percent slopes.	Slightly erodible; moderately droughty; low in fertility.	RROMM	Mulch tillage	60	21	45	2.4	120
			RRROx	Contouring and mulch tillage.	60	21	45	2.4	120
			Intensive row cropping.	Terracing or stripcropping and mulch tillage.	60	21	45	2.4	120
LaC	Lamont sandy loam, 5 to 9 percent slopes.	Moderately erodible; moderately droughty; low in fertility.	ROMMM	Mulch tillage	52	18	39	2.1	105
			ROM	Contouring and mulch tillage.	52	18	39	2.1	105
			RROM[6]	Terracing or stripcropping and mulch tillage.	52	18	39	2.1	105
LaD	Lamont sandy loam, 9 to 14 percent slopes.	Highly erodible; moderately droughty; low in fertility.	Hay or pasture	None	-----	-----	-----	1.8	90
			ROMMM	Terracing or stripcropping and mulch tillage.	44	-----	33	1.8	90
LdB	Lamont sandy loam, till subsoil variant, 2 to 9 percent slopes.	Slightly erodible; slightly droughty.	RROM	Mulch tillage	70	24	52	2.8	140
			RRROx	Contouring and mulch tillage.	70	24	52	2.8	140
LkA	Lawson and Kennebec silt loams, 0 to 2 percent slopes.	Slightly wet; occasionally flooded.	Intensive row cropping.	Some tile drainage	88	31	66	3.5	175
LmB	Lawson silt loam, 2 to 5 percent slopes.	Slightly erodible; slightly wet; occasionally flooded.	RRROM	Some tile drainage	85	30	64	3.4	170
			RRROx	Contouring and some tile drainage.	85	30	64	3.4	170
LnE	Loamy colluvial land, 9 to 18 percent slopes.	Highly erodible	Long-term meadow.	None	-----	-----	-----	2.6	130
			ROMMMM	Stripcropping; diversion terraces.	65	-----	48	2.6	130
LnF	Loamy colluvial land, 18 to 24 percent slopes.	Extremely erodible	Permanent pasture.[5]	Controlled grazing; diversion terraces.	-----	-----	-----	1.5	75

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
LoF	Loamy terrace escarpments, 16 to 30 percent slopes.	Extremely erodible; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	1. 2	60
MaB	Marlean loam, 2 to 5 percent slopes.	Shallow but variable root zone; very droughty; slightly erodible; low in fertility.	Hay and pasture ROMMM RROMM	None Contouring Stripcropping	----- 50 50	----- 18 18	---- 37 37	2. 0 2. 0 2. 0	100 100 100
MaC	Marlean loam, 5 to 9 percent slopes.	Shallow but variable root zone; very droughty; moderately erodible; low in fertility.	Hay and pasture ROMMMM	None Stripcropping	----- 42	----- 15	---- 32	1. 7 1. 7	89 89
MaC2	Marlean loam, 5 to 9 percent slopes, moderately eroded.	Shallow but variable root zone; very droughty; moderately erodible; low in fertility.	Hay and pasture ROMMMM	None Stripcropping	----- 38	----- 13	---- 28	1. 5 1. 5	75 75
MaD2	Marlean loam, 9 to 14 percent slopes, moderately eroded.	Shallow but variable root zone; very droughty; very erodible; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	1. 6	80
MaD3	Marlean loam, 9 to 14 percent slopes, severely eroded.	Shallow but variable root zone; very droughty; very erodible; low in fertility; in poor tilth.	Permanent pasture.[5]	Limited grazing	-----	-----	----	1. 0	50
MaE2	Marlean loam, 14 to 24 percent slopes, moderately eroded.	Highly erodible; shallow but variable root zone; very droughty; low in fertility.	Permanent pasture.[5]	Limited grazing	-----	-----	----	1. 2	60
MaE3	Marlean loam, 14 to 24 percent slopes, severely eroded.	Extremely erodible; shallow but variable root zone; very droughty; low in fertility.	Permanent pasture.[5]	Limited grazing	-----	-----	----	. 8	40
NaC2	Nasset silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; somewhat limited root zone.	ROMMMM RROMMM RROM [6]	None Contouring Terracing or stripcropping.	72 72 72	25 25 25	54 54 54	2. 9 2. 9 2. 9	145 145 145
NaD2	Nasset silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; somewhat limited root zone.	Long-term meadow. ROMMM	None Terracing or stripcropping.	----- 64	----- -----	---- 48	2. 6 2. 6	130 130
NaE2	Nasset silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible; somewhat limited root zone.	Long-term meadow. ROMMMM	None Stripcropping	----- 56	----- -----	---- 42	2. 2 2. 2	110 110
NoD	Nordness silt loam, 5 to 14 percent slopes.	Shallow root zone; very droughty; highly erodible; low in fertility.	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	1. 2	60

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
NoE	Nordness silt loam, 14 to 24 percent slopes.	Shallow root zone; very droughty; extremely erodible; low in fertility.	Permanent pasture.[5]	Limited grazing	----	----	----	.5	25
OrA	Oran loam, 0 to 2 percent slopes.	Moderately wet; has a variable water table.	Intensive row cropping.	Some tile drainage	88	31	66	3.5	175
OrB	Oran loam, 2 to 5 percent slopes.	Slightly erodible; slightly wet; has a variable water table.	RROMM	Some tile drainage	83	29	62	3.3	165
			RRROM	Contouring and some tile drainage.	83	29	62	3.3	165
			Intensive row cropping.	Terracing and some tile drainage.	83	29	62	3.3	165
OsB	Orwood silt loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	90	31	67	3.6	180
			RRROM	Contouring	90	31	67	3.6	180
			Intensive row cropping.	Terracing	90	31	67	3.6	180
OsC2	Orwood silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	80	28	60	3.2	160
			RROMM	Contouring	80	28	60	3.2	160
			RRROM	Terracing or stripcropping.	80	28	60	3.2	160
OsD2	Orwood silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	----	----	----	2.9	145
			ROMMMM	Contouring	72	----	54	2.9	145
			ROMM [6]	Terracing or stripcropping.	72	----	54	2.9	145
OsE2	Orwood silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible	Long-term meadow	None	----	----	----	2.6	130
			ROMMMM	Stripcropping	66	----	49	2.6	130
OsE3	Orwood silt loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; low in fertility.	Permanent pasture.[5]	Controlled grazing.	----	----	----	2.2	110
OsF2	Orwood silt loam, 18 to 30 percent slopes, moderately eroded.	Extremely erodible	Permanent pasture.[5]	Controlled grazing.	----	----	----	1.6	80
Ot	Ossian silt loam	Very wet; occasionally flooded; has a high water table; slow runoff.	Intensive row cropping.	Tile drainage; protection from flooding.	78	27	58	3.1	155
OuA	Ostrander loam, 0 to 2 percent slopes.	None	Intensive row cropping.	None	95	33	72	3.8	190
OuB	Ostrander loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	90	31	67	3.6	180
			RRROM	Contouring	90	31	67	3.6	180
			Intensive row cropping.	Terracing	90	31	67	3.6	180
OuC	Ostrander loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	85	30	64	3.4	170
			RROMM	Contouring	85	30	64	3.4	170
			RRROM	Terracing or stripcropping.	85	30	64	3.4	170
OvB	Otter-Lawson-Ossian complex, 1 to 4 percent slopes.	Very wet to moderately wet; occasionally flooded; has a variable water table.	Intensive row cropping.	Tile drainage	87	31	66	3.5	175

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Ow	Otter-Ossian complex	Very wet; occasionally flooded; has a high water table; slow runoff.	Intensive row cropping.	Tile drainage; protection from flooding.	86	30	65	3. 4	170
Ox	Otter and Ossian silt loams, overwashed.	Very wet; occasionally to frequently flooded; has a high water table.	Intensive row cropping.	Protection from overflow; tile drainage.	84	30	65	3. 4	170
PaC2	Palsgrove silt loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; somewhat limited root zone.	Long-term meadow.	None	----	----	----	2. 7	135
			ROMM	Contouring	68	24	51	2. 7	135
			RROMM	Terracing or stripcropping.	68	24	51	2. 7	135
PaD2	Palsgrove silt loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; somewhat limited root zone.	Long-term meadow.	None	----	----	----	2. 4	120
			ROMMM	Terracing or stripcropping.	60	----	45	2. 4	120
PaD3	Palsgrove silt loam, 9 to 14 percent slopes, severely eroded.	Highly erodible; somewhat limited root zone; in poor tilth; low in fertility.	Long-term meadow.	None	----	----	----	2. 0	100
			ROMMMM	Terracing or stripcropping.	50	----	37	2. 0	100
PaE2	Palsgrove silt loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible; somewhat limited root zone.	Long-term meadow.	None	----	----	----	2. 1	115
			ROMMMM	Stripcropping	52	----	39	2. 1	115
PaE3	Palsgrove silt loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; somewhat limited root zone; in poor tilth; low in fertility.	Permanent pasture. [5]	Controlled grazing.	----	----	----	1. 8	90
PaF2	Palsgrove silt loam, 18 to 24 percent slopes, moderately eroded.	Extremely erodible; somewhat limited root zone.	Permanent pasture. [5]	Controlled grazing.	----	----	----	1. 0	50
Pk	Peaty muck	Very wet, has a high water table; subject to ponding, and there is a frost hazard; low in fertility.	Intensive row cropping.	Tile drainage and surface drainage.	60	21	45	2. 4	120
Pw	Peaty muck, overwashed.	Very wet; has a variable water table; subject to overflow.	Intensive row cropping.	Tile drainage or surface drainage and protection from overflow.	65	23	48	2. 6	130
RaA	Racine loam, 0 to 2 percent slopes.	None	Intensive row cropping.	None	92	32	69	3. 7	185
RaB	Racine loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	88	31	66	3. 5	175
			RRROM	Contouring	88	31	66	3. 5	175
			Intensive row cropping.	Terracing	88	31	66	3. 5	175
RaC	Racine loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	80	28	60	3. 2	160
			RROMM	Contouring	80	28	60	3. 2	160
			RRROM	Terracing or stripcropping.	80	28	60	3. 2	160
RaC2	Racine loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMM	None	76	27	57	3. 0	150
			RROMM	Contouring	76	27	57	3. 0	150
			RRROM	Terracing or stripcropping.	76	27	57	3. 0	150

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
RaD2	Racine loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	-----	-----	-----	2.7	135
			ROMMMM	Contouring	68	-----	51	2.7	135
			ROMM [6]	Terracing or stripcropping.	68	-----	51	2.7	135
ReB	Renova loam, 2 to 5 percent slopes.	Slightly erodible	RROM	None	85	30	64	3.4	170
			RRROM	Contouring	85	30	64	3.4	170
			Intensive row cropping.	Terracing	85	30	64	3.4	170
ReC	Renova loam, 5 to 9 percent slopes.	Moderately erodible	ROMM	None	76	27	57	3.0	150
			RROMM	Contouring	76	27	57	3.0	150
			RRROM	Terracing or stripcropping.	76	27	57	3.0	150
ReC2	Renova loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible	ROMMM	None	72	25	54	2.9	145
			RROMM	Contouring	72	25	54	2.9	145
			RROM [6]	Terracing or stripcropping.	72	25	54	2.9	145
ReD2	Renova loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	-----	-----	-----	2.6	130
			ROMMMM	Contouring	64	-----	48	2.6	130
			ROMM [6]	Terracing or stripcropping.	64	-----	48	2.6	130
ReD3	Renova loam, 9 to 14 percent slopes, severely eroded.	Highly erodible; in poor tilth; low in fertility.	Long-term meadow.	None	-----	-----	-----	2.2	110
			ROMMMM	Terracing or stripcropping.	56	-----	42	2.2	110
ReE2	Renova loam, 14 to 18 percent slopes, moderately eroded.	Highly erodible	Long-term meadow.	None	-----	-----	-----	2.2	110
			ROMMMM	Stripcropping	56	-----	42	2.2	110
ReE3	Renova loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; in poor tilth; low in fertility.	Permanent pasture [5]	Controlled grazing.	-----	-----	-----	1.8	90
RfB	Riceville loam, 2 to 7 percent slopes.	Slightly erodible; slightly wet; has a variable water table.	RROMM	Some tile drainage.	82	29	61	3.3	165
			RRROM	Contouring and drainage.	82	29	61	3.3	165
			Intensive row cropping.	Terracing and drainage.	82	29	61	3.3	165
RkA	Rockton loam, 0 to 2 percent slopes.	Limited root zone; slightly droughty.	Intensive row cropping.	None	81	28	61	3.2	160
RkB	Rockton loam, 2 to 5 percent slopes.	Slightly erodible; limited root zone; slightly droughty.	ROMM	None	74	26	56	3.0	150
			RROM	Contouring	74	26	56	3.0	150
RkC	Rockton loam, 5 to 9 percent slopes.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	-----	-----	-----	2.6	130
			ROMMM	Contouring	66	23	49	2.6	130
			ROMM [6]	Terracing or stripcropping.	66	23	49	2.6	130
RkD	Rockton loam, 9 to 14 percent slopes.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture	None	-----	-----	-----	2.3	115
			ROMMMM	Stripcropping	58	-----	43	2.3	115
RoA	Rowley silt loam, 0 to 4 percent slopes.	Slightly wet; has a variable water table.	Intensive row cropping.	Some tile drainage.	95	33	72	3.8	190

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Rw	Rowley and Lawson silt loams, overwashed.	Slightly wet; occasionally flooded.	Intensive row cropping.	Protection from overflow and some tile drainage.	90	31	67	3.6	180
SdA	Sattre loam, moderately deep, 0 to 2 percent slopes.	Slightly droughty; limited root zone.	Intensive row cropping.	None	78	27	58	3.1	155
SdB	Sattre loam, moderately deep, 2 to 5 percent slopes.	Slightly erodible; limited root zone; slightly droughty.	RROM RRROx	None Contouring	72 72	25 25	54 54	2.9 2.9	145 145
SdC2	Sattre loam, moderately deep, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; limited root zone; slightly droughty.	ROMMM RROMMM RROM [6]	None Contouring Terracing or stripcropping.	62 62 62	22 22 22	47 47 47	2.5 2.5 2.5	125 125 125
SdD2	Sattre loam, moderately deep, 9 to 14 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture ROMMM	None Terracing or stripcropping.	---- 52	---- ----	---- 39	2.1 2.1	105 105
SbA	Sattre loam, deep, 0 to 2 percent slopes.	Somewhat limited root zone.	Intensive row cropping.	None	85	30	64	3.4	170
SbB	Sattre loam, deep, 2 to 5 percent slopes.	Slightly erodible; somewhat limited root zone.	RROM RRROx Intensive row cropping.	None Contouring Terracing	80 80 80	28 28 28	60 60 60	3.2 3.2 3.2	160 160 160
SbC2	Sattre loam, deep, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; somewhat limited root zone.	ROMMM RROMMM RROM [6]	None Contouring Terracing or stripcropping.	72 72 72	25 25 25	54 54 54	2.9 2.9 2.9	145 145 145
Sp	Spillville loam	Occasionally flooded	Intensive row cropping.	Protection from flooding.	88	31	66	3.5	175
Sr	Steep rock land	Rocky; very low in fertility; very limited root zone; very droughty.	Permanent pasture.[5]	Very limited grazing.	----	----	----	.5	25
SsF	Steep sandy land, 14 to 30 percent slopes.	Very droughty; extremely erodible; very low in fertility.	Permanent pasture.[5]	Very limited grazing.	----	----	----	.5	25
TeA	Terril loam, 0 to 2 percent slopes.	Occasionally flooded	Intensive row cropping.	Protection from overflow.	90	31	67	3.6	180
TeB	Terril loam, 2 to 5 percent slopes.	Slightly erodible; occasionally flooded.	RROM RRROx	Protection from overflow. Contouring and protection from overflow; some diversion terraces.	87 87	30 30	66 66	3.4 3.4	170 170
TgA	Turlin gritty silt loam, 0 to 2 percent slopes.	Slightly wet; occasionally flooded.	Intensive row cropping	Protection from flooding; some tile drainage.	87	31	66	3.5	175

See footnotes at end of table.

TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soy-beans	Oats	Hay	Pas-ture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
TgB	Turlin gritty silt loam, 2 to 5 percent slopes.	Slightly erodible; slightly wet; occasionally flooded.	RRROM	Some tile drainage.	84	30	63	3.4	170
			RRROx	Contouring and tile drainage.	84	30	63	3.4	170
VcA	Volney channery silt loam, 0 to 1 percent slopes.	Occasionally flooded; contains many fragments of limestone; droughty in a few places.	Intensive row cropping.	Protection from overflow.	70	24	52	2.8	140
VcB	Volney channery silt loam, 2 to 5 percent slopes.	Slightly erodible; contains many fragments of limestone; droughty in a few places.	RRROM	None	68	24	51	2.7	135
			RRROx	Contouring and diversion terraces in places.	68	24	51	2.7	135
VoA	Volney silt loam, overwashed, 0 to 1 percent slopes.	Occasionally flooded	Intensive row cropping.	Protection from overflow.	75	26	56	3.0	150
VoB	Volney silt loam, overwashed, 2 to 5 percent slopes.	Slightly erodible; occasionally flooded.	RRROM	Protection from overflow.	72	25	54	2.9	145
			RRROx	Contouring or diversion terraces in places.	72	25	54	2.9	145
WcA	Waucoma loam, 0 to 2 percent slopes.	Somewhat limited root zone.	Intensive row cropping.	None	84	30	63	3.4	170
WcB	Waucoma loam, 2 to 5 percent slopes.	Slightly erodible; somewhat limited root zone.	RROMM	None	78	27	58	3.1	155
			RRROM	Contouring	78	27	58	3.1	155
			Intensive row cropping.	Terracing	78	27	58	3.1	155
WcC	Waucoma loam, 5 to 9 percent slopes.	Moderately erodible; somewhat limited root zone.	ROMMM	None	70	24	52	2.8	140
			RROMMM	Contouring	70	24	52	2.8	140
			RROM [6]	Terracing or stripcropping.	70	24	52	2.8	140
WcD	Waucoma loam, 9 to 14 percent slopes.	Highly erodible; somewhat limited root zone.	Long-term meadow.	None	----	----	----	2.5	125
			ROMMM	Terracing or stripcropping.	62	----	47	2.5	125
WdA	Waukegan loam, deep, 0 to 2 percent slopes.	Somewhat limited root zone.	Intensive row cropping.	None	87	31	66	3.5	175
WdB	Waukegan loam, deep, 2 to 5 percent slopes.	Slightly erodible; somewhat limited root zone.	RROM	None	82	29	61	3.3	165
			RRROx	Contouring	82	29	61	3.3	165
			Intensive row cropping.	Terracing	82	29	61	3.3	165
WgA	Waukegan loam, moderately deep, 0 to 2 percent slopes.	Limited root zone; slightly droughty.	Intensive row cropping.	None	80	28	60	3.2	160
WgB	Waukegan loam, moderately deep, 2 to 5 percent slopes.	Slightly erodible; limited root zone; slightly droughty.	RROM	None	76	27	57	3.0	150
			RRROx	Contouring	76	27	57	3.0	150
WhB	Whalan loam, 2 to 5 percent slopes.	Slightly erodible; limited root zone; slightly droughty.	ROMM	None	70	24	52	2.8	140
			RROM	Contouring	70	24	52	2.8	140

See footnotes at end of table.

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TABLE 2.—*Management and yield data for soils*—Continued

Map symbol	Soil	Soil limitations	Crop rotation and other uses	Management practices	Expected yields per acre under high-level management				
					Corn	Soybeans	Oats	Hay	Pasture
					Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
WhC2	Whalan loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	-----	-----	----	2.3	115
			ROMMM	Contouring	58	20	43	2.3	115
			ROMM [6]	Terracing or stripcropping.	58	20	43	2.3	115
WhD2	Whalan loam, 9 to 14 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Hay or pasture	None	-----	-----	----	2.2	110
			ROMMMM	Stripcropping	54	-----	40	2.2	110
WhE2	Whalan loam, 14 to 24 percent slopes, moderately eroded.	Highly erodible; limited root zone; slightly droughty.	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	1.0	50
WhE3	Whalan loam, 14 to 18 percent slopes, severely eroded.	Extremely erodible; limited root zone; slightly droughty; in poor tilth; low in fertility.	Permanent pasture.[5]	Limited grazing	-----	-----	----	1.2	60
WkA	Winneshiek loam, 0 to 2 percent slopes.	Limited root zone; slightly droughty.	Intensive row cropping.	None	76	27	57	3.0	150
WkB	Winneshiek loam, 2 to 5 percent slopes.	Slightly erodible; limited root zone; slightly droughty.	ROMM	None	73	25	55	2.9	145
			RROM	Contouring	73	25	55	2.9	145
WkC	Winneshiek loam, 5 to 9 percent slopes.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	-----	-----	----	2.6	130
			ROMMM	Contouring	65	23	48	2.6	130
			ROMM [6]	Terracing or stripcropping.	65	23	48	2.6	130
WkC2	Winneshiek loam, 5 to 9 percent slopes, moderately eroded.	Moderately erodible; limited root zone; slightly droughty.	Long-term meadow.	None	-----	-----	----	2.4	120
			ROMMM	Contouring	60	21	45	2.4	120
			ROMM [6]	Terracing or stripcropping.	60	21	45	2.4	120
WkD	Winneshiek loam, 9 to 14 percent slopes.	Highly erodible; limited root zone; slightly droughty,	Long-term meadow.	None	-----	-----	----	2.2	110
			ROMMMM	Stripcropping	55	-----	41	2.2	110
WkE	Winneshiek loam, 14 to 18 percent slopes.	Highly erodible; limited root zone; slightly droughty.	Permanent pasture.[5]	Controlled grazing.	-----	-----	----	1.6	80

[1] Number of days during a growing season that 1 acre will provide grazing for an animal unit (1 cow, horse, or steer; 5 hogs; or 7 sheep) without injury to the pasture.

[2] By long-term meadow is meant continuous grass-legume meadow for 4 years or more.

[3] Corn or soybeans grown for 4 years or more and followed by hay, pasture, or other close-growing crops.

[4] R=1 year of row crops (corn or soybeans); O=1 year of oats (or other small grain); M=1 year of meadow; Ox=oats followed by a catch crop grown for green manure.

[5] Also suitable for trees or wildlife; the section "Management of Woodland" shows the annual production of hardwoods, in board feet per acre, on soils that are used for timber.

[6] A rotation in which row crops are grown in alternate strips with close-growing crops.

The yields in table 2 are considered to be fairly reliable appraisals of what can be harvested if normal methods of good management are followed. The figures are based on about 90 percent of the historical yields obtained under a high level of management on plots at the Iowa State University Agricultural Experiment Station; on research data from the Corn Yield Study Project (1377) of the Iowa State University Agricultural Experiment Station from 1958 to 1966; and on estimates made by soil scientists of the Soil Conservation

Service. The yields fluctuate from year to year. Depending on the climate and on the level of management used, yields in this county range from 10 to 20 percent above those shown, to 10 to 20 below. Some farmers who use the best techniques and management known at the present time may increase yields in the future by the use of new varieties of crops, by better fertilization practices, or by other improved methods.

In other parts of the survey, a statement that yields are above average means that yields of 70 bushels or more per acre are obtained; a statement that yields are average means that yields of 55 to 69 bushels per acre are obtained; and a statement that the yields are below average means that yields of below 55 bushels per acre are obtained.

Some idea of the possible potential of these soils can be had from the results of the contoured corn-yield contest that has been sponsored by the Winneshiek County Soil Conservation District for the past 18 years. This contest has been conducted according to the rules of the Master Corn Growers' Contest, which is regulated by the Iowa Crop Improvement Association.

In this contest the number of contestants that have participated each year has ranged from 3 to 27, but the average number is 12. Low yields obtained by the contestants have ranged from 49 to 104 bushels per acre. The overall average of the low yields is 82 bushels per acre. An average low yield of 65 bushels or less was obtained in only 4 of the years. High yields obtained have ranged from 77 to 142 bushels per acre, but the overall average of the high yields is 116 bushels per acre. An average high yield of 100 bushels or less was obtained in 4 of the years, and of 130 bushels or more in 6 of the years.

The yearly average yields of all the contestants have ranged from 62 to 125 bushels per acre. Only in 2 years was the average of all the yields obtained by the contestants less than 80 bushels. The average of all the yields was more than 109 bushels per acre in 6 of the years and more than 90 bushels in 12 of the years.

Seven persons entered this annual contest in a total of 7 to 13 years. Twenty others entered the contest in a total of 3 to 6 years.

Management of Woodland

Trees formerly covered nearly all of the eastern part of Winneshiek County. They also covered a large acreage in the western part. Many of the wooded tracts in the western part of the county were adjacent to streams. Now, about 13 percent of the county is wooded.

The present pattern of tree cover is directly related to the nine soil associations within the county. Soil associations 1, 2, 4, 7, and 8 have the smallest proportion of wooded acreage. In those associations occasional woodlots and trees are scattered along fence rows and on farmsteads. Some trees also grow along drainageways, except in association 8.

Some trees and shrubs seed naturally in areas that are not cultivated or grazed. In soil associations 3 and 5, for example, the landscape is dotted with small clusters of trees that have seeded naturally around large sinkholes. Naturally seeded individual trees and trees in woodlots also grow along drainageways and on farmsteads in these same associations.

Soil associations 6 and 9 have a large acreage of woodland. In many places the soils in those associations are steep. They are unsuitable for cultivation and are in wooded tracts as much as 80 acres in size. The ridgetops, bottom lands, and stream benches, however, as well as the gently sloping sidehills and foot slopes, have all been cleared. Many areas now used for crops have a border of woods, and some trees grow in most areas that are pastured.

Nearly all of the wooded areas are producing far below their capability. Many of the wooded tracts have been poorly managed and have been used for grazing. Other areas have been subjected to overcutting of the best species. The acreage in woods has decreased slightly because of conversion to cropland. The areas that have been converted consist of areas of bottom lands and stream benches where the soils are well suited to cultivated crops.

Some scattered trees have also been cleared from areas in pasture, but in general the total acreage of woodland has not appreciably decreased. This is because some areas that were formerly cleared by settlers could not be farmed profitably. Many of those areas have been left idle, and natural seeding of trees, shrubs, and grass has taken place. Also, some landowners are planting trees in areas formerly idle or used for crops.

The demand for trees for lumber is not great. Although several sawmills are operated in this county, they often are operated part time. The supply of logs for the sawmills is usually obtained by taking selected cuttings from a number of sites, rather than harvesting the trees from an entire tract. The quality of the present stand would not justify extensive and sustained cutting for lumber.

Much of the strongly sloping land bordering the Turkey, Upper Iowa, and Yellow Rivers is not suited to crops and is only poorly suited to pasture. In those areas the present stands of timber are extremely important for controlling erosion. Also, the towering limestone bluffs surrounded by woods make that part of the county among the most scenic of any of the areas in the State.

Types of woodland

In Winneshiek County two forest types—oak-hickory and soft maple-elm—are predominant. The types of woodland are placed in three settings, however, based on these forest types and on the kind of landscape. As indicated by the names of the forest types, oaks, hickory trees, and maples are the predominant species.

Oak-hickory type on rolling uplands.—This type of woodland occupies tracts throughout the county where the relief is rolling or moderately rolling. Much of the acreage has been cleared since the time of early settlement. The principal soils of the rolling uplands are the Coggon, Fayette, Renova, Bassett, Downs, Orwood, Racine, Atterberry, and Oran. These soils are deep and generally contain an ample supply of soil moisture. Soils that are somewhat droughty, however, namely, the Backbone, Lamont, and Chelsea, also occur in this area.

On the rolling uplands, the stands contain some maple, elm, basswood, hackberry, green ash, and cherry in addition to the oak and hickory. Also, landscape plantings and plantings for windbreaks have been established since the time the area was first settled. Trees in those plantings include Scotch, white, red, and Austrian pines, Douglas-fir, and Norway spruce.

Oak-hickory type on steep uplands.—This type of woodland is in the eastern part of the county and along areas that border the major streams and tributaries throughout the county. The soils on steep uplands vary in moisture-supplying capacity and in depth over bedrock and shale. Some of them formed in deep loess. The principal soils on steep uplands are the Dubuque, Fayette, Palsgrove, Whalan, Frankville, Orwood, Nasset, Waucoma, and Winneshiek. Also common along stream bottoms are the Chaseburg soils.

Soft maple-elm on nearly level stream benches and bottoms.—A number of different soils support this woodland type, and the soils vary in moisture-supplying capacity. Examples of these soils are the Bixby, Camden, Sattre, and Hayfield, which occur on benches and are underlain by sand and gravel. Other soils that are deeper over coarse-textured material are the Bertrand, Chaseburg, and Canoe.

The predominant species on the nearly level stream benches and bottoms are maple and elm, but willow, swamp white oak, bur oak, shellbark hickory, cottonwood, green ash, and black walnut are common. Willow, cottonwood, and swamp white oak are more common on the bottom lands than in other areas.

Factors affecting woodland management

Soils differ in their capabilities for use as woodland. The factors that influence such use are somewhat different and less restrictive than those that limit use of the soils for cultivated crops. This soil survey can help the owner of a wooded tract determine where he can get the best returns for his investment in woodland management. If the soils are good for trees, the owner can afford to spend time and money in managing his woodland carefully. Little management other than that needed to protect the soils, however, is justified on poor sites. Some factors that are important in woodland management are discussed in the following paragraphs.

Moisture.—The growth of trees is directly related to the ability of a soil to supply moisture. The available moisture capacity of any soil depends largely on the slope, effective depth, texture, permeability, and internal drainage. Examples of soils and land types that have only a limited supply of available moisture are the Chelsea, Nordness, and Steep sandy land.

Aspect, or direction of exposure.—Forest studies show a definite relationship between the exposure of a site and the rate of tree growth. Trees generally grow better and make better yields on slopes facing north and east and on gently sloping or nearly level valley flats and broad ridgetops than on slopes facing south or west. Steep, long slopes that have various exposures are typical for soils and land types, such as the Fayette, Nordness, and Steep rock land.

Erosion.—Eroded soils are generally not suitable for hardwoods, though pines may be planted on those sites. Examples of soils in which erosion has reduced the effective depth are the Winneshiek, Waucoma, Whalan, Rockton, Sattre, and Nordness. Natural reseeding of trees is greatly reduced by erosion.

Other factors.—Other factors that affect the growth of trees are soil reaction and soil fertility. Also, soils that are frequently flooded are generally not desirable for woody cover suitable for wildlife, although wildlife use those areas part of the time. In this county the growth of trees and the adaptation of different species do not appear to have been influenced by soil reaction and lack of fertility. Flooding and poor soil drainage, however, have affected the growth of trees in areas of Alluvial land and of Dorchester and Arenzville soils.

A higher mortality of trees and wildlife species can be expected on droughty or tight soils than on soils more suitable for trees and wildlife. Also, most pines do poorly on soils that are high in lime, although Eastern redcedar is more tolerant of lime than are some other species. In general, hardwoods grow better than conifers on soils that are high in lime.

Woodland suitability groups

Management of woodland can be planned more effectively if soils are grouped according to those characteristics that affect the growth of trees and the management of the stands. For this reason, the soils of Winneshiek County have been placed in five woodland suitability groups (see table 3). Each group consists of soils that have about the same suitability for wood crops, require about the same management, and have about the same potential productivity.

In each group trees most suitable for forest, windbreaks, and Christmas trees are listed. Also listed are trees and shrubs most suitable as cover for wildlife. These include some species that provide food as well as cover. The county agent or the Experiment Station can provide additional information about the suitability of certain trees for a specific use.

In table 3 the estimated potential annual acre yields of hardwoods and the site index also are given for the soils of Winneshiek County. The site index is the height, in feet, of the dominant trees in the stand at the age of 50 years (*9*).[1] It refers to oaks and hickory trees on the uplands and to soft maples, elms, or cottonwood trees on the nearly level stream benches and bottoms. The estimates are for well-stocked, even-aged stands that have good tree density and that have been well managed. They are based on the experience and judgment of the woodland conservationist and soil scientists. Most of the wooded areas in the county are producing far below their potential. Better management than is now practiced will be required to attain the yields shown.

[1] Italic numbers in parentheses refer to Literature Cited, p. 223.

TABLE 3.—*Soil ratings for the planting of trees and for woodland production*

[Absence of a site index or yield figure indicates that the soils have developed under prairie, and trees generally do not grow on them]

Soil series and mapping unit	Woodland suitability group [1]	Estimated site index	Annual production of hardwoods in board feet per acre [2]
Alluvial land (Ab)	2	60	190
Arenzville (Ar)	4	65	220
Atkinson (AtB)	3		
Atterberry (AyA)	3	60	190
Backbone (BaB, BaC, BaD)	1	50	125
Bassett (BeA, BeB, BeC, BeC2, BlB, BlC)	3	53	140
Bertrand (BnA, BnB)	3	65	220
Bixby (BoA, BoB, BoC2)	3	50	125
Burkhardt (BuB, BuC2)	1		
Calamine (CaA, CaB)	5		
Calmar (CcB, CcC)	3		
Camden (CdA, CdB, CdC)	3	62	195
Caneek (Ce)	4		
Canoe (Cf)	3	60	190
Chaseburg (ChA, ChB)	3	63	200
Chelsea (ClB, ClD)	1	56	155
Clyde (CmB)	4		
Coggon (CoB, CoC2)	3	53	140
Colo and Otter (Cs)	4		
Colo-Otter-Ossian complex (Ct)	4		
Dickinson (DcA, DcB, DcC, DcD)	1		
Donnan (DdB)	5		
Dorchester (De)	4	63	200
Dorchester-Chaseburg-Volney complex (DgB)	4	60	190
Dow (DhE3)	3	60	190
Downs (DoA, DoB, DoC, DoD, DoE2, DoF2)	3	68	250
Downs and Tama (DtB, DtC, DtC2, DtD2)	3	68	250
Dubuque (DuC2, DuD2, DuD3, DuE2, DuE3, DuF2)	3	60	190
Fayette (FaA, FaB, FaC2, FaC3, FaD2, FaD3, FaE2, FaE3, FaF2, FaF3, FaG)	3	68	250
Festina (FeA, FeB)	3	68	250
Floyd (FlB)	3		
Floyd-Clyde complex (FmB)	4		
Franklin, gray subsoil variant (FnB)	3	58	165
Frankville (FrC, FrD2, FrE2)	3	60	190
Hagener (HaA, HaB, HaD)	1		
Hayfield (HdA, HmA)	3	58	165
Huntsville (HuA, HuB)	3		
Jacwin (JaA, JaB, JaC, JaD)	5		
Kato (KaA, KdA, KsB, KsC)	3		
Kenyon (KyB)	3		
Lamont (LaB, LaC, LaD)	3	60	190
Lamont, till subsoil variant (LdB)	3	63	200
Lawson and Kennebec (LkA, LmB)	4		
Loamy colluvial lands (LnE, LnF)	3		
Loamy terrace escarpments (LoF)	3	60	190
Marlean (MaB, MaC, MaC2, MaD2, MaD3, MaE2, MaE3)	1		
Nasset (NaC2, NaD2, NaE2)	3	63	200
Nordness (NoD, NoE)	1	50	125
Oran (OrA, OrB)	3	60	190
Orwood (OsB, OsC2, OsD2, OsE2, OsE3, OsF2)	3	68	250
Ossian (Ot)	4		
Ostrander (OuA, OuB, OuC)	3		
Otter-Lawson-Ossian complex (OvB)	4		
Otter-Ossian complex (Ow)	4		
Otter and Ossian, overwashed (Ox)	4		
Palsgrove (PaC2, PaD2, PaD3, PaE2, PaE3, PaF2)	3	63	200
Peaty muck (Pk)			
Peaty muck, overwashed (Pw)			
Racine (RaA, RaB, RaC, RaC2, RaD2)	3	60	190
Renova (ReB, ReC, ReC2, ReD2, ReD3, ReE2, ReE3)	3	60	190
Riceville (RfB)	3		
Rockton (RkA, RkB, RkC, RkD)	3		
Rowley (RoA)	4		
Rowley and Lawson, overwashed (Rw)	4		
Sattre (SbA, SbB, SbC2, SdA, SdB, SdC2, SdD2)	3	60	190
Spillville (Sp)	4		
Steep rock land (Sr)	1	45	80
Steep sandy land (SsF)	1	50	125
Terril (TeA, TeB)	3		
Turlin (TgA, TgB)	4		
Volney (VcA, VcB, VoA, VoB)	4	60	190
Waucoma (WcA, WcB, WcC, WcD)	3	63	200
Waukegan (WdA, WdB, WgA, WgB)	3		
Whalan (WhB, WhC2, WhD2, WhE2, WhE3)	3	58	165
Winneshiek (WkA, WkB, WkC, WkC2, WkD, WkE)	3	60	190

[1] Refers to planting on all aspects.
[2] Figure given is for fully stocked, even-aged stands under a high level of management.

WOODLAND SUITABILITY GROUP 1

The soils in this group generally are droughty because of their slopes and their position, as on narrow ridgetops. They are also droughty because of their extremely sandy texture, excessively drained sandy or gravelly subsoil, or a layer of rock close to the surface. Some areas of these soils are nearly level, but in other places the slopes are as steep as 14 percent. The soils that have slopes of between 0 and 14 percent have all exposures. Those that have slopes greater than 14 percent have northern and eastern exposures.

The trees suitable for planting are—

- Eastern redcedar.
- Eastern white pine.
- European larch.
- Jack pine.
- Scotch pine.

The shrubs and trees suitable for planting for wildlife cover are—

- Eastern redcedar.
- Honeysuckle.
- Russian-olive.
- Wild plum.

In some areas of soils of this group, the slopes may be greater than 14 percent and have a southern or western exposure. Because of the climatic extremes in such areas, growing conditions are less favorable than in areas where the soils have slopes greater than 14 percent but where the slopes face north or east. The trees suitable for planting in these less favorable areas are—

Eastern redcedar.	Scotch pine.
Jack pine.	

The shrubs and trees suitable for wildlife cover are—

Eastern redcedar.	Honeysuckle.

WOODLAND SUITABILITY GROUP 2

The soils in this group are similar to those of group 1, except that they are subject to repeated overflow.

The trees suitable for planting are—

Cottonwood.

The shrubs and trees suitable for wildlife cover are—

Honeysuckle.

WOODLAND SUITABILITY GROUP 3

In this group are deep, moderately permeable soils in coves, on second bottoms, and on nearly level to sloping uplands. The soils that have a slope range of between 0 and 14 percent generally have all exposures. In places those that have slopes greater than 14 percent have northern and eastern exposures. The soils of this group generally are considered good for farming, and they are also favorable for wood crops. Competition from weeds is a serious threat to new plantings, however, and the weeds should be controlled.

The trees suitable for planting are—

Basswood.	Green and white ash.
Black cherry.	Norway spruce.
Black walnut.	Red and white oak.
Cottonwood.	Red pine.
Eastern white pine.	Scotch pine.
European larch.	

The shrubs and trees suitable for wildlife cover are—

Asiatic trailing raspberry.	Multiflora rose.
Dogwood.	Nannyberry.
Eastern redcedar.	Ninebark.
Hazelnut.	Russian-olive.
Honeysuckle.	Wild plum.

In some areas the soils may have slopes of 14 percent or more and have a southern or western exposure. In such areas growing conditions are less favorable for plants than in areas where the slopes are 14 percent or more but face north or east. The trees suitable for planting in these less favorable areas are—

Black cherry.	Green and white ash.
Black walnut.	Jack pine.
Cottonwood.	Norway spruce.
Eastern redcedar.	Red pine.
Eastern white pine.	

The shrubs and trees suitable for wildlife cover are—

Asiatic trailing raspberry.	Multiflora rose.
Chokecherry.	Nannyberry.
Eastern redcedar.	Ninebark.
Hazelnut.	Russian-olive.
Honeysuckle.	Wild plum.
Mulberry.	

WOODLAND SUITABILITY GROUP 4

The soils in this group are the same as those in group 3, except that they are subject to repeated flooding.

The trees suitable for planting are—

Cottonwood.	Hackberry.
Green ash.	Soft maple.

The shrubs and trees suitable for wildlife cover are—

Honeysuckle.

WOODLAND SUITABILITY GROUP 5

The soils of this group are tight at a depth fairly near the surface. They are moderately permeable to very slowly permeable, and their texture ranges from clay loam to silty clay or clay. The ones that have a slope range of between 0 and 14 percent generally have all exposures. Those that have slopes of more than 14 percent generally have northern or eastern exposures.

The trees suitable for planting are—

Cottonwood.	Green ash.
Eastern redcedar.	Hackberry.
Eastern white pine.[2]	Norway spruce.[2]

The shrubs and trees suitable for wildlife cover are—

Dogwood.	Honeysuckle.
Eastern redcedar.	

Wildlife

Winneshiek County supports many kinds of wildlife that contribute to the economy of the county and that have recreational value. White-tailed deer frequent the rolling wooded areas along streams. Many other game animals, such as squirrel, fox, and cottontail rabbit, are hunted. Varying numbers of birds frequent the county. Wild turkeys have been stocked in this part of the State and have a limited population. The population of pheasant is increasing in the eastern part of the county. The streams are stocked with trout, and the Upper Iowa, Turkey, and Yellow Rivers contain other kinds of gamefish.

Cardinal Marsh, in the west-central part of the county, is a Federal game refuge. In that area a dam has been constructed, which impounds a spring-fed body of water about a quarter of a mile wide and a mile long. The refuge is used by ducks and geese for food and nesting. It is also used by many other birds and animals.

Much can be done to increase the population of desirable wildlife in this county. Brushy or wooded areas can be fenced so that food and cover will not be destroyed. Areas that are too small to farm or that are inaccessible for cropping can be planted to grasses, shrubs, and trees. The borders of fields can also be planted to grasses and legumes. Those areas should be left unclipped, especially during the nesting season for upland birds.

Engineering Applications

For a long time, engineers have studied soil characteristics that affect construction and have devised systems of soil classification based on those characteristics. Most of these studies have been at the site of construction because general information about the soils of an area has not been readily available.

With the use of a soil map for identification, however, engineering interpretations can be made that are highly useful for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving

[2] Plant only on the moderately permeable soils.

heavy loads and where the excavations are deeper than the depths of the layers reported. Furthermore, engineers and others should not apply specific values to the estimated values given for bearing capacity of soils. Nevertheless, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

By using the information in a soil survey, the soils engineer can concentrate on the most important soil units. Then he can obtain a minimum number of soil samples for laboratory testing and can make adequate investigations of the soils at minimum cost.

This soil survey contains information that can be used by engineers to—

1. Make studies of soil and land use that will aid in selecting and developing sites for industries, businesses, residences, and recreational areas.
2. Assist in planning and designing drainage and irrigation structures and in planning dams and other structures for water and soil conservation.
3. Make reconnaissance surveys of soil and ground conditions that will aid in selecting locations for highways and airports and in planning more detailed soil surveys for the intended locations.
4. Locate probable sources of sand and gravel for use in structures.
5. Correlate pavement performance with types of soil, and thus develop information that will be useful in designing and maintaining pavements.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and from aerial photographs.

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and some words, for example, soil, clay, silt, and sand may have special meanings in soil science. These and other special terms used in the soil survey are defined in the Glossary in the back of this publication.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of clayey soils having low strength when wet.

Some engineers prefer to use the Unified soil classification system (*6*, *15*). In this system, soil materials are identified as coarse grained (eight classes), fine grained (six classes), or highly organic. An approximate classification can be made in the field. Estimated classifications of the soils in Winneshiek County under both systems are given in table 4.

Soil engineering data and interpretations [3]

Information and interpretations of most significance to engineers are presented in tables 4, 5, and 6. The data in table 4 are based on the test data in table 6, on information in other parts of the survey, and on experience with the same kinds of soils in other counties. Table 6 presents laboratory test data for samples taken from selected soil profiles in Winneshiek County. Additional information can be obtained from other parts of the survey, especially from the sections "General Soil Map," "Descriptions of the Soils," and "Genesis, Classification, and Morphology of Soils."

[3] This subsection prepared by ROBERT E. BLATTERT, soils geologist, Iowa State Highway Commission.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
Ab	Alluvial land.	Sandy, gravelly, or silty alluvial soil material that is excessively drained to poorly drained. On flat, low bottom lands. Subject to flooding.	(1)
Ar	Arenzville silt loam.	Deep, noncalcareous alluvial soil material low in content of sand. Well drained and on low bottom lands. No effective water table. Surface layer low in content of organic matter, but content of organic matter medium to high below a depth of 20 inches or more. Subject to frequent flooding.	0–30 30–46
AtB	Atkinson loam, 2 to 5 percent slopes.	30 to 50 inches of medium-textured glacial soil material of fairly variable particle size. Underlain by bedrock, dominantly limestone; well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–13 13–36 36–40
AyA	Atterberry silt loam, 1 to 4 percent slopes.	Deep, medium-textured loessal soil material. Somewhat poorly drained and on upland flats, in concave drainageways, or on ridgetops. A seasonal high water table is at a depth of 1½ to 3½ feet. Surface layer medium in content of organic matter.	0–14 14–35 35–68
BaB BaC BaD	Backbone loamy sand, 2 to 5 percent slopes. Backbone loamy sand, 5 to 9 percent slopes. Backbone loamy sand, 9 to 14 percent slopes.	Less than 40 inches of fairly uniform loamy sand over bedrock, dominantly limestone. Excessively drained and on convex slopes in the uplands. No effective water table. Low in content of organic matter.	0–8 8–24 24–27
BeA BeB BeC BeC2	Bassett loam, 0 to 2 percent slopes. Bassett loam, 2 to 5 percent slopes. Bassett loam, 5 to 9 percent slopes. Bassett loam, 5 to 9 percent slopes, moderately eroded.	Deep, medium-textured glacial soil material of fairly variable particle size. Moderately well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of about 4 feet. Surface layer medium in content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–13 13–18 18–50
BlB BlC	Bassett silt loam, 2 to 5 percent slopes. Bassett silt loam, 5 to 9 percent slopes.	Deep soil material consisting of 20 inches of windblown material low in content of sand and of variable particle size. Well drained or moderately well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of about 4 feet. Surface layer medium in content of organic matter.	0–17 17–24 24–43
BnA BnB	Bertrand silt loam, 0 to 2 percent slopes. Bertrand silt loam, 2 to 5 percent slopes.	About 40 inches of deep alluvial soil material low in content of sand. Well drained and in flat areas or on convex slopes. A seasonal high water table is below a depth of 4 feet. Surface layer low in content of organic matter.	0–14 14–44 44–52
BoA BoB BoC2	Bixby loam, 0 to 2 percent slopes. Bixby loam, 2 to 5 percent slopes. Bixby loam, 5 to 9 percent slopes, moderately eroded.	24 to 36 inches of variable, loamy soil material over gravelly sand. Well drained and in flat areas or on convex slopes on terraces or uplands. No effective water table. Surface layer low in content of organic matter.	0–7 7–28 28–32 32–44
BuB BuC2	Burkhardt soils, 0 to 5 percent slopes. Burkhardt soils, 5 to 14 percent slopes, moderately eroded.	15 to 24 inches of fairly variable, loamy soil material over gravelly sand. Excessively drained and in flat areas or on convex slopes on terraces and uplands. No effective water table. Surface layer low in content of organic matter.	0–7 7–17 17–42
CaA CaB	Calamine silty clay loam, 0 to 2 percent slopes. Calamine silty clay loam, 2 to 5 percent slopes.	As much as 30 inches of soil material that is low to medium in content of sand and is underlain by shale. Poorly drained and in flat areas or on concave slopes in the uplands and on high benches. A seasonal high water table is at a depth of 1½ to 2½ feet. Uppermost 10 to 16 inches high in content of organic matter.	0–16 16–28 28–48
CcB CcC	Calmar clay loam, 2 to 5 percent slopes. Calmar clay loam, 5 to 14 percent slopes.	Less than 40 inches of clay loam of glacial origin. Soil material is of fairly uniform particle size and is underlain by shaly limestone bedrock. Well drained or moderately well drained and on convex or concave side slopes in the uplands. No effective water table. Uppermost 16 to 26 inches moderately high in content of organic matter.	0–21 21–28 28–33 33

See footnotes at end of table.

material and its estimated properties

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1).
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	0. 18	6. 6-7. 3	Moderate.
Silt loam	CL or ML	A-6 or A-7	100	100	95-100	0. 8-2. 5	. 20	6. 6-7. 3	Moderate to high.
Loam	ML or CL	A-4 or A-6	95-100	95-100	55-75	0. 8-2. 5	. 17	5. 6-7. 3	Low.
Clay loam	CL	A-4 or A-6	85-100	80-95	50-75	0. 8-2. 5	. 18	5. 1-6. 0	Moderate.
Clay	CH	A-7-6	85-100	80-100	70-100	<0. 05	. 15	6. 6-8. 4	High to none.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 20	5. 6-6. 6	Moderate.
Silty clay loam	CL or ML	A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 6-6. 0	Moderate.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 19	6. 1-7. 3	Moderate.
Loamy sand to sandy loam.	SM	A-2-4	95-100	95-100	25-35	2. 5-5. 0	. 12	6. 1-6. 5	Low.
Sandy loam	SM	A-2-4	95-100	95-100	25-35	2. 5-5. 0	. 11	6. 5-7. 0	Low.
Clay	CH	A-7-6	85-100	80-100	70-100	<0. 05	. 15	6. 2-8. 2	(1).
Loam	CL	A-6	95-100	95-100	65-75	0. 8-2. 5	. 18	5. 6-6. 6	Moderate.
Loam [2]	CL	A-6 or A-4	90-95	80-95	55-65	0. 8-2. 5	. 16	4. 5-5. 5	Moderate.
Sandy clay loam	SC or CL	A-4 or A-6	90-100	85-100	30-65	0. 2-0. 8	. 16	4. 5-6. 0	Moderate.
Silt loam	CL or ML	A-4 or A-6	98-100	98-100	95-100	0. 8-2. 5	. 20	5. 1-6. 6	Moderate.
Loam [2]	CL	A-6 or A-4	90-95	80-90	55-65	0. 8-2. 5	. 16	4. 5-5. 5	Moderate.
Loam	CL	A-6	90-100	85-100	55-75	0. 2-0. 8	. 16	5. 1-6. 0	Moderate.
Silt loam	CL or ML	A-6 or A-4	100	100	95-100	0. 8-2. 5	. 18	6. 0-6. 8	Moderate.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 4-6. 2	Moderate.
Loam to gravelly clay loam.	CL	A-6	90-100	85-100	55-75	2. 5-5. 0	. 16	5. 0-5. 6	Moderate.
Loam	CL	A-4 or A-6	90-100	85-100	55-75	0. 8-2. 5	. 15	6. 0-6. 6	Low.
Sandy clay loam	SC or CL	A-4 or A-6	90-100	85-100	35-65	0. 8-2. 5	. 16	5. 4-6. 1	Low.
Sandy loam	SM	A-2	90-100	85-100	25-35	2. 5-5. 0	. 12	5. 4-6. 1	Low.
Gravelly sand [3]	GM or SM	A-1 or A-2	45-90	5-85	10-35	10+	. 02	5. 4-6. 2	Low to none.
Loam to sandy loam	SM	A-4 or A-2	85-100	80-100	25-45	2. 5-5. 0	. 16	6. 0-6. 6	Low.
Loam to sandy loam	SM	A-4 or A-2	85-100	80-100	20-45	2. 5-5. 0	. 16	5. 6-6. 2	Low.
Gravelly sand [3]	GM or SM	A-1 or A-2	45-90	5-85	5-35	10+	. 02	5. 4-6. 4	None.
Silty clay loam	CL or CH	A-7-6	90-100	85-100	85-100	0. 2-0. 8	. 20	6. 4-7. 4	Moderate to high.
Silty clay	CH	A-7-6	90-100	85-100	85-100	<0. 05	. 15	6. 4-7. 4	High.
Silty clay loam	CH	A-7-6	90-100	85-100	85-100	<0. 05	<. 14	6. 8-7. 8	High to moderate.
Clay loam	CL or CH	A-6 or A-7-6	90-100	80-100	55-85	0. 2-0. 8	. 18	6. 0-6. 6	Moderate to high.
Clay loam	CL or CH	A-6 or A-7-6	90-100	80-100	55-85	0. 2-0. 8	. 18	6. 0-6. 6	Moderate to high.
Clay	CH	A-7-6	90-100	85-100	85-100	<0. 05	. 15	6. 4-7. 2	High.
Limestone	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4).

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
CdA CdB CdC	Camden silt loam, 0 to 2 percent slopes. Camden silt loam, 2 to 5 percent slopes. Camden silt loam, 5 to 9 percent slopes.	At least 36 inches of medium-textured soil material that is low or medium in content of sand. Underlain by gravelly sand. Well drained and in flat areas or on convex slopes on terraces. No effective water table. Surface layer low in content of organic matter.	0–12 12–25 25–39 39–60
Ce	Caneek silt loam.	Deep alluvial soil material low in content of sand. Somewhat poorly drained and on low bottom lands. A seasonal high water table is at a depth of ½ foot to 2½ feet. The surface layer is 18 to 40 inches thick and is low in content of organic matter. The second layer is moderately high in content of organic matter.	0–15 15–32 32–50
Cf	Canoe silt loam.	Deep alluvial soil material low in content of sand. Somewhat poorly drained and on low, flat terraces. A seasonal high water table is at a depth of 1½ to 3½ feet. Surface layer medium in content of organic matter.	0–8 8–72
ChA ChB	Chaseburg silt loam, 0 to 2 percent slopes. Chaseburg silt loam, 2 to 5 percent slopes.	Deep soil material of local alluvium low in content of sand. Well drained and in flat areas or on convex slopes in the outlets of drainageways. Subject to frequent flooding of short duration, and additional material is deposited when the soils are flooded. No effective water table. Surface layer low in content of organic matter.	0–34 34–48
ClB ClD	Chelsea loamy fine sand, 1 to 5 percent slopes. Chelsea loamy fine sand, 5 to 14 percent slopes.	Deep, uniform loamy sand. Excessively drained and on convex slopes on terraces and uplands. No effective water table. Surface layer low in content of organic matter.	0–19 19–58
CmB	Clyde silt loam, 0 to 4 percent slopes.	Deep soil material from glacial outwash. Low to medium in content of sand. Poorly drained and in flat areas or on concave slopes in drainageways. A seasonal high water table is at a depth of 1 to 2 feet. The areas receive runoff and continual lateral seepage. Surface layer high in content of organic matter.	0–11 11–22 22–33 33–56
CoB CoC2	Coggon loam, 2 to 5 percent slopes. Coggon loam, 5 to 9 percent slopes, moderately eroded.	Deep, medium-textured glacial soil material of variable particle size. Moderately well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of 3 to 4 feet. Surface layer low in content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–10 10–22 22–40 40–50
Cs	Colo and Otter silt loams.	*Colo:* Deep, medium-textural alluvial soil material moderately low to high in content of sand and fairly uniform in particle size. Poorly drained and on flat bottom lands. A seasonal high water table is at a depth of 2 to 3 feet. Uppermost 30 to 40 inches high in content of organic matter.	0–22 22–34 34–52 52–60
		Otter: Deep, medium-textured alluvial soil material low in content of sand. Poorly drained and on flat bottom lands. A seasonal high water table is at a depth of 2 to 3 feet. Uppermost 30 to 40 inches high in content of organic matter.	0–26 26–37 37–58
Ct	Colo-Otter-Ossian complex.	For a description of the Colo and Otter soil material, see Colo and Otter silt loams; for a description of the Ossian soil material, see Ossian silt loam.	
DcA DcB DcC DcD	Dickinson sandy loam, 0 to 2 percent slopes. Dickinson sandy loam, 2 to 5 percent slopes. Dickinson sandy loam, 5 to 9 percent slopes. Dickinson sandy loam, 9 to 14 percent slopes.	Deep sandy loam. Excessively drained, and in flat areas or on convex slopes on uplands or terraces. No effective water table. Surface layer moderately low in content of organic matter.	0–20 20–28 28–52

See footnotes at end of table.

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 18	6. 2-6. 8	Low to moderate.
Silt loam	CL	A-6	90-100	85-100	55-85	0. 8-2. 5	. 15	6. 2-6. 8	Moderate.
Silty clay loam to sandy clay loam.	SC or CL	A-6	90-100	85-100	35-65	0. 8-2. 5	. 16	6. 2-6. 8	Low.
Loamy sand	SP or SM	A-1 or A-2	85-100	85-100	5-15	5. 0-10. 0	. 03	5. 8-6. 6	None.
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 18	7. 4-8. 4	Low to moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 21	6. 6-7. 2	Low to moderate.
Silt loam	OL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 22	6. 6-7. 0	Low to moderate.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	[5] . 20	6. 1-6. 5	Moderate.
Silt loam	CL or ML	A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 1-6. 0	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2+5	. 18	6. 4-7. 2	Low to moderate.
Silt loam	CL or ML	A-6	100	100	95-100	0. 8-2+5	. 18	6. 4-7. 2	Low to moderate.
Loamy fine sand	SM	A-2-4	90-100	85-100	10-30	5. 0-10+0 10	. 05	5. 8-6. 4	None.
Sand	SM or SP	A-2 or A-1	90-100	85-100	5-15		. 03	5. 8-6. 4	None.
Silt loam	OL or ML	A-7-6 or A-8	100	100	95-100	0. 8-2. 5	. 21	6. 4-7. 4	High.
Loam	CL	A-6	85-100	80-100	55-75	0. 8-2. 5	. 16	6. 4-7. 4	Moderate.
Loam and silt loam	CL	A-6	85-100	80-100	55-75	0. 8-2. 5	. 16	6. 4-7. 4	Moderate.
Clay loam and cobbly sandy loam.	CL	A-6 or A-6	85-100	80-100	55-85	0. 8-2. 5	. 17	7. 0-7. 8	Moderate.
Loam	CL or ML	A-6 or A-4	95-100	95-100	65-75	0. 8-2. 5	. 18	5. 6-6. 8	Moderate.
Sandy clay loam.[2]	SC or CL	A-4 or A-6	75-95	65-95	35-65	0. 8-2. 5	. 15	4. 8-5. 8	Moderate.
Sandy clay loam	SC or CL	A-4 or A-6	90-100	85-100	35-65	0. 2-0. 8	. 15	4. 8-5. 8	Moderate.
Loam	CL	A-6	90-100	85-100	55-75	0. 2-0. 8	. 15	5. 0-5. 6	Moderate.
Silt loam to silty clay loam.	OL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 21	6. 5-7. 4	High.
Silty clay loam	OL or ML	A-7-6	100	100	95-100	0. 2-0. 8	. 18	6. 6-7. 4	High.
Silty clay loam	MH or CL	A-7-6	95-100	90-100	85-100	0. 8-2. 5	. 18	6. 6-7. 4	High to moderate.
Gravelly sandy loam	SM or GM	A-1 or A-2	50-90	20-95	15-30	5. 0-10. 0	. 08	6. 6-7. 4	None.
Silt loam	ML or OL	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 20	6. 4-7. 4	Moderate to high.
Silt loam	ML or CL	A-7-6	100	100	95-100	0. 8-2. 5	. 18	6. 4-7. 4	High.
Silt loam	ML or CL	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 18	6. 4-7. 4	Moderate to high.
Sandy loam	SM	A-2-4	95-100	95-100	25-35	2. 5-5. 0	. 13	5. 2-6. 0	Low.
Sandy loam	SM	A-2-4	95-100	95-100	25-35	2. 5-5. 0	. 12	5. 0-5. 6	Low to none.
Loamy sand and sand.	SP or SM	A-2	85-100	85-100	3-15	5. 0-10. 0	. 03	5. 0-5. 6	None.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
DdB	Donnan loam, 2 to 5 percent slopes.	20 to 40 inches of friable, medium-textural glacial soil material of fairly variable particle size over firm till that resembles gumbo. Moderately well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of 1½ to 3½ feet. Surface layer medium in content of organic matter. Commonly a prominent stone line at a depth of 18 to 24 inches.	0–8 8–23 23–52
De	Dorchester silt loam.	Deep, calcareous soil material low in content of sand. Well drained and on low bottom lands. No effective water table. Surface layer low in content of organic matter, and buried soil medium to high in content of organic matter.	0–20 20–59
DgB	Dorchester-Chaseburg-Volney complex, 2 to 5 percent slopes.	For a description of the Dorchester soil material, see Dorchester silt loam; for a description of the Chaseburg soil material, see the Chaseburg silt loams; and for a description of the Volney soil material, see the Volney channery silt loams.	
DhE3	Dow silt loam, 14 to 24 percent slopes, severely eroded.	Deep, gray, unleached, medium-textural loessal soil material low in content of sand. Well drained and on convex slopes in the uplands. A seasonal perched water table is at a depth of 4 feet. Low in content of organic matter.	0–11 11–72
DoA DoB DoC DoD DoE2 DoF2	Downs silt loam, 0 to 2 percent slopes. Downs silt loam, 2 to 5 percent slopes. Downs silt loam, 5 to 9 percent slopes. Downs silt loam, 9 to 14 percent slopes. Downs silt loam, 14 to 18 percent slopes, moderately eroded. Downs silt loam, 18 to 24 percent slopes, moderately eroded.	Deep loessal soil material low in content of sand. Well drained and on convex slopes in the uplands. A seasonal perched water table is below a depth of 4 feet. Surface layer medium in content of organic matter, except in severely eroded spots, where the content of organic matter is low.	0–10 10–30 30–50
DtB DtC DtC2 DtD2	Downs and Tama silt loams, 2 to 5 percent slopes. Downs and Tama silt loams, 5 to 9 percent slopes. Downs and Tama silt loams, 5 to 9 percent slopes, moderately eroded. Downs and Tama silt loams, 9 to 14 percent slopes, moderately eroded.	*Downs:* For a description of the Downs soil material, see the Downs silt loams. *Tama:* Deep loessal soil material low in content of sand. Well drained and on convex slopes in the uplands. A seasonal high water table is below a depth of 4 feet. Surface layer medium in content of organic matter.	0–15 15–33 33–47
DuC2 DuD2 DuD3 DuE2 DuE3 DuF2	Dubuque silt loam, 5 to 9 percent slopes, moderately eroded. Dubuque silt loam, 9 to 14 percent slopes, moderately eroded. Dubuque silt loam, 9 to 14 percent slopes, severely eroded. Dubuque silt loam, 14 to 18 percent slopes, moderately eroded. Dubuque silt loam, 14 to 18 percent slopes, severely eroded. Dubuque silt loam, 18 to 30 percent slopes, moderately eroded.	15 to 30 inches of loessal soil material over limestone bedrock. Low in content of sand. Well drained and on convex slopes in the uplands. No effective water table. Surface layer low in content of organic matter.	0–6 6–25 25
FaA FaB FaC2 FaC3 FaD2 FaD3 FaE2 FaE3 FaF2	Fayette silt loam, 0 to 2 percent slopes Fayette silt loam, 2 to 5 percent slopes. Fayette silt loam, 5 to 9 percent slopes, moderately eroded. Fayette silt loam, 5 to 9 percent slopes, severely eroded. Fayette silt loam, 9 to 14 percent slopes, moderately eroded. Fayette silt loam, 9 to 14 percent slopes, severely eroded. Fayette silt loam, 14 to 18 percent slopes, moderately eroded. Fayette silt loam, 14 to 18 percent slopes, severely eroded. Fayette silt loam, 18 to 24 percent slopes, moderately eroded.	Deep loessal soil material low in content of sand. Well drained and on convex slopes in the uplands. A seasonal perched water table is below a depth of 4 feet. Low in content of organic matter.	0–7 7–46 46–80

See footnotes at end of table.

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Loam	CL	A-6 or A-4	95–100	95–100	65–75	0. 8–2. 5	. 16	6. 2–6. 8	Moderate.
Clay loam [2]	CL	A-6 or A-4	85–95	80–95	50–75	0. 2–0. 8	. 16	5. 0–5. 6	Moderate.
Clay	CH	A-7-6	85–100	80–100	70–100	<0. 05	. 15	5. 4–6. 4	High.
Silt loam	CL or ML	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 18	7. 4–8. 2	Low to moderate.
Silt loam	OL or ML	A-6 or A-7-6	100	100	95–100	0. 8–2. 5	. 20	6. 5–7. 2	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 17	7. 2–7. 6	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 17	7. 4–8. 2	Moderate.
Silt loam	CL or ML	A 4 or A-6	100	100	95–100	0. 8–2. 5	. 20	5. 6–6. 8	Moderate.
Silty clay loam	CL	A-7-6	100	100	95–100	0. 8–2. 5	. 19	5. 0–5. 8	Moderate to high.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95–100	0. 8–2. 5	. 18	5. 0–5. 8	Moderate to high.
Silt loam	CL or ML	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 21	5. 6–6. 8	Moderate.
Silty clay loam	CL	A-7-6	100	100	95–100	0. 8–2. 5	. 19	5. 2–6. 0	Moderate to high.
Silt loam	CL	A-6 or A-7-6	100	100	95–100	0. 8–2. 5	. 18	5. 2–6. 0	Moderate to high.
Silt loam	CL or ML	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 18	5. 6–6. 8	Moderate.
Silt loam and silty clay loam.	CL	A-7-6	100	100	95–100	0. 8–2. 5	. 19	5. 0–5. 8	Moderate to high.
Clay and limestone	CH	A-7-6	85–100	80–100	70–100	<0. 05	. 15	6. 2–8. 4	High to none.
Silt loam	ML or CL	A-4 or A-6	100	100	95–100	0. 8–2. 5	. 18	6. 0–6. 8	Moderate.
Silty clay loam	CL	A-7-6	100	100	95–100	0. 8–2. 5	. 19	5. 0–5. 8	Moderate to high.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95–100	0. 8–2. 5	. 18	5. 0–5. 8	Moderate.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
FaF3 FaG	Fayette silt loam, 18 to 24 percent slopes, severely eroded. Fayette silt loam, 24 to 35 percent slopes.		
FeA FeB	Festina silt loam, 0 to 2 percent slopes. Festina silt loam, 2 to 5 percent slopes.	Deep, medium-textured alluvial soil material low in content of sand. Well drained and in flat areas or on convex slopes on terraces. A seasonal high water table is below a depth of 4 feet. Surface layer medium in content of organic matter.	0–12 12–38 38–68
FlB	Floyd loam, 0 to 5 percent slopes.	Deep, medium-textured glacial soil material of variable particle size. Somewhat poorly drained and in flat areas or on concave or convex slopes in drainageways in the uplands. A seasonal high water table is at a depth of 1 to 3½ feet. Surface layer high in content of organic matter. In places a prominent stone line is at a depth of 18 to 30 inches.	0–15 15–42 42–50
FmB	Floyd-Clyde complex, 0 to 4 percent slopes.	For a description of the Floyd soil material, see Floyd loam, 0 to 5 percent slopes; for a description of the Clyde soil material, see Clyde silt loam, 0 to 4 percent slopes.	
FnB	Franklin silt loam, gray subsoil variant, 2 to 5 percent slopes.	15 to 40 inches of windblown soil material low or moderately low in content of sand and underlain by medium-textured glacial material of variable particle size. Somewhat poorly drained and in flat areas or on concave or convex slopes in drainageways in the uplands. A seasonal high water table is at a depth of 1½ to 3½ feet. Surface layer medium in content of organic matter.	0–6 6–26 26–68
FrC FrD2 FrE2	Frankville silt loam, 5 to 9 percent slopes. Frankville silt loam, 9 to 14 percent slopes, moderately eroded. Frankville silt loam, 14 to 18 percent slopes, moderately eroded.	15 to 30 inches of loessal soil material that is low in content of sand and is underlain by limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter, except in severely eroded spots, where the content of organic matter is low.	0–6 6–23 23–28
HaA HaB HaD	Hagener loamy sand, 0 to 2 percent slopes. Hagener loamy sand, 2 to 5 percent slopes. Hagener loamy sand, 5 to 14 percent slopes.	Deep, uniform windblown soil material or outwash soil material high in content of sand. Excessively drained and in flat areas or on convex slopes on terraces or uplands. No effective water table. Surface layer moderately low in content of organic matter.	0–9 9–18 18–60
HdA	Hayfield loam, deep, 0 to 3 percent slopes.	36 to about 45 inches of medium-textured soil material over gravelly sand. Somewhat poorly drained and in flat areas or on convex slopes of terraces. A seasonal high water table is at a depth of 2 to 3 feet. Surface layer medium in content of organic matter.	0–11 11–40 40–45
HmA	Hayfield loam, moderately deep, 0 to 4 percent slopes.	24 to 36 inches of medium-textured soil material over gravelly sand. Somewhat poorly drained and in flat areas or on convex slopes on terraces. A seasonal high water table is at a depth of 2 to 3 feet. Surface layer medium in content of organic matter.	0–9 9–26 26–44
HuA HuB	Huntsville silt loam, 0 to 2 percent slopes. Huntsville silt loam, 2 to 6 percent slopes.	Deep soil material in local alluvium and low in content of sand. Well drained and in flat areas or on convex slopes in the outlets of drainageways. Subject to frequent flooding of short duration, and additional material is deposited when the soils are flooded. No effective water table. Surface layer is 20 to 40 inches thick and is medium in content of organic matter.	0–31 31–64
JaA JaB JaC JaD	Jacwin loam, 0 to 2 percent slopes. Jacwin loam, 2 to 5 percent slopes. Jacwin loam, 5 to 9 percent slopes. Jacwin loam, 9 to 14 percent slopes.	15 to 30 inches of glacial outwash soil material that is underlain by shale and is of uniform particle size. Somewhat poorly drained and in flat areas or on concave or convex slopes in the uplands. The areas in many places resemble benches. A seasonal high water table is above the shale. Surface layer high in content of organic matter.	0–19 19–27 27–48

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 20	5. 6-6. 6	Moderate.
Silt loam	CL	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 4-6. 2	Moderate to high.
Silt loam	CL	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 4-6. 2	Moderate to high.
Loam to gritty silty clay loam.	OL or CL	A-6 or A-7-6	85-100	80-100	55-75	0. 8-2. 5	. 20	6. 4-7. 2	Moderate to high.
Loam	CL or SC	A-6 or A-4	75-100	70-95	35-75	0. 8-2. 5	. 17	5. 8-7. 2	Moderate.
Clay loam	CL	A-6	85-100	80-100	55-75	0. 2-0. 8	. 17	5. 8-7. 8	Moderate.
Silt loam	CL or ML	A-6 or A-4	100	95-100	95-100	0. 8-2. 5	. 20	5. 4-6. 2	Moderate.
Silt loam and silty clay loam.	CL	A-6 or A-7-6	100	95-100	95-100	0. 8-2. 5	. 18	4. 8-5. 6	Moderate to high.
Loam	CL	A-6	90-100	85-100	55-75	0. 2-0. 8	. 16	5. 2-6. 2	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 20	6. 0-6. 8	Moderate.
Silt loam and silty clay loam.	CL	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 18	5. 8-6. 4	Moderate to high.
Clay and fragments of limestone.	CH	A-7-6	85-100	80-100	70-100	<0. 05-5. 0	. 15	6. 4-8. 2	High.
Loamy sand	SM	A-2	100	95-100	10-30	5. 0-10. 0	. 04	5. 6-6. 8	None.
Loamy sand	SP or SM	A-2	100	95-100	5-20	5. 0-10. 0	. 03	5. 4-6. 4	None.
Sand	SP or SM	A-1 or A-2	100	95-100	0-20	10+	. 03	5. 4-6. 4	None.
Loam	CL	A-6	90-100	90-100	55-75	0. 8-2. 5	. 16	6. 0-6. 8	Moderate.
Loam, light clay loam, and sandy loam.	CL or SC	A-2 or A-6	90-100	85-100	30-65	0. 8-2. 5	. 15	5. 0-5. 6	Low to moderate.
Gravelly sand	SM or SW	A-2 or A-1	85-100	80-100	0-20	10+	. 02	5. 0-5. 6	None.
Loam	CL or ML	A-6 or A-4	90-100	90-100	55-75	0. 8-2. 5	. 16	6. 0-6. 8	Moderate.
Sandy clay loam	CL or SC	A-2 or A-6	90-100	85-100	30-65	0. 8-2. 5	. 15	5. 0-5. 6	Low to moderate.
Gravelly sand	SM or SW	A-2 or A-1	85-100	80-100	0-20	10+	. 02	5. 0-5. 6	None.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 21	6. 4-7. 4	Moderate to high.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 20	6. 4-7. 4	Moderate to high.
Loam	CL or OL	A-6 or A-7-6	85-100	80-100	55-75	0. 8-2. 5	. 17	6. 4-7. 2	Moderate to high.
Loam	CL	A-6	85-100	80-100	55-75	0. 8-2. 5	. 16	6. 4-7. 2	Moderate.
Silty clay loam and silty clay shale.	CH	A-7-6	85-100	80-100	70-100	<0. 05	<. 15	6. 4-7. 6	High.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
KaA	Kato loam, moderately deep, 0 to 4 percent slopes.	36 to 42 inches of glacial outwash soil material over outwash of gravelly sand of uniform particle size. Somewhat poorly drained and in flat areas, on concave slopes of terraces, or in drainageways iu the uplands; a seasonal high water table is at a depth of 1½ to 3 feet. Surface layer high in content of organic matter.	0–17 17–37 37–43
KdA	Kato loam, deep, 0 to 4 percent slopes.	36 to 42 inches of glacial outwash soil material of uniform particle size. Underlain by sandy material over clayey shale that is within 4 feet of the surface. Somewhat poorly drained and in flat areas or on concave or convex slopes in the uplands. The areas in many places resemble benches. A seasonal high water table is at a depth of 1½ to 3½ feet. Surface layer high in content of organic matter.	0–14 14–30 30–44 44
KsB KsC	Kato loam, deep, clay shale substratum, 1 to 5 percent slopes. Kato loam, deep, clay shale substratum, 5 to 9 percent slopes.	24 to 36 inches of glacial outwash soil material of uniform particle size over outwash of gravelly sand. Somewhat poorly drained and in flat areas, on concave or convex terraces, or in drainageways in the uplands. A seasonal high water table is at a depth of 1½ to 2½ feet. Surface layer high in content of organic matter.	0–15 15–27 27–42
KyB	Kenyon loam, 2 to 5 percent slopes.	Deep, medium-textured, glacial soil material of variable particle size. Moderately well drained and on convex slopes in the uplands. A seasonal high water table is between a depth of 3 and 4 feet. Surface layer medium in content of organic matter. Prominent stone line common at a depth of 18 to 24 inches.	0–12 12–65
LaB LaC LaD	Lamont sandy loam, 1 to 5 percent slopes. Lamont sandy loam, 5 to 9 percent slopes. Lamont sandy loam, 9 to 14 percent slopes.	Deep soil material of uniform sandy loam. Excessively drained and in flat areas or on convex slopes of uplands or terraces. No effective water table. Low in content of organic matter.	0–12 12–21 21–47 47–54
LdB	Lamont sandy loam, till subsoil variant, 2 to 9 percent slopes.	15 to 36 inches of uniform sandy loam of windblown material or outwash over medium-textured glacial material. Well drained and on convex slopes in the uplands. Has a seasonal perched water table above the junction of the glacial till and windblown material for short periods. Low content of organic matter.	0–7 7–20 20–72
LkA	Lawson and Kennebec silt loams, 0 to 2 percent slopes.	For a description of the Lawson soil material, see Lawson silt loam, 2 to 5 percent slopes.	
		Kennebec: Deep alluvial soil material low in content of sand. Well drained and on bottom lands. No effective water table. Moderately high content of organic matter to a depth of at least 42 inches.	0–47
LmB	Lawson silt loam, 2 to 5 percent slopes.	Deep, medium-textured alluvial soil material low in content of sand. Somewhat poorly drained and in flat areas or on concave or convex slopes of terraces. A seasonal high water table is at a depth of 1½ to 3½ feet. The surface layer is 20 to 40 inches thick and is high in content of organic matter.	0–29 29–50
LnE LnF	Loamy colluvial land, 9 to 18 percent slopes. Loamy colluvial land, 18 to 24 percent slopes.	Deep, medium-textured colluvial soil material low to high in content of sand and of uniform particle size. Well drained and on convex slopes in the uplands. A seasonal high water table is below a depth of 4 feet. The surface layer is 6 to 30 inches thick and is medium to low in content of organic matter.	0–14 14–48
LoF	Loamy terrace escarpments, 16 to 30 percent slopes.	Uppermost soil material loamy; in places gravelly or sandy material is below a depth of 20 inches. Well drained to excessively drained and on convex slopes of escarpments. No effective water table. Content of organic matter generally low.	0–42
MaB MaC MaC2 MaD2	Marlean loam, 2 to 5 percent slopes. Marlean loam, 5 to 9 percent slopes. Marlean loam, 5 to 9 percent slopes, moderately eroded. Marlean loam, 9 to 14 percent slopes, moderately eroded.	Less than 15 inches of loam of fairly uniform particle size over fragmented, earthy limestone bedrock. Well drained to excessively drained and on convex slopes in the uplands. No effective water table. Surface layer moderately low in content of organic matter.	0–12 12–48

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Loam	OL or CL	A-6 or A-7-6	85-100	80-100	55-75	0. 8-2. 5	. 17	5. 8-7. 0	Moderate to high.
Loam	CL	A-6	85-100	80-100	55-75	0. 8-2. 5	. 16	5. 6-6. 6	Moderate.
Gravelly loamy sand	SM or GM	A-1 or A-2-4	50-90	20-95	15-30	10+	. 03	5. 6-6. 6	None.
Loam	CL or OL	A-6 or A-7-6	85-100	80-100	55-75	0. 8-2. 5	. 17	6. 4-7. 2	Moderate to high.
Loam to clay loam	CL	A-6	85-100	70-100	55-75	0. 8-2. 5	. 16	6. 4-7. 2	Moderate.
Sandy loam to sand	SM or GM	A-2-4	50-90	20-95	15-30	5. 0-10. 0	. 03	6. 4-7. 2	Low to none.
Shale material or shaly limestone.	CH	A-7-6	85-100	80-100	70-100	<0. 05	<. 15	6. 4-7. 6	High.
Loam	OL or CL	A-6 or A-7-6	85-100	80-100	55-75	0. 8-2. 5	. 17	5. 8-7. 0	Moderate to high.
Loam	CL	A-6	85-100	70-100	55-75	0. 8-2. 5	. 16	5. 6-6. 6	Moderate.
Gravelly loamy sand	SM or GM	A-1 or A-2-4	50-90	20-95	15-30	10+	. 03	5. 6-6. 6	None.
Loam	CL	A-6 or A-4	85-100	80-100	55-75	0. 8-2. 5	. 21	6. 6-7. 2	Moderate.
Heavy loam [2]	CL	A-6	85-100	80-100	55-75	0. 2-0. 8	. 16	5. 4-6. 4	Moderate.
Sandy loam	SM or ML	A-2 or A-4	85-100	80-100	25-55	2. 5-5. 0	. 12	5. 6-6. 6	Low to none.
Sandy loam	SM	A-2 or A-4	85-100	80-100	25-45	2. 5-5. 0	. 12	5. 4-6. 2	Low to none.
Light loam	CL or SM	A-4 or A-2	85-100	80-100	25-65	2. 5-5. 0	. 12	5. 4-6. 2	Low to none.
Sand	SP or SM	A-2	85-100	80-100	0-15	10+	. 03	5. 6-6. 2	None.
Sandy loam	SM	A-2 or A-4	85-100	80-100	25-45	2. 5-5. 0	. 12	5. 6-7. 0	Low.
Sandy loam	SM	A-2 or A-4	85-100	80-100	25-45	2. 5-5. 0	. 12	5. 4-6. 2	Low.
Loam	CL	A-6	85-100	80-100	55-75	0. 2-0. 8	. 15	4. 8-6. 0	Moderate.
Silt loam	OL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 21	6. 6-7. 2	Moderate to high.
Silt loam	ML or OL	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 21	6. 2-6. 8	Moderate to high.
Silt loam	CL or ML	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 19	6. 0-6. 8	Moderate to high.
Loam	CL	A-6 or A-4	90-100	80-100	50-75	0. 8-2. 5	. 15	6. 2-7. 4	Moderate.
Loam	CL	A-6 or A-4	90-100	80-100	50-75	0. 8-2. 5	. 15	5. 6-7. 2	Moderate to low.
Loam and sandy loam.	CL or SM	A-4 or A-2	85-100	80-100	30-75	0. 8-2. 5	. 15	5. 4-6. 4	Low to moderate.
Loam	CL	A-4 or A-6	85-100	80-100	55-75	0. 8-2. 5	. 16	5. 4-6. 4	Low to moderate.
Loam and fragmented limestone.	GP	A-1	5-30	5-25	0-10	2. 5-10. 0	>. 10	6. 2-8. 2	Low to none.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
MaD3	Marlean loam, 9 to 14 percent slopes, severely eroded.		
MaE2	Marlean loam, 14 to 24 percent slopes, moderately eroded.		
MaE3	Marlean loam, 14 to 24 percent slopes, severely eroded.		
NaC2	Nasset silt loam, 5 to 9 percent slopes, moderately eroded.	30 to 50 inches of loessal soil material of low sand content over limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–15 15–37 37–42 42
NaD2	Nasset silt loam, 9 to 14 percent slopes, moderately eroded.		
NaE2	Nasset silt loam, 14 to 18 percent slopes, moderately eroded.		
NoD	Nordness silt loam, 5 to 14 percent slopes.	Less than 15 inches of loamy soil material over limestone bedrock. Well drained to excessively drained and on convex slopes in the uplands. No effective water table. Surface layer low in content of organic matter.	0–5 5–12 12–18
NoE	Nordness silt loam, 14 to 24 percent slopes.		
OrA	Oran loam, 0 to 2 percent slopes.	Deep, medium-textured, glacial soil material of variable particle size. Somewhat poorly drained and in flat areas, on concave or convex slopes in the uplands, or in drainageways in the uplands. A seasonal high water table is at a depth of 1 to 3½ feet. Surface layer medium in content of organic matter. In places a prominent stone line at a depth of 18 to 28 inches	0–14 14–42 42–50
OrB	Oran loam, 2 to 5 percent slopes.		
OsB	Orwood silt loam, 2 to 5 percent slopes.	Deep, medium-textured, windblown soil material moderately low to medium in content of sand. Well drained and on convex slopes in the uplands. A seasonal high water table is below a depth of 4 feet. Surface layer medium in content of organic matter, except in severely eroded areas, where the content of organic matter is low.	0–8 8–50 50–60
OsC2	Orwood silt loam, 5 to 9 percent slopes, moderately eroded.		
OsD2	Orwood silt loam, 9 to 14 percent slopes, moderately eroded.		
OsE2	Orwood silt loam, 14 to 18 percent slopes, moderately eroded.		
OsE3	Orwood silt loam, 14 to 18 percent slopes, severely eroded.		
OsF2	Orwood silt loam, 18 to 30 percent slopes, moderately eroded.		
Ot	Ossian silt loam.	Deep, medium-textured alluvial soil material low in content of sand. Poorly drained and in flat areas or on concave slopes of very low terraces or narrow bottom lands. Has a seasonal high water table.	0–15 15–42 42–50
OuA	Ostrander loam, 0 to 2 percent slopes.	Deep, medium-textured, glacial soil material of variable particle size. Well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of 3½ to more than 5 feet. Surface layer medium in content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–18 18–24 24–55
OuB	Ostrander loam, 2 to 5 percent slopes.		
OuC	Ostrander loam, 5 to 9 percent slopes.		
OvB	Otter-Lawson-Ossian complex, 1 to 4 percent slopes.	For a description of the Otter soil material, see Colo and Otter silt loams; for a description of the Lawson soil material, see Lawson silt loam, 2 to 5 percent slopes; for a description of the Ossian soil material, see Ossian silt loam.	
Ow	Otter-Ossian complex.		
Ox	Otter and Ossian silt loams, overwashed.		
PaC2	Palsgrove silt loam, 5 to 9 percent slopes, moderately eroded.	30 to 50 inches of medium-textured loessal soil material that is low in content of sand and is underlain by limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Low in content of organic matter.	0–6 6–40 40–42 42
PaD2	Palsgrove silt loam, 9 to 14 percent slopes, moderately eroded.		
PaD3	Palsgrove silt loam, 9 to 14 percent slopes, severely eroded.		
PaE2	Palsgrove silt loam, 14 to 18 percent slopes, moderately eroded.		
PaE3	Palsgrove silt loam, 14 to 18 percent slopes, severely eroded.		
PaF2	Palsgrove silt loam, 18 to 24 percent slopes, moderately eroded.		

See footnotes at end of table.

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 20	5. 6-6. 8	Moderate.
Silt loam and silty clay loam.	CL	A-7 or A-6	100	100	95-100	0. 8-2. 5	. 18	5. 4-6. 4	Moderate to high.
Clay	CH	A-7-6	85-100	80-100	70-100	<0. 05	. 15	6. 2-7. 2	High.
Limestone	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4].
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 18	6. 2-6. 8	Low to moderate.
Silt loam and silty clay loam.	CL	A-6 or A-7-6	95-100	95-100	90-100	0. 8-2. 5	. 18	6. 2-6. 8	Moderate.
Clay and limestone	CH	A-7-6	85-100	80-100	70-100	0. 05-2. 5	. 15	6. 2-8. 2	High.
Loam	CL or ML	A-6	85-100	80-100	55-75	0. 8-2. 5	. 16	5. 2-6. 8	Moderate.
Heavy loam [2]	CL	A-6	85-100	80-100	55-75	0. 2-0. 8	. 16	5. 4-6. 2	Moderate.
Loam	CL	A-6	85-100	80-100	55-75	0. 2-0. 8	. 15	6. 2-7. 8	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	85-100	0. 8-2. 5	. 19	5. 8-7. 0	Moderate.
Loam and silt loam	CL or ML	A-6	100	90-100	60-90	0. 8-2. 5	. 16	5. 4-6. 2	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	85-100	0. 8-2. 5	. 16	5. 4-6. 4	Moderate.
Silt loam	ML or OL	A-7-6	100	100	95-100	0. 8-2. 5	. 20	6. 2-7. 2	High.
Silt loam	ML or CL	A-6 or A-7-6	100	100	95-100	0. 8-2. 5	. 18	6. 2-7. 2	Moderate to high.
Silt loam	ML or CL	A-6	100	100	95-100	0. 8-2. 5	. 18	6. 4-7. 6	Moderate.
Loam	CL	A-4 or A-6	85-100	80-100	55-75	0. 8-2. 5	. 17	5. 6-6. 8	Moderate.
Loam [2]	CL	A-6	75-100	65-90	55-75	0. 8-2. 5	. 16	5. 4-6. 2	Moderate.
Clay loam	CL	A-6	85-100	80-100	55-75	0. 2-0. 8	. 18	5. 6-7. 4	Moderate.
Silt loam	CL or ML	A-4 or A-6	100	100	95-100	0. 8-2. 5	. 18	5. 6-6. 8	Low to moderate.
Silty clay loam and silt loam.	CL	A-7-6	100	100	95-100	0. 8-2. 5	. 19	5. 2-5. 8	Moderate to high.
Clay	CH	A-7-6	85-100	85-100	70-100	<0. 05	. 15	6. 2-7. 4	High.
Limestone	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4]	[4].

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
Pk	Peaty muck.	10 to 48 inches of soil material, very high in content of organic matter, over silty, loamy, or sandy material. Poorly drained and in flat areas, on convex slopes in the uplands, or in drainageways in the uplands. A seasonal high water table is at the surface.	0–37 37–46
Pw	Peaty muck, overwashed.	6 to 20 inches of medium-textured alluvial soil material low in content of sand and underlain by peaty muck and muck. Somewhat poorly drained or poorly drained and in flat areas, on concave or convex slopes of narrow bottom lands, or in drainageways in the uplands. A seasonal high water table is at the surface of the peaty muck or muck. Surface layer low in content of organic matter; the next lower layer very high in content of organic matter.	0–10 10–31 31–42
RaA RaB RaC RaC2 RaD2	Racine loam, 0 to 2 percent slopes. Racine loam, 2 to 5 percent slopes. Racine loam, 5 to 9 percent slopes. Racine loam, 5 to 9 percent slopes, moderately eroded. Racine loam, 9 to 14 percent slopes, moderately eroded.	Deep, medium-textured, glacial soil material of variable particle size. Well drained and on convex slopes in the uplands. A seasonal high water table is at a depth of 3½ to more than 5 feet. Surface layer medium in content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–12 12–34 34–44
ReB ReC ReC2 ReD2 ReD3 ReE2 ReE3	Renova loam, 2 to 5 percent slopes. Renova loam, 5 to 9 percent slopes. Renova loam, 5 to 9 percent slopes, moderately eroded. Renova loam, 9 to 14 percent slopes, moderately eroded. Renova loam, 9 to 14 percent slopes, severely eroded. Renova loam, 14 to 18 percent slopes, moderately eroded. Renova loam, 14 to 18 percent slopes, severely eroded.	Deep, medium-textured, glacial soil material of variable particle size. Well drained and on convex slopes in the uplands. A seasonal high water table is below a depth of 4 feet. Low content of organic matter. A prominent stone line common at a depth of 18 to 24 inches.	0–7 7–16 16–50
RfB	Riceville loam, 2 to 7 percent slopes.	Deep, medium-textured, glacial soil material of fairly variable particle size. Moderately well drained and on convex slopes in the uplands. The structure, texture, and bulk density result in firm consistence at a depth of 1½ to 3½ feet. Surface layer medium in content of organic matter.	0–12 12–16 16–56
RkA RkB RkC RkD	Rockton loam, 0 to 2 percent slopes. Rockton loam, 2 to 5 percent slopes. Rockton loam, 5 to 9 percent slopes. Rockton loam, 9 to 14 percent slopes.	15 to 30 inches of medium-textured glacial soil material of variable particle size over limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–18 18–28 28–31 31
RoA	Rowley silt loam, 0 to 4 percent slopes.	Deep, medium-textured alluvial soil material low in content of sand. Somewhat poorly drained and in low, flat areas or on concave or convex slopes of terraces. A seasonal high water table is at a depth of 2 to 4 feet. Uppermost 8 to 15 inches of the surface layer moderately high in content of organic matter.	0–13 13–30 30–46
Rw	Rowley and Lawson silt loams, overwashed.	Soil material on low, flat bottom lands, where some deposits of soil material low in content of organic matter is received. The layer of overwash is 5 to 20 inches thick. For a description of the Rowley soil, see Rowley silt loam, 0 to 4 percent slopes; for a description of the Lawson soil, see Lawson silt loam, 2 to 5 percent slopes.	0–18 18–38 38–50
SbA SbB SbC2	Sattre loam, deep, 0 to 2 percent slopes. Sattre loam, deep, 2 to 5 percent slopes. Sattre loam, deep, 5 to 9 percent slopes, moderately eroded.	More than 36 inches of medium-textured soil material that is medium to high in content of sand and is underlain by gravelly sand. Well drained and in flat areas or on convex slopes on terraces or uplands. No effective water table above a depth of 4 to 5 feet. Surface layer medium in content of organic matter.	0–11 11–22 22–44 44–56

See footnotes at end of table.

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Peaty muck	Pt	(1)	(1)	(1)	(1)	(1)	.25	6.0–7.0	Moderate.
Silty clay loam	CL	A–7–6	85–100	80–100	65–100	0.2–0.8	.18	6.0–7.0	Moderate to high.
Silt loam	CL or ML	A–4 or A–6	100	100	95–100	0.8–2.5	.18	6.6–7.8	Low to moderate.
Peaty muck	Pt	(1)	(1)	(1)	(1)	(1)	.25	6.0–7.0	Moderate.
Loam	CL	A–6	85–100	80–100	55–85	0.8–2.5	.14	6.0–7.0	Moderate.
Loam	CL	A–6 or A–4	95–100	90–100	65–75	0.8–2.5	.16	5.6–6.8	Moderate.
Loam [2]	CL	A–6	75–95	65–95	65–75	0.2–0.8	.15	5.0–5.8	Moderate.
Sandy clay loam	CL or SC	A–6 or A–4	90–95	80–95	40–75	0.2–0.8	.14	5.0–7.6	Moderate.
Loam	CL	A–6 or A–4	95–100	95–100	65–75	0.8–2.5	.16	5.8–6.8	Moderate.
Loam [2]	CL	A–6	75–95	65–95	65–75	0.8–2.5	.15	5.0–6.0	Moderate.
Loam and sandy clay loam.	CL or SC	A–6 or A–4	90–95	80–95	40–75	0.8–2.5	.14	5.0–6.4	Moderate.
Loam	CL	A–6	95–100	95–100	65–75	0.8 2.5	.18	5.6–6.6	Moderate.
Loam [2]	CL	A–6	75–95	65–95	65–75	0.8–2.5	.16	4.5–5.5	Moderate.
Clay loam	CL	A–6	90–100	85–100	55–75	0.2–0.8	.16	5.1–6.5	Moderate.
Loam	CL or ML	A–4 or A–6	95–100	95–100	55–75	0.8–2.5	.17	6.2–6.8	Moderate.
Clay loam	CL	A–6 or A–4	85–100	80–95	50–75	0.8–2.5	.16	6.0–6.6	Moderate.
Clay	CH	A–7–6	85–100	80–100	70–100	<0.05	.14	6.6–7.8	High.
Limestone	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Silt loam	OL or ML	A–6 or A–7–6	100	100	95–100	0.8–2.5	.21	6.0–7.0	Moderate to high.
Silt loam	CL	A–7–6	100	100	95–100	0.8–2.5	.19	5.6–6.0	High.
Silt loam	CL	A–6 or A–7–6	100	100	95–100	0.8–2.5	.18	5.6–6.6	Moderate to high.
Silt loam	CL or ML	A–6 or A–4	100	100	95–100	0.8–2.5	.18	6.2–7.8	Moderate.
Silt loam	OL or ML	A–6 or A–7–6	100	100	95–100	0.8–2.5	.20	6.2–7.0	Moderate to high.
Silt loam	CL	A–6 or A–7–6	100	100	95–100	0.8–2.5	.19	6.0–6.8	Moderate to high.
Loam	CL	A–6 or A–4	90–100	80–100	55–75	0.8–2.5	.16	5.8–6.8	Low to moderate.
Loam	CL	A–6	90–100	80–100	55–75	0 8–2.5	.15	5.6–6.6	Moderate.
Loam to sandy loam	SM or CL	A–2 or A–6	90–100	80–100	30–65	2.5–5.0	.14	5.2–6.0	Low.
Sand (gravelly) [3]	SP or SW	A–1 or A–2	70–100	75–100	0–15	5–10	.02	4.8–5.8	None.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
SdA SdB SdC2 SdD2	Sattre loam, moderately deep, 0 to 2 percent slopes. Sattre loam, moderately deep, 2 to 5 percent slopes. Sattre loam, moderately deep, 5 to 9 percent slopes, moderately eroded. Sattre loam, moderately deep, 9 to 14 percent slopes, moderately eroded.	24 to 36 inches of medium-textured soil material that is medium to high in content of sand and is underlain by gravelly sand. Well drained and in flat areas or on convex slopes on terraces or uplands. No effective water table above a depth of 4 to 5 feet. Surface layer medium in content of organic matter.	0–10 10–30 30–46
Sp	Spillville loam.	Deep, alluvial soil material medium to high in content of sand. Moderately well drained and on flat, low bottom lands. A seasonal high water table is below a depth of 4 feet. Uppermost 30 to 50 inches medium in content of organic matter.	0–60
Sr	Steep rock land.	Outcrops of bedrock dominant in these areas. The bedrock is dominantly limestone, but sandstone and shale are interbedded.	([4])
SsF	Steep sandy land, 14 to 30 percent slopes.	Sandy loam to sand is dominant in this land type, and the soil material includes some gravel. Dominantly terrace escarpments, but there are some convex slopes in the uplands.	0–60
TeA TeB	Terril loam, 0 to 2 percent slopes. Terril loam, 2 to 5 percent slopes.	Deep, uniform, alluvial loam. Well drained and on convex slopes of terraces and alluvial fans. A seasonal high water table is below a depth of 4 feet. The surface layer is 20 to 40 inches thick and is high in content of organic matter.	0–32 32–48
TgA TgB	Turlin gritty silt loam, 0 to 2 percent slopes. Turlin gritty silt loam, 2 to 5 percent slopes.	Deep, medium-textured, alluvial soil material that is medium to high in content of sand and is of uniform particle size. Somewhat poorly drained and in low, flat areas or on convex slopes on terraces. A seasonal high water table is at a depth of 2 to 3½ feet. The surface layer is 20 to 40 inches thick and is moderately high in content of organic matter.	0–34 34–52
VcA VcB	Volney channery silt loam, 0 to 1 percent slopes. Volney channery silt loam, 2 to 5 percent slopes.	Deep, medium-textured, alluvial soil material low in content of sand. Fragments of limestone that are generally 2 to 6 inches in diameter but that range from one-eight inch in diameter to slabs 15 inches in diameter are dominant in the soil material. Well drained and on low bottom lands that are frequently flooded. No effective seasonal high water table. Low in content of organic matter.	0–30 30–50
VoA VoB	Volney silt loam, overwashed, 0 to 1 percent slopes. Volney silt loam, overwashed, 2 to 5 percent slopes.	6 to 20 inches of medium-textured, alluvial soil material low in content of sand. Underlain by medium-textured alluvial soil material, also low in content of sand, in which fragments of limestone 2 to 6 inches in diameter are dominant. Well drained and on low bottom lands that are commonly flooded. No effective seasonal high water table. Low in content of organic matter.	0–17 17–37 37–50
WcA WcB WcC WcD	Waucoma loam, 0 to 2 percent slopes. Waucoma loam, 2 to 5 percent slopes. Waucoma loam, 5 to 9 percent slopes. Waucoma loam, 9 to 14 percent slopes.	30 to 50 inches of medium-textured glacial soil material of variable particle size over limestone bedrock. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–14 14–23 23–36 36–39 39
WdA WdB	Waukegan loam, deep, 0 to 2 percent slopes. Waukegan loam, deep, 2 to 5 percent slopes.	36 to 45 inches of medium-textured soil material over gravelly sand. Well drained and in flat areas or on convex slopes on terraces or uplands. No effective water table above a depth of 4 to 5 feet. Surface layer medium in content of organic matter.	0–14 14–38 38–45
WgA WgB	Waukegan loam, moderately deep, 0 to 2 percent slopes. Waukegan loam, moderately deep, 2 to 5 percent slopes.	24 to 36 inches of medium-textured soil material over gravelly sand. Well drained and in flat areas or on convex terraces or uplands. No effective water table. Surface layer medium in content of organic matter.	0–9 9–25 25–50

See footnotes at end of table.

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Loam	CL	A-6 or A-4	90–100	80–100	55–75	0. 8–2. 5	. 16	5. 8–6. 8	Low to moderate.
Loam	CL	A-6	90–100	80–100	55–75	0. 8–2. 5	. 15	5. 4–6. 6	Moderate.
Sand (gravelly) [3]	SM or SW	A-2	70–100	75–100	0–15	5–10	. 02	4. 8–5. 8	None.
Loam	CL	A-6 or A-4	95–100	95–100	55–85	0. 8–2. 5	. 17	6. 6–7. 4	Moderate.
(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4).
Sand	SM or SW	A-1, A-2, or A-4.	90–100	80–100	5–50	2–5–10. 0	. 03	5. 4–6. 6	Low to none.
Loam	CL	A-6	85–100	80–100	55–75	0. 8–2. 5	. 18	6. 4–7. 0	Moderate.
Loam	CL	A-6	85–100	80–100	55–75	0. 8–2. 5	. 17	6. 4–7. 0	Moderate.
Gritty silt loam and loam.	OL or ML	A-6	95–100	90–100	55–75	0. 8–2. 5	. 18	6. 2–7. 2	Moderate.
Loam	CL	A-6 or A-4	95–100	90–100	55–75	0. 8–2. 5	. 17	5. 8–7. 0	Moderate.
Channery silt loam	SC	A-4 or A-2	50–60	40–60	25–50	0. 8–2. 5	. 17	7. 0–8. 2	Low.
Limestone fragments and silty material.	GM	A-2-4	10–50	20–50	15–35	5. 0–10. 0+	. 08	6. 6–7. 6	None.
Silt loam	ML or CL	A-4 or A-6	95–100	90–100	85–100	0. 8–2. 5	. 18	6. 8–8. 2	Low to moderate.
Channery silt loam	SC	A-4 or A-2	50–60	40–60	25–50	0. 8–2. 5	. 17	7. 0–8. 2	Low.
Limestone fragments and silty material.	GM	A-2-4	10–50	20–50	15–35	5. 0–10. 0	. 08	6. 6–7. 6	None.
Loam	CL	A-4 or A-6	85–100	80–100	55–75	0. 8–2. 5	. 16	5. 8–6. 8	Low to moderate.
Loam [2]	CL or SC	A-6	75–95	65–85	35–75	0. 8–2. 5	. 16	5. 4–6. 2	Moderate.
Sandy clay loam and loam.	CL or SC	A-6 or A-2	90–100	85–100	30–65	0. 8–2. 5	. 16	5. 2–6. 2	Low to moderate.
Clay	CH	A-7-6	85–100	80–100	70–100	<0. 05	. 15	6. 4–8. 2	High.
Limestone	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4).
Loam	CL	A-4 or A-6	85–100	80–100	55–75	0. 8–2. 5	. 17	5. 8–6. 8	Low to moderate.
Loam	CL	A-6	85–100	80–100	55–75	0. 8–2. 5	. 16	5. 6–6. 4	Moderate.
Sand (gravelly) [3]	SM or SW	A-2 or A-1	70–100	75–100	0–15	10+	. 02	5–4. 6. 6	None.
Loam	CL	A-4 or A-6	85–100	80–100	55–75	0. 8–2. 5	. 17	5. 8–6. 8	Low to moderate.
Loam	CL	A-6	85–100	80–100	55–75	0. 8–2. 5	. 16	5. 4–6. 4	Moderate.
Gravelly sand [3]	SM or SW	A-2 or A-1	70–100	75–100	0–15	10+	. 02	5. 2–6. 4	None.

TABLE 4.—*Brief description of the soil*

Symbol on map	Soil name	Description of soil material and site	Depth from surface
			Inches
WhB WhC2 WhD2 WhE2 WhE3	Whalan loam, 2 to 5 percent slopes. Whalan loam, 5 to 9 percent slopes, moderately eroded. Whalan loam, 9 to 14 percent slopes, moderately eroded. Whalan loam, 14 to 24 percent slopes, moderately eroded. Whalan loam, 14 to 18 percent slopes, severely eroded.	15 to 30 inches of medium-textured glacial soil material of fairly variable particle size. Underlain by bedrock, dominantly limestone. Well drained and on convex slopes in the uplands. No effective water table. Low in content of organic matter.	0–7 7–15 15–28 28–30 30
WkA WkB WkC WkC2 WkD WkE	Winneshiek loam, 0 to 2 percent slopes. Winneshiek loam, 2 to 5 percent slopes. Winneshiek loam, 5 to 9 percent slopes. Winneshiek loam, 5 to 9 percent slopes, moderately eroded. Winneshiek loam, 9 to 14 percent slopes. Winneshiek loam, 14 to 18 percent slopes.	15 to 30 inches of medium-textured glacial material of fairly variable particle size. Underlain by bedrock, dominantly limestone. Well drained and on convex slopes in the uplands. No effective water table. Surface layer medium in content of organic matter.	0–11 11–21 21–24 24

[1] No estimates feasible.
[2] Includes pebble band or stone line.
[3] Has a variable content of gravel, ranging from only a small amount to dominant.

TABLE 5.—*Interpretations of*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Alluvial land (Ab)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Arenzville (Ar)	Good	Not suitable.	Not suitable.	Not suitable.	Fair to very poor; low stability and bearing capacity when wet; in many places has moderately high content of organic matter to a depth of 2 to 3 feet; high compressibility.	Poor; subject to frequent flooding; low potential as borrow material; poor material for foundation of high fills.	Not suitable; nearly level; subject to frequent flooding; if used for a reservoir, the bottom of reservoir should be compacted.
Atkinson (AtB)	Good	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 30 to 50 inches.	Subsoil fair; good bearing capacity; moderate volume change; limestone below a depth of 30 to 50 inches.	Fair; hard, level-bedded bedrock below a depth of 30 to 50 inches; good potential as borrow material.	Poor; limestone is fractured in many places; material too porous to hold water.

See footnote at end of table.

material and its estimated properties—Continued

Classification			Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
USDA texture	Unified	AASHO	No. 4	No. 10	No. 200				
						Inches per hour	*Inches per inch of soil*	*pH value*	
Loam to silt loam	CL	A-4 or A-6	85-100	80-100	55-75	0.8-2.5	.16	5.6-6.8	Moderate.
Loam	CL	A-6	85-100	80-100	55-75	0.8-2.5	.15	5.4-6.2	Moderate.
Clay loam	CL	A-6	85-100	80-100	55-75	0.2-0.8	.16	5.2-6.2	Moderate.
Clay	CH	A-7-6	85-100	80-100	70-100	<0.05	.15	6.4-7.8	High.
Limestone	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4).
Loam	CL	A-6 or A-4	85-100	85-100	55-75	0.8-2.5	.16	5.8-6.8	Moderate.
Loam and clay loam.[2]	CL	A-6	80-100	70-100	55-75	0.2-0.8	.16	5.4-6.2	Moderate.
Clay	CH	A-7-6	85-100	80-100	70-100	<0.05	.15	6.4-7.8	High.
Limestone	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4).

[4] Bedrock.
[5] Assumes that the necessary artificial drainage for optimum rotation farming has been installed and is functioning properly.

engineering properties of soils

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
(1)	(1)	(1)	(1)	(1)	(1)	(1).
Fair; fair stability and moderate to high volume change; poor workability when wet.	Needs protection from flooding.	Protection from flooding required before irrigating; high available moisture capacity.	Diversions, properly placed, give some protection from local runoff and reduce siltation.	Good; generally not needed.	Not suitable; subject to flooding.	Severe; subject to frequent flooding; high compressibility; uniform consolidation.
Fair; fair stability; limestone bedrock below a depth of 30 to 50 inches; low to moderate volume change above the limestone.	Not needed	Fair to good; moderate available moisture capacity.	In places bedrock at a depth of 30 to 50 inches may hinder construction.	Satisfactory, but generally not needed.	Moderate; in places the fractured bedrock allows unfiltered sewage to travel a long distance.	None where the footings can be set on limestone bedrock; bedrock at a depth of 30 to 50 inches.

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TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Atterberry (AyA)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; high volume change and low bearing capacity when wet; moderate to high compressibility; very narrow range of moisture content for suitable compaction.	Fair to poor; seasonal high water table; moderately high content of organic matter in the surface layer; low potential as borrow material.	Fair; bottom of reservoir should be compacted.
Backbone (BaB BaC, BaD).	Very poor	Fair; poorly graded sand.	Not suitable.	Bedrock suitable for crushing.	Sand is good; bedrock not suitable unless crushed; good bearing capacity and shear strength; very low compressibility.	Fair; generally great need for cuts and fills; bedrock at a depth of 20 to 40 inches; good potential as borrow material.	Poor; rapid seepage; material too porous to hold water.
Bassett loam (BeA, BeB, BeC, BeC2).	Good to fair.	Not suitable.	Not suitable.	Not suitable.	Good below a depth of 15 to 20 inches; fair to good bearing capacity; easily compacted to a high density.	Good; seepage may occur in some cuts; susceptible to frost action where pockets of water-bearing sand occur; good workability.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir should be scarified and compacted.
Bassett silt loam (BlB, BlC).	Good	Not suitable.	Not suitable.	Not suitable.	Fair in the silty material, which is about 20 inches thick over glacial till; good in the till; the till has good bearing capacity.	Good; in places seepage may occur in some cuts; susceptible to frost action where the soil material is water bearing.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir should be scarified and compacted.
Bertrand (BnA, BnB)	Fair	Not suitable.	Not suitable.	Not suitable.	Poor; moderate to high volume change; poor stability when wet.	Fair to poor; poor potential as borrow material; poor compaction when wet.	Fair to poor; the subsoil is pervious; sealer may be required to prevent excessive seepage.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair; fair stability; moderate to high volume change; difficult to compact to high density.	Tile drains function well but are not required in all areas.	Good; in places tile drains are required before an area is irrigated; high available moisture capacity.	Generally not needed, because of gently sloping topography.	Satisfactory, but in places tile drains are needed on the sides of the waterways to control seepage.	Moderate to severe; seasonal high water table.	Moderate; in places saturation is likely to cause the soil to lose cohesion and settle; uniform consolidation; seasonal high water table.
Fair to poor; pervious, even where compacted; high stability; low volume change when the soils are wetted; susceptible to piping.	Not needed	Fair; low available moisture capacity; high infiltration rate.	Terraces difficult to construct and maintain; limestone at a depth of 20 to 40 inches.	Erodible, and vegetation is difficult to establish or maintain.	Moderate to severe; in places the cracked bedrock allows unfiltered sewage to travel a long distance.	None where footings rest on bedrock.
Good; moderate stability; slow permeability and low volume change where compacted.	Tile drains function well, but they are not needed in most areas.	Fair; moderate or moderately slow permeability below a depth of 2½ feet; high available moisture capacity.	Subsoil is low in fertility below a depth of about 15 to 20 inches; cuts should be held to a minimum; stones occur in places.	Some limitations; vegetation difficult to establish; tile drains needed on the sides of waterways to control seepage.	Moderate; moderate or moderately slow permeability below a depth of 2½ feet.	Slight; good bearing capacity and shear strength; low compressibility.
Good; moderate stability; moderate volume change in silty material; slow permeability where compacted.	Not needed	Good; moderate or moderately slow permeability below a depth of 3 feet; high available moisture capacity.	Well suited	Well suited; tile drains needed on the sides of the waterways to control seepage.	Slight to moderate; moderate or moderately slow permeability below a depth of 3 feet.	Slight; moderate to low compressibility; fair to good bearing capacity and shear strength.
Good to fair; moderate stability; poor compaction when wet.	Not needed	Good water intake and high moisture capacity.	Good, but not needed in most places.	Satisfactory, but not needed in most places.	Slight; moderate permeability.	Moderate; fair shear strength; moderate compressibility; saturation may cause soil to lose cohesion and settle.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Bixby (BoA, BoB, BoC2).	Fair to poor.	Good below a depth of 2 feet; poorly graded.	Good below a depth of 2 feet; at that depth consists of stratified sand and gravel; poorly graded.	Not suitable.	Fair to a depth of 2 feet; good below that depth; good stability at any moisture content.	Good; vegetation may be difficult to establish; good potential as borrow material.	Not suitable; gravelly sand below a depth of 2 feet; material too porous to hold water.
Burkhardt (BuB, BuC2).	Fair to poor.	Good in substratum; substratum contains poorly graded sand and gravel.	Variable; substratum contains stratified sand and gravel.	Not suitable.	Good; subsoil highly stable when dry, but may soften when moist; substratum excellent; highly stable at any moisture content.	Good; protection of slopes required, but vegetation is difficult to establish in some places; good potential as borrow material.	Poor; rapid permeability; soil material too porous to hold water.
Calamine (CaA, CaB)	Good, but likely to be wet.	Not suitable.	Not suitable.	Not suitable.	Not suitable; elastic; high content of organic matter; subject to high volume change.	Poor; seasonal high water table; high in content of organic matter; poor workability when wet.	Poor to fair for dugout ponds; bottom of reservoir needs to be compacted.
Calmar (CcB, CcC)	Good	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 2 to 3½ feet.	Fair to good; compaction good in the soil material above bedrock; uppermost layer is moderately high in content of organic matter.	Fair; contains a limited supply of material for fill; bedrock near the surface hinders construction in places.	Poor; bedrock is fractured in many places; soil material too porous to hold water.
Camden (CdA, CdB, CdC).	Fair	Suitable below a depth of 3 feet.	Fair below a depth of 3 feet.	Not suitable.	Fair to good; good below a depth of 3 feet; low volume change and good bearing capacity below a depth of 3 feet.	Fair to good; good, except where the substratum contains less than 15 percent fines.	Poor; gravelly sand below a depth of 3 feet; too porous to hold water.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Good; very stable; fair to good compaction, except where the content of fines is less than 15 percent; low volume change.	Not needed	Good; because of the gravelly sand below a depth of 2 feet, however, more frequent application of water is required than in areas where the underlying material is finer textured; low to medium available moisture capacity.	The ridges of terraces are difficult to construct and maintain.	Not needed in most places; vegetation difficult to establish.	Slight; in places, however, the gravelly sand may allow unfiltered sewage to travel a long distance.	Slight; good bearing capacity and shear strength; low compressibility; low volume change.
Fair; very stable; pervious; fair to good compaction, except where the content of fines is less than 15 percent; low volume change when the soils are wetted.	Not needed	Fair; rapid permeability; low available moisture capacity.	Highly erodible, and vegetation is difficult to establish; shallow over coarse-textured material.	Highly erodible, and vegetation difficult to establish and maintain.	Moderate; poor filtering of the material allows unfiltered sewage to travel a long distance.	Slight; good shear strength; low compressibility; low volume change if the soil material is wetted.
Poor; high in content of clay; wet; high in content of organic matter and less than 3 feet deep over shale; the shale has high shrink-swell potential.	Each site requires investigation; tile may not drain all areas.	Poor; slow or very slow permeability in the substratum; drainage needed before irrigating.	Diversions, properly placed, make the soils less wet by preventing local flooding.	Tile drains needed to control seepage so that vegetation can be established.	Not suitable; has a seasonal high water table; slow or very slow permeability.	Severe; underlain by weathered shale; subject to dangerous expansion if initially dry; moderate compressibility.
Fair; contains a limited supply of suitable material; compaction good in soil material above bedrock; low compressibility.	Generally not needed.	Fair; low to moderate available moisture capacity.	Bedrock hinders construction in places; cuts should be held to a minimum.	Satisfactory for shallow excavations, but not needed in most places.	Moderate; the fractured bedrock allows unfiltered sewage to travel a long distance.	None where the foundation rests on limestone bedrock.
Fair to good; the subsoil has moderate stability and moderate volume change; the substratum has high stability and low volume change.	Not needed	Good; medium available moisture capacity; moderately permeable.	Cuts should be restricted to a minimum to prevent exposing the coarse-textured material in the substratum.	Satisfactory, but not needed in most places.	Slight; the coarse texture of the substratum, however, may permit unfiltered sewage to travel a long distance.	Slight below a depth of 3 feet; good shear strength; low compressibility; low volume change on wetting and drying.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Caneek (Ce)	Good	Not suitable.	Not suitable.	Not suitable.	Fair to poor; has very low stability and bearing capacity when wet; difficult to compact to high density.	Poor; subject to flooding and has a high water table; the soil material has low density and has low potential as borrow material.	Poor to fair; subject to flooding; some seepage can be expected.
Canoe (Cf)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; has high volume change and low bearing capacity when wet; very narrow range of moisture content for suitable compaction.	Fair to poor; has seasonal high water table; surface layer moderately high in content of organic matter; has low potential as borrow material.	Fair, but a good site is rare; bottom of reservoir should be compacted.
Chaseburg (ChA, ChB, DgB). (In places mapped with Dorchester and Volney soils; interpretations for the Dorchester and Volney soils are given under their respective series.)	Good	Not suitable.	Not suitable.	Not suitable.	Fair to poor; low stability and bearing capacity when wet; poor compaction when wet.	Fair; subject to flash flooding; low potential as borrow material.	Poor to fair; the bottom of reservoir should be compacted; some seepage can be expected.
Chelsea (ClB, ClD)	Not suitable.	Good; source of poorly graded fine to medium sands.	Not suitable.	Not suitable.	Fair to good; except when damp, lacks stability under wheel loads; no volume change when wet.	Fair to good; loose sand may hinder hauling operations; highly erodible; vegetation difficult to establish on cuts; may become quick or flow when saturated.	Not suitable; rapid permeability; material too porous to hold water.
Clyde (CmB, FmB) (In places mapped with Floyd soils; interpretations for the Floyd soils are given under the Floyd series.)	Good, but often wet.	Not suitable.	Not suitable.	Not suitable.	Not suitable; high content of organic matter; high water table; moderate to high volume change; poor workability.	Poor; high water table and high content of organic matter; highly susceptible to frost action; nearly level.	Fair to good; bottom of reservoir may need to be compacted; thin layer of sand common.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair in upper part and poor in lower part; high water table; low stability when wet; moderate volume change.	Tile drains function well; protection from stream overflow needed.	Good; requires tile drainage before irrigating; subject to flooding; high available moisture capacity.	Diversions helpful in protecting the areas from local runoff; terraces not needed.	Not needed	Not suitable; subject to flooding and has a high water table.	Severe; wet and subject to flooding and deposition; fair shear strength and moderate to high compressibility.
Fair; fair stability; moderate to high volume change; difficult to compact to high density.	Tile drains function well; not all areas require them.	Good; tile drains required in places before irrigating; high available moisture capacity.	Diversions, properly placed, help to control local runoff and reduce wetness.	Generally not needed; tile drains needed in places to control seepage on the sides of the waterways.	Moderate; has a seasonal high water table.	Moderate; seasonal high water table; substratum may lose cohesion and settle.
Fair; fair stability; moderate volume change; poor compaction when wet.	Not needed	Good; protection from flash flooding needed in some areas; high available moisture capacity.	Well suited to diversions.	Well suited	Moderate; subject to flash flooding that is likely to damage the filter field.	Severe; subject to flash flooding and deposition; soils may liquefy if excavations are made when they are wet.
Poor; pervious; high stability; low volume change; susceptible to piping.	Not needed	Fair; rapid intake; very low available moisture capacity.	Not suitable; highly erodible; terraces and diversions difficult to construct.	Highly erodible; vegetation difficult to establish and maintain.	Moderate; very rapid permeability; untreated sewage may travel a long distance.	Slight; very low compressibility; low volume change when moisture content changes; good shear strength; may liquefy if an excavation is made when the soil material is saturated.
Poor; medium stability; high volume change; poor to fair compaction when wet; contains large boulders in places.	Needed; tile drains function well, but in some places boulders interfere with installing them.	Fair; requires drainage before irrigation; high available moisture capacity.	Diversions will help to control local runoff and reduce wetness.	Good; tile drains needed to control seepage; boulders interfere with construction in some places.	Not suitable; high water table.	Severe; fair to poor shear strength; high water table; the soil material may become quick and flow if the excavation extends to a depth below the level of the water table.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Coggon (CoB, CoC2)	Fair to poor.	Not suitable.	Not suitable.	Not suitable.	Good; good bearing capacity and easily compacted to high density.	Good; seepage may occur in some cuts; susceptible to frost action where pockets of water-bearing sand occur.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir needs to be scarified and compacted.
Colo (Cs, Ct) (Mapped only with Otter and Ossian soils; interpretations for the Otter and Ossian soils are given under their respective series.)	Good, but often wet.	Not suitable.	Not suitable.	Not suitable.	Very poor; high in content of organic matter; fair to poor bearing capacity; high compressibility; difficult to compact to high density.	Poor; high in content of organic matter; subject to flooding; seasonal high water table; low borrow potential; poor bearing capacity.	Poor; nearly level; subject to flooding.
Dickinson (DcA, DcB DcC, DcD).	Fair to good.	Good; poorly graded fine and medium sands.	Fair to poor.	Not suitable.	Good to excellent; good workability and stability; low volume change on wetting and drying.	Good; protection of the slopes required; loose sand may hinder hauling operations; seepage occurs in places in some deep cuts.	Poor; rapidly permeable material, too porous to hold water.
Donnan (DbB)	Fair	Not suitable.	Not suitable.	Not suitable.	Fair in uppermost 20 to 40 inches; not suitable in the substratum; moderate to high volume change; poor bearing capacity; poor workability when wet.	Poor; seasonal perched water table at a depth of 20 to 40 inches; highly susceptible to frost action; in many places seepage occurs in the cuts.	Good; very slow permeability when compacted; reservoir area not uniform and should be compacted.
Dorchester (De, DgB) (In places mapped with Chaseburg and Volney soils; interpretations for the Chaseburg and Volney soils are given under their respective series.)	Good	Not suitable.	Not suitable.	Not suitable.	Fair in upper part and poor below; soil material has low density; substratum high in content of organic matter; low bearing capacity when wet.	Poor; subject to flooding; low potential as borrow material.	Poor; nearly level; subject to flooding.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Good; moderate stability; slow permeability when compacted; good workability at optimum moisture content.	Generally not needed.	Fair; moderate to moderately slow permeability below a depth of 2½ feet; high available moisture capacity.	In places a stone line below a depth of about 20 inches will interfere with construction; some areas are wet after terraces are installed; cuts should be held to a minimum.	Some limitations; in places a stone line will hinder construction; in places tile drains are needed for vegetation to become established.	Moderate; moderate to moderately slow permeability below a depth of 2½ feet.	Slight; low consolidation; good bearing capacity and shear strength.
Poor; high in content of organic matter; high shrink-swell potential; poor workability.	Needs protection from flooding; tile drains function well.	Good; soil requires drainage before it is irrigated; high available moisture capacity.	In places diversions are beneficial for controlling local runoff and reducing wetness.	Not needed	Not suitable; seasonal high water table; subject to flooding.	Severe; high compressibility but uneven consolidation; high water table; subject to flooding.
Fair to good; pervious, even when compacted; high stability and some volume change; susceptible to piping in places.	Not needed	Good; rapid intake; low available moisture capacity.	Highly erodible; vegetation difficult to establish where cuts expose the sandy substratum.	Highly erodible; vegetation difficult to establish.	Moderate; soils make poor filtering material and may allow unfiltered sewage to travel a long distance.	Slight; good shear strength; very low compressibility; negligible volume change, but may become quick and flow if the soil material is saturated.
Fair to poor; high shrink-swell potential; poor compaction and workability when wet.	All areas may not need drainage.	Poor; adequate drainage needed before irrigation; subsoil is slowly permeable.	Not well suited; a clayey subsoil is at a depth of 20 to 40 inches, and the surface layer is low in fertility; cuts should be held to a minimum.	Not needed in most places; vegetation difficult to establish; tile drains needed on the sides of the waterway.	Severe; slowly permeable below a depth of 20 to 40 inches; seasonal high water table.	Severe; the substratum is clayey and subject to dangerous changes in volume if it is initially dry; moderate compressibility.
Fair in upper part and poor below; low stability when wet; high compressibility.	Protection from flooding needed.	Good; subject to flooding; high available moisture capacity.	Diversions help to protect the soils from local runoff.	Not needed	Severe; subject to flooding and deposition.	Severe; subject to flooding and deposition; moderate to high compressibility.

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TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Dow (DhE3)	Very poor	Not suitable.	Not suitable.	Not suitable.	Fair to poor; low stability and bearing capacity when wet; fair workability and compaction at optimum moisture content.	Fair to poor; rolling topography; highly erodible; high content of moisture in some deep cuts; unstable when wet.	Fair to poor; reservoir area needs to be compacted; in places a sealer is needed to prevent excessive seepage.
Downs (DoA, DoB, DoC, DoD, DoE2, DoF2, DtB, DtC, DtC2, DtD2). (In places mapped with Tama soils; interpretations for Tama soils are given under the Tama series.)	Good in most places; poor where severely eroded.	Not suitable.	Not suitable.	Not suitable.	Fair; poor shear strength; great loss of bearing capacity when wet; moderate to high compressibility.	Fair; rolling topography; low borrow potential; fairly stable slopes.	Fair to poor; reservoir area needs to be compacted; in places a sealer is needed to prevent excessive seepage.
Dubuque (DuC2, DuD2, DuD3, DuE2, DuE3, DuF2).	Fair in most places; poor where severely eroded.	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 to 30 inches.	Fair in uppermost 15 to 30 inches; limestone at a depth of 15 to 30 inches.	Fair; rolling topography; great need for cuts and fills; limestone hard and level bedded.	Poor; only 15 to 30 inches deep over fractured limestone; requires compacted seal blanket over the limestone.
Fayette (FaA, FaB, FaC2, FaC3, FaD2, FaD3, FaE2, FaE3, FaF2, FaF3, FaG).	Fair; poor in severely eroded areas.	Not suitable.	Not suitable.	Not suitable.	Fair; poor shear strength; medium to high compressibility; great loss of bearing capacity when soil material is wet.	Fair; rolling topography; great need for cuts and fills; low borrow potential; highly erodible.	Fair to poor; the soil material in reservoir areas needs to be compacted; a sealer needed in places to prevent excessive seepage.
Festina (FeA, FeB)	Good	Not suitable.	Not suitable.	Not suitable.	Fair; poor bearing capacity when soil material is wet; moderate to high volume change; fair workability and fair compaction when soil material is at optimum moisture content.	Fair; level to gently sloping topography; low potential as borrow material; soil material has low density.	Fair to poor; a good site is rare; in places a sealer needed to prevent excessive seepage; in some areas thin layers of coarse-textured material are below a depth of 4 feet.

properties of soils—Continued

Farm ponds—Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—: Septic tank fields	Degree of limitation for—: Foundations for low buildings
Fair to poor; fair stability; high volume change when compacted; poor workability when wet.	Tile drains not needed in most areas.	Fair to poor; highly erodible; has steep slopes; high available moisture capacity.	Not suitable on slopes of more than 12 percent.	Highly erodible, and vegetation difficult to establish.	Severe on slopes that exceed 12 percent; moderate permeability.	Moderate; low stability and low bearing capacity when wet; moderate to high compressibility.
Fair; medium stability; moderate to high expansion potential; good compaction at optimum moisture content.	Not needed	Good; moderate intake of water; high available moisture capacity; control of erosion needed.	Well suited on slopes as steep as 12 percent.	Well suited; tile drains needed on the sides of the waterways to control seepage in some areas.	Slight on slopes of less than 10 percent; moderate permeability.	Slight to moderate; fair bearing capacity, except where saturated; medium to high compressibility; uniform consolidation.
Fair to poor; only 15 to 30 inches deep over limestone; semipervious when compacted; some settling can be expected if large fragments are used in the fills.	Not needed	Fair; very low or low moisture capacity; control of erosion needed.	In places bedrock only 15 to 30 inches beneath the surface hinders construction; the slopes generally exceed 12 percent.	Limestone at a depth of only 15 to 30 inches; vegetation difficult to establish and to maintain, unless sufficient cover is left over the limestone.	Not suitable; fractured bedrock at a depth of only 15 to 30 inches; the slopes generally exceed 10 percent.	None where the footings rest on limestone bedrock.
Fair; medium stability; moderate to high potential for expansion; fair compaction at optimum moisture content.	Not needed	Fair to good; moderate water intake and high available moisture capacity; practices needed that will control erosion.	Well suited to terraces where slopes are less than 12 percent.	Well suited; tile drains needed to control seepage in some areas.	Slight where slopes are less than 10 percent; moderate permeability.	Moderate; fair bearing capacity; moderate to high compressibility; uniform consolidation.
Fair; fair stability; high volume change when soil material is compacted; susceptible to piping.	Not needed	Good; moderate rate of water intake; high available moisture capacity.	No limiting factors.	Good, but not needed in most places.	Slight; moderate permeability.	Moderate; moderate to high compressibility; uniform consolidation; fair shear strength.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Floyd (FlB, FmB) (In places mapped with Clyde soils; interpretations for the Clyde soils are given under the Clyde series.)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; high content of organic matter to a depth of about 20 inches; moderate to high shrink-swell potential; moderate to high compressibility in uppermost 3 feet of soil material.	Poor; has a seasonal high water table; high content of organic matter to a depth of 20 inches; highly susceptible to frost heaving; has low borrow potential.	Fair to poor; in places contains layers of coarse-textured material that require sealing to prevent excessive seepage.
Franklin (FnB)	Good	Not suitable.	Not suitable.	Not suitable.	Fair in upper part of profile; good in the glacial till; fair to good bearing capacity; till easily compacted to high density; has a seasonal high water table.	Fair; has a seasonal high water table; highly susceptible to frost action.	Fair to poor; bottom of reservoir should be compacted; pockets and strata of sand occur in places.
Frankville (FrC, FrD2, FrE2).	Good where soils are not eroded; poor where soils are eroded.	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 to 30 inches.	Fair to good; excellent in substratum; 15 to 30 inches deep over limestone; fair bearing capacity; moderate to high volume change when soil is compacted; underlain by limestone bedrock.	Fair; rolling topography; a great need for cuts and fills; limestone hard and level bedded.	Poor; fractured bedrock at a depth of 15 to 30 inches; a compacted seal blanket required over the limestone.
Hagener (HaA, HaB, HaD).	Poor	Good, but poorly graded fine and medium sands.	Not suitable.	Not suitable.	Good; low compressibility; low volume change when wet; when damp, stable under a wheel load.	Fair to good; loose sand may hinder hauling operations; soil material in high cuts may become quick and flow when it is saturated.	Not suitable; rapid permeability; material too porous to hold water.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair; fair stability; high content of organic matter; high volume change when soil material is compacted; fair to good compaction at optimum moisture content.	Tile drains function well.	Good; drainage required before irrigating; high available moisture capacity.	Terraces not needed, because of nearly level or gently sloping topography; diversions, properly placed, help to make this soil less wet.	Tile needed on the sides of waterway to control seepage so that vegetation can be established.	Severe; has a seasonal high water table.	Moderate; moderate to high compressibility; uniform consolidation; fair shear strength.
Fair to poor in uppermost 15 to 40 inches of soil material; good below that depth; till has slow permeability when compacted; low compressibility.	Tile drains function well, but not needed in all areas.	Good; high available moisture capacity; in places tile drains required before irrigating.	Terraces not needed, because of nearly level or gently sloping topography.	Well suited; tile drains needed on the sides of waterway to control seepage so that vegetation can be established.	Moderate to severe; has a seasonal high water table.	Moderate; has a seasonal high water table; fair to good bearing capacity; uneven consolidation.
Fair; limestone bedrock at a depth of 15 to 30 inches; moderate to high volume change when the material over limestone is compacted.	Not needed	Fair; low available moisture capacity; erosion control practices needed.	Fairly well suited where slopes are 12 percent or less; bedrock near the surface may hinder construction.	Well suited; limestone bedrock near the surface hinders construction in places.	Not suitable; fractured limestone bedrock at a depth of 15 to 30 inches.	None where footings rest on limestone bedrock.
Not suitable for cores; fair to good for shells; stability good; low volume change; highly erodible; susceptible to piping.	Not needed	Fair; rapid water intake; very low available moisture capacity.	Not suitable; highly erodible; terraces and diversions difficult to construct and maintain; loose, unproductive sand exposed in the cuts.	Highly erodible; vegetation difficult to establish.	Slight; very rapid permeability; soils make poor filtering material and may allow unfiltered sewage to travel a long distance.	Slight; very low compressibility; low volume change when content of moisture changes; good shear strength; if soil material is wet, it may liquefy during excavation.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Hayfield: Deep (HdA)	Good	Good below a depth of 36 inches.	Fair to good below a depth of 36 inches.	Not suitable.	Fair above a depth of 36 inches; good below that depth; great loss in bearing capacity when material above a depth of 36 inches is wet; moderate volume change to a depth of 36 inches; low volume change below that depth.	Fair to good; nearly level topography; has a seasonal high water table; good potential as borrow material below a depth of 36 inches; high potential frost action.	Not suitable; substratum coarse textured and too porous to hold water.
Moderately deep (HmA).	Good	In places good below a depth of 24 to 36 inches.	In places good below a depth of 24 to 36 inches.	Not suitable.	Fair to a depth of 24 to 36 inches; good below that depth.	Fair to good; nearly level; has a seasonal high water table; good potential as borrow material; high potential frost action.	Not suitable; substratum coarse textured and too porous to hold water.
Huntsville (HuA, HuB).	Very good	Not suitable.	Not suitable.	Not suitable.	Poor; low bearing capacity when wet; high volume change when compacted; high in content of organic matter.	Fair to poor; subject to overflow; high content of organic matter; high compressibility; poor foundation for high fills.	Poor; nearly level; subject to overflow; material used for reservoir area needs to be compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair to a depth of 36 inches; good below that depth; medium stability and moderate volume change in subsoil; high stability and low volume change in substratum; poor resistance to piping.	Tile drains function well; the coarse texture of the substratum increases difficulty of installing tile.	Good; drainage required before irrigating; medium to high available moisture capacity.	Generally not needed; diversions, properly placed, help to protect from local runoff.	Generally not needed.	Moderate to severe; has a seasonal high water table; below a depth of 36 inches, the soil makes poor filtering material.	Moderate; good shear strength; has a seasonal high water table; very low compressibility; low volume change below a depth of 36 inches when soil material is wetted and dried; soil material below a depth of 36 inches may become quick and flow if it is saturated when excavation takes place.
Fair to a depth of 24 to 36 inches; good below a depth of 36 inches; medium stability and moderate volume change in subsoil; high stability and low volume change in substratum; poor resistance to piping.	Tile drains function well; the coarse texture of the substratum increases difficulty of installing tile.	Good; in places drainage is required before irrigating; medium available moisture capacity.	Generally not needed; diversions, properly placed, help to protect from local runoff.	Generally not needed.	Moderate to severe; has a seasonal high water table; below a depth of 24 to 36 inches, the soil makes poor filtering material.	Moderate; good shear strength; has a seasonal high water table; very low compressibility; low volume change when soil material below a depth of 24 to 30 inches is wetted and dried; soil material below a depth of 36 inches may become quick and flow if it is saturated when excavation takes place.
Fair; medium stability; moderate volume change; fair compaction at optimum moisture content; poor compaction if material is wet.	Not needed	Good; moderate water intake rate; high available moisture capacity; protection from stream overflow needed in some places.	Terraces not needed; well suited to diversions.	No limitations; not needed in most areas.	Slight to moderate; subject to stream overflow of short duration; moderate permeability.	Slight to moderate; fair shear strength and bearing capacity; moderate compressibility; subject to overflow.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Jacwin (JaA, JaB, JaC, JaD).	Good	Not suitable.	Not suitable.	Not suitable.	Not suitable; shale at a depth of 15 to 30 inches; soil material above the shale is high in content of organic matter and has low density; shale subject to high volume change.	Poor; surface layer high in content of organic matter; seasonal high water table; low borrow potential.	Fair; shale at a depth of 15 to 30 inches; bottom of reservoir may need to be compacted; contains thin strata of limestone in places.
Kato:							
Deep (KdA)	Good	Fair; high water table.	Fair below a depth of 36 to 42 inches; high water table.	Not suitable.	Poor to a depth of 3 feet; very good below that depth; material to a depth of 3 feet is high in content of organic matter and is of low density.	Fair; has a seasonal high water table; surface layer high in content of organic matter.	Bottom of reservoir needs to be compacted; coarse-textured material, too porous to hold water, below a depth of 36 inches; seasonal high water table.
Moderately deep (KaA).	Good	Fair; high water table.	Fair below a depth of 24 to 36 inches; high water table.	Not suitable.	Poor to a depth of 2 feet; material high in content of organic matter and has low density; very good below a depth of 2 to 3 feet; low compressibility and low volume change.	Fair; has a seasonal high water table; surface layer high in content of organic matter.	Bottom of reservoir needs to be compacted; coarse-textured material below a depth of 24 to 36 inches too porous to hold water; seasonal high water table.
Deep, clay shale substratum (KsB, KsC).	Good	Not suitable.	Not suitable.	Not suitable.	Poor to not suitable; shaly substratum within 4 feet of surface; high in content of organic matter; material overlying the shale is of low density.	Poor; seasonal high water table; surface layer high in content of organic matter; highly susceptible to frost action.	Fair; nearly level ln places; suitable for dugout ponds.

properties of soils—Continued

Farm ponds—Con.: Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—: Septic tank fields	Degree of limitation for—: Foundations for low buildings
Poor; shale at a depth of 15 to 30 inches; shale has high shrink-swell potential; high volume change; poor workability when wet.	Tile may not drain all areas; proper placement of tile drains and proper back filling are important.	Fair; drainage required before irrigating; subsoil and substratum very slowly permeable.	Diversions, properly placed, help to control local runoff and reduce wetness.	Tile drainage needed to control seepage so that vegetation can be established.	Not suitable; has a seasonal high water table; very slow permeability in shaly material in subsoil and substratum.	Severe; shale subject to dangerous volume change when content of moisture changes.
Fair to good; fair stability and moderate compressibility to a depth of 3 feet; good stability and very low compressibility below that depth; susceptible to piping.	Tile drains function well; has thin layers of coarse-textured material below a depth of 36 inches; soil material may become quick and flow when saturated and hinder installation of the system.	Fair to good; drainage required before irrigating; medium available moisture capacity.	Terraces not needed, because of topography.	Well suited, but tile drains required to prevent seepage where vegetation is to be established.	Moderate; has a seasonal high water table; soils make poor filtering material below a depth of 3 feet.	Moderate; soil material below a depth of 3 feet subject to low volume change on wetting; material below a depth of 2 feet may become quick and flow if it is saturated during excavation.
Fair to good; fair stability to a depth of 2 to 3 feet; compressibility and volume change moderate to a depth of 2 to 3 feet and very low below that depth; susceptible to piping.	Tile drains function well; contains coarse-textured strata below a depth of 2 to 3 feet; soil material may become quick and flow when saturated and hinder installation of the system.	Fair to good; drainage required before irrigating; low to medium available moisture capacity.	Terraces not needed, because of topography.	Well suited, but tile drains required to prevent seepage where vegetation is to be established.	Moderate; has a seasonal high water table; soils make poor filtering material below a depth of 2 to 3 feet.	Moderate; soil material below a depth of 2 to 3 feet subject to low volume change on wetting; material below a depth of 2 to 3 feet may become quick and flow if it is saturated during excavation.
Fair to poor; fair stability to a depth of 3 feet; moderate volume change; shale has high expansion potential.	Tile drains function satisfactorily, but placement of tile is highly important because of variations in the depth of the layers of sand and shale and in the thickness of those layers.	Fair; requires drainage before irrigating; high available moisture capacity; very slowly permeable material within 4 feet of the surface.	Terraces not needed, because of topography; diversions, properly placed, help to control local runoff and reduce wetness.	Well suited, but tile drains required to prevent seepage where vegetation is to be established.	Severe; seasonal high water table; material that is very slowly permeable is within 4 feet of the surface.	Severe; shale is within 4 feet of the surface and is subject to dangerous expansion if it is initially dry; seasonal high water table.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Kennebec (LkA) (Mapped only with Lawson soils; interpretations for the Lawson soils are given under the Lawson series.)	Very good	Not suitable.	Not suitable.	Not suitable.	Poor to very poor; high in content of organic matter; low bearing capacity when wet; moderate to high volume change.	Fair to poor; nearly level; subject to flooding; low potential as borrow material; high content of organic matter.	Poor; subject to flooding; nearly level; bottom of reservoir needs to be compacted.
Kenyon (KyB)	Good	Not suitable.	Not suitable.	Not suitable.	Good below a depth of about 1½ feet; fair to good bearing capacity; low compressibility; easily compacted to high density.	Good; seepage may occur in some cuts; good source of borrow material; susceptible to frost action where pockets of water-bearing sand occur.	Good to fair; vertical and horizontal veins of sand are common; bottom of reservoir should be scarified and compacted.
Lamont:							
Sandy loam (LaB, LaC, LaD).	Poor	Good; poorly graded fine and medium sands.	In a few places below a depth of 2 feet.	Not suitable.	Good; low volume change on wetting; good workability and good compaction except where the content of fines is less than 15 percent; highly stable under wheel loads, regardless of the moisture content.	Good; soil material on slopes highly erodible; has good potential as borrow material; in some cuts the sand may be saturated and become quick and flow when an excavation is made.	Poor; rapid permeability; material too porous to hold water without a sealer.
Sandy loam, till subsoil variant (LdB).	Poor	Good to a depth of 15 to 36 inches, but poorly graded fine and medium sands.	Not suitable.	Not suitable.	Good; low compressibility; good bearing capacity and shear strength; good compaction and workability.	Good; seepage may occur in some cuts; good source of borrow material; highly susceptible to frost action where saturated strata occur.	Fair; veins of sand are common; the material in reservoir area should be compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Poor; fair stability; moderate to high content of organic matter; moderate to high shrink-swell potential; medium compressibility.	Tile drains function well, but not needed in most areas.	Good; requires protection from flooding; high available moisture capacity.	Diversions, properly placed, help to divert local runoff and reduce wetness and deposition.	Not needed	Severe; subject to occasional flooding; moderate permeability.	Moderate to severe; occasional flooding; high content of organic matter; fair bearing capacity and shear strength; moderate compressibility; uniform consolidation.
Upper part fair; good below a depth of about 1½ feet; moderate stability; slow permeability where compacted; low compressibility.	Tile drains function well, but not needed in most areas.	Fair; moderate rate of water intake; moderate to moderately slow permeability; high available moisture capacity.	Some areas may be wet after terraces are installed; soil contains pebble band; subsoil low in fertility below a depth of about 18 to 24 inches; cuts should be held to a minimum.	Contains stone line, and subsoil is low in fertility below a depth of 18 to 24 inches; tile drains needed in places on the sides of the waterway so that seepage will be controlled and vegetation can be established.	Moderate; moderate to moderately slow permeability below a depth of 2½ feet.	Slight; good bearing capacity and shear strength; low compressibility; uneven consolidation.
Fair; high stability; low volume change; susceptible to piping.	Not needed	Fair; rapid rate of water intake; low moisture capacity.	Highly erodible; terraces and diversions difficult to construct and maintain.	Highly erodible; vegetation difficult to establish.	Moderate; rapid permeability; soils poor as filtering material and may allow unfiltered sewage to travel a long distance.	Slight; very low compressibility; low volume change on wetting; good shear strength; may flow when excavation takes place if the soil material is saturated.
Fair to good; good stability; low compressibility; material below a depth of 15 to 30 inches easily compacted to high density; low to moderate shrink-swell potential.	Generally not needed.	Good; rapid infiltration; medium available moisture capacity.	Highly erodible; terraces and diversions difficult to construct and maintain where sand is deep.	Erodible; vegetation difficult to establish where sand is deep.	Slight; permeability moderately rapid to a depth of 15 to 36 inches and moderate below that depth.	Slight; good bearing capacity; low compressibility; low volume change in upper layers when wetted.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Lawson (LkA, LmB, Rw). (In places mapped with Kennebec or Rowley soils; interpretations for the Kennebec and Rowley soils are given under their respective series.)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; high content of organic matter to a depth of 20 to 40 inches; low bearing capacity when wet; high volume change when compacted.	Fair to poor; has low potential as borrow material; seasonal high water table; subject to flooding; poor as a foundation for high fills.	Fair for dugout ponds; material on bottom of reservoir should be compacted.
Loamy colluvial land (LnE, LnF).	Good to poor.	Not suitable.	Not suitable.	Not suitable.	Fair; high content of organic matter; moderate to high compressibility; low bearing capacity when material is wet.	Fair to poor; steep and adjacent to areas of Steep rock land; for short periods receives local runoff of high velocity.	Not suitable; material too porous to hold water.
Loamy terrace escarpments (LoF).	Fair to poor.	Good in places below a depth of 2 to 3 feet.	Good in places below a depth of 2 to 3 feet.	Not suitable.	Fair to good; in places sand and gravel are below a depth of 20 inches; good shear strength and bearing capacity; low volume change.	Fair to good; great need for cuts and fills; good source of borrow material; good workability, except where the content of fines is less than 15 percent.	Not suitable; material too porous to hold water.
Marlean (MaB, MaC, MaC2, MaD2, MaD3, MaE2, MaE3).	Not suitable.	Not suitable.	Not suitable.	Fair to good; shaly or cherty in places.	Good; good bearing capacity and shear strength; negligible volume change on wetting; some settling can be expected if large fragments are used in fills.	Fair to good; great need for cuts and fills; good source of borrow material; hard, level-bedded limestone below a depth of about 10 feet; contains thin layers of shale in places.	Not suitable; material too porous to hold water.
Nasset (NaC2, NaD2, NaE2).	Good	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 30 to 50 inches.	Fair to a depth of 30 to 50 inches and has fair bearing capacity; very poor in clay residuum; has high volume change on wetting; limestone is below a depth of 30 to 50 inches.	Fair to good; rolling topography; may have great need for cuts and fills; limestone hard and level bedded.	Poor; in most places bedrock too porous to hold water; seal blanket needed over the limestone.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair; fair stability; high content of organic matter; moderate volume change; poor compaction if material is wet.	Tile drains function well; protection from flooding needed in some areas.	Good; drainage and protection from flooding required before irrigation; high available moisture capacity.	Diversions, properly placed, help to divert local runoff and reduce flooding and wetness.	Satisfactory, but generally not needed.	Severe; seasonal high water table; subject to flooding.	Moderate to severe; subject to flooding; moderate compressibility; uniform consolidation; fair shear strength; subject to frost action; subject to loss of bearing capacity on thawing.
Fair; fair stability; moderate to high shrink-swell potential; moderate compressibility.	Not needed	Not suitable; highly erodible.	Not suitable for terraces; too steep; diversions, properly placed, help to protect soils downslope from local runoff.	Highly erodible	Severe; the slopes exceed 12 percent.	Moderate; for short periods receives local runoff of high velocity.
Fair to good; good stability; low volume change on wetting.	Not needed	Not suitable; highly erodible.	Not suitable for terraces; diversions placed on the lower side of the areas help to protect soils downslope from runoff and silting.	Not suitable; highly erodible; establishing vegetation very difficult.	Not suitable	Severe because of the length and steepness of the slopes.
Not suitable; pervious, even when compacted; low volume change on wetting; less than 15 percent of loamy material between the pieces of fragmented shaly limestone.	Not needed	Not suitable; very low available moisture capacity.	Poor to not suitable; low fertility in substratum.	Poor; shallow over fragmented limestone; vegetation very difficult to establish.	Not suitable; fragments of limestone hinder installation.	Slight; bedrock is fragmented to a depth of about 10 feet and is hard and level bedded below that depth; contains thin layers of shale in places.
Fair; stability fair in material over the limestone; moderate volume change if material is compacted; some settling can be expected if large fragments of limestone are used in fill.	Not needed	Fair; medium available moisture capacity; control of erosion needed.	Bedrock at a depth of 30 to 50 inches hinders construction in places; cuts should be held to a minimum.	Good	Moderate; fractured limestone at a depth of 30 to 50 inches hinders installation in places and permits unfiltered sewage to travel a long distance.	None where footings rest on limestone bedrock.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Nordness (NoD, NoE)	Not suitable.	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 inches.	Very good where crushed; 15 inches or less of soil material over limestone bedrock.	Fair; 15 inches or less of soil material over hard, level-bedded limestone; generally a great need for cuts and fills; good potential for borrow material.	Not suitable; limestone fractured in most places and too porous to hold water.
Oran (OrA, OrB)	Good	Not suitable.	Not suitable.	Not suitable.	Good to fair below a depth of 2 feet; low compressibility; easily compacted to high density; fair to good bearing capacity.	Fair; nearly level or gently sloping; seasonal high water table; highly susceptible to frost action.	Poor to fair; vertical and horizontal veins of gravelly sand are common; bottom of reservoir should be compacted.
Orwood (OsB, OsC2, OsD2, OsE2, OsE3, OsF2).	Generally fair, but poor in severely eroded areas.	Not suitable.	Not suitable.	Not suitable.	Fair to good; moderate compressibility; good workability and compaction at optimum moisture content; low bearing capacity when wet.	Fair; rolling topography; high moisture content in some cuts; highly susceptible to frost action where strata of waterbearing material occur.	Fair; bottom of reservoir needs to be compacted; a sealer may be needed to prevent excessive seepage.
Ossian (Ct, Ot, OvB, Ow, Ox). (In places mapped with Colo, Otter, or Lawson soils; interpretations for Colo, Otter, and Lawson soils are given under their respective series.)	Good, but wet in many places.	Not suitable.	Not suitable.	Not suitable.	Poor or very poor, moderate compressibility; low bearing capacity when wet; surface layer high in content of organic matter; difficult to compact to high density.	Poor; nearly level; seasonal high water table; subject to flooding; low potential as borrow material.	Fair for dugout ponds; subject to flooding; bottom of reservoir should be compacted; a sealer may be needed to prevent seepage.
Ostrander (OuA, OuB, OuC).	Good	Not suitable.	Not suitable.	Not suitable.	Good below a depth of about 1½ feet; fair to good bearing capacity; low compressibility; easily compacted to high density; surface layer high in content of organic matter.	Good; seepage occurs in some cuts; susceptible to frost heaving where pockets of saturated sand occur; good potential as borrow material.	Fair to good; vertical and horizontal veins of sand are common; bottom of reservoir should be scarified and compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Poor; limestone at a depth of 15 inches or less; some settling can be expected when large fragments are used in fills.	Not needed	Poor; very low available moisture capacity.	Not suitable; very shallow over bedrock.	Poor; shallow over bedrock.	Not suitable; shallow over fractured bedrock.	None where footings rest on limestone bedrock.
Good to fair; fair stability; slow permeability when compacted; moderate shrink-swell potential.	Tile drains function well.	Fair; tile drainage required before irrigating; high available moisture capacity.	Terraces not needed, because of topography; diversions, properly placed, help to make the soils less wet.	Good; tile needed on the sides of waterways to control seepage so that vegetation can be established.	Severe; seasonal high water table.	Moderate; seasonal high water table; fair to good bearing capacity below a depth of about 2 feet; highly susceptible to frost action; uneven consolidation.
Good to fair; good stability; moderate volume change where compacted; good compaction at optimum moisture content.	Not needed	Good; erosion control practices needed; highly erodible; high available moisture capacity.	Good on slopes of less than 12 percent.	Good	Slight where slopes are less than 10 percent; moderate permeability.	Slight to moderate; moderate compressibility; uniform consolidation; fair bearing capacity.
Poor; fair stability when dry, poor stability when wet; difficult to compact to high density; high volume change; very narrow range of satisfactory moisture content for compaction.	Needed; tile drains function well.	Fair; drainage and flood protection required before irrigating; high available moisture capacity.	Terraces not needed; diversions, properly placed, help to protect from local runoff and make the soil less wet.	Good; generally not needed; tile needed to control seepage.	Not suitable; seasonal high water table; subject to flooding.	Severe; poor bearing capacity and shear strength; high expansion potential; subject to flooding; moderate compressibility.
Good below a depth of 1½ feet; moderate stability; easily compacted to high density.	Not needed	Good; high available moisture capacity.	Cuts should be held to a minimum because of stone line at a depth of about 1½ feet, and because of the low fertility of the subsoil.	Good; tile needed on the sides of waterway to control seepage so that vegetation can be established.	Slight; moderate limitations.	Slight; good bearing capacity and shear strength; low compressibility; uneven consolidation.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Otter (Cs, Ct, OvB, Ow, Ox). (Mapped only with Colo, Lawson, or Ossian soils interpretations for the Colo, Lawson, and Ossian soils are given under their respective series.)	Good, but often wet.	Not suitable.	Not suit-	Not suitable.	Not suitable; high in content of organic matter; high compressibility; very low stability and bearing capacity when wet.	Poor; seasonal high water table; subject to flooding; low potential as borrow material; poor foundation for high fills.	Poor; nearly level; subject to flooding.
Palsgrove (PaC2, PaD2, PaD3, PaE2, PaE3, PaF2).	Fair to poor	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 30 to 50 inches.	Fair to a depth of 30 to 50 inches; fair bearing capacity; moderate to high compressibility; limestone below a depth of 30 to 50 inches.	Fair; rolling topography; great need for cuts and fills; limestone hard and level bedded.	Poor; fractured limestone 30 to 50 inches below the surface; compacted seal blanket required over the limestone.
Peaty muck (Pk)	Poor if used alone; oxidizes rapidly when mixed with mineral soil material.	Not suitable.	Not suitable.	Not suitable.	Not suitable; organic soil material should not be used in fills and should be avoided if possible.	Not suitable; organic soil material; high water table.	Not suitable
Peaty muck, overwashed (Pw).	Fair to good.	Not suitable.	Not suitable.	Not suitable.	Not suitable below a depth of 6 to 20 inches; organic soil material should not be used in fills and should be avoided if possible.	Not suitable; organic soil material; high water table.	Not suitable
Racine (RaA, RaB, RaC, RaC2, RaD2).	Good	Not suitable.	Not suitable.	Not suitable.	Good below a depth of 18 to 20 inches; good bearing capacity; low compressibility; easily compacted to high density.	Good; seepage may occur in some cuts; good source of borrow material; susceptible to frost action where pockets of water-bearing sand occur.	Fair to good; vertical and horizontal veins of sand are common; bottom of reservoir should be compacted.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Poor; fair stability when dry, very low when wet; high in content of organic matter; high compressibility; high volume change; very narrow range of moisture content for suitable compaction.	Needed; tile drains function well; protection from flooding necessary.	Fair; tile drainage and protection from flooding required; high available moisture capacity.	Diversions, properly placed, help to control local runoff and reduce wetness.	Good; not needed in most places.	Not suitable; seasonal high water table; subject to flooding.	Severe; seasonal high water table and subject to flooding; very low bearing capacity when wet; may liquefy and flow if it is saturated when excavation takes place.
Uppermost 30 to 50 inches fair; has moderate stability; high compaction; difficult to compact to high density and has slow permeability; settling can be expected if large fragments of limestone are used in the fills.	Not needed	Fair to moderate available moisture capacity; highly erodible.	Fair on slopes of less than 12 percent; bedrock at a depth of 30 to 50 inches hinders construction in places.	Good	Moderate; bedrock at a depth of 30 to 50 inches; slopes generally exceed 10 percent; permeability moderate above the limestone.	None where footings rest on limestone bedrock.
Not suitable; organic soil material; high water table.	Interceptor tile needed in seepage areas; open intakes or surface ditches needed in ponded areas.	Good; rapid rate of water intake; very high available moisture capacity; drainage required before irrigating.	Not suitable	Not suitable	Not suitable; water table at or near the surface all year.	Not suitable.
Not suitable; organic soil material; high water table.	Open intakes or surface ditches needed in ponded areas; where feasible, tile should be placed in contact with the mineral soil material, below the organic soil material.	Good; rapid rate of water intake; very high or high available moisture capacity; drainage and protection from flooding required before irrigating.	Not suitable	Not suitable	Not suitable; water table at or near the surface.	Not suitable.
Good; moderate stability; easily compacted to high density; slow permeability where compacted; has moderate potential for expansion.	Not needed	Good; moderate intake rate; high available moisture capacity.	Cuts should be held to a minimum because of stone line and low fertility of the subsoil.	Good; tile needed on the sides of waterways in many places to control seepage so that vegetation can be established.	Slight; moderate permeability.	Slight; good bearing capacity and shear strength; low compressibility; uneven consolidation.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Renova (ReB, ReC, ReC2, ReD2, ReD3, ReE2, ReE3).	Fair in areas that are not eroded; poor in eroded areas.	Not suitable.	Not suitable.	Not suitable.	Good below a depth of 18 to 20 inches; good bearing capacity; low compressibility; easily compacted to high density.	Good; seepage may occur in some cuts; good source of borrow material; susceptible to frost action where pockets of water-bearing sand occur.	Fair to good; vertical and horizontal veins of sand are common; bottom of reservoir should be compacted.
Riceville (RfB)	Good to fair.	Not suitable.	Not suitable.	Not suitable.	Good in glacial till below a depth of 15 to 20 inches; good bearing capacity; easily compacted to high density.	Good to fair; seasonal perched water table; susceptible to frost action where pockets of water-bearing sand occur.	Good; sand lenses and pockets of sand are common; bottom of reservoir should be scarified and compacted.
Rockton (RkA, RkB, RkC, RkD).	Good	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 to 30 inches.	Fair to good to a depth of 15 to 30 inches; good bearing capacity; moderate volume change; limestone bedrock at a depth of 15 to 30 inches; clayey residuum, where present above the limestone, is not suitable.	Fair; hard, level-bedded limestone at a depth of 15 to 30 inches; good potential for borrow material.	Poor; in many places bedrock is fractured and too porous to hold water.
Rowley (RoA, Rw) (In places mapped with Lawson soils; interpretations for the Lawson soils are given under the Lawson series.)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; surface layer high in content of organic matter; high volume change and low bearing capacity when wet; very narrow range of moisture content for suitable compaction.	Fair to poor; seasonal high water table; low potential as borrow material; surface layer high in content of organic matter.	Fair; bottom of reservoir should be compacted.

properties of soils—Continued

Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for— Septic tank fields	Foundations for low buildings
Good; moderate stability; easily compacted to high density; slow permeability where compacted; moderate potential for expansion.	Not needed	Good; moderate intake rate; high available moisture capacity.	Cuts should be held to a minimum because of stone line and low fertility of the subsoil.	Good; tile needed on the sides of waterways in many places to control seepage so that vegetation can be established.	Slight; moderate permeability.	Slight; good bearing capacity and shear strength; low compressibility; uneven consolidation.
Good; moderate stability; slow permeability where compacted.	Tile drainage allows field operations to be more timely; close spacing and careful placement of the tile necessary.	Fair; moderately slow permeability below a depth of 2 feet; high available moisture capacity.	Subsoil low in fertility; cuts should be held to less than 2 feet; in some places tile are needed in the channels of the terraces.	Some limitations; stone line at a depth of 2 feet; vegetation difficult to establish; tile are needed on the sides of waterways to control seepage.	Moderate; moderately slow permeability; seasonal perched water table.	Moderate; seasonal perched water table; good bearing capacity and shear strength; low compressibility.
Poor; limited supply of usable material above the bedrock; moderate volume change and good compaction of material over the bedrock.	Not needed	Fair; moderate intake rate; very low to low available moisture capacity.	In places limestone bedrock 15 to 30 inches below the surface hinders construction.	Satisfactory where sufficient cover can be left over the limestone.	Severe; shallow over bedrock; in places cracked bedrock allows unfiltered sewage to travel a long distance.	None where footings can be set on limestone bedrock.
Fair; fair stability; medium to high volume change on wetting; difficult to compact to high density; narrow range of moisture content for good workability.	Tile drains function well.	Fair to good; tile drainage required before irrigating; high available moisture capacity.	Terraces generally not needed; diversions, properly placed, help to control local runoff and reduce wetness.	Good; tile may be needed so that vegetation can be established.	Moderate; seasonal high water table.	Moderate; if soil becomes saturated, it may lose cohesion and settle; uniform consolidation; fair shear strength.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Sattre:							
Deep (SbA, SbB, SbC2).	Good	Good below a depth of 36 inches.	Good below a depth of 36 inches.	Not suitable.	Fair to a depth of 36 inches; very good in substratum; little or no volume change; good stability at all moisture contents.	Good; generally little need for cuts and fills; good potential as borrow material.	Poor; substratum too porous to hold water.
Moderately deep (SdA, SdB, SdC2, SdD2).	Good	Good below a depth of 24 to 36 inches.	Fair to good below a depth of 24 to 36 inches.	Not suitable.	Fair to a depth of 24 to 36 inches; very good in substratum; low volume change and good bearing capacity; highly stable at all moisture contents.	Good; generally little need for cuts and fills; good potential for borrow material.	Poor; substratum too porous to hold water.
Spillville (Sp)	Very good	Not suitable.	Not suitable.	Not suitable.	Fair; high content of organic matter; moderate volume change on wetting; fair bearing capacity; good workability.	Fair to poor; subject to flooding; high content of organic matter to a depth of about 2 feet; nearly level; makes poor foundation for high fills; seasonal high water table.	Poor; subject to flooding; reservoir area needs to be compacted; in places coarse-textured strata below a depth of 4 feet.
Steep rock land (Sr)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Steep sandy land (SsF)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Tama (DtB, DtC, DtC2, DtD2). (Mapped only with Downs soils; interpretations for the Downs soils are given under the Downs series.)	Good	Not suitable.	Not suitable.	Not suitable.	Fair; large loss of bearing capacity when wet; moderate to high compressibility; surface layer high in content of organic matter.	Fair; surface layer high in content of organic matter; low potential for borrow material; large amount of moisture in some cuts.	Fair to poor; reservoir area needs to be compacted; a sealer may be needed to prevent excessive seepage.

See footnote at end of table.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair to good; subsoil has medium stability and moderate volume change; good workability; high stability and low volume change in substratum; poor resistance to piping.	Not needed	Good; moderate intake rate; medium to high available moisture capacity.	Cuts should be held to a minimum to prevent exposure of the coarse-textured substratum.	Good; cuts should not expose the coarse-textured substratum.	Slight; moderate permeability; in places below a depth of 36 inches, material poor for filtering allows unfiltered sewage to travel a long distance.	Slight in substratum; good shear strength; very low compressibility; low volume change on wetting and drying.
Fair to good; subsoil has medium stability and moderate volume change; substratum has high stability, low volume change, and low susceptibility to piping.	Not needed	Good; moderate intake rate; medium available moisture capacity.	Cuts should be held to a minimum to prevent exposure of the coarse-textured substratum.	Good; where the coarse-textured substratum is not exposed.	Slight to moderate; in places poor material for filtering below a depth of 24 to 36 inches allows unfiltered sewage to travel a long distance.	Slight in subsoil; good shear strength; very low compressibility; low volume change on wetting and drying.
Fair; moderate stability; moderate compressibility; high content of organic matter; susceptible to piping in some areas.	Tile drains not needed; protection from flooding needed.	Good; protection from flooding required; high available moisture capacity.	Diversions, properly placed, help to protect from local runoff.	Not needed	Severe; subject to flooding; seasonal high water table.	Severe; subject to flooding; moderate compressibility; material below a depth of 4 feet may become quick and flow if it is saturated when the excavation is made.
[1]	[1]	[1]	[1]	[1]	[1]	[1].
[1]	[1]	[1]	[1]	[1]	[1]	[1].
Fair; fair stability; narrow range of moisture content for good compaction; moderate to high expansion potential.	Not needed	Good; moderate intake rate; high available moisture capacity.	Well suited on slopes as steep as 12 percent.	Good; in places tile drains needed on the sides of drainageways to control seepage.	Slight on slopes of less than 10 percent; moderate permeability.	Slight to moderate; fair shear strength; moderate to high compressibility; uneven consolidation; moderate to high potential for expansion.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Terril (TeA, TeB)	Very good	Not suitable.	Not suitable.	Not suitable.	Fair to poor; high in content of organic matter to a depth of 20 to 40 inches; good workability and compaction at optimum moisture content.	Fair; subject to damage from local runoff and deposition; susceptible to frost action.	Fair; reservoir area should be scarified and compacted; sand lenses occur in places.
Turlin (TgA, TgB)	Good	Not suitable.	Not suitable.	Not suitable.	Poor; high in content of organic matter; moderate compressibility; low bearing capacity when wet.	Fair to poor; surface layer high in content of organic matter; seasonal high water table; subject to flooding; poor foundation for high fills.	Poor; may be used for dugout ponds; subject to flooding; reservoir area needs to be compacted; strata of coarse-textured material occur in places.
Volney channery silt loam (VcA, VcB, DgB). (In places mapped with Dorchester and Chaseburg soils; interpretations for Dorchester and Chaseburg soils are given under their respective series.)	Not suitable.	Not suitable.	Not suitable.	Not suitable.	Good; good bearing capacity; good shear strength; low volume change on wetting.	Fair to poor; subject to frequent local flooding by water of high velocity; good potential for borrow material.	Not suitable; material too porous to hold water.
Volney silt loam, overwashed (VoA, VoB).	Fair to good.	Not suitable.	Not suitable.	Not suitable.	Fair to good; upper part has fair bearing capacity and lower part has good bearing capacity; lower strata have low volume change on wetting.	Poor to fair; subject to local flooding by water of high velocity.	Not suitable; material too porous to hold water.
Waucoma (WcA, WcB, WcC, WcD).	Good	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 30 to 50 inches.	Subsoil fair; fair bearing capacity and shear strength; moderate volume change on wetting; limestone bedrock at a depth of 30 to 50 inches.	Fair; bedrock, at a depth of 30 to 50 inches; bedrock hard and level bedded.	Poor; bedrock fractured in many places and too porous to hold water; compacted seal needed over the limestone.

properties of soils—Continued

Farm ponds—Con. Embankment	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for— Septic tank fields	Degree of limitation for— Foundations for low buildings
Fair; good stability; high in content of organic matter; high volume change; fair to poor resistance to piping.	Not needed	Good; high intake rate; high available moisture capacity.	Satisfactory; diversions help to protect from local runoff.	Satisfactory; not needed in most places.	Not suitable where soil occurs in drainageways; slight in other areas; moderate permeability.	Moderate; moderate to high compressibility; uneven consolidation; fair bearing capacity.
Fair; high content of organic matter; fair stability; moderate volume change.	Tile drains function well.	Good; drainage required before irrigating; high available moisture capacity.	Diversions, properly placed, help to protect from local runoff.	In places tile needed on the sides of drainageway to control seepage.	Severe; seasonal high water table; subject to flooding.	Severe; subject to flooding; moderate compressibility; material below a depth of 4 feet may become quick and flow if it is saturated when excavation is made.
Fair; fair stability; pervious; large fragments in fill can result in settling.	Not needed	Not suitable	Diversions, properly placed, help to protect from local runoff.	Not suitable	Not suitable; subject to flooding of short duration by water of high velocity.	Severe; subject to flooding of short duration by water of high velocity.
Fair; fair stability; pervious; large fragments in fill can result in settling.	Not needed	Not suitable	Diversions, properly placed, help to protect from local runoff.	Not suitable	Not suitable; subject to flooding of short duration by water of high velocity.	Severe; subject to flooding of short duration by water of high velocity.
Fair; semipervious where compacted; moderate stability and volume change; bedrock at a depth of 30 to 50 inches.	Not needed	Fair to good; medium available moisture capacity.	Bedrock at a depth of 30 to 50 inches may hinder construction.	Satisfactory, but generally not needed.	Moderate; in places fractured bedrock allows unfiltered sewage to travel a long distance; in places bedrock interferes with installation.	None where footings rest on limestone bedrock.

TABLE 5.—*Interpretations of engineering*

Soil series or land type and map symbol	Suitability as source of—					Highway location	Farm ponds
	Topsoil	Sand	Gravel	Limestone	Road fill		Reservoir area
Waukegan: Deep (WdA, WdB).	Good	Good below a depth of 36 to 45 inches.	Good below a depth of 36 to 45 inches.	Not suitable.	Fair to a depth of 36 to 45 inches; very good below that depth; subsoil has moderate volume change and fair bearing capacity when wet; substratum stable at all moisture contents.	Fair to good; surface layer high in content of organic matter; generally little need for cuts and fills; good potential for borrow material below a depth of 36 to 45 inches.	Poor; coarse textured; too porous to hold water.
Moderately deep (WgA, WgB).	Good	Good below a depth of 24 to 36 inches.	Good below a depth of 24 to 36 inches.	Not suitable.	Fair to a depth of 24 to 36 inches; very good below that depth; the subsoil has moderate volume change and fair bearing capacity when wet; subsoil is stable at all moisture contents.	Fair to good; surface layer high in content of organic matter; generally little need for cuts and fills; good potential for borrow material below a depth of 24 to 36 inches.	Poor; substratum coarse textured; too porous to hold water.
Whalan (WhB, WhC2, WhD2, WhE2, WhE3).	Fair	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 to 30 inches.	Subsoil fair; fair bearing capacity and shear strength; moderate volume change; limestone bedrock at a depth of 15 to 30 inches.	Rolling topography; great need for cuts and fills; limestone bedrock at a depth of 15 to 30 inches.	Poor; bedrock is fractured in many places and too porous to hold water.
Winneshiek (WkA, WkB, WkC, WkC2, WkD WkE).	Good	Not suitable.	Not suitable.	Limestone suitable for crushing below a depth of 15 to 30 inches.	Subsoil fair; fair bearing capacity and shear strength; moderate volume change on wetting; limestone bedrock, at a depth of 15 to 30 inches.	Fair to poor; bedrock at a depth of 15 to 30 inches; bedrock is hard and level bedded.	Poor; bedrock is fractured in many places and too porous to hold water.

[1] Soil characteristics variable. Not feasible to make interpretations. Check each site.

properties of soils—Continued

Farm ponds—Con.	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Degree of limitation for—	
Embankment					Septic tank fields	Foundations for low buildings
Fair to good; subsoil medium in stability and has moderate volume change; high stability and low volume change below a depth of 36 to 45 inches; poor resistance to piping.	Not needed	Good; moderate water intake rate; medium to high available moisture capacity.	Cuts should be held to a minimum to prevent exposure of the coarse-textured substratum.	Satisfactory, but generally not needed.	Slight; moderate permeability; material below a depth of 36 to 45 inches poor for filtering.	Slight in substratum; good shear strength; very low compressibility; low volume change on wetting and drying.
Fair; subsoil has medium stability and modate volume change; high stability and low volume change below a depth of 24 to 36 inches; poor resistance to piping.	Not needed	Good; moderate water intake rate; medium available moisture capacity.	Cuts should be held to a minimum to prevent exposure of coarse-textured substratum.	Satisfactory, but generally not needed.	Slight to moderate; moderate permeability; below a depth of 24 to 36 inches, material poor for filtering.	Slight in substratum; good shear strength; very low compressibility; low volume change on wetting and drying.
Fair to poor; subsoil semipervious where compacted; fair stability and moderate volume change; bedrock at a depth of 15 to 30 inches.	Not needed	Fair; moderate water intake rate and very low or low available moisture capacity.	In places bedrock at a depth of 15 to 30 inches hinders construction; cuts should be held to a minimum to prevent exposure of the bedrock.	Bedrock may hinder construction.	Moderate to severe; in places fractured bedrock allows unfiltered sewage to travel a long distance; bedrock hinders installation in some places.	None where footings rest on bedrock.
Fair to poor; subsoil semipervious where compacted; fair stability and moderate volume change; bedrock at a depth of 15 to 30 inches.	Not needed	Fair; moderate water intake and very low or low available moisture capacity.	In places bedrock, at a depth of 15 to 30 inches hinders construction; cuts should be held to a minimum to prevent exposing the bedrock.	In places bedrock hinders construction.	Moderate to severe; in places fractured bedrock allows unfiltered sewage to travel a long distance; bedrock hinders installation in some places.	None where footings rest on bedrock.

240-019—68——11

TABLE 6.—*Engineering test data for soil*

Soil name and location	Parent material	Iowa report No. AADO	Depth	Horizon	Moisture-density[2] Maximum dry density	Moisture-density[2] Optimum moisture
			Inches		*Lb. per cu. ft.*	*Percent*
Bassett loam: 460 feet S. and 175 feet E. of the NW. corner of SW¼ sec. 34, T. 97 N., R. 10 W.	Glacial till.	8409	6–12	A2	109	17
		8410	27–47	IIB22	118	13
		8411	47–72	IIB3	118	12
Clyde silt loam: 215 feet N. and 35 feet E. of the SE. corner of NE¼NW¼ sec. 5, T. 96 N., R. 10 W.	Outwash over till.	8406	0–11	A1	79	32
		8407	27–33	B2g	118	12
		8408	38–56	IIIC2	120	11
Dorchester silt loam: NE¼SW¼ sec. 33, T. 98 N., R. 8 W.	Alluvium.	8400	0–20	C	102	19
		8401	20–30	A1b	94	23
		8402	48–59	B22b	102	18
Fayette silt loam: 250 feet W. and 45 feet S. of the NE. corner of NW¼NE¼ sec. 21, T. 100 N., R. 8 W.	Loess.	8397	0–7	Ap	103	18
		8398	27–39	B22	103	18
		8399	46–80	C1	106	18
Floyd loam: 150 feet N. of the SW. corner of NW¼SW¼ sec. 4, T. 96 N., R. 10 W.	Glacial drift.	8412	0–12	A1	84	28
		8413	29–37	IIB22	(6)	(6)
		8414	41–64	IIB32	114	14
Ossian silt loam: SW¼NW¼ sec. 2, T. 96 N., R. 7. W.	Alluvium.	8394	7–17	C2	104	17
		8395	29–40	B21b	104	17
		8396	47–64	B3b	106	17
Riceville loam: 580 feet N. of the SW. corner of sec. 3, T. 96 N., R. 10 W.	Glacial till.	8391	0–8	A1	94	24
		8392	12–16	B1	107	18
		8393	20–42	IIB22	111	16

[1] Tests performed by the Iowa State Highway Commission in accordance with standard procedures of the American Association of State Highway Officials (AASHO).
[2] Based on AASHO Designation T 99–57, Method A (*1*).
[3] Mechanical analyses according to AASHO Designation T 88–57 (*1*). Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 mm. in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method

samples taken from selected soil profiles [1]

Mechanical analysis [3]									Liquid limit	Plasticity index	Classification	
Percentage passing sieve—					Percentage smaller than—						AASHO [4]	Unified [5]
¾ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.	0.001 mm.				
--------	--------	100	93	70	67	31	26	22	30	12	A-6(8)	CL.
98	97	96	90	57	51	32	27	24	32	17	A-6(7)	CL.
--------	100	99	92	60	56	32	26	22	32	18	A-6(8)	CL.
--------	--------	100	97	85	82	33	22	16	65	21	A-7-5(16)	MH.
98	96	95	85	58	53	27	23	20	36	21	A-6(9)	CL.
--------	99	98	89	56	50	25	23	20	29	17	A-6(7)	CL.
--------	--------	--------	100	97	90	22	16	13	32	9	A-4(8)	ML-CL.
--------	--------	--------	100	97	89	29	20	14	47	20	A-7-6(13)	ML-CL.
--------	--------	100	99	93	89	32	26	22	37	17	A-6(11)	CL.
--------	--------	--------	100	98	89	23	15	10	32	9	A-4(8)	ML-CL.
--------	--------	--------	--------	100	90	35	30	28	42	21	A-7-6(13)	CL.
--------	100	99	99	97	89	32	27	24	37	17	A-6(11)	CL.
--------	--------	100	94	73	69	24	16	10	55	15	A-7-5(13)	MH.
87	80	77	63	27	21	11	10	9	22	10	A-2-4(0)	SC.
--------	99	99	93	73	69	36	32	30	37	21	A-6(12)	CL.
--------	--------	--------	--------	99	93	29	22	17	35	13	A-6(9)	ML-CL.
--------	--------	100	99	99	93	39	32	27	43	22	A-7-6(13)	CL.
--------	--------	--------	--------	99	91	34	29	26	41	22	A-7-6(13)	CL.
--------	--------	100	94	74	67	29	20	14	41	16	A-7-6(10)	ML-CL.
90	87	86	81	60	54	31	26	23	39	20	A-6(9)	CL.
--------	100	99	93	66	58	34	29	26	39	22	A-6(11)	CL.

and the material coarser than 2 mm. in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[4] Based on AASHO Designation M 145-49 (*1*).

[5] Based on the Unified soil classification system (*15*). SCS and BPR have agreed to consider that all soils having plasticity indexes within two points from A-line are to be given a borderline classification. An example of a borderline classification is ML-CL.

[6] Not enough material passed the No. 4 sieve for a moisture-density test.

Shown in table 4 is the percentage passing sieves of different sizes. This is the normal range of soil particles passing the respective screen sizes.

Permeability refers to the rate of movement of water through the undisturbed soil. Permeability depends largely on the soil texture and structure.

Available water capacity is the amount of water in a moist soil, at field capacity, that can be removed by plants. The ratings in this column, expressed in inches of water per inch of soil depth, are of particular value to engineers engaged in irrigation.

Shrink-swell potential is a rating of the ability of soil material to change volume when the soil is subjected to changes in moisture. Those soil materials rated high in shrink-swell potential are normally undesirable from the engineering standpoint, since the increase in volume when the dry soil is moistened is usually accompanied by a loss in bearing capacity. In general, soils classed as CH and A–7 have high shrink-swell potential. Clean sand and gravel (single-grain structure) and soils containing a small amount of nonplastic to slightly plastic fines have low shrink-swell potential.

Soil features affecting work on highways

Many of the soils in the northeastern two-thirds of Winneshiek County formed in a thick deposit of loess on the uplands. In the same part of the county, many other soils formed in strongly sloping areas in a thin deposit of loess over limestone. Many of the soils in the southwestern third of the county formed in a very thin mantle of loess over glacial till. The till is currently recognized as Iowan drift (*4*). However, recent publications by Wright and Ruhe, discussing the studies made by Ruhe and his associates of the type of Iowan till in this part of the State (*17*), indicate that the landscape consists of a multileveled sequence of erosional surfaces and that erosion has cut into Kansan and Nebraskan till in many of the levels.

The Downs and Fayette are examples of soils derived from a thick layer of loess on the uplands. They are fine textured and are classified A–4 to A–7 (ML or CL). These soils generally have a dark-brown surface layer and a slightly plastic subsoil. In some closed depressions in the uplands, however, their surface layer is brownish black. The soil material in those areas contains organic matter to a depth of a foot or more and is difficult to compact to a good density. More sloping Downs and similar soils have also formed in loess. Those soils have a less well developed surface layer than the more nearly level soils, and they have a less plastic subsoil. Their subsoil is classified A–7 (CL). Loessal soils erode readily if runoff is concentrated. In areas of loessal soils, sodding, paving, or constructing check dams in gutters and ditches may be necessary to prevent erosion.

In the soils derived from a thin layer of loess over till or material weathered from bedrock, the seasonal high water table generally is above the point of contact between the loess and the glacial till. In the more nearly level areas and in depressions, a shallow water table is perched above the plastic B horizon in some places. In those areas the in-place density of the loess is relatively low and the moisture content is high. This high moisture content may make embankments unstable unless it is controlled enough to permit the soil to be compacted to high density. Because of their high in-place density, soils derived from glacial till generally do not have an excessively high moisture content and are more easily compacted than the soils derived from loess.

Soils such as the Bassett have formed in loamy till, mainly in the western part of the county. Those soils are loams and sandy loams and are classified A–6, A–4, or A–2 (CL or SC). Where those soils occur in or adjacent to a grading project, they are normally placed in the upper part of the subgrade throughout unstable areas. Pockets and lenses of sand that in many places are water bearing are commonly interspersed throughout those areas. Where the road grade is only a few feet above such deposits, and where silty till overlies the deposits, frost heaving is likely, unless the soil material is drained or the material above it is replaced with granular backfill or with clayey glacial till.

The soils of bottom lands formed in recent alluvium washed from hills and uplands. The Colo and similar soils have a thick organic surface layer that may consolidate erratically under the load of an embankment. The soils are generally classified A–7 (CL, ML, or OH). They have low in-place density and a high content of moisture. Therefore, if an embankment is to be more than 15 feet high, the soil material should be carefully analyzed to be sure that the soils are strong enough to support the load. Roadways through bottom lands need to be constructed on a continuous embankment that extends above the level reached by floodwaters.

Some soils of the bottom lands have an overwash of fine sand. An embankment constructed on those soils only a few feet above the water table may be damaged by frost heaving, unless proper drainage is established or material not susceptible to frost action is used in the subgrade.

Limestone and shale are the kinds of bedrock underlying the glacial till. In areas where the limestone is not deeply buried below glacial till or loess, sinkholes have developed, leaving typical drained potholes or depressions. These sinkholes do not provide enough support for the embankments for roadways or for other structures. Therefore, great care is needed to determine their location and extent during preliminary investigations. The Dubuque and Winneshiek soils, classified A–7 or A–6 (ML, CL, or CH) occur where limestone is close to the surface. The subsoil of those soils is undesirable for use in the upper part of the subgrade, because of its high content of clay and nonuniform residual characteristics.

The soils of the Calamine and Jacwin series have formed in areas where shale is near the surface, and they are classified as A–6 or A–7–6 (CL, CH, or ML). Where shale is exposed to weathering, it becomes plastic and loses its normal in-place density. Where embankments are constructed over sloping areas of shale, care is needed to assure that moisture is not left free to lubricate the surface of the shale and thus create the possibility of a slide. Likewise, if a cut is necessary through shale that has an overburden of glacial material or loess, the cut slope must be designed so that it is flat enough to eliminate a backslope slide when the shaly surface may be lubricated by moisture from natural infiltration areas.

Conservation engineering [4]

In Winneshiek County engineering work for soil conservation consists mainly of building structures that control erosion. These structures consist chiefly of terraces, grassed waterways, structures that help to stabilize gullies and grades, and dams to retain water. The major practices that increase productivity are those that improve surface and subsurface drainage.

EROSION CONTROL STRUCTURES

Terraces.—A terrace is a channel built across a slope to intercept runoff or water from seepage and to help control erosion. Generally, only graded terraces are used in this county (fig. 9), but occasionally a level terrace is used where the soil is well drained and is more than 6 feet deep. The Orwood soils, for example, are suitable for level terraces if a suitable outlet is not available for graded terraces.

***Figure 9.*—A graded terrace used to provide protection in a field of Fayette soils.**

Terraces help to control erosion by reducing the length of the slope so that the soils can be used more intensively for row crops without excessive loss of soil material. The trend toward more intensive cultivation of the soils makes terracing the most acceptable complementary practice that can be used to keep the loss of soil material within acceptable limits. Table 5 shows some features that affect the suitability of the soils of the county for terracing.

In this county cut and fill terraces are suggested for most of the deep soils that have slopes as steep as 10 percent. By cutting and filling, the terraces can be run parallel to each other and point rows can be eliminated between the terraces. The maximum cut should be no more than 3 feet. In some places bedrock near the surface limits the depth of cut that is practical.

For soils that have slopes steeper than 10 percent, bench-type terraces that have seeded backslopes should be considered. Tile inlets can be constructed on these bench-type terraces, and the need for a waterway is thus eliminated.

In general, the Fayette, Downs, Tama, and other soils that were derived from loess, that are 3 feet or more deep, and that have slopes of less than 10 percent are suitable for terracing. Soils that were derived from till, such as the Kenyon, Ostrander, Racine, Coggon, Bassett, and Renova, are less well suited to terracing. They have a less fertile subsoil than the soils derived from loess. Also, most of them have a concentration of small stones and pebbles at a depth of about 2 feet, and those stones and pebbles are undesirable when exposed on the surface. Installing terraces on some till-derived soils increases the hazard of wetness, unless proper drainage is installed.

The Chelsea and Hagener soils are sandy and thus are not suited to terracing. On those soils terrace channels, ridges, and outlets are extremely difficult to maintain.

Diversions.—A diversion is a channel constructed across the slope to intercept surface water and channel it to a safe outlet. Diversions can be used to control erosion at the heads of small gullies. This can be done by conveying the runoff water to an area where it can be safely disposed of. Diversions can also be used to protect nearly level soils of first bottoms and foot slopes from being flooded by surface runoff from adjacent higher lying soils. A properly placed diversion not only reduces local flooding but also controls silting caused by local runoff. In the drainage area, good practices must be used to conserve the soils, or the diversion will require a great deal of maintenance. The Chaseburg, Huntsville, Dorchester, Ossian, and Volney are examples of soils that can be protected by diversions.

Grassed waterways.—A grassed waterway is a vegetated channel that conducts runoff, at a nonerosive velocity, to a stable outlet. Unless a good cover of plants is kept in drainageways, gullying is a hazard. Where the cover of plants has been destroyed, deep, raw gullies are likely to form (fig. 10). These gullies require a large amount of work to fill and reshape. Grade stabilization structures are needed in many waterways that have a steep grade. Such structures reduce the velocity of the runoff and remove the water without causing erosion.

Most of the soils of the county are fertile enough for growing suitable vegetation if the drainageways have been shaped and the velocity of the water is reduced. Generally, large areas of subsoil material that is lacking in fertility are exposed when the gullies are reshaped and filled. In those areas large applications of manure and commercial fertilizer are likely to be needed before a good cover of plants can be established. In most places tile lines are needed on both sides of the shaped drainageways to permit grass to become established and to reduce wetness so that the drainageways can be crossed with farm machinery.

Water flows swiftly in many of the permanent streams of the county, and it causes severe streambank erosion in places (fig. 11). This kind of erosion is difficult to control. Technical assistance in controlling it can be

[4] Prepared by HAROLD J. SHOLD, agricultural engineer, Soil Conservation Service.

Figure 10.—**In the lower picture is a deep gully across an area occupied by Dorchester-Chaseburg-Volney complex, 2 to 5 percent slopes. Shaping of the gully has just been started. In the upper picture is the area after the gully has been filled, reshaped, and seeded.**

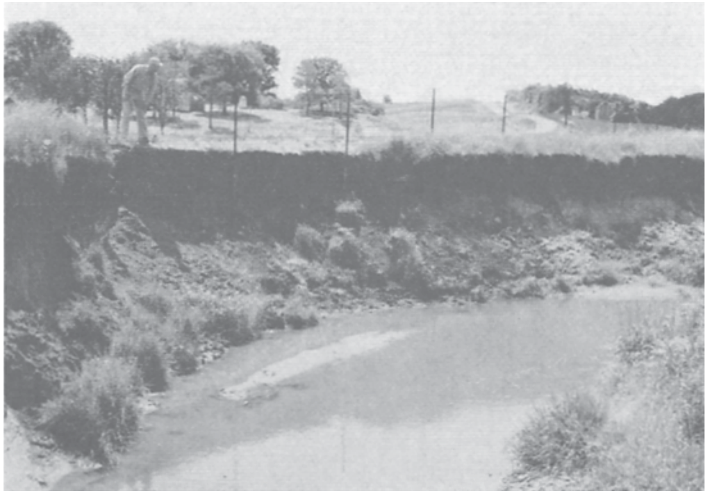

Figure 11.—**Severe streambank erosion caused by a permanent stream flowing through a pasture occupied by Dorchester soils. A large amount of soil material has been lost, and the fence is damaged.**

obtained from an engineer of the Soil Conservation Service.

Other structures for controlling erosion.—The most common structures used for controlling erosion in this county are reinforced concrete drop spillways or drop inlets. As a rule, reinforced concrete drop spillways are used where the drop in elevation is no greater than 6 feet. Below a reinforced concrete drop spillway, the grade must be stabilized to prevent gullies from forming and undermining the structure on the downstream side. If the structure can be placed on a rock base, the grade below the structure may be steep.

Examples of soils that require structures for controlling excess water are those of the Colo, Otter, Dorchester, Chaseburg, and Volney series. Drop inlet structures are used for stabilizing the slopes and providing a safe outlet for water where the drop in elevation exceeds 8 feet. Drop inlets are constructed of metal or concrete, and the inlet is set into the upper side of an earthen dam at the elevation desired to stabilize the upstream grade. The inlet is connected to a spillway of metal or concrete pipe that passes through the dam and empties into a stable waterway at a lower elevation. If suitable fill material is to be obtained, it may be necessary to obtain material from areas some distance from the site of the structure. Suitable compaction can generally be obtained by using normal contracting equipment, if care is used in selecting and placing the fill material. Soil material of glacial origin is better for fill than that of loessal origin.

If the side abutments are seepy, toe drainage ought to be provided beneath the structure. Toe drains are commonly needed for structures placed in Clyde and similar soils.

Constructing an erosion control structure presents difficult problems. Therefore, technical assistance should be obtained before major structures are planned.

Farm ponds.—By making water available to livestock on all parts of the farm, farm ponds help to control erosion because more acreage can be used for rotation grazing. Farm ponds furnish water for livestock where there is no natural supply of water or where the supply is not great enough to satisfy the needs. Ponds are also used for fishing and for other kinds of recreation. Table 5 names characteristics of the soils that affect use of the soils for farm ponds.

Care is needed in choosing a site for a pond. If sinkholes are near the proposed site, the area to be used for the fill and reservoir should be located so that the sinkholes are not within the work area. After the pond has been filled with water, leaks or sinkholes may develop in areas where none were visible at the time the pond was constructed. Sinkholes are most common in areas of soils in soil associations 5 and 6.

Bentonite and other sealing materials have been used with considerable success for sealing ponds where seepage is excessive. If a sinkhole that causes leakage develops, it may be possible to plug it by excavating to the rock crevice or hole, filling the hole with concrete, and backfilling with material from the subsoil or with a mixture of soil material and a sealing agent.

To insure that leakage will not occur through the fill area, it is necessary to excavate a core trench to impervious material, or to a depth of about 4 feet, and backfill with impervious material from the subsoil. In general, soils derived from glacial material make better fill material for farm ponds than soils derived from loess. In many places, however, a suitable site for a pond is not available in the part of the county underlain by glacial material. Toe drainage is needed where the side abutments are seepy.

PRACTICES THAT INCREASE SOIL PRODUCTIVITY

Drainage.—Nearly all of the wet soils of the county are improved greatly by drainage. Table 5 indicates the suitability and names limitations that affect suitability of the soils for drainage. Tile drainage is necessary for optimum production on a large part of the acreage in the southwestern third of the county where the Clyde and Floyd soils are extensive.

Tile drains should generally be placed at a depth between 3½ and 4 feet. The laterals ought to be spaced 60 to 80 feet apart, depending on the characteristics of the soils. In some areas it is necessary to extend a tile outlet main a considerable distance before a satisfactory outlet is obtained. Natural outlets, however, are generally available. As a rule, it is not necessary to construct a drainage ditch.

In the northeastern two-thirds of the county, tile drainage is necessary along many of the drainageways so that a good cover of vegetation can be established and maintained and the drainageways can be crossed with farm equipment. In many places tile lines are installed along the outer edges of the wet areas where they will intercept seepage. Tile drains have been installed in some areas of Colo, Ossian, Otter, Caneek, and other soils of first bottoms. For optimum results, however, those soils need some protection from flooding. Surface drainage is also required in some areas to remove the surplus surface water within a reasonable length of time.

Irrigation.—Irrigation is not of major concern in Winneshiek County, for rainfall is generally more than adequate for the production of all crops. Also, not enough water is generally available to permit extensive irrigation. Table 5 rates the soils according to their suitability for irrigation and indicates features that affect the use of the soils for that use.

Genesis, Classification, and Morphology of Soils

The purpose of this section is to present the outstanding morphologic characteristics of the soils of Winneshiek County and to relate them to the factors of soil formation. Physical and chemical data are limited for these soils, and the discussion of soil genesis and morphology is correspondingly incomplete. The first part of the section deals with the environment of the soils; the second, with the classification of soils; and the third with the morphology of the soils.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material (*3*).

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of the parent material into a soil profile. It may be much or little, but some time is always required for horizon differentiation. Usually, a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The initial step in the development of a soil profile is the formation of soil parent material. Some of the soils in the county formed as the result of weathering of the bedrock. Most of the soils, however, formed in material that was transported from the site of the parent rock and redeposited at a new location through the action of ice, water, wind, and gravity (fig. 12).

The principal parent materials in Winneshiek County are loess, glacial drift, alluvium, and wind-deposited sand. Much less extensive parent materials are organic deposits and residuum.

Loess, a silty material deposited by wind, is the most extensive parent material in the county. Loess consists mostly of silt. It does not contain coarse sand, gravel, and boulders, because those materials were too large to be moved by wind, but it does contain a small amount of very fine sand or clay. The large amount of silt-size particles in soil derived from loess give those soils a smooth, floury feel. The thickness of the layer of loess in stable areas ranges from about 1 to 10 feet or more.

Except in the southwestern quarter of the county, most of the soils in the county have formed in loess. Among the most extensive soils derived from that parent material are the Fayette, Tama, Downs, Dubuque, Palsgrove, and Atterberry. Those soils are among the most productive in the county.

Glacial drift is a product of the Pleistocene, or Ice age, when snow and ice accumulated to a great depth. Pressure increased with an increase in the depth of the ice and snow, and as a result, the glacial ice began to flow as a plastic mass. Like a giant bulldozer, it moved across the landscape, grinding rocks into smaller particles, leveling hills, and filling valleys. Glacial drift is the name given to the unconsolidated mixture of gravel and partly weathered fragments of rock left by the glaciers. The unsorted mixture of clay, silt, sand, gravel, and boulders deposited by the ice sheet is called glacial till. Soils formed in this glacial material are most numerous in the southwestern third of the county.

In most places the glacial till in which the soils developed has a texture of loam. The glacial till in which the Donnan and Riceville soils developed, however, has a texture of clay or of clay loam.

Most of the soils in Jackson, Washington, Calmar, Sumner, Lincoln, and Orleans Townships developed in glacial drift. Among the most extensive soils of glacial origin in those townships are the Kenyon, Floyd, Clyde, Ostrander, Bassett, Renova, Coggon, Racine, and Oran. Most of the soils that formed in glacial drift contain a stone line or pebble band. In the soils of the uplands, this stone line or pebble band is generally at a depth of about 1½ to 2 feet. In the Floyd and Clyde soils in drainageways, however, it is at a greater depth (fig. 13). The stone line consists of a layer, 2 to 4 inches thick, in which stones 1 to 3 inches in diameter are concentrated. This layer rests on a layer of finer loam to clay loam glacial till. The material above the pebble band generally has a texture of loam, but the soil particles are of a much more uniform size than those in the material in the pebble band, and the soil material is free of rocks and boulders.

Alluvium is material that was deposited by water on flood plains along streams. In Winneshiek County two major areas in which soils have formed in alluvium occur along the Upper Iowa River and on the bottoms along the Turkey River. Smaller areas are along streams that are tributaries of those rivers.

Soils derived from alluvium are generally stratified and contain layers of sand, silt, or gravel. Also, many

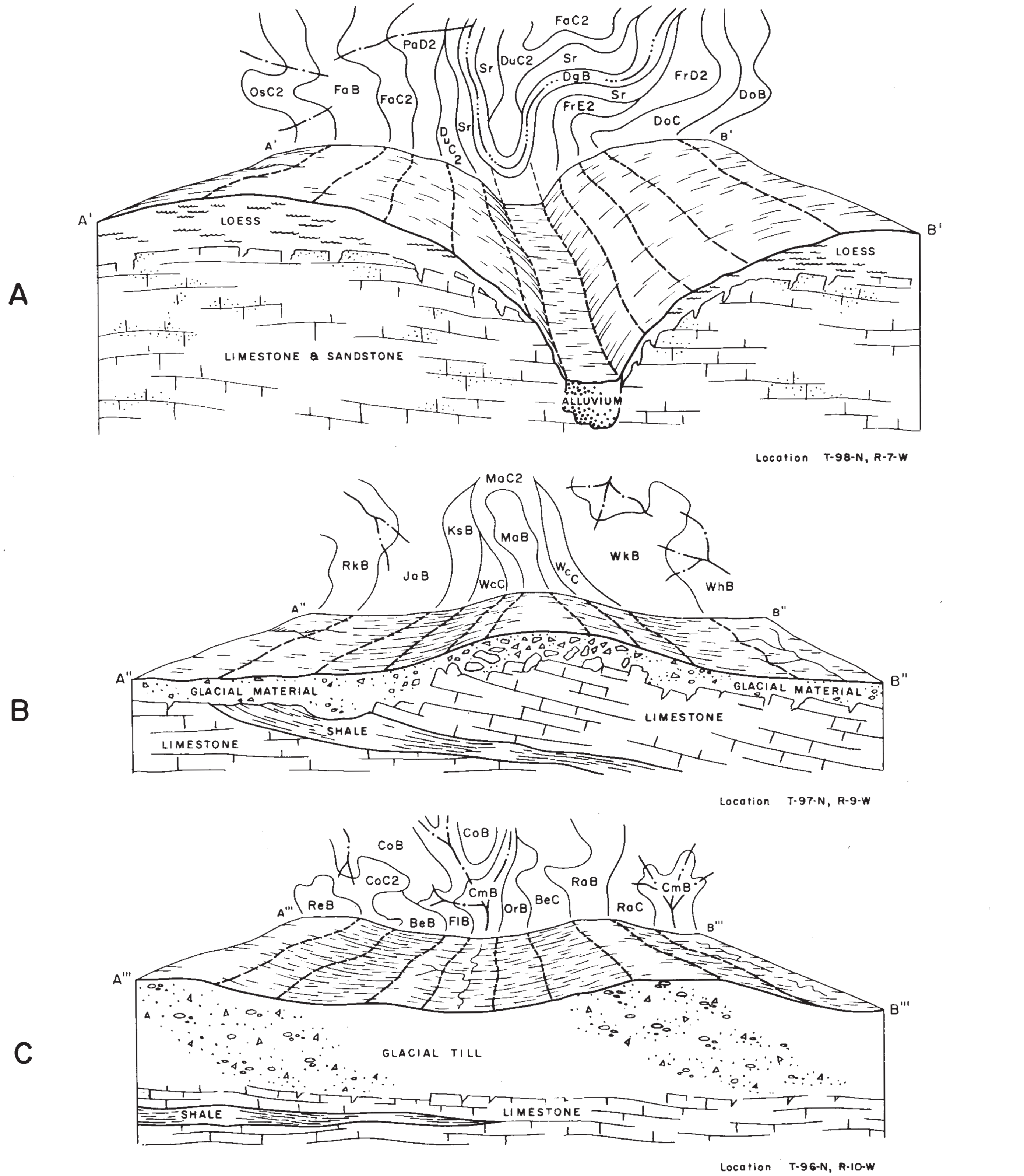

Figure 12.—**Relationship of the underlying formations to the mapping units in three areas of Winneshiek County.**

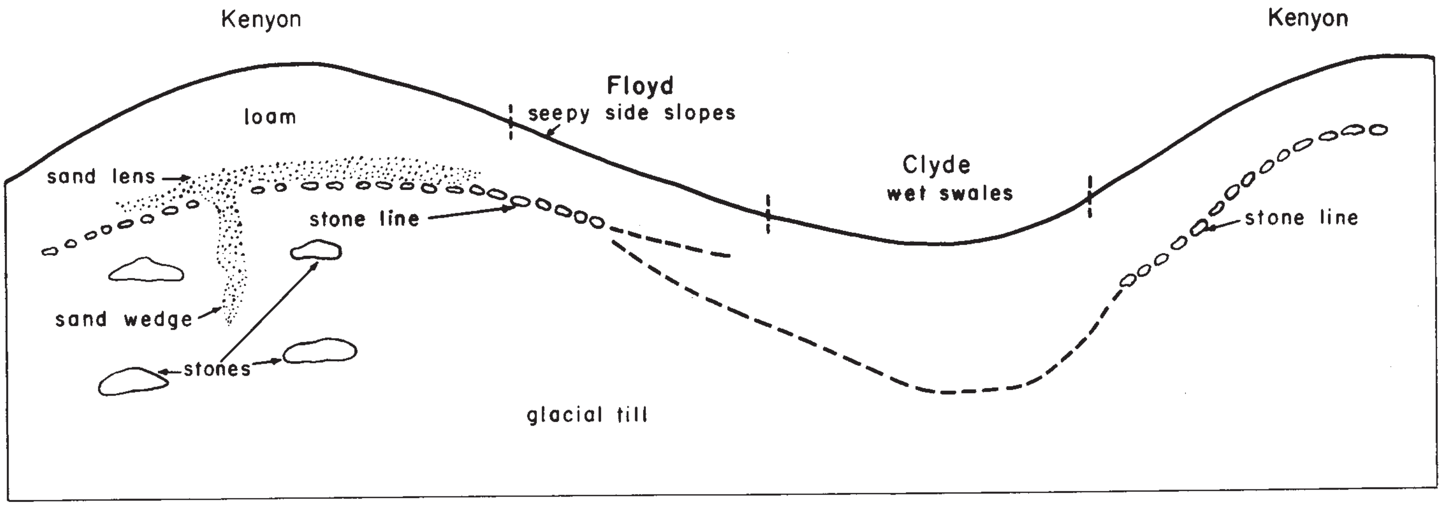

Figure 13.—**Parent material in which the Kenyon, Floyd, and Clyde soils formed.**

soils that formed in recently deposited alluvium are calcareous. Examples of soils formed in calcareous alluvium are those of the Dorchester, Caneek, and Volney series. Those soils have a calcareous surface layer.

Much of the alluvium in this county washed from soils on loess-covered slopes in the uplands. Many of the alluvial sediments are silty and low in content of sand. Examples of silty soils formed in alluvium are those of the Ossian, Otter, Lawson, Colo, Huntsville, Arenzville, and Kennebec series. Loamy soils that also formed in alluvium but that contain more sand than the silty soils are those of the Spillville and Turlin series.

Where sediments accumulate at the base of upland slopes as the result of gravity or local runoff, they are called local alluvium or colluvium. In this county the Chaseburg and Volney soils formed in that material.

Wind-deposited sand is not extensive in Winneshiek County. The deposits occur along the valleys of the major streams and are much higher in content of sand than the deposits of loess. Smaller areas occur in elongated ridges that orient from a northwesterly to a southeasterly direction in what are called pahas (*10*).

Wind-deposited sand consists largely of quartz, which is highly resistant to weathering. It has not been altered appreciably since it was deposited. Examples of soils that developed mainly in wind-deposited sand are those of the Hagener and Chelsea series. The Orwood soils also developed in wind-deposited material, but the material in which they formed has a loamy rather than a sandy texture.

Residuum, the material derived from the weathering of sedimentary rocks in place, is a minor source of parent material in this county. Limestone, shale, and sandstone are the most extensive sedimentary rocks in the county as shown in figure 14. In most places a deposit of loess or glacial drift covers the residuum, and in only a few areas does residuum make up the entire solum. Residuum makes up nearly all of the solum, however, in some Jacwin soils and in eroded areas of Nordness soils. In this county the layer of limestone residuum is generally less than 12 inches thick over bedrock. In soils such as the Dubuque, Palsgrove, Nasset, and Frankville, a deposit of loess covers the thin layer of residuum from limestone.

In soils such as the Calamine and Jacwin, part of the solum is made up of residuum from shale. Generally, however, less than 12 inches of the solum consists of residuum from shale. The residuum commonly has a texture of silty clay or clay. Residuum from limestone commonly has a more reddish hue than that from shale, and the residuum from shale is yellowish.

Deposits of organic matter are the parent material for organic soils (peats and mucks). Organic soils occupy small wet areas in the county, where poor drainage has retarded the decay of plant remains that have accumulated over a period of time. In Winneshiek County the thickness of the layer of organic matter ranges from about 10 to 48 inches.

Climate

According to available evidence, the soils of Winneshiek County have been developing under the influence of a midcontinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to the growth of forest vegetation (*7*). The morphology of most of the soils in the county indicates that the climate under which the soils formed is similar to the present one. At present, the climate is fairly uniform throughout the county but is marked by wide seasonal extremes in temperature. Precipitation is distributed throughout the year.

The influence of the general climate of the region is modified by the local conditions in or near the developing soil. For example, a sandy soil on dry, south-facing slopes has a local climate, or microclimate, that is warmer and less humid than the average climate in areas nearby. A low-lying, poorly drained soil on bottoms and terraces, on the other hand, has a wetter, colder climate than that in most of the surrounding areas. These contrasts account for some of the differences in soils within the same general climatic region.

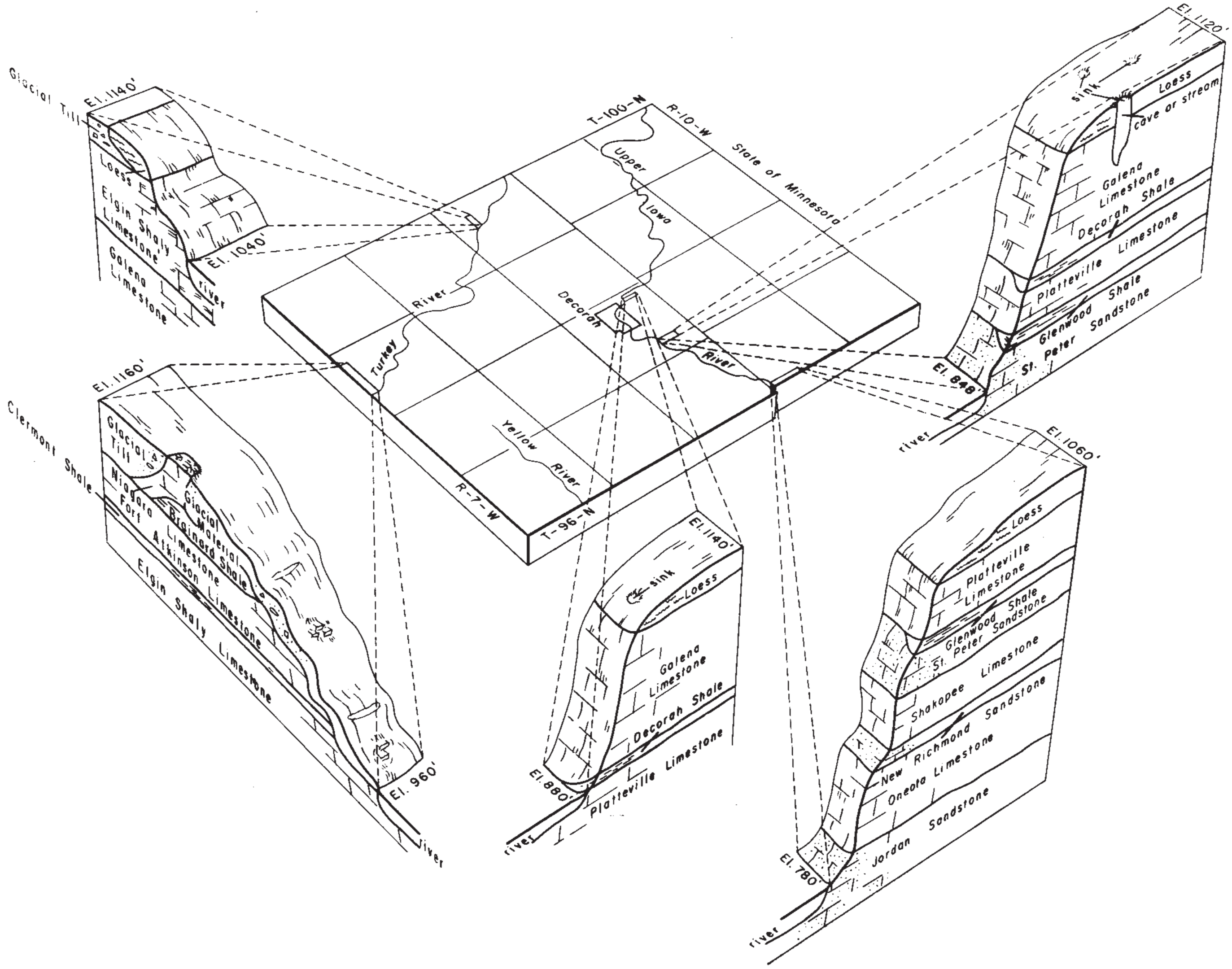

***Figure 14.*—Section showing geologic stratigraphy in Winneshiek County.**

Plant and animal life

Plant and animal life are important factors in the formation of soils. Soils are made up partly of organic matter—living organisms (plants and animals) or the remains of plants and animals—in addition to the mineral matter provided by the parent material. Plants and animals perform two main functions in the development of the soil profile. First, they are the source of organic matter in the soils. Secondly, deep-rooted plants help to bring plant nutrients up from a lower depth to a place where the nutrients can be used by other plants. The organic matter may be stored in the A horizon, and it imparts a dark color to the surface soil. It releases plant nutrients for the use of plants.

In the eastern and northern parts of Winneshiek County and along the major streams in the southwestern part of the county, forest vegetation, chiefly oak and hickory, was prominent in the past. From this forest vegetation came organic matter in the form of leaves, twigs, and logs. Because this organic matter accumulated mainly on the surface, the soils that formed under forest vegetation have a thin, dark-colored surface layer (less than 4 inches thick). They have a lighter colored A2 horizon immediately below the surface layer. In contrast, soils that formed under prairie vegetation contain a large amount of organic matter from roots. That organic matter has accumulated below the surface. As a result, soils that developed under prairie vegetation have a thick, dark-colored surface layer. Many soils in Winneshiek County developed under both forest and prairie vegetation.

Micro-organisms also play an important role in the development of the soil profile. They are a source of organic matter. Also, they help to decompose organic matter, to combine free nitrogen into a form that can be used by plants, and to release nitrogen and other nutrients stored in the organic matter so that those nutrients can be used by plants.

Relief

Relief, or topography, refers to the lay of the land. It varies greatly in Winneshiek County. The range is from nearly level to very steep. Relief is an important factor in determining the pattern and distribution of the soils of a landscape, primarily because of its influence on drainage, runoff, and erosion.

A secondary influence that greatly affects the formation of soils is the aspect, or direction of slope. South-facing slopes, for example, normally are warmer and drier than north-facing slopes. This factor can have a great effect on the kind and amount of vegetation that grows in an area.

Relief may be characterized by the gradient (degree or percent of slope) and by the length, shape, aspect, and uniformity of the slopes that make up a landscape. Because of its influence on drainage and on climate, plant growth, and the amount of erosion, relief is important in determining the pattern in which various soil types occur within different areas of the county.

In Winneshiek County the nearly level ridgetops are generally not more than a quarter of a mile wide. Most of the soils that occur on them, for example some Fayette soils, have well-developed profiles. Examples of soils that have limited profile development because of the steepness of the slopes are the Dow. Relief also has contributed to seepage, slow movement of water, and a high water table. This is true, especially in the area underlain by glacial drift, and has resulted in the development of somewhat poorly drained and poorly drained soils, such as the Floyd and Clyde.

Time

Time is necessary for the various processes of soil formation to take place. The amount of time necessary ranges from a few days for the formation of soils in fresh alluvial deposits to thousands of years for the paleosols that lie just above the limestone deposits in the county. In general, if other factors are favorable, the texture of the subsoil becomes finer and a greater amount of soluble materials are leached out as the soils continue to weather. Exceptions to this rule are soils formed in quartz sand or other materials that are resistant to weathering, for such soils do not change much over a long period of time. Other exceptions are soils that have steep slopes and that, therefore, have a small amount of water infiltration and are subject to a large amount of runoff. Such soils weather more slowly than soils in stable, less steep areas.

Glacial material and loessal deposits were discussed under parent material. The glacial material is of Pleistocene age. In contrast, loess that covers much of the county is probably only 14,000 to 16,000 years old, the maximum age for loessal soils (*8*). The present landscape has been influenced and is still being influenced by geologic erosion. Thus, the soils that are a part of the modern landscape may be young, even though the material that was deposited is old.

Where organic materials, such as trees, have been buried by later deposition through the action of ice, water, or wind, the age of a landscape can be determined by a process known as radiocarbon dating. Studies of radioactive carbon can help in estimating the time that the radioactive carbon was deposited.

Classification and Morphology of Soils

Soils are placed in narrowly defined classes so that knowledge about their behavior within farms and counties can be organized and applied. They are placed in broadly defined categories so that large areas, such as continents, can be studied and compared.

Two systems of natural classification of soils are now in general use in the United States. One of these systems is that described in "Soils and Men," the 1938 Yearbook of Agriculture (*2*), and later revised by Thorp and Smith (*13*) in 1949. The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study (*11, 14*). Therefore, readers, interested in developments of the system should search for the latest literature available.

The older system consists of six categories. In the highest of these, soils of the whole country have been placed in three classes of the soil order. The next two categories, the suborder and family, have not been fully developed and, therefore, have not been used much. Attention has centered on the categories of great soil group, soil series, and soil type. A great soil group consists of soils that have about the same general kind of profile but that may differ greatly in slope, thickness of profile, and other characteristics. The categories of soil series, soil type, and a subdivision of the soil type, called the soil phase, are defined in the section "How This Survey Was Made."

The current system of soil classification was developed by soil scientists of the Soil Conservation Service, assisted by their colleagues in other organizations and in foreign countries. This comprehensive system was needed because of the shortcomings of the older system that were apparent when soils were classified in foreign countries and for interpretations in new fields of use.

Like the older system, the current system consists of six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series (*2*). In this system the criteria used as a basis for classification are soil properties that are observable or measurable. The properties are chosen so that soils of similar genesis, or mode of origin, are grouped together.

In the orders of the new classification, soils are grouped according to common properties that seem to be the result of the same kinds of processes, acting to about the same degree on soil material and forming horizons. Each order is subdivided into suborders, primarily on the basis of physical or chemical properties that reflect degree of wetness, differences that are the result of differences in climate and vegetation, and extremes of texture. Each great group is defined within its respective suborder, according to the presence or absence of diagnostic horizons and the arrangement of those horizons. Subgroups can be defined only in terms of reference to a great group and may represent the central concept of the great group or reflect properties that intergrade toward other classes. Soils are grouped in families largely on the basis of properties important to plant growth.

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the country. A proposed new series has tentative status until review of the series concept at State, regional, and national levels of responsibility for soil classification result in a judgment that the new series should be established. Most of the soil series described in this publication have been established earlier. Fourteen of the soil series described in this survey, however, had tentative status when the survey was sent to the printer. They are the Calmar, Caneek, Canoe, Donnan, Festina, Frankville, Jacwin, Marlean, Nasset, Nordness, Orwood, Ossian, Turlin, and Waucoma.

Listed in table 7 for each soil series in Winneshiek County are the family and subgroup of the current system (*11*, *14*). Also shown is the great soil group of the older system of classification (*13*).

Following is a description of the great soil groups of the 1938–49 system that are represented in Winneshiek County.

TABLE 7.—*Classification of the soil series according to the 1938–49 system and the current system*

Soil series	Current classification		1938–49 system
	Family	Subgroup	Great soil group
Arenzville	Fine-silty, mixed, nonacid, mesic	Typic Udifluvent	Alluvial.
Atkinson	Fine-loamy, mixed, mesic	Typic Argiudoll	Brunizem.
Atterberry	Fine-silty, mixed, mesic	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Backbone	Coarse-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Bassett	Fine-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Bertrand	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Bixby	Fine-loamy over sand or sandy skeletal, mixed over siliceous, mesic.	Typic Hapludalf	Gray-Brown Podzolic.
Burkhardt	Coarse-loamy, over sandy skeletal, siliceous, mesic.	Entic Hapludoll	Brunizem intergrading toward Regosol.
Calamine	Fine, illitic, noncalcareous, mesic	Typic Argiaquoll	Humic Gley (Wiesenboden).
Calmar	Fine-loamy, mixed, mesic	Cumulic Argiudoll	Brunizem.
Camden	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Caneek	Fine-silty, mixed, calcareous, mesic	Fluventic Haplaquept	Alluvial.
Canoe	Fine-silty, mixed, mesic	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Chaseburg	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Chelsea	Sandy, siliceous, nonacid, mesic	Alfic Udipsamment	Gray-Brown Podzolic intergrading toward Regosol.
Clyde	Fine-loamy, mixed, noncalcareous, mesic.	Typic Haplaquoll	Humic Gley (Wiesenboden).
Coggon	Fine-loamy, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Colo	Fine-silty, mixed, noncalcareous, mesic.	Cumulic Haplaquoll	Humic Gley (Wiesenboden) intergrading toward Alluvial soils.
Curran	Fine-silty, mixed, mesic	Typic Ochraqualf	Gray-Brown Podzolic.
Dickinson	Coarse-loamy, siliceous, mesic	Typic Hapludoll	Brunizem.
Donnan	Fine-loamy over clay, mixed over montmorillonitic, mesic.	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Dorchester	Fine-silty, mixed, calcareous, mesic	Typic Udifluvent	Alluvial.
Dow	Fine-silty, mixed, calcareous, mesic	Typic Udorthent	Regosol intergrading toward Gray-Brown Podzolic.
Downs	Fine-silty, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Dubuque	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Fayette	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Fayette, gray variants	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Festina	Fine-silty, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Floyd	Fine-loamy, mixed, mesic	Aquic Hapludoll	Brunizem.
Franklin, gray subsoil variant.	Fine-silty, mixed, mesic	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Frankville	Fine-silty, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Hagener	Sandy, siliceous, mesic	Entic Hapludoll	Brunizem intergrading toward Regosol.
Hayfield	Fine-loamy over sand or sandy skeletal, mixed over siliceous, mesic.	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Huntsville	Fine-silty, mixed, mesic	Cumulic Hapludoll	Brunizem.
Jacwin	Fine-loamy, mixed, mesic	Aquic Hapludol	Brunizem.
Kato	Fine-loamy over sand or sandy skeletal, mixed over siliceous, noncalcareous, mesic.	Typic Haplaquoll	Brunizem.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludoll	Brunizem intergrading toward Alluvial soils.

TABLE 7.—*Classification of the soil series according to the 1938-49 system and the current system*—Continued

Soil series	Current classification		1938-49 system
	Family	Subgroup	Great soil group
Kenyon	Fine-loamy, mixed, mesic	Typic Hapludoll	Brunizem.
Lamont	Coarse-loamy, siliceous, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Lamont, till subsoil variant.	Coarse-loamy, over fine loamy, mixed, mesic.	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Lawson	Fine-silty, mixed, mesic	Aquic Cumulic Hapludoll.	Brunizem.
Marlean	Loamy skeletal, mixed, mesic	Typic Hapludoll	Brunizem.
Nasset	Fine-silty, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Nordness	Fine-silty, mixed, mesic	Lithic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Oran	Fine-loamy, mixed, mesic	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Orwood	Fine-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Ossian	Fine-silty, mixed, noncalcareous, mesic	Typic Haplaquoll	Humic Gley (Wiesenboden).
Ostrander	Fine-loamy, mixed, mesic	Typic Hapludoll	Brunizem.
Otter	Fine-silty, mixed, noncalcareous, mesic	Cumulic Haplaquoll	Humic Gley (Wiesenboden).
Palsgrove	Fine-silty, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Peaty muck		Histosol	Bog.
Racine	Fine-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Renova	Fine-loamy, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Riceville	Fine-loamy, mixed, mesic	Aeric Mollic Ochraqualf	Gray-Brown Podzolic intergrading toward Brunizem.
Rockton	Fine-loamy, mixed, mesic	Typic Argiudoll	Brunizem.
Roseville	Fine-loamy, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Rowley	Fine-silty, mixed, mesic	Aquic Argiudoll	Brunizem.
Sattre	Fine-loamy over sand or sandy skeletal, mixed, over siliceous, mesic.	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Spillville	Fine-loamy, mixed, mesic	Cumulic Hapludoll	Brunizem intergrading toward Alluvial soils.
Tama	Fine-silty, mixed, mesic	Typic Argiudoll.	Brunizem.
Terril	Fine-loamy, mixed, mesic	Cumulic Hapludoll	Brunizem.
Turlin	Fine-loamy, mixed, mesic	Aquic Cumulic Hapludoll.	Brunizem.
Volney	Loamy skeletal, mixed, mesic	Cumulic Hapludoll	Brunizem intergrading toward Alluvial soils.
Waucoma	Fine-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.
Waukegan	Fine-loamy over sand and sandy skeletal, mixed over siliceous, mesic.	Typic Hapludoll	Brunizem.
Whalan	Fine-loamy, mixed, mesic	Typic Hapludalf	Gray-Brown Podzolic.
Winneshiek	Fine-loamy, mixed, mesic	Mollic Hapludalf	Gray-Brown Podzolic intergrading toward Brunizem.

Brunizems

In the Brunizem (Prairie) great soil group are soils that developed under prairie grasses in a temperate, relatively humid climate (*12*). In this county these soils are generally nearly level to rolling. The soils classified as Brunizems are most extensive in the southwestern third of the county.

Typically, Brunizems have a black or very dark brown, acid A horizon that is 10 to 16 inches thick; a brown or mottled gray and brown B horizon 15 to 24 inches thick; and a yellowish-brown, mottled C horizon that in most places is leached of carbonates. In Winneshiek County the texture of the A horizon is silt loam or loam, and the texture of the B horizon is loam, silty clay loam, or clay loam. The A horizon has granular structure. The B horizon have structural aggregates that consist of slightly rounded, subangular blocks, and the C horizon generally lacks a distinct structure. In most places the boundaries between horizons are gradual.

Examples of Brunizems in Winneshiek County are those of the Ostrander, Tama, Kenyon, Floyd, Huntsville, and Waukegan series. The Brunizems are generally among the most productive soils in the county, but some are sandy, and others are shallow over gravel, shale, or limestone. In many places erosion is a hazard because of the slopes and the frequency with which row crops are grown.

Gray-Brown Podzolic soils

Gray-Brown Podzolic soils formed under deciduous forest vegetation. They are more extensive in the eastern and northern parts of Winneshiek County than in other areas, but they occur in every township.

Typically, Gray-Brown Podzolic soils have a very dark gray to dark grayish-brown A1 horizon 2 to 4 inches thick; a grayish-brown or brown A2 horizon 4 to 10 inches thick; a yellowish-brown or mottled gray and yellowish-brown B horizon 20 to 40 inches thick; and a yellowish-brown C horizon.

The A1 and A2 horizons most commonly have a texture of silt loam or loam, and the B horizon has a texture of silty clay loam or of loam to clay loam. The A1 horizon generally has weak granular structure, and the A2 horizon has thin platy structure. In many places the aggregates in the B horizon have angular blocky structure. The C horizon does not have well-developed structure. The boundaries of horizons in this great soil group are more distinct than those of the Brunizems.

Gray-Brown Podzolic soils are generally more sloping and lower in content of organic matter than Brunizems, and they are likely to be more severely affected by erosion. As in the Brunizem great soil group, a few Gray-Brown Podzolic soils are sandy and are shallow over limestone or gravel. Examples of soils in the Gray-Brown Podzolic great soil group in Winneshiek County are those of the Fayette, Dubuque, Palsgrove, Coggon, Renova, Bertrand, Camden, Lamont, and Whalan series.

Many soils in Winneshiek County exhibit properties intermediate between those of Brunizems and Gray-Brown Podzolic soils. These soils are called transitional and are said to be intergrading from one group to another. Examples of such transitional soils are those of the Downs, Racine, Bassett, Orwood, Nasset, Waucoma, Winneshiek, and Oran series.

The encroachment of deciduous trees on the prairie is thought to be related to changes in climate (*5*). In general, soils formed in areas where deciduous trees have encroached on the prairie have a thicker, darker A1 horizon and a less distinct A2 horizon than typical Gray-Brown Podzolic soils and are transitional to the Brunizem great soil group. Laboratory data indicate that genetically the transitional soils are more closely related to Gray-Brown Podzolic soils than to Brunizems (*16*).

Humic Gley soils

Humic Gley soils, formerly called Wiesenboden, formed under wet prairie or sedge vegetation in poorly drained sites, and they are associated with Brunizems. They are most extensive in the southwestern third of the county but are along streams throughout the county.

A typical soil of the Humic Gley great soil group has a black or very dark gray A horizon 16 to 24 inches thick; an olive-gray B horizon 10 to 20 inches thick; and a mottled olive-gray C horizon. The texture varies, but it is loam, silt loam, silty clay loam, or clay loam, both in the A and B horizons. The maximum content of clay may be in the A horizon. The structure is typically granular in the A horizon and weakly expressed blocky or prismatic in the B horizon.

Humic Gley soils developed in areas in which the water table is high as a result of poor natural drainage. While they were developing, the excess water restricted the oxygen in the soil pores, which brought about reduction, segregation, and removal of the iron compounds and produced an olive-gray subsoil. If an effective drainage system has been installed, these are among the most productive soils in the county. Examples of typical Humic Gley soils in Winneshiek County are those of the Clyde, Ossian, Calamine, and Otter series. The Colo soils are also in the Humic Gley great soil group, but they have some characteristics of Alluvial soils.

Alluvial soils

Alluvial soils are on bottoms and low terraces along streams throughout the county. The largest areas are along the Upper Iowa and Turkey Rivers. These soils formed in water-laid sediments deposited with each flood. Depth to the water table and the frequency of flooding are variable.

Alluvial soils generally do not have distinct horizons. Although some distinct layers are present, they are caused by variations in the kinds of sediments rather than by development of soil horizons. In many places these soils contain layers of sand and silt, and they may also contain light-colored and dark-colored layers. This layering is referred to as stratification. Because of the wide variation in the sediments, Alluvial soils vary widely in properties.

Alluvial soils range from high to low in productivity. Wetness and siltation caused by flooding are common limitations. In places soils that vary widely in productivity occur together in an intricate pattern. This is typical of the soils in the Alluvial great soil group. Examples of soils in the Alluvial great soil group are those of the Caneek, Dorchester, and Arenzville series.

Regosols

In Winneshiek County the soils classified as Regosols are generally steep and occur in areas underlain by loess. Typically, these soils lack a B horizon. Thus, they have an A–C profile consisting of a thin, dark grayish-brown A horizon and a yellowish-brown C horizon. Generally, all layers of these soils are calcareous. In Winneshiek County the texture of these soils is silt loam throughout the profile.

In these soils geologic erosion nearly keeps pace with development of a soil profile. The steep slopes limit productivity, and the soils are more suitable for permanent pasture than for field crops. In Winneshiek County the only soils classified as Regosols are the Dow. In this county those soils have some characteristics of Gray-Brown Podzolic soils, however, and are considered to be intergrading toward that great soil group.

Bog soils

Bog soils consist of areas of peat and muck. They occur in depressions where drainage is very poor or in areas that are kept continually wet because water from seepage is received. Organic material has accumulated in these areas because the limited supply of oxygen retards its decay. In Bog, or organic, soils more than 30 percent of the surface layer is organic matter, and that layer is more than 12 inches thick.

Peat is composed of brown, partly decomposed plant residue in which part of the plant remains can be recognized. Muck is black, consists of thoroughly decomposed plant residue, and contains a larger proportion of mineral matter than peat. Peaty muck is an example of Bog soils in Winneshiek County.

One problem in farming organic soils is providing adequate drainage without overdraining the soils. Another is providing adequate phosphorus and potassium.

Technical Descriptions of the Soil Series

This section is provided for those who need more detailed information about the soils in Winneshiek County. A narrative profile description of one soil type is followed by both a detailed description of a representative soil profile and the range of significant characteristics. The descriptions represent the modal concept of the series in Winneshiek County. Unless otherwise indicated, the Munsell color notations are for moist soils.

Arenzville Series

The Arenzville series consists of well drained or moderately well drained soils formed in stratified, noncalcareous alluvium that has a texture of silt loam. These soils are nearly level to undulating and are on first bottoms and in drainageways in the uplands. Vegetation has had no influence on the development of their profile. The profile of the Arenzille soils consists of 20 inches or more of light-colored, stratified silt loam over a dark-colored, medium-textured buried soil.

The Arenzville soils, unlike the Dorchester, are noncalcareous, and they are more brownish and are less mottled than the Caneek soils. The Arenzville soils lack the thick, dark surface layer that is typical of the Lawson soils, and unlike those soils, they are stratified to a depth of 30 inches. They are more stratified than the Chaseburg soils, and they lack the B horizon that is typical in the profile of the Chaseburg soils.

Representative profile of Arenzville silt loam in a permanent pasture, 660 feet north and 320 feet west of the SE. corner of the NE¼ sec. 1, T. 99 N., R. 9 W.:

C—0 to 30 inches, stratified dark grayish-brown (10YR 4/2), very dark gray (10YR 3/1), brown (10YR 5/3), and some black (10YR 2/1) silt loam; weak, thin, platy structure breaking to weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

IIAB—30 to 46 inches, black (10YR 2/1) silt loam; weak, very fine, subangular blocky structure; neutral.

The Arenzville soils are distinctly stratified, but the texture centers on silt loam of which less than 20 percent is generally fine sand. The predominant colors have a value of 4 or higher and a chroma of 2 or higher. In places thin layers of dark-colored material are on the horizontal cleavage surfaces of the peds. In some areas that are less subject to occasional flooding, the color of the plow layer is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). A few yellowish-brown, strong-brown, or dark-brown mottles occur in places. In most places the reaction of these soils is neutral.

Atkinson Series

In the Atkinson series are soils that are well drained. These soils formed in 30 to 50 inches of loamy glacial sediments, underlain by a thin layer of moderately fine textured or fine textured material over limestone bedrock. They are gently sloping to sloping and are on convex ridgetops and side slopes in the uplands. The native vegetation was prairie grasses.

The Atkinson soils have a moderately thick A1 horizon of dark-colored loam and B horizons of brown clay loam. The B horizons vary in thickness and are underlain by fragmented limestone. Clay films are evident in the B2 horizons. These soils do not have a C horizon.

The Atkinson soils have a thicker solum than the Rockton soils. They have a thinner solum than the Ostrander and Kenyon soils, and their solum is more variable in thickness. The Atkinson soils have a thicker solum and more brownish B horizons than the Jacwin soils, and they are underlain by limestone rather than by shale. They lack the A2 horizon that is typical in the profiles of the Waucoma and Whalan soils, and they have a darker and thicker A1 horizon than the Whalan soils.

The A1 horizon of the Atkinson soils is thinner than that of the Calmar soils. In contrast to the Kato and Waukegan soils, which are underlain by loamy sand and sand, the Atkinson soils are underlain by limestone. The Atkinson soils lack the A2 horizon that is typical in the profile of the Winneshiek and Whalan soils, and they have a thicker solum than those soils.

The Atkinson soils are the Brunizemic members of the biosequence that includes the Waucoma soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward the Brunizem great soil group.

Representative profile of Atkinson loam in a cultivated field, 465 feet east and 45 feet south of the NW. corner of sec. 18, T. 96 N., R. 10 W.:

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

A1—7 to 10 inches, same as the Ap horizon; clear, smooth boundary.

A3—10 to 13 inches, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) loam; very weak, fine, prismatic structure breaking to weak, fine, granular structure; friable; common fine pores; medium acid; clear, smooth boundary.

B1—13 to 16 inches, very dark grayish-brown (10YR 3/2) and some brown or dark-brown (10YR 4/3) loam; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; many fine and medium pores; in some places very dark brown (10YR 2/2) ped coats; medium acid; abrupt, smooth boundary.

IIB21t—16 to 23 inches, brown or dark-brown (10YR 4/3) and some dark yellowish-brown (10YR 4/4) clay loam; has a pebble band that contains some cobbles about 6 inches in diameter; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; medium acid; abrupt, smooth boundary.

IIB22t—23 to 31 inches, brown to dark-brown (10YR 4/3) clay loam; some dark yellowish-brown (10YR 4/4) ped interiors; contains some pebbles; weak, fine and medium, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; common fine pores; medium acid; clear, smooth boundary.

IIB23t—31 to 36 inches, clay loam with some pebbles; brown or dark-brown (10YR 4/3) and some yellowish-brown (10YR 5/4) ped exteriors and dark yellowish-brown (10YR 4/4) ped interiors; weak, fine and medium, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable; thin, discontinuous, brown to dark-brown (10YR 4/3) clay films; many fine pores; medium acid; abrupt, smooth boundary.

IIIB24t—36 to 40 inches, dark-brown (7.5YR 3/2) and yellowish-brown (10YR 5/4) clay; moderate, very fine, subangular blocky structure; firm; moderately thick, continuous, brown (7.5YR 4/2) and dark yellowish-brown (10YR 4/4) clay films; neutral; abrupt, wavy boundary.

IIIR—40 inches, limestone bedrock that is fragmented to some extent; calcareous.

The color of the A1 horizon ranges from black (10YR 2/1) or very dark gray (10YR 3/1) to very dark brown (10YR 2/2), and the thickness of that horizon ranges from 7 to 15 inches. In places colors that have a value of 3 and chromas of 3 or less extend to a depth of 20 inches.

The texture of the B2 horizons centers on clay loam. Clay films are evident in the B2 horizons, and an indistinct or distinct pebble band occurs in many places. Color values of 3 to 5 and chromas of 3 to 6 are common in the B horizons. In most areas of these soils, a layer of clay, 1 to 8 inches thick, lies immediately above the limestone bedrock. This layer is a paleo B horizon or consists of material weathered from limestone or shale. In the fine-textured material, the hues range from 10YR to 7.5YR. In the most acid part of the solum, this soil is medium acid. The upper part of the limestone bedrock is fragmented or fractured in most places.

Atterberry Series

The Atterberry series consists of somewhat poorly drained soils that formed in thick deposits of loess. These soils are on nearly level, moderately wide divides in the uplands and in gently sloping areas formed by drainageways. The native vegetation was trees and prairie grasses.

The soils of the Atterberry series have a thin to moderately thick A1 horizon of dark-colored silt loam and a thin, indistinct A2 horizon that also has a texture of silt loam. Their B horizons are moderately well defined and consist of mottled silty clay loam. Clay films and coats of gray, grainy silt are evident in the B2 horizons.

The Atterberry soils have less variable B/C clay ratios than the Canoe soils. Also, they have stronger horizonation, more clayey B horizons, and a solum that is less variable in thickness and in content of sand. Unlike the Downs soils, the Atterberry soils have mottled B horizons in which the colors are of two chromas. The solum of the Atterberry soils formed in loess instead of in loess and glacial sediments like that of the gray subsoil variant of the Franklin series, and their solum is less variable in thickness than that of the Franklin variant.

The Atterberry soils are the somewhat poorly drained analogs of the Downs soils.

Representative profile of Atterberry silt loam in a cultivated field, 325 feet east and 250 feet north of the SW. corner of sec. 34, T. 97 N., R. 8 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam; same color kneaded; a few peds dark grayish brown (10YR 4/2) when moist and gray (10YR 5/1) when dry; moderate, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—8 to 14 inches, dark grayish-brown (10YR 4/2) silt loam; light brownish gray (10YR 6/2) when dry; few very dark grayish-brown coats on the horizontal surfaces of peds; weak, medium, platy structure; very friable; medium acid; clear, smooth boundary.

B1—14 to 18 inches, light silty clay loam; ped exteriors dark grayish brown (2.5Y 4/2), except that 20 percent is olive brown (2.5Y 4/4); ped interiors olive brown (2.5Y 4/4); weak, fine, subangular blocky structure; thin, continuous, gray (10YR 5/1) silt coats on the surfaces of peds; few, fine, soft, dark-brown oxides; strongly acid; clear, smooth boundary.

B21t—18 to 28 inches, light to medium silty clay loam; grayish-brown (2.5Y 5/2) ped exteriors and grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) ped interiors; common, fine, distinct, yellowish-brown (10YR 5/6 to 5/8) mottles; moderate, fine, subangular blocky and angular blocky structure; slightly firm; thin, discontinuous clay coats; few gray (5Y 5/1) silt coats on the vertical surfaces of peds; few, medium, soft, dark-brown oxides; medium acid; gradual, smooth boundary.

B22t—28 to 35 inches, mottled grayish-brown (2.5Y 5/2) and olive-brown (2.5Y 5/4) light silty clay loam; common, medium, yellowish-brown (10YR 5/4 to 5/6) mottles; moderate, medium, prismatic structure breaking to moderate, fine, angular blocky structure; friable to slightly firm; thin, dark grayish-brown, discontinuous clay coats; some clay in pores; few discontinuous silt coats; common, medium, soft, dark-brown oxides; medium acid; smooth, diffuse boundary.

B31t—35 to 48 inches, silt loam the same color as B22t horizon; weak, medium, prismatic structure breaking to weak, medium, angular blocky structure; friable; thin, dark grayish-brown (10YR 4/2), discontinuous clay coats; few very dark gray clay flows in pores; common, fine, soft, dark-brown oxides; slightly acid; gradual, smooth boundary.

B32t—48 to 54 inches, grayish-brown (2.5Y 5/2) silt loam; common, fine, distinct, yellowish-brown (10YR 5/4) and light olive-brown (2.5Y 5/4) mottles; some vertical cleavage; friable; few very dark gray clay flows in pores; few, fine, soft, dark-brown oxides; slightly acid; smooth, diffuse boundary.

C—54 to 68 inches, olive-gray (5Y 5/2), massive silt loam but has a zone of yellowish red (5YR 5/8) at a depth of 60 to 62 inches; an accumulation of very dark gray clay at a depth of 66 to 68 inches; slightly acid to neutral; few, fine, hard nodules of calcium carbonate at a depth of 78 inches.

The A1 horizon ranges from 4 to 8 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1) in color. The A2 horizon is indistinct. It ranges from very dark gray (10YR 3/1) to dark gray (10YR 4/1) in color and from 2 to 6 inches in thickness. In many places the A2 horizon is mottled and contains concretions of an oxide.

In the part of the B horizon that contains the most clay, the texture is medium silty clay loam. The B horizons have hues that grade from 2.5Y to 5Y with increasing depth. The colors have values of 4 and 5 and a chroma of 2. In places some dark-colored coats are on the peds in the uppermost B horizon. Thin, discontinuous clay films and coats of gray, grainy material are in the B horizons. Also in the B horizons are common mottles that range from light olive brown or yellowish brown to olive gray in color and increase in number with increasing depth. Olive-gray (5Y 5/2) colors in the B3 and C horizons may be relict and related to the deoxidized zone that typically occurs in some loessal soils. In general, these soils range from medium acid to slightly acid in reaction, but strongly acid horizons are not excluded.

Backbone Series

Soils that are well drained to excessively drained are in the Backbone series. These soils developed in 20 to 40 inches of moderately coarse textured, wind-deposited material and in a thin layer of fine or moderately fine textured material that is underlain by limestone bedrock. They are gently sloping to sloping and are on convex highs, ridgetops, and side slopes in the uplands. The native vegetation was trees and prairie grasses.

The Backbone soils have a moderately thick, moderately dark colored or dark colored A1 horizon of loamy sand to sandy loam; an indistinct A2 horizon in areas that have not been cultivated; and B horizons that vary in thickness and that formed mainly in material that has a texture of sandy loam. The lower B horizon, just above the limestone bedrock, consists of a thin layer of clay loam to clay.

The Backbone soils have a thinner, more variable solum than the Chelsea and Lamont soils, and unlike those soils, they are underlain by a uniform layer of bedrock. Also, their surface layer is darker colored than that of the Chelsea soils, and the texture of their upper B horizons is generally sandy loam instead of loamy sand. The Backbone soils are underlain by limestone bedrock instead of by glacial till like that underlying the till subsoil variants of the Lamont soils. Unlike the Dickinson soils, they commonly have an A2 horizon. Also, their B horizons are more variable in thickness than those of the Dickinson soils, and they are underlain by limestone bedrock instead of by sandy material. In contrast to the Nasset, Orwood, Waucoma, and Frankville soils, the Backbone soils have a texture of sandy loam in most parts of the solum.

Representative profile of Backbone loamy sand in a cultivated field, 240 feet south of a drainageway that drains to a fence on the west side of a road in the NW¼SW¼SE¼ sec. 18, T. 97 N., R. 9 W., then 70 feet west of the fence:

Ap—0 to 8 inches, very dark gray (10YR 3/1) loamy sand to sandy loam; very friable; neutral; abrupt, smooth boundary.

B1—8 to 17 inches, dark-brown to brown (10YR 4/3), dark-brown (10YR 3/3), and dark grayish-brown (10YR 4/2) loamy sand to sandy loam; weak, fine, subangular blocky structure; very friable; common dark grayish-brown (10YR 4/2) coatings on the ped surfaces; a few streaks of very dark gray (10YR 3/1) soil material from the Ap horizon mixed with this horizon; neutral; clear, smooth boundary.

B21—17 to 24 inches, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) sandy loam; weak, fine prismatic structure breaking to very weak, fine and very fine, subangular blocky structure; very friable; neutral; clear, wavy boundary.

IIB22t—24 to 27 inches, dark-brown (10YR 3/3) and dark yellowish-brown (10YR 3/4) heavy clay loam and a minor amount of dark yellowish-brown (10YR 4/4) heavy clay loam; moderate, fine, subangular blocky structure; firm or very firm; common, thin, discontinuous clay films; neutral; abrupt, wavy boundary.

IIIR—27 inches, limestone bedrock.

Horizonation ranges from weak in the loamy sand to sandy loam to moderate to strong in the material below. The A1 horizon ranges from very dark gray (10YR 3/1) to very dark brown (10YR 2/2) in color, from loamy sand to sandy loam in texture, and from 4 to 8 inches in thickness. In cultivated areas the color of the Ap horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). Where the profile contains an A2 horizon, that horizon is dominantly dark grayish brown (10YR 4/2) and is 2 to 4 inches thick. In many places, however, the A2 horizon is mixed with the plow layer.

The B horizons, which developed in material that has a texture of sandy loam, generally have a color value of 4 and chromas of 3 and 4, but the value is 3 in a few places. In many places the IIB22t horizon has more reddish hues than the horizons above it but has similar chromas and values. In places the IIB22t horizon consists of material weathered from limestone, or it may be a paleo B horizon formed in other material. Clay films are absent, except in the IIB22t horizon. The soil reaction is variable and ranges from neutral to strongly acid.

Bassett Series

In the Bassett series are moderately well drained soils that are gently sloping and sloping. These soils formed in 14 to 24 inches of loam or in 12 to 18 inches of silt loam over clay loam to loam glacial till. They are on convex upland highs, ridgetops, and side slopes. The native vegetation was trees and prairie grasses.

The Bassett soils have a moderately thick, dark-colored A1 horizon of loam or silt loam; a thin, fairly distinct A2 horizon, also of loam or silt loam; and moderately fine textured B horizons that are moderately to strongly defined and that contain a distinct band of pebbles and some mottles. Clay films occur in places in the B horizons. Also, the colors in the interior of the peds in the lower B horizons contrast slightly with the colors of the exteriors. The consistence of the material beneath the lithologic discontinuity is friable to slightly firm. The solum contains some cobbles and pebbles.

The Bassett soils have a thinner A1 horizon than the Kenyon soils. Unlike the Kenyon soils, they have either an A2 horizon or an abrupt boundary between the A and B1 horizons. They have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the Coggon soils. In the lower B horizons, the Bassett soils have more mottling and have more contrasting colors between the interior and exterior of the peds than the Racine soils. The Bassett soils, unlike the Oran, lack mottling in the upper B horizons, and they have chromas of 3 and 4 instead of 2 in those horizons.

The Bassett soils are underlain by glacial till rather than by limestone bedrock or material weathered from limestone bedrock like that underlying the Waucoma soils. Also, their B horizons are less variable in thickness than the B horizons of the Waucoma soils. The B horizons of the Bassett soils have a texture of loam to clay loam, and they formed in glacial till instead of in two contrasting materials like the B horizons of the Donnan soils. The lower B horizons of the Bassett soils are coarser textured and are less grayish and less firm than those in the profile of the Donnan soils.

The Bassett soils are the intermediate members of the biosequence that includes the Kenyon (Brunizemic) soils and Coggon (Gray-Brown Podzolic) soils.

Representative profile of Bassett loam in a cultivated field, 20 feet west of a highway right-of-way and 75 feet south of the north edge of the NW¼SW¼SE¼ sec. 18, T. 96 N., R. 9 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam; weak fine, granular structure; friable; neutral; abrupt smooth boundary.

A2—7 to 13 inches, brown or dark-brown (10YR 4/3) loam and some loam that is very dark gray (10YR 3/1) or dark grayish brown (10YR 4/2); weak, thin, platy structure breaking to weak, very fine, granular structure; friable; common fine pores; neutral; clear, smooth boundary.

B1—13 to 18 inches, brown or dark-brown (10YR 4/3) loam; kneads to yellowish brown (10YR 5/4); common, fine, faint, yellowish-brown (10YR 5/8) mottles; very weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; very dark gray (10YR 3/1) coatings on some prism surfaces; common fine concretions of an oxide; pebble band in lower part of this horizon; strongly acid; clear, smooth boundary.

IIB21t—18 to 28 inches, sandy clay loam that contains some stones and pebbles; ped exteriors dark yellowish brown (10YR 4/4) and brown or dark brown (10YR 4/3); ped interiors yellowish brown (10YR 5/8) to strong brown (7.5YR 5/6); kneads to yellowish brown (10YR 5/4); weak, fine, prismatic structure breaking to weak, fine, subangular blocky structure; friable; below a depth of 24 inches, prism surfaces are grayish brown (2.5Y 5/2) and dark yellowish brown (10YR 4/4); thin, discontinuous clay films; many concretions of an oxide; common fine pores; strongly acid; clear, smooth boundary.

IIB22t—28 to 44 inches, sandy clay loam that contains some stones and pebbles; ped exteriors grayish brown (2.5Y 5/2) and dark yellowish brown (10YR 4/4); ped interiors grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8); few, fine, gray (5Y 5/1) mottles; moderate, fine and medium, prismatic structure breaking to weak and very weak, fine and medium, subangular blocky structure; friable to firm; many concretions of an oxide; common black (10YR 2/1) clay films in root channels and in pores; common fine pores; strongly acid; clear, smooth boundary.

IIB3—44 to 50 inches, yellowish-brown (10YR 5/8) and olive-gray (5Y 5/2) sandy clay loam that contains some stones and pebbles; moderate, medium, prismatic structure; friable to firm; thin, discontinuous, light olive-gray (5Y 6/2) coats on prism surfaces; noncalcareous to a depth of 6½ feet.

The horizonation of the Bassett soils ranges from moderate to strong. The A1 horizon ranges from 4 to 8 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1) in color. In areas that have been cultivated, the plow layer is very dark grayish brown (10YR 3/2) in places. The A2 horizon has values of 3 and 4 and chromas of 2 and 3. A pebble band is between a depth of 14 and 24 inches in many places.

The B horizons developed mostly in glacial till, but partly in loamy sediments. In the B horizons that contain the maximum amount of clay, the texture is generally loam to clay loam, but a texture of sandy clay loam is common. Clay films and grainy coats are evident in the B horizons, and the B1 horizon contains some yellowish-brown mottles. In some places the surfaces of the prisms in the lower part of the solum have grayer hues, higher values, and lower chromas than the interiors. The glacial till is friable or firm. The most acid part of the solum is strongly acid or very strongly acid.

Representative profile of Bassett silt loam in a cultivated field, 560 feet east and 35 feet north of the SW. corner of sec. 29, T. 99 N., R. 10 W.:

Ap—0 to 6 inches, very dark gray (10YR 3/1) silt loam; granular structure; friable; abundant worm casts; slightly acid; abrupt, smooth boundary.

A21—6 to 9 inches, dark grayish-brown (10YR 4/2) and some brown to dark-brown (10YR 4/3) silt loam; very weak, thin, platy structure; very friable; very strongly acid; clear, smooth boundary.

A22—9 to 17 inches, brown to dark-brown (10YR 4/3) silt loam; very weak, very fine, subangular blocky structure; some horizontal cleavage; friable; numerous pinhole pores; very strongly acid; abrupt, smooth boundary.

IIB1—17 to 24 inches, brown (10YR 5/3) and some strong-brown (7.5YR 5/8) loam; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; numerous pinhole pores; a thin pebble band occurs in the lower 2 inches of this horizon; very strongly acid; clear, smooth boundary.

IIB21t—24 to 31 inches, brown (10YR 5/3) and strong-brown (7.5YR 5/8) light clay loam; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; numerous pinhole pores; very strongly acid; clear, smooth boundary.

IIB22t—31 to 38 inches, loam; ped exteriors pale olive (5Y 6/3), and ped interiors strong brown (7.5YR 5/6); moderate, fine, prismatic structure breaking to weak, fine, subangular blocky structure; friable; ped surfaces coated with white silt or very fine sand; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

IIB23t—38 to 43 inches, strong-brown (7.5YR 5/6) and pale-brown (10YR 6/3) light clay loam; moderate, medium, prismatic structure; the surfaces of prisms coated with clean, white sand; breaks to moderate, fine, subangular blocky structure with some coatings of white sand on the peds; friable; few, thin, discontinuous clay films; common iron-manganese concretions of an oxide; slightly acid.

Bassett silt loams have characteristics similar to those of Bassett loams. The profile above the glacial till material, however, is silt loam that has a content of fine sand amounting to 7 to 20 percent and is generally less than 20 inches thick. Cobbles and stones are absent in this material.

Bertrand Series

In the Bertrand series are well-drained soils that formed in medium-textured, silty alluvium. These soils are nearly level or gently sloping and are on low benches along the major rivers and their tributaries. The native vegetation was trees and prairie grasses.

The Bertrand soils have a thin, moderately dark colored A1 horizon of silt loam; a distinct, light-colored A2 horizon, also of silt loam; and brown to yellowish-brown B horizons of silt loam to silty clay loam of variable thickness. In some places mottling occurs below a depth of 30 inches. Stratification is not uncommon below a depth of 36 inches.

The Bertrand soils have a thinner, less dark colored A1 horizon than the Festina soils. Their B1 horizon has browner hues and higher chromas than the B1 horizon of the Canoe soils, and it is also free of mottling. The B horizons of the Bertrand soils vary more in thickness than those of the Fayette soils, and they contain thin layers of coarse-textured material below a depth of 36 inches that are lacking in the Fayette soils. They have thinner A horizons and more strongly defined B horizons than the Chaseburg soils, and they also have a distinct A2 horizon. The Bertrand soils have a thinner, lighter colored A1 horizon and a less distinct A2 horizon than the Orwood soils, and they lack the content of fine sand that is typical in the profile of the Orwood soils.

The Bertrand soils are the Gray-Brown Podzolic members of the biosequence that includes the Festina soils, which are also in the Gray-Brown Podzolic great soil group but are intergrading toward the Brunizem great soil group.

Representative profile of Bertrand silt loam in a cultivated field, 670 feet west and 40 feet north of the north side of a bridge on E–W road in the NE¼SE¼ sec. 2, T. 96 N., R. 7 W.:

Ap—0 to 8 inches, dark-gray (10YR 4/1) and some dark grayish-brown (10YR 4/2) silt loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—8 to 14 inches, dark grayish-brown (10YR 4/2) and brown (10YR 5/3) silt loam; weak, thin, platy structure; friable; slightly acid; clear, smooth boundary.

B1—14 to 20 inches, silt loam; ped exteriors brown or dark brown (10YR 4/3); ped interiors brown or dark brown (10YR 4/3) and yellowish brown (10YR 5/4); weak, very fine, subangular blocky structure; friable; whitish very fine sand coats or silt coats on the surfaces of many peds; medium acid; clear, smooth boundary.

B21t—20 to 28 inches, heavy silt loam that has the same colors as the B1 horizon; weak, fine, prismatic structure breaking to moderate, very fine and fine, subangular blocky structure; friable; few, thin, discontinuous clay films; whitish very fine sand coats or silt coats on the surfaces of many peds; medium acid; clear, smooth boundary.

B22t—28 to 44 inches, heavy silt loam; ped exteriors brown or dark brown (10YR 4/3) and in some places dark yellowish brown (10YR 4/4); ped interiors yellowish brown (10YR 5/4 and 5/6); weak, medium, prismatic structure breaking to strong, fine and medium, subangular blocky structure; friable; thin, discontinuous clay films; whitish very fine sand coats or silt coats on the prism surfaces; strongly acid; abrupt, smooth boundary.

IIB23t—44 to 48 inches, loam; ped exteriors dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4); ped interiors yellowish brown (10YR 5/4 and 5/6); weak, medium, prismatic structure breaking to moderate, fine and medium, subangular blocky structure; friable; thin, discontinuous clay films; whitish very fine sand coats or silt coats on the prism surfaces; strongly acid; clear, smooth boundary.

IIB3—48 to 52 inches, dark yellowish-brown (10YR 4/4) gravelly clay loam; massive and has some vertical cleavage; friable; strongly acid.

The horizonation of the Bertrand soils ranges from moderate to strong. The A1 horizon ranges from 2 to 5 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. In plowed areas the Ap horizon in many places is dark gray (10YR 4/1) or very dark grayish brown (10YR 4/2). The A2 horizon ranges from 4 to 8 inches in thickness. The colors in that horizon have values of 4 or higher and chromas of 2 or higher.

In the part of the profile that contains the maximum amount of clay, the texture is silt loam to silty clay loam. Fine mottling is below a depth of 30 inches. Silt coats and clay films are evident in the B horizons. In many places the lower B horizon is stratified and contains thin layers of loam, silt, or fine sandy loam. The soil reaction ranges from medium acid to strongly acid in the most acid part of the solum.

Bixby Series

In the Bixby series are well-drained to excessively drained soils that formed in 24 to 36 inches of loamy material over leached sand and gravel. These soils are on the convex high parts of poorly defined ridgetops and on side slopes in the uplands. They are also in nearly level areas on benches and on sloping escarpments of benches. The native vegetation was trees.

The Bixby soils have a thin, moderately dark colored A1 horizon, a distinct or somewhat distinct A2 horizon, and moderately fine textured B horizons that are yellowish brown and free of mottles. The loamy overburden is friable and is free of stones and pebbles. Some clay films are evident in the B horizons.

The Bixby soils are similar to the Camden, except that they have thinner B horizons and leached, coarse-textured material nearer the surface, or at a depth of 24 to 36 inches. Also, the upper part of their solum has a somewhat higher content of sand than the comparable part of the solum in the Camden soils. The Bixby soils have a thinner, lighter colored A1 horizon and generally have a more distinct A2 horizon than the moderately deep Sattre soils. Unlike the Renova soils, they are free of cobbles and pebbles. Also, their B horizons vary in thickness and are underlain by coarse-textured material rather than by glacial till.

Bixby soils form a biosequence with the moderately deep Waukegan soils, which are Brunizems, and with the moderately deep Sattre soils, which are Gray-Brown Podzolic soils but are intergrading toward Brunizems.

Representative profile of Bixby loam in a cultivated field, 200 feet north and 75 feet west of the SE. corner of sec. 2, T. 97 N., R. 10 W.:

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

A2—7 to 12 inches, brown or dark-brown (10YR 4/3) and some very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2) sandy clay loam; very weak, thin, platy and very weak, very fine, subangular blocky structure; very friable; medium acid; clear, smooth boundary.

B21t—12 to 24 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; weak, very fine, subangular blocky structure; friable; few, thin, discontinuous, brown (10YR 4/3) and dark-brown (7.5YR 4/4) clay films; common fine pores; medium acid; clear, smooth boundary.

B22t—24 to 28 inches, yellowish-brown (10YR 5/6) sandy clay loam; very weak, very fine, subangular blocky structure; very friable; few, thin, discontinuous, brown to dark-brown (10YR 4/3) clay films; common fine pores; medium acid; clear, wavy boundary.

I & IIB3—28 to 32 inches, yellowish-brown (10YR 5/6) sandy loam; very weak, fine to medium, subangular blocky structure; very friable; medium acid; abrupt, wavy boundary.

IIC—32 to 44 inches +, yellowish-brown (10YR 5/4 and 5/6) gravelly sand; loose; medium acid.

The A1 horizon ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. In cultivated areas part of the A2 horizon is mixed with the surface layer and the Ap horizon is dark gray (10YR 4/1) to dark grayish brown (10YR 4/2). The A2 horizon is very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) to brown or dark brown (10YR 4/3) and ranges from 4 to 8 inches in thickness.

The texture of the B2 horizons ranges from loam to clay loam, but a texture of sandy clay loam is most common. The combined thickness of the B horizons ranges from 18 to 24 inches, and the thickness varies within short distances. The coarse-textured material is leached to a depth of 60 inches or more. In many places the profile is medium acid throughout.

Burkhardt Series

In the Burkhardt series are soils that are excessively drained. These soils formed in 15 to 24 inches of material that has a texture of sandy loam or light loam and is underlain by leached sand and gravel. They are on convex, high knolls, on ridgetops, and on side slopes in the uplands and are also on benches and on bench escarpments. The native vegetation was prairie grasses.

The Burkhardt soils have a moderately thick, dark-colored A1 horizon of sandy loam to loam, and they have brown, weakly defined B horizons that vary in thickness. The A and B horizons contain some gravel. The underlying material consists of medium and coarse gravelly sand.

The Burkhardt soils have a thicker A1 horizon than the moderately deep Sattre soils. Also, they lack an A2 horizon and their B horizon has a texture of sandy loam instead of loam. The Burkhardt soils have a thinner solum than the Dickinson soils, and they are underlain by sand and gravel rather than by fine and medium sands. They also have a thinner solum than the Bixby soils, and the texture of their B horizon is sandy loam rather than sandy clay loam. The Burkhardt soils have a thicker A1 horizon but a thinner solum than the Backbone soils, and they lack an A2 horizon. Also, they are underlain by sand and gravel rather than by residuum and limestone bedrock.

Representative profile of Burkhardt sandy loam in a cultivated field, SE. corner of NW¼SE¼ sec. 8, T. 98 N., R. 7 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) and some very dark grayish-brown (10YR 3/2) sandy loam; weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

B—7 to 17 inches, brown or dark-brown (10YR 4/3) sandy loam; very weak, very fine, subangular blocky structure; very friable; medium acid; abrupt, wavy boundary.

IIC—17 to 42 inches, yellowish-brown (10YR 5/4 to 5/8) gravelly sand; single grain; loose; strongly acid.

In the Burkhardt profile, the horizonation is very weak. In areas that are not eroded, the A1 horizon ranges from very dark gray (10YR 3/1) to very dark brown (10YR 2/2) in color and from 6 to 10 inches in thickness. The B horizon is only weakly defined and has color values and chromas of 3 and 4. The texture of the A and B horizons centers on sandy loam. More than 15 percent of the IIC horizon is gravel. The soil material is leached of carbonates to a depth of 48 inches or more. It ranges from medium acid to strongly acid in the most acid part of the solum.

Calamine Series

In the Calamine series are soils that are poorly drained. These soils formed in 15 to 30 inches of medium-textured and moderately fine textured material over neutral, fine-textured shale. They are nearly level or gently sloping and are on low to high structural benches and on foot slopes. The native vegetation was grasses and sedges tolerant of excessive wetness.

The Calamine soils have moderately thick, dark-colored A horizons that have a texture of silt loam grading to silty clay loam. The silty clay loam of the A horizons grades to grayish silty clay in the B. The B horizons developed predominantly in material weathered from shale. They are mottled and contain clay films.

The Calamine soils have B horizons that are finer textured and have lower chroma than those of the Jacwin soils. Also, the B horizons of the Calamine soils developed mainly in material derived from shale, and the Jacwin soils were derived from glacial material underlain by shale. The Calamine soils, unlike the Clyde, have fine-textured B horizons, and their B horizons were derived from shale rather than from loamy, stratified glacial material.

Representative profile of Calamine silty clay loam in a cultivated field, 245 feet north and 55 east of the SW. corner of the NW¼SE¼ sec. 7, T. 97 N., R. 9 W.:

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam to silt loam; weak to moderate, very fine, granular structure; friable; neutral; abrupt, smooth boundary.

A1—6 to 10 inches, black (N 2/0) silty clay loam; moderate, very fine and fine, granular structure; friable to firm; neutral; clear, smooth boundary.

A3—10 to 16 inches, black (10YR 2/1 and 5Y 2/1) silty clay loam; moderate, very fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

IIB21tg—16 to 23 inches, gray (5Y 5/1) and olive-gray (5Y 4/2) heavy silty clay loam to silty clay; very weak, fine, prismatic structure breaking to moderate, very fine, subangular blocky structure; firm; thin, continuous clay films; many fine pores; neutral; clear, smooth boundary.

IIB22tg—23 to 28 inches, dark-gray (5Y 4/1) and olive (5Y 5/3) silty clay; common, fine, prominent, yellowish-brown (10YR 5/6) mottles; weak, fine, prismatic structure breaking to moderate, very fine, subangular blocky structure; firm; thin, continuous clay films and some black (10YR 2/1) clay streaks; common fine pores; neutral; clear, smooth boundary.

IIB3g—28 to 31 inches, olive-gray (5Y 5/2), light olive-gray (5Y 6/2), and yellowish-brown (10YR 5/6) gritty silty clay loam; weak, very fine, subangular blocky structure; friable to firm; neutral; abrupt, wavy boundary.

IIR—31 to 48 inches, brownish-yellow (10YR 6/6) and greenish-gray (5GY 6/1) heavy silty clay loam shale; common, fine, distinct, yellowish-brown (10YR 5/8) and few, medium to coarse, strong-brown (7.5YR 5/8) mottles; massive, with some vertical cleavage; very firm; springy when pressed; common fine pores; partly neutral and partly calcareous.

The A1 horizon is black (N 2/0 to 10YR 2/1) and ranges from silty clay loam to silt loam in texture and from 4 to 12 inches in thickness. The color is black (10YR 2/1) or grades to very dark gray (10YR 3/1) in the A3 horizon. The B horizons have hues of 2.5Y to 5Y, values of 4 or higher, and generally chromas of 1 or 2. The texture of the B horizons centers on silty clay. In places in the B horizons, there are contrasting mottles of high chroma. The profile has thin layers of gritty material above the shale in some places. The shale bedrock is dominantly yellowish and greenish and has a texture of heavy silty clay loam to clay. These soils are neutral in reaction, but the shale is slightly calcareous in places.

Calmar Series

The Calmar series consists of soils that are well drained or moderately well drained. These soils formed in leached, moderately fine textured glacial sediments or in wind-deposited material over hard, fractured limestone. They are on uplands, topographically below areas of soils that are steeper and that consist of a thin covering of soil material over limestone bedrock. Depth to limestone ranges from about 24 to 40 inches. The native vegetation was grasses.

These soils have a thick, dark-colored A horizon of clay loam, and brownish B horizons that vary in thickness. The B horizons contain a few clay films. A thin layer of fine-textured material commonly lies above the limestone bedrock.

The Calmar soils have a thicker A horizon than the Atkinson, Rockton, Winneshiek, and Waucoma soils, and the upper part of their solum is finer textured than the comparable part of the solum in those soils. Also, they lack the A2 horizon that is typical in the profiles of the Winneshiek and Waucoma soils. The Calmar soils have a thinner, finer textured solum than the Terril soils and a thicker solum than the Marlean soils. They have a finer textured A horizon than the Kenyon soils. Also, their B horizons vary in thickness and are underlain by limestone bedrock.

Representative profile of Calmar clay loam in a permanent pasture, 500 feet east and 60 feet south of the NE. corner of the NW¼NE¼ sec. 2, T. 97 N., R. 9 W.:

A1—0 to 21 inches, very dark brown (10YR 2/2) clay loam; moderate, very fine, subangular blocky structure breaking to moderate, fine, granular structure; friable; abundant roots; slightly acid; clear, smooth boundary.

B1—21 to 26 inches, very dark grayish-brown (10YR 3/2) clay loam; moderate, very fine, subangular blocky and some moderate, fine, granular structure; friable; common, very thin, discontinuous clay films; slightly acid; clear, smooth boundary.

B2t—26 to 28 inches, dark-brown (10YR 4/3 to 3/3) clay loam; weak, fine, prismatic structure breaking to moderate, very fine, subangular blocky structure; friable to firm; common, thin, discontinuous clay films; slightly acid; abrupt, wavy boundary.

IIB3t—28 to 33 inches, dark yellowish-brown (10YR 4/4) and brown or dark-brown (10YR 4/3) clay; weak, fine, subangular blocky structure; friable to firm; weathered indurated rock; fragile fragments of rock are dominant; neutral. (This layer may be a paleo B horizon.)

IIIR—33 inches, limestone (shaly) bedrock.

The Calmar soils have moderate horizonation. Their A1 horizon commonly ranges from black (10YR 2/1) to very dark brown (10YR 2/2) in color, but in places the color grades to very dark gray (10YR 3/1) with increasing depth. The A1 horizon ranges from 15 to 24 inches in thickness. The texture of the A1 horizon ranges from light to heavy clay loam.

The B horizons have values of 3 and chromas of 2 to 3, but the values grade to 4 and 5 and the chromas grade to 3 and 4 with increasing depth. Colors that have a value of 3 occur to a depth between 20 and 30 inches. The hues center on 10YR to 7.5YR. The texture of the B1 and B2t horizons ranges from medium to heavy clay loam.

The thickness of the residuum, or IIB3t horizon, varies greatly within a short distance. That horizon is typically less than 6 inches thick, but it is as much as 12 inches thick in places. The texture of the IIB3t horizon shows a distinct increase in content of clay over that in the horizons above it. In many places the texture of that horizon is clay, but the texture ranges to silty clay. The limestone bedrock is hard and is typically level bedded. In places it contains numerous vertical and horizontal fractures. Thin, interbedded shale and limestone make up a minor part of the substratum. In general these soils range from slightly acid to medium acid in reaction.

Camden Series

In the Camden series are soils that are well drained. These soils formed in 36 to 42 inches of medium-textured and moderately fine textured alluvium over slightly leached, coarse-textured material. They are nearly level to sloping and are on stream benches and on the escarpments of benches. The native vegetation was trees.

The Camden soils have a thin, moderately dark colored A1 horizon of silt loam, a distinct A2 horizon that also has a texture of silt loam, and moderately fine textured B horizons developed in silty and loamy material. The alluvium is predominantly silty, but a layer of loamy material lies below the silty material and above the sand and gravel.

The Camden soils have a thicker solum than the Bixby soils, and they also have less sand in the upper part of their solum than the Bixby soils. The Camden soils have thinner, more variable B horizons than the Bertrand soils. Also, unlike the Bertrand and Fayette soils, they have leached sand and gravel below a depth of 36 to 42 inches. They contain more sand than the Fayette soils. The Camden soils have a lower content of sand than do the deep Sattre soils. Also, they have a lighter colored, thinner A1 horizon than those soils, and they have a more distinct A2 horizon in most places.

Camden soils form a biosequence with the deep Waukegan soils, which are Brunizems, and with the deep Sattre soils, which are Gray-Brown Podzolic soils intergrading toward Brunizems.

Representative profile of Camden silt loam in a meadow, 265 feet SW. along a road that leads from the western edge of Siewers Spring Fish Hatchery, then 40 feet southeast of the road right-of-way in the SW¼NW¼SW¼ sec. 27, T. 98 N., R. 8 W.:

Ap—0 to 8 inches, dark gray (10YR 4/1) and some very dark gray (10YR 3/1) silt loam (less than 10 percent sand); material has slightly higher chroma if kneaded; weak, thin, platy structure and fine granular structure; friable; neutral; clear, smooth boundary.

A2—8 to 12 inches, silt loam; ped exteriors very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2); ped interiors dark brown or brown (10YR 4/3); weak, thin, platy structure; friable; common very dark gray (10YR 3/1) worm casts; neutral; clear, smooth boundary.

B1—12 to 19 inches, silt loam; ped exteriors dark brown or brown (10YR 4/3); ped interiors yellowish brown (10YR 5/4); weak, fine, subangular blocky structure; friable; few fine concretions of black oxide; neutral; gradual, smooth boundary.

B21—19 to 25 inches, heavy silt loam (estimated 15 to 20 percent fine sand); ped exteriors dark brown or brown (10YR 4/3); ped interiors yellowish brown (10YR 5/4); moderate, medium, subangular blocky structure; friable; on the peds are discontinuous coats of grainy material that are gray (10YR 6/1) when dry; neutral; gradual, smooth boundary.

B22t—25 to 30 inches, yellowish-brown (10YR 5/4) light gritty silty clay loam; moderate, medium, subangular blocky structure; friable; thin, discontinuous clay films; on the peds are discontinuous coats of grainy material that is gray (10YR 6/1) when dry; medium acid; clear, smooth boundary.

B3t—30 to 39 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; weak, coarse, subangular blocky structure; friable; slight concentration of flat limestone fragments at the top of this horizon; contains some pebbles ¼ to 1 inch in diameter; some clay flows in pores; on the peds are discontinuous coats of grainy material that is gray (10YR 6/1) when dry; medium acid; clear, smooth boundary.

IIC—39 to 60 inches, yellowish-brown (10YR 5/4) loamy sand; few dark yellowish-brown (10YR 4/4) balls that stick together mixed within the horizon; single grain; very friable to loose; slight concentration of flat limestone fragments and pebbles ¼ to ⅜ inch in diameter at the top of horizon; between a depth of 49 and 50 inches, a dark yellowish-brown (10YR 3/4) iron band that shows a slight increase in clay; slightly acid.

The horizonation in the Camden profile ranges from moderate to strong. The A1 horizon ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. In areas that have been cultivated or that are eroded, the color of the surface layer ranges from dark gray (10YR 4/1) to dark grayish brown (10YR 4/2). The A2 horizon ranges from 4 to 8 inches in thickness and from dark grayish brown (10YR 4/2) to brown or dark brown (10YR 4/3) in color. The A2 horizon is absent in some eroded areas, and in many places it is mixed with the surface soil. The A horizons have a texture of silt loam.

The texture in the part of the B horizons that contains the most clay is light silty clay loam. The B horizons developed in silty and loamy, moderately fine textured material. Grainy coats and clay fills or clay films are evident in places in the B horizons. The coarse-textured underlying material consists of fine to medium sand and some gravel. In places fragments of limestone occur. The most acid part of the solum is medium acid, but in many places the coarse-textured underlying material is only slightly acid.

Caneek Series

Calcareous, somewhat poorly drained, light-colored soils that formed in stratified alluvial sediments, predominantly of silt loam, are in the Caneek series. These soils are on the parts of first bottoms where recent calcareous sediments have been deposited. The alluvium originated mainly from areas of soils of the Gray-Brown Podzolic great soil group that were derived from loess. The native vegetation was variable. Apparently, it had no influence on the development of the soils.

In these soils the sediments of recent, calcareous silt loam are typically about 1½ to 3 feet thick and are stratified. This material is light colored and is slightly mottled, especially around old root channels. In most places a buried, medium-textured or moderately fine textured soil is at a depth of 18 to 36 inches.

The Caneek soils resemble the Dorchester soils, but they have more grayish hues and have mottles in the stratified material. They are lighter colored than the Lawson, Kennebec, and Huntsville soils. Also, unlike those soils, they are stratified and are calcareous. The Caneek soils are calcareous and are more mottled than the Arenzville soils.

The Caneek soils form a hydrosequence with the Dorchester soils, which are moderately well drained.

Representative profile of Caneek silt loam in a permanent pasture, in the center of E½NE¼ sec. 15, T. 99 N., R. 8 W.:

C1—0 to 15 inches, dark grayish-brown (10YR 4/2) silt loam; common, fine, prominent, dark reddish-brown (2.5YR 3/4) mottles closely associated with old roots; weak, fine, granular structure; friable; calcareous; clear, smooth boundary.

C2—15 to 32 inches, mixed dark grayish-brown (10YR 4/2), dark-gray (5Y 4/1), and olive-gray (5Y 5/2) silt loam; common, fine, prominent, dark reddish-brown (2.5YR 3/4) and red (2.5YR 4/6) mottles closely associated with old roots; very weak, thin, platy and very weak, very fine, subangular blocky structure; friable; distinctly stratified; mildly alkaline, but contains some thin layers of calcareous material; abrupt, smooth boundary.

IIA1b—32 to 50 inches, black (10YR 2/1) silt loam; common, fine, prominent, red (2.5YR 4/6) mottles; weak, very fine, subangular blocky structure breaking to weak, fine, granular structure; friable; neutral.

In the upper horizons of relatively recent, calcareous, stratified sediments, the color of the matrix is commonly dark gray (10YR 4/1) and dark grayish brown (10YR 4/2). The range of colors includes hues of 5Y, however, with values of 4 and 5 and chromas of 1 and 2. Reddish mottles, mainly near old root channels, are common in these sediments. The texture is generally silt loam, but it ranges to light silty clay loam.

In many places a dark-colored buried soil that has a texture of silt loam to light silty clay loam is at a depth between 1½ and 3 feet. This underlying soil lacks reddish mottles in some places. In some areas above a depth of 4 feet, the profile contains very thin lenses of soil material that is coarser textured than silt loam. In much of the acreage, the soil material is calcareous to a depth of 18 to 36 inches and the buried soil is neutral to slightly acid.

Canoe Series

In the Canoe series are soils that are somewhat poorly drained. These soils formed in 40 inches or more of silty alluvium that is low in content of sand and that is underlain by leached sand. They are nearly level or gently sloping and are on benches that lie above the flood plains of rivers. The native vegetation was trees and prairie grasses.

The Canoe soils have a thin to moderately thick, dark-colored A1 horizon that has a texture of silt loam. They also have thin, indistinct A2 horizons and weakly defined, mottled B horizons of silt loam to silty clay loam that vary in thickness. Some clay fills are evident in root channels or pores.

The solum of the Canoe soils is less variable in thickness than that of the Hayfield soils, and unlike the Rowley soils, the Canoe soils have an A2 horizon. They have a darker, thicker A1 horizon than the Bertrand soils. Unlike the Bertrand soils, they have chromas of 1 and 2 in the upper B horizons.

The Canoe soils have weaker horizonation, less clay in the B horizons, and more variable B/C clay ratios than the Atterberry soils. Also, they have an A2 horizon that is more variable in thickness and have a more variable content of sand than the Atterberry soils, and they were derived from silty alluvium instead of loess.

The Canoe soils are the intermediate members of the biosequence that includes the Rowley soils, which are Brunizems. They are also the somewhat poorly drained analogs of the Festina soils, which are well drained.

Representative profile of Canoe silt loam, 580 feet west and 144 feet north of a fence line bordering a permanent pasture in the SW¼SE¼ sec. 24, T. 99 N., R. 8 W.:

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

A21—8 to 12 inches, mixed very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2) silt loam; weak, medium, platy structure; friable; few, fine, soft, dark reddish-brown (5YR 3/2) and dark-brown (7.5YR 3/2) oxides; medium acid; clear, smooth boundary.

A22—12 to 18 inches, dark grayish-brown (10YR 4/2) silt loam; same color if kneaded; few, fine, distinct mottles of yellowish brown (10YR 5/4); weak, medium, platy structure; friable; nearly continuous coats of grainy material that is light brownish gray (10YR 6/2) when dry; few, very fine, soft concretions of a dark reddish-brown (5YR 3/2) and dark-brown to brown (7.5YR 4/4) oxide; strongly acid; clear, wavy boundary.

A23—18 to 23 inches, grayish-brown (10YR 5/2) silt loam; brown (10YR 5/3) if kneaded; many, fine, faint mottles of yellowish brown (10YR 5/4); moderate, medium, platy structure; friable; on the peds are discontinuous silt coats that are light gray (10YR 7/2) when dry; few, fine, soft, dark-brown (7.5YR 3/2) oxides; strongly acid; gradual, smooth boundary.

B1—23 to 30 inches, silt loam; grayish-brown (10YR 5/2) ped exteriors; mottled grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/4) interiors; brown (10YR 5/3) if kneaded; moderate, medium, subangular blocky structure; friable; contains discontinuous silt coats and oxides like those in A23 horizon: strongly acid; gradual, smooth boundary.

B21—30 to 40 inches, silt loam; colors like those of B1 horizon; weak, fine, prismatic structure breaking to weak, medium, subangular blocky structure; friable to firm; on the prisms are nearly continuous silt coats that are gray (10YR 7/1) when dry; on the blocky peds are nearly continuous silt coats that are gray (10YR 7/2) when dry; contains oxides like those in A23 and B1 horizons; strongly acid; gradual, smooth boundary.

B22t—40 to 49 inches, mottled gray (5Y 5/1) and dark yellowish-brown (10YR 4/4) silty clay loam; grayish brown (2.5Y 5/2) if kneaded; weak, fine, prismatic structure; friable to firm; common, black, clay-filled old channels; contains oxides like those in A23, B1, and B21 horizons; medium acid; gradual, smooth boundary.

B3—49 to 60 inches, mottled gray (5Y 5/1) and olive-gray (5Y 5/2) silt loam; olive gray (5Y 5/2) if kneaded; few, fine, distinct mottles of olive brown (2.5Y 4/4) and light olive brown (2.5Y 5/6); weak, medium, prismatic structure; friable to firm, common, very fine, soft oxides of dark reddish brown (5YR 3/2) and dark brown to brown (7.5YR 4/4); slightly acid; gradual, smooth boundary.

C1—60 to 72 inches, light olive-gray (5Y 6/2) silt loam; few, medium, distinct mottles of light olive brown (2.5Y 5/6); massive; friable; contains oxides like those in B3 horizon; slightly acid; abrupt, smooth boundary.

C2—72 to 82 inches, gray (5Y 5/1) loam; massive: friable; contains oxides like those in B3 and C1 horizons; neutral; clear, smooth boundary.

C3—82 to 90 inches, olive-gray (5Y 5/2) sandy loam containing coarse fragments of chert; common, fine to medium, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) mottles; olive gray (5Y 5/2) if kneaded; massive; friable; neutral.

The A1 horizon generally has a texture of silt loam. It ranges from 10YR 3/1 to 10YR 3/2 in color and from 6 to 10 inches in thickness. In places, however, a layer of silt loam that has a color of 10YR 4/2 has been deposited. In most places the A2 horizon is distinct, has a color that is predominantly 10YR 4/2, and has platy structure. The combined thickness of the A2 horizons ranges from 8 to 18 inches, and depth to the B1 horizon ranges from 20 to 24 inches. The content of clay in the A horizons is commonly between 15 and 25 percent.

Grayish-brown silt coats are common in the B horizons. In many places the boundary between the A23 and B1 horizons is gradual and indistinct. The B2 horizons generally have a texture of heavy silt loam or silty clay loam. They include, however, thin layers that contain the maximum amount of clay or that have a content of clay as high as 30 percent. The part of the profile that contains the maximum amount of clay is at variable depths. In many places it is below a depth of 30 inches. In some places the depth does not correspond to that of the horizon of maximum structural development.

The colors in the B horizons are centered on 2.5Y 4/2 and 2.5Y 5/2, and the interiors of the peds in those horizons are mottled and have chromas of 3 and 4. In the lower B horizon, the content of clay decreases as the content of sand increases. Stratification of the coarse and fine silts is apparent in the uppermost 40 inches of the solum, and stratification of the sand occurs at a depth between 40 and 60 inches. The reaction of the upper B horizon is typically medium acid to strongly acid, but reaction is variable in the lower B horizons.

Chaseburg Series

In the Chaseburg series are well-drained soils that have a thick, light-colored surface layer and weak horizonation. These soils formed in alluvium that has a texture of silt loam. They are nearly level or gently sloping and are at the base of areas of uplands and in upland drainageways. The native vegetation was trees, but the vegetation had little influence on the development of the soil profile.

These soils have thickened, light-colored A horizons and very weakly defined B horizons of brown and yellowish-brown silt loam. Silt coats are evident on the peds in the B horizons.

The Chaseburg soils are not calcareous like the Dorchester soils, and they have recognizable B horizons. They are similar to the Arenzville soils but are less stratified, have B horizons, and do not have a dark-colored, buried A horizon below a depth of 20 inches. The Chaseburg soils have lighter colored A horizons than the Huntsville soils. They are not calcareous like the Caneek soils. Unlike those soils, they have B horizons and have chromas of 3 or higher at a depth of 30 inches or below. The Chaseburg soils have a thicker A1 horizon and less well defined B horizons than the Fayette soils.

Representative profile of Chaseburg silt loam in a cultivated field, 620 feet west of bridge on east-west road near the center of the NE¼SE¼ sec. 2 T., 97 N., R. 7 W.

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) and some dark gray (10YR 4/1) and very dark gray (10YR 3/1) silt loam; weak granular structure; very friable; neutral; abrupt, smooth boundary.

A2—7 to 34 inches, dark grayish-brown (10YR 4/2) and some very dark gray (10YR 3/1), very dark grayish-brown (10YR 3/2), and brown (10YR 5/3) silt loam; weak, thin, platy structure breaking to very weak, very fine, subangular blocky structure; friable; light grayish-brown (10YR 6/2) silt coats oriented on plates; neutral; clear, smooth boundary.

B1t—34 to 40 inches, brown or dark-brown (10YR 4/3) heavy silt loam; very weak, very fine, subangular blocky structure; friable; thin, discontinuous, light-gray silt coats on peds; neutral; clear, smooth boundary.

B2t—40 to 48 inches, yellowish-brown (10YR 5/4) heavy silt loam; weak, very fine, subangular blocky structure; friable; thin, discontinuous, light-gray silt coats on peds; neutral.

The combined thickness of the A horizons ranges from 20 to 36 inches, and those horizons are predominantly dark grayish brown (10YR 4/2). In some places part of the surface layer consists of recently deposited sediments. Platy structure is common in places in the A horizons. The A2 and B horizons contain silt coats. The texture of the B horizons centers on heavy silt loam. The B horizons have color values of 4 or higher and chromas of 3 or higher. In some places fine mottles occur below a depth of 40 inches. These soils range from slightly acid to neutral in reaction.

Chelsea Series

The Chelsea series consists of excessively drained soils that formed in fine and medium sands, primarily of eolian origin. These soils are gently sloping and are on upland highs or ridgetops, side slopes, and stream benches. The native vegetation was trees.

The Chelsea soils have a thin, moderately dark colored to light-colored A1 horizon of light loamy fine sand, and zones of brown or dark-brown loamy sand and sand that are considered B horizons. The C horizons contain very thin, horizontal iron bands.

The Chelsea soils have a lighter colored, thinner A1 horizon than the Hagener soils. They have a texture of loamy sand or sand instead of sandy loam like the Lamont soils. Also, unlike the Lamont soils, which have B2 horizons of loam to sandy loam, they have no textural B horizon. The Chelsea soils are coarser textured and have a lighter colored surface layer than the Dickinson soils. They have a lighter colored A1 horizon than the Backbone soils and the till subsoil variant of the Lamont series, and unlike those soils, they have a coarse texture to a depth of 42 inches or more.

Representative profile of Chelsea loamy fine sand, in a cultivated field reached by going from the point where the road crosses the western edge of the SW¼NE¼ sec. 13, T. 98 N., R. 8 W., along a fence 80 feet to the north, then 20 feet east toward road:

Ap—0 to 10 inches, dark grayish-brown (10YR 4/2) loamy fine sand with some brown or dark brown (10YR 4/3) and some very dark gray (10YR 3/1); very weak, very thin, platy structure; loose; slightly acid; abrupt, smooth boundary.

B1—10 to 11 inches, brown or dark-brown (10YR 4/3) loamy sand; single grain; loose; some mixing of darker colored peds by rodents; slightly acid; clear, smooth boundary.

B2—11 to 19 inches, brown or dark-brown (10YR 4/3) and some dark-brown (10YR 3/3) and dark grayish-brown (10YR 4/2) loamy sand; single grain; loose; dark-brown coloring is iron stains; some mixing of darker colored peds by rodents; medium acid; clear, smooth boundary.

B3—19 to 24 inches, brown or dark-brown (10YR 4/3) and yellowish-brown (10YR 5/4) sand; single grain; loose; slightly acid; clear, smooth boundary.

C1—24 to 37 inches, yellowish-brown (10YR 5/4) and some brown or dark-brown (10YR 4/3) sand; single grain; loose; very few pebble-size fragments of chert or limestone; slightly acid; clear, smooth boundary.

C2—37 to 48 inches, yellowish-brown (10YR 5/4) and light yellowish-brown (10YR 6/4) sand; single grain; one very thin, dark reddish-brown (5YR 3/3) iron band; loose; a few pebble-size fragments of chert or limestone; slightly acid; clear, smooth boundary.

C3—48 to 58 inches, light yellowish-brown (10YR 5/4) and some very pale brown (10YR 7/4) sand; single grain; loose; very few pebble-size fragments of chert or limestone; slightly acid.

The thickness and color of the A horizon vary. In some undisturbed sites, the A1 horizon is 2 to 4 inches thick and is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). In most places, however, these soils have a dark grayish-brown (10YR 4/2) surface layer. A zone that is browner than the surface layer lies below the A horizon. These soils have a texture of loamy sand to sand to a depth of 42 inches or more. In some places bedrock or medium-textured glacial till is below that depth. The sand size is predominantly fine.

The C horizons have color values of 5 or higher and chromas of 4 or higher. Very thin, dark-brown and dark reddish-brown, horizontal iron bands are below a depth of 30 inches, or in the C horizons. The texture of these bands ranges from loamy sand to sandy loam. These soils range from medium acid to slightly acid in reaction.

Clyde Series

The Clyde series consists of soils that are poorly drained or very poorly drained. These soils developed in moderately fine textured, reworked glacial material containing pockets and thin lenses of sand and silt. A pebble band separates this material from the underlying glacial till. The soils are in slightly concave, moderately broad drainageways in the uplands and are at the base of sloping areas of uplands that grade to broad drainageways. The native vegetation was grasses and sedges that are tolerant of excessive wetness.

The Clyde soils have a thick, dark-colored A1 horizon and gleyed B horizons that contain strata of silty and sandy material. They have glacial stones and boulders on the surface and in the solum. Loam to clay loam till is below a depth of 36 inches.

The Clyde soils have more gleyed B horizons than the Floyd soils, and their B horizons have a chroma of 1 and values of 4 or higher. The Clyde soils contain stones and boulders and have a higher content of sand than the Otter and Ossian soils, which formed in silty alluvium. They have a higher content of clay than the Ossian soils.

The Clyde soils form a hydrosequence with the Floyd soils, which are somewhat poorly drained.

Representative profile of Clyde silt loam in a permanent pasture, 215 feet north and 35 feet east of the SE. corner of the NE¼NW¼ sec. 5, T. 96 N., R. 10 W.:

A1—0 to 11 inches, black (N 2/0) and some very dark gray (10YR 3/1) gritty silt loam; weak, very fine, subangular blocky structure breaking to granular structure; friable; abundant roots; few dark reddish-brown organic iron stains; neutral; clear, smooth boundary.

A3—11 to 22 inches, black (10YR 2/1) grading to very dark gray (10YR 3/1 or 5Y 3/1) loam and some dark-gray (5Y 4/1) peds in lower part; very weak, medium and coarse, subangular blocky structure breaking to weak, very fine, subangular blocky structure; friable; some dark reddish-brown (5YR 3/4) iron stains; water table at a depth of 19 inches; neutral; clear, wavy boundary.

B1g—22 to 27 inches, mottled gray (5Y 6/1), strong-brown (7.5YR 5/8), and yellowish-red (5YR 4/8) silt loam; below free water table; structure not determined; friable; neutral; clear, smooth boundary.

B2g—27 to 33 inches, mottled gray (5Y 6/1), strong-brown (7.5YR 5/8), and yellowish-red (5YR 4/8) loam; neutral; clear, wavy boundary.

IIC1g—33 to 38 inches, gray (5Y 5/1) to olive-gray (5Y 5/2) and yellowish-brown (10YR 5/4) cobbly sandy loam; very friable; pebble band containing cobbles up to 8 inches in diameter; abrupt, smooth boundary.

IIC2g—38 to 56 inches, mottled gray (5Y 5/1 and 5/0) and strong-brown (7.5YR 5/8) clay loam containing some stones and pebbles; friable to firm; neutral; calcareous at a depth of 56 inches.

The texture of the surface horizon is dominantly silt loam, but the range of texture includes loam, silty clay loam, and clay loam. The A horizons are generally black (N 2/0 to 10YR 2/1), but their colors have a value of 3 and chroma of 1 to a depth of 24 inches in places.

The B horizons are moderately fine textured for the most part, but they contain thin layers of moderately coarse textured and coarse textured material in places. The B and C horizons are strongly gleyed and have a hue of 5Y, values of 4 and higher, and chromas of 1. Below the A horizon is strong-brown and yellowish-brown mottling.

The solum formed in pedisediment, local alluvium, or reworked glacial till, and a pebble band separates this material from the underlying glacial till in many places. Depth to the glacial till ranges from 30 to 60 inches. The solum is friable to firm. These soils range from neutral to slightly acid in reaction. In places calcareous material is below a depth of 42 inches.

Coggon Series

In the Coggon series are soils that are moderately well drained. These soils formed in 14 to 24 inches of material that has a texture of loam and is underlain by loam to clay loam glacial till. They are gently sloping to sloping and are on convex upland highs, ridgetops, and side slopes. The native vegetation was trees.

The Coggon soils have a thin, moderately dark colored loam A1 horizon; a distinct, light-colored loam A2 horizon; and B horizons developed in reworked material and glacial till. The upper B horizons contain a pebble band, and cobbles and pebbles are common in the solum. The underlying glacial till is friable to firm. In the lower B horizons, the ped interiors and ped exteriors have somewhat contrasting colors. Clay films are evident.

The Coggon soils have more contrasting interior and exterior colors in the lower B horizon than the Renova soils, and they also are slightly mottled and have gray colors below a depth of 30 inches. They have a thinner, less dark colored A1 horizon than the Bassett and Racine soils.

The solum of the Coggon soils developed in loam material and glacial till, unlike that of the Orwood soils, which developed in medium-textured, wind-deposited material. Also, the Coggon soils have a lighter colored, thinner A1 horizon and a more clearly defined A2 horizon than the Orwood soils. The Coggon soils formed in a layer of glacial material that is more than 42 inches thick. This is in contrast to the Whalan soils, which have B horizons of variable thickness that are underlain uniformly by limestone bedrock or by bedrock residuum and limestone.

The Coggon soils form a biosequence with the Bassett soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems, and with the Kenyon soils, which are Brunizems.

Representative profile of Coggon loam in a cultivated field, 575 feet west and 120 feet south of the NE. corner of the SW¼SE¼ sec. 14, T. 96 N., R. 9 W.:

Ap—0 to 6 inches, about 80 percent dark-gray (10YR 4/1) and 20 percent dark grayish-brown (10YR 4/2) loam; weak, very fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—6 to 10 inches, dark grayish-brown (10YR 4/2) and brown to dark-brown (10YR 4/3) loam; weak, thin, platy structure breaking to weak, very fine, subangular blocky structure; friable; some very dark grayish-brown (10YR 3/2) ped coats; medium acid; clear, smooth boundary.

B1t—10 to 15 inches, sandy clay loam; brown or dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; very weak, fine, prismatic structure breaking to weak, moderate and fine, subangular blocky structure; few, thin, discontinuous clay films; friable; strongly acid; clear, smooth boundary.

IIB21t—15 to 22 inches, sandy clay loam containing some pebbles; brown or dark-brown (10YR 4/3) ped exteriors; yellowish-brown (10YR 5/6) ped interiors; medium, fine, prismatic structure breaking to weak, fine, subangular blocky structure; friable to firm; pebble band in this layer; thin, discontinuous, dark-brown (7.5YR 3/2) clay films; very strongly acid; clear, smooth boundary.

IIB22t—22 to 31 inches, dark-brown (7.5YR 4/4) and some light olive-brown (2.5Y 5/4) sandy clay loam containing some stones and pebbles; moderate, fine and medium, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable; thin, brown (10YR 5/3) to olive (5Y 5/3), sandy prism coatings and few, fine, prominent, dark-brown (7.5YR 4/4) mottles on the prism surfaces; thin, discontinuous clay films on the blocky structural peds; strongly acid; clear, smooth boundary.

IIB23t—31 to 40 inches, grayish-brown (2.5Y 5/2) and dark yellowish-brown (10YR 4/4) sandy clay loam containing some stones and pebbles; moderate, fine, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable to firm; thin, light brownish-gray (2.5Y 6/2) to light olive-gray (5Y 6/2), sandy prism coatings; few, thin, discontinuous clay films; many oxide concretions; strongly acid; clear, smooth boundary.

IIB3t—40 to 44 inches, olive-gray (5Y 5/2) and dark yellowish-brown (10YR 4/4) loam containing some pebbles; moderate, fine and medium, prismatic structure breaking to very weak, fine, subangular blocky structure; friable to firm; thin, gray (5Y 6/1) prism coatings; many concretions of an oxide; common black (10YR 2/1) clay accumulations in root channels or pores; strongly acid.

The Coggon soils have an A1 horizon that ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. In many cultivated areas, the plow layer is partly dark gray (10YR 4/1) and partly dark grayish brown (10YR 4/2). The A2 horizon ranges from 4 to 8 inches in thickness and from dark grayish brown (10YR 4/2) to brown or dark brown (10YR 4/3) in color. The A horizons generally have a texture of loam, but the texture ranges to gritty silt loam in places.

Depth to the pebble band ranges from 14 to 24 inches. In places the lower B horizon contains thin, grayish sand coats. The texture of the B horizons ranges from loam to clay loam, but a texture of sandy clay loam is common. In places the upper B horizon contains a few fine mottles of high chroma, and grayish mottles occur below a depth of 30 inches in some places. Cobbles and pebbles are common in the soil material derived from glacial till. The reaction of these soils ranges from strongly acid to very strongly acid in the most acid part of the solum.

Colo Series

In the Colo series are poorly drained soils that formed in moderately fine textured alluvium. These soils are nearly level and occur on first bottoms in a complex pattern with the Otter soils. The native vegetation was prairie grasses and sedges that tolerate excessive wetness.

The Colo soils have very thick, dark-colored A horizons of silt loam that grades to silty clay loam. They have color values of 3 or less and chromas of 1 to a depth of 40 inches or more. The B horizons consist of gleyed silty clay loam, and they are mottled below a depth of 40 inches in many places. In places stratified coarse-textured material is below a depth of 48 inches.

The Colo soils are finer textured than the Otter soils. They are also finer textured than the Spillville and Kennebec soils, and unlike those soils, they are gleyed. The Colo soils have finer textured B horizons than the Ossian soils, and unlike the Ossian soils, they have chromas of 3 or less to a depth of 40 inches.

Representative profile of Colo silt loam in a permanent pasture, sec. 7, T. 98 N., R. 9 W. (Can be reached by going from SE. corner of section, north to creek bank, and 40 feet west on the south bank of the creek.):

A11—0 to 16 inches, black (10YR 2/1) gritty silt loam; very weak, very fine, subangular blocky structure breaking to very fine granular structure; friable; neutral; clear, smooth boundary.

A12—16 to 22 inches, black (10YR 2/1) gritty silt loam to silty clay loam; weak, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A13—22 to 34 inches, black (N 2/0 and 10YR 2/1) gritty silty clay loam; moderate, very fine, subangular blocky structure; friable; neutral; clear, wavy boundary.

B1—34 to 41 inches, very dark gray (10YR to 5Y 3/1) and dark gray (5YR 4/1) silty clay loam; moderate, very fine, subangular blocky structure; friable to firm; shiny ped coats; neutral; clear, wavy boundary.

B2g—41 to 46 inches, olive-gray (5Y 5/2) and some yellowish-red (5YR 4/8) silty clay loam; moderate, very fine, subangular blocky structure; friable to firm; neutral; clear, smooth boundary.

B3g—46 to 52 inches, gray (5Y 5/1 and 5Y 6/1) silty clay loam; massive with some vertical cleavage; friable to firm; neutral; abrupt, wavy boundary.

IIC—52 inches, gravelly sandy material.

The combined A horizons range from 20 to 36 inches in thickness. The color of those horizons is black (N 2/0 to 10YR 2/1) grading to very dark gray (10YR 3/1). Colors that have a value of 3 or less and a chroma of 1 extend to a depth of 40 inches or more. The A11 horizon ranges from 12 to 18 inches in thickness.

The lower B horizons are gleyed and range from medium or light silty clay loam to clay loam in texture. In many places the B horizons have moderate structure, but genetic development is weak. In places some mottling occurs below a depth of 40 inches. In places below a depth of 40 inches, the soil material consists of stratified silty or loamy material. Thin layers of gravel or sand occur in places below a depth of 48 inches. These soils range from slightly acid to neutral in reaction.

Curran Series[5]

The Curran series consists of somewhat poorly drained soils that formed in medium-textured and moderately fine textured, silty alluvium. These soils are on the nearly level or flat parts of low benches along the major rivers and their tributaries. The native vegetation was trees.

These soils have a thin, moderately dark colored A1 horizon of silt loam; distinct, moderately thick A2 horizons, also of silt loam; and B horizons of silt loam and mottled silty clay loam. Grainy coats and clay films or accumulations of clay are evident in places in the B horizons.

In many places the Curran soils have a thinner, less dark-colored A1 horizon and a thicker, more distinct A2 horizon than the Canoe soils. The Canoe soils, unlike the Bertrand, are mottled, and they also have lower chroma in the B horizons. In contrast to the Rowley

[5] Because of their small acreage, Curran soils are not mapped separately in Winneshiek County but are mapped with Canoe silt loam. On the soil map, they are indicated by the symbol for wet spots.

soils, they have a distinct A2 horizon. The Curran soils have a thinner A1 horizon than the Hayfield soils. They also have B horizons that are less variable in thickness, and a thicker solum that contains less sand. In most places coarse-textured material is below a depth of 48 inches.

The Curran soils form a biosequence with the Rowley soils, which are in the Brunizem great soil group, and with the Canoe soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of Curran silt loam in a cultivated field, 40 feet east of the east road fence and 12 feet from the north boundary fence in the NE¼NW¼ sec. 36, T. 99 N., R. 9 W.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) and some very dark gray (10YR 3/1) silt loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A21—8 to 10 inches, gray to light-gray (10YR to 5Y 6/1) silt loam; some dark-brown to brown (7.5YR 4/4) mottles or concretions of an oxide; weak, thin, platy structure; friable; common fine pinhole pores; very fine sand or silt coats on some plates; neutral; clear, smooth boundary.

A22—10 to 15 inches, light brownish-gray (2.5Y 6/2) silt loam; some strong-brown (7.5YR 5/6) mottles or concretions of an oxide; weak, thin, platy structure; friable; common fine pinhole pores; common very fine sand or silt coats on the plates; neutral; clear, smooth boundary.

B11—15 to 22 inches, mottled light brownish-gray (2.5Y 6/2) and dark-brown to brown (7.5YR 4/4) silt loam; weak, very fine, subangular blocky structure; friable; common very fine sand or silt coats; neutral; clear, smooth boundary.

B12—22 to 29 inches, mottled light brownish-gray (2.5Y 6/2) and dark yellowish-brown (10YR 4/4) silt loam; weak, very fine, subangular blocky structure; friable; common very fine sand or silt coats; neutral; abrupt, smooth boundary.

B21t—29 to 37 inches, mottled grayish-brown (2.5Y 5/2), light brownish-gray (2.5Y 6/2), and some dark yellowish-brown (10YR 4/4) silty clay loam; moderate, very fine, subangular blocky structure; friable to firm; thin, continuous clay films; common very fine sand or silt coats; medium acid; clear, smooth boundary.

B22t—37 to 44 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) silty clay loam; moderate, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable to firm; some accumulations of black clay in root channels and pores; some very fine sand or silt coats on the surfaces of prisms; medium acid; clear, smooth boundary.

B3t—44 to 52 inches, light olive-gray (5Y 6/2) to light brownish-gray (2.5Y 6/2) and some strong-brown (7.5YR 5/6) silty clay loam; very weak, coarse, subangular blocky structure; friable to firm; some accumulations of black clay in root channels and pores; slightly acid.

The Curran soils have moderate to strong horizonation. They have a very dark gray (10YR 3/1) A1 horizon that is 2 to 5 inches thick. In cultivated areas the Ap horizon is dark gray (10YR 4/1) or dark grayish brown (10YR 4/2). The A2 horizon ranges from 4 to 10 inches in thickness. It generally has hues of 10YR and 2.5Y, with values of 5 and 6. In most places it has chromas of 1 and 2. The texture of the A horizons is silt loam.

The color of the B horizons centers on grayish brown (2.5Y 5/2), with brownish and yellowish mottles of higher chroma. The texture of the B2 horizons is light to medium silty clay loam. In places stratified silty and loamy material is below a depth of 40 inches. In the most acid part of the solum, the soil reaction is medium acid.

Dickinson Series

In the Dickinson series are well-drained to excessively drained soils that formed in 24 to 30 inches of sandy loam over leached loamy sand and sand. In most places this moderately coarse textured or coarse textured underlying material is of wind-deposited origin. It consists of glaciofluvial or alluvial material in other places. Gently sloping or sloping areas of these soils are on upland highs, ridgetops, and side slopes, and also on the sloping escarpments of stream benches. The nearly level areas are on benches. The native vegetation was prairie grasses.

These soils have a moderately thick, dark-colored A1 horizon of sandy loam, and B horizons of sandy loam that grades to loamy sand. The soils are free of gravel and cobbles.

The Dickinson soils have a darker, thicker A1 horizon than the Lamont soils, and unlike those soils, they lack an A2 horizon. They differ from the Hagener soils in having a moderately coarse textured upper B horizon. The Dickinson soils have thicker, less variable B horizons than the Backbone soils, and they are not underlain by a uniform layer of limestone or limestone residuum as are the Backbone soils. They have a thicker solum than the Burkhardt soils and have no gravel in their substratum. The Dickinson soils, unlike the till subsoil variant of the Lamont series, lack an A2 horizon. Also, the thickness of their B horizon is less variable, and they are underlain by loamy sand and sand rather than by loam glacial till.

The Dickinson soils form a biosequence with the Lamont soils of the Gray-Brown Podzolic great soil group.

Representative profile of Dickinson sandy loam in a cultivated field, 765 feet west and 45 feet north of the SE. corner of the SW¼SW¼ sec. 29, T. 98 N., R. 10 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) sandy loam; very friable; medium acid; abrupt, smooth boundary.

A1—7 to 10 inches, very dark brown (10YR 2/2) sandy loam; very friable; medium acid; clear, smooth boundary.

A3—10 to 20 inches, very dark grayish-brown (10YR 3/2) and some patches of very dark brown (10YR 2/2) sandy loam; very friable; strongly acid; clear, smooth boundary.

B2—20 to 28 inches, brown or dark-brown (10YR 4/3) heavy sandy loam; very weak, fine, prismatic structure breaking to very weak, very fine, subangular blocky structure; very friable; some ped coatings of very dark grayish brown (10YR 3/2); common fine pores; strongly acid; clear, smooth boundary.

B3—28 to 36 inches, dark yellowish-brown (10YR 4/4) loamy sand; very weak, medium, prismatic structure to structureless; very friable; strongly acid; clear, smooth boundary.

C—36 to 52 inches, yellowish-brown (10YR 5/4) sand; loose; strongly acid.

The Dickinson soils have weak horizonation. In areas that are not eroded, the color of the A horizons is very dark brown (10YR 2/2), but the color grades to very dark grayish brown (10YR 3/2) with increasing depth. In places the A horizons have values of 3 and chromas of 2 to a depth of 24 inches. The thickness of the sandy loam ranges from 24 to 30 inches. The B horizons formed in sandy loam and loamy sand, and the size of the particles of sand is fine or medium. The color of the B horizons centers on values and chromas of 3 and 4. Mottling is absent. In places gravel is below a depth of 60 inches. The soils range from medium acid to strongly acid in reaction. The soil material contains carbonates below a depth of 60 inches.

Donnan Series

The Donnan series consists of soils that are moderately well drained or somewhat poorly drained. These soils formed in loamy material derived mainly from glacial sediments that are 20 to 40 inches thick. Beneath the glacial sediments is plastic, very firm and fine-textured, weathered, gray glacial till. These soils are gently sloping and are on convex ridges and side slopes of uplands in the part of the county where glacial material occurs. They developed under a succession of forest and prairie vegetation.

Typically, the Donnan soils have thin to moderately thick, dark-colored loam A horizons and a thin, indistinct A2 horizon. The upper B horizons are brownish and vary in thickness. They are underlain by a gray, mottled lower B horizon of very firm clay.

The Donnan soils, unlike the Bassett and Racine, are underlain by gray, very firm, weathered glacial till below a depth of 20 to 40 inches. In contrast to the Kenyon and Ostrander soils, they have an A2 horizon, B horizons that vary in thickness, and a solum underlain by weathered glacial till. The Donnan soils have higher chroma and fewer mottles in the upper B horizon than the Jacwin soils, and they have a substratum of gray, weathered glacial till instead of shale.

Representative profile of Donnan loam in a cultivated field, 175 feet west and 300 feet north of the SE. corner of the NW¼NE¼ sec. 23, T. 96 N., R. 10 W.:

Ap—0 to 6 inches, very dark gray (10YR 3/1) loam; weak, very fine, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

A2—6 to 8 inches, very dark gray (10YR 3/1) and less than 10 percent dark-brown or brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2) if kneaded; weak, medium, platy structure breaking to weak, fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

B1t—8 to 15 inches, clay loam containing some pebbles; dark-brown or brown (7.5YR 4/4) ped exteriors, and dark-brown or brown (10YR 4/3) ped interiors; weak, very fine, subangular blocky structure; friable to firm; few discontinuous clay films; strongly acid; clear, smooth boundary.

B21t—15 to 23 inches, dark-brown to brown (7.5YR 4/4 and 10YR 4/3) clay loam containing some pebbles; moderate, fine and very fine, subangular blocky structure; friable to firm; common, thin, discontinuous clay films; strongly acid; abrupt, smooth boundary.

IIB22tb—23 to 27 inches, gray (N 6/0) clay; common, medium, prominent, red (2.5YR 4/8) mottles; moderate, very fine, subangular blocky structure; very firm; thin, continuous clay films; medium acid; clear, smooth boundary.

IIB23tb—27 to 40 inches, gray (5Y 5/1 and 6/1) clay; strong, very fine, subangular blocky structure; very firm; thin, continuous clay films; medium acid; gradual, smooth boundary.

IIB24tb—40 to 52 inches, mottled gray (5Y 5/1 and 6/1) and reddish-brown (2.5YR 4/4) clay; moderate, very fine, subangular blocky structure; very firm; thick, continuous clay films; slightly acid.

The Donnan soils have moderate horizonation. In areas that are not eroded, the A horizons are very dark gray (10YR 3/1), and their combined thickness ranges from 4 to 8 inches. In some cultivated areas, the surface layer is very dark grayish brown (10YR 3/2). In areas that have not been disturbed, the A2 horizon ranges from 2 to 4 inches in thickness and from very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/2) in color. The texture of the A horizons centers on loam.

In the B horizons above the IIB, these soils have hues of 10YR and 7.5YR, values of 4, and chromas of 3 or higher. Those horizons have a texture of clay loam, and they contain some clay films. The IIB horizons are considered to be a buried, fine-textured paleosol formed from glacial till. Gray mottles are absent in the B horizons above the IIB, but some strong-brown and yellowish-brown mottles occur in places below a depth of 30 inches. The reaction of these soils ranges from medium acid to strongly acid in the most acid part of the solum.

Dorchester Series

In the Dorchester series are soils that are moderately well drained. These soils formed in 20 inches or more of material consisting of stratified, calcareous silt loam. They are on nearly level or slightly undulating bottoms and on gently sloping low benches. Vegetation has not influenced the development of the soil profile.

These soils have a surface layer of stratified, light-colored, calcareous silt loam, and this stratified material extends to a depth of 20 inches or more. In many places a buried soil that has a dark-colored surface layer and medium texture occurs at a depth of 20 to 40 inches.

The Dorchester soils differ from the Arenzville soils in that the silty, light-colored material is calcareous. In contrast to the Volney soils, which contain many fragments, the Dorchester soils are free of limestone fragments. In many places the Dorchester soils lack mottling and have browner hues in the stratified material than the Caneek soils. Unlike the overwashed phase of the Otter and Ossian soils, they have 20 inches or more of calcareous silt loam in the upper part of their profile instead of 6 to 20 inches of calcareous and noncalcareous silt loam. The Dorchester soils, in contrast to the Chaseburg, are distinctly stratified, are calcareous, and lack a B horizon.

The Dorchester soils, which are moderately well drained, form a hydrosequence with the Caneek soils, which are somewhat poorly drained.

Following are descriptions of two profiles considered representative for the Dorchester series. More than one profile is described to give the reader a better idea of the range of characteristics of the Dorchester soils in Winneshiek County.

Representative profile of Dorchester silt loam in a permanent pasture, 200 feet east of bridge on south edge of NE¼SW¼ sec. 33, T. 98 N., R. 8 W., then north to south bank of Trout Run Creek:

C1—0 to 20 inches, stratified dark grayish-brown (10YR 4/2) and some very dark gray (10YR 3/1) and brown (10YR 5/3) silt loam; weak, very thin, platy structure and some weak, very fine, granular structure; very friable; weakly calcareous; clear, smooth boundary.

IIA1b—20 to 30 inches, black (10YR 2/1) silt loam; weak, very fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIA3b—30 to 40 inches, very dark brown (10YR 2/2) silt loam; moderate, very fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIB21b—40 to 48 inches, very dark gray (10YR 3/1) silt loam; moderate, very fine and fine, subangular blocky structure; very friable; neutral; diffuse, wavy boundary.

IIB22b—48 to 59 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silt loam; moderate, fine to medium, subangular blocky structure; friable; neutral.

Representative profile of Dorchester silt loam in a permanent pasture, 300 feet north of river and 200 feet west of bend in road in northwestern corner of SW¼ sec. 13, T. 98 N., R. 8 W.:

C1—0 to 36 inches, stratified dark grayish-brown (10YR 4/2) and thin layers of brown (10YR 5/3), light brownish-gray, (10YR 6/2), and very dark gray (10YR 3/1) silt loam; weak, very thin, platy structure and some weak, fine, granular structure; very friable; weakly calcareous; moderately alkaline; abrupt, smooth boundary.

IIAb—36 to 47 inches, black (10YR 2/1) loam to silt loam; very weak, fine, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIA3—47 to 56 inches, very dark grayish-brown (10YR 3/2) and some dark-brown (10YR 3/3) loam to silt loam; weak, very fine, subangular blocky structure; neutral.

The calcareous, stratified sediments of silt loam that make up the upper part of the profile generally have color values of 4 or higher and chromas of 2 or higher. Thin layers of darker colored sediments, however, occur in places. The dark, buried soil that occurs in most areas of Dorchester soils and that has a texture of loam to light silty clay loam is at a depth ranging from 20 to 40 inches. Pebbles, cobbles, or fragments of limestone are absent to a depth of 40 inches or more. The light-colored sediments contain a few yellowish or brownish mottles in places. Although the stratified silty material is calcareous, the buried soil is slightly acid to neutral in reaction.

Dow Series

In the Dow series are well-drained soils formed in calcareous, relict, gleyed (deoxidized) loess. These soils are steep, and they occur with Fayette soils on side slopes in the uplands. The native vegetation was trees.

The Dow soils have a thin, moderately dark colored to light-colored A1 horizon of silt loam. Their B horizon is weakly defined, and they have a calcareous, olive-gray C horizon that contains mottles and many hard, tubular iron concretions.

The Dow soils, unlike the Fayette, Palsgrove, and Downs, are calcareous, lack a distinct A2 horizon, and have a grayish subsoil. In contrast to the gray subsoil variants of the Franklin series, they are calcareous and lack B horizons that developed in loam glacial till.

The Dow soils of Winneshiek County differ from the Dow soils in other counties in Iowa in that they have a B horizon and are leached of carbonates to a depth of 10 to 20 inches.

Representative profile of Dow silt loam in a cultivated field, 160 feet east and 200 feet north of the SW. corner of the SE¼SE¼ sec. 25, T. 96 N., R. 9 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) and some brown to dark-brown (10YR 4/3) silt loam; weak, very fine, subangular blocky structure; friable; common oxide concretions; neutral; abrupt, smooth boundary.

B—6 to 11 inches, dominantly light olive-gray (5Y 6/2) and some dark-brown (10YR 3/3) and brown to dark-brown (10YR 4/3) silt loam; common iron streaks of yellowish brown (10YR 5/8) and hard iron tubules of dark reddish brown (5YR 3/2, 3/3, and 3/4); weak, very fine, subangular blocky structure; friable; mildly alkaline; clear, wavy boundary.

C—11 to 72 inches, olive-gray (5Y 5/2) silt loam; common iron streaks of yellowish brown (10YR 5/8) and many hard iron tubules of dark reddish brown (5YR 3/2, 3/3, and 3/4); weak, coarse, subangular blocky structure to massive; friable; calcareous.

The thickness of the A horizon ranges from 6 to 12 inches, and the color of that horizon grades from very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/2). The areas that are dark grayish brown (10YR 4/2) have been cultivated or are eroded. In places these soils have a very weakly defined A2 horizon or have a slightly leached zone between the A1 and the C horizon.

In most places the profile contains an indistinct B horizon. In areas that are not eroded, the soil material is leached to a depth of 8 to 12 inches. The grayish color of the subsoil is considered to be a relict feature typical of an older and wetter climatic regime. Geologic erosion has removed part of the yellowish-brown oxidized loess and has exposed a zone of gleyed loess. Mottles and tubular iron concretions are common. Depth to calcareous material ranges from 10 to 20 inches.

Downs Series

The Downs series consists of well-drained soils that formed in loess. These soils are gently sloping to strongly sloping and are on convex ridgetops and side slopes in the uplands. The native vegetation was trees and prairie grasses.

The Downs soils have a moderately thick A1 horizon of dark colored or moderately dark colored silt loam and a somewhat distinct A2 horizon. Their B horizons have a brownish color and a texture of silty clay loam, and they are free of mottles to a depth of about 30 inches. Clay films and grainy silt coats are evident in the B horizons.

The Downs soils have a darker, thicker A1 horizon and generally have a less distinct A2 horizon than the Fayette soils. Their solum is less variable in thickness than that of the Frankville soils, and it is not uniformly underlain by limestone or by limestone residuum. The solum formed in a layer of loess that is 50 inches or more thick instead of being stratigraphically underlain by limestone or by residuum and limestone at a depth of 30 to 50 inches like that of the Nasset soils.

The Downs soils have a thinner A1 horizon than the Tama soils. They also have an A2 horizon or an abrupt boundary between the A horizon and a B horizon in which grainy coats are evident. The Downs soils, unlike the Atterberry, have chromas of 3 and 4 and no mottles to a depth of 30 inches. They developed in loess that contains less than 15 percent fine sand instead of having between 20 and 40 percent fine and medium sand throughout their solum like the Orwood soils. The Downs soils have a B horizon of silty clay loam instead of silt loam like that of the Festina soils. In places they have stratified silty and loamy layers below a depth of 36 inches.

The Downs soils are the intermediate members of the biosequence that includes the Tama soils, which are in the Brunizem great soil group, and the Fayette soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Downs silt loam in a cultivated field, 150 feet east and 60 feet north of the SE. corner of the SE¼SW¼ sec. 29, T. 97 N., R. 7 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) and some dark gray (10YR 4/1) silt loam; very dark grayish brown (10YR 3/2, moist) but grayish brown (10YR 5/2, dry) if kneaded; weak, fine, granular structure; very friable; slightly acid; abrupt, smooth boundary.

A2—8 to 10 inches, dark grayish-brown (10YR 4/2), dark gray (10YR 4/1), and some very dark gray (10YR 3/1) and brown to dark-brown (10YR 4/3) silt loam; dark grayish brown (10YR 4/2) if kneaded; weak, thin, platy structure breaking to weak, fine, granular structure; very friable; medium acid; clear, smooth boundary.

B1t—10 to 16 inches, dark grayish-brown (10YR 4/2), brown to dark-brown (10YR 4/3), and some dark gray (10YR 4/1) and very dark gray (10YR 3/1) light silty clay loam; weak, very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

B21t—16 to 23 inches, light silty clay loam; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; weak, very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

B22t—23 to 30 inches, light silty clay loam; brown to dark-brown (10YR 4/3) ped exteriors; yellowish-brown (10YR 5/4 and 5/6) ped interiors; moderate, very fine and fine, subangular blocky structure; friable; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

B31—30 to 34 inches, yellowish-brown (10YR 5/4) silt loam; very weak, very fine, subangular blocky structure; very friable; strongly acid; clear, smooth boundary.

B32—34 to 50 inches, yellowish-brown (10YR 5/4) silt loam; very weak, very fine, subangular blocky structure; silt coats on ped surfaces are light gray (10YR 7/1) when dry; very friable; strongly acid.

The Downs soils have moderate horizonation. Their A1 horizon ranges from 4 to 8 inches in thickness and from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) in color. Their A2 horizon, where present, ranges from 2 to 4 inches in thickness. In eroded areas, however, the A2 horizon is absent or is incorporated in the plow layer.

The B horizons have values of 4 that grade to 5 with increasing depth, and chromas of 3 or higher. The texture of the B horizons centers on light silty clay loam, and grainy silt coats are common. Mottling, where present, is below a depth of 30 inches. The most acid part of the solum is strongly acid.

Dubuque Series

Soils that are well drained are in the Dubuque series. These soils formed in 15 to 30 inches of loess over a thin layer of residuum and limestone bedrock. They are on gently sloping ridgetops and on sloping to very steep side slopes. The native vegetation was trees.

These soils have a thin, moderately dark colored A1 horizon of silt loam, and they have a distinct A2 horizon in areas that are not eroded. Their B horizons have a texture of light silty clay loam and are free of mottles. Clay films are evident in the B horizons. In some places the limestone residuum contains a paleo B horizon.

The Dubuque soils have a thinner solum than the Palsgrove soils, which formed in a layer of loess 30 to 50 inches thick. They have a thinner, more variable solum than the Fayette soils. The Dubuque soils have a thinner, darker colored A1 horizon and in places a more distinct A2 horizon than the Frankville soils. They have a thicker solum than the Nordness soils, which developed in only 5 to 15 inches of loess. The Dubuque soils have a thinner solum; a lighter colored, thinner A1 horizon; and a more distinct A2 horizon in uneroded areas than the Nasset soils. They differ from the Whalan soils in having formed in loess rather than in glacial till. As a result, they contain less sand than the Whalan soils and they lack pebbles and stones like those in the solum of the Whalan soils.

The Dubuque soils are the Gray-Brown Podzolic members of the biosequence that includes the Frankville soils, which are also in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of a moderately eroded Dubuque silt loam that has slopes of 7 percent, in a cultivated field 350 feet east and 280 feet south of the NW. corner of the SW¼SE¼ sec. 14, T. 100 N., R. 8 W. (A2 horizon included with the Ap):

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; weak granular structure; friable; some silt coats on the peds; medium acid; abrupt, smooth boundary.

B1t—6 to 10 inches, yellowish-brown (10YR 5/4) and brown to dark-brown (10YR 4/3) heavy silt loam; moderate, very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; common silt coats on the peds; strongly acid; clear, smooth boundary.

B21t—10 to 19 inches, light silty clay loam; brown to dark-brown (10YR 4/3) ped exteriors; yellowish-brown (10YR 5/4) ped interiors; moderate, very fine and fine, subangular blocky structure; friable; few, thin, discontinuous clay films; common silt coats on the peds; very few iron-manganese concretions of an oxide; very strongly acid; clear, smooth boundary.

B22t—19 to 25 inches, light silty clay loam; mainly brown to dark-brown (10YR 4/3) ped exteriors but a few splotches of dark reddish brown (5YR 3/4); yellowish-brown (10YR 5/4) and brown (10YR 5/3) ped interiors; strong, fine and medium, subangular blocky structure; friable to firm; common, thin, discontinuous clay films; prominent silt coats on the peds; few fine iron-manganese concretions of an oxide; common fragments of chert up to 4 inches long; strongly acid; clear, smooth boundary.

IIB23t—25 to 27 inches, dark reddish-brown (5YR 3/3) and reddish-brown (5YR 4/4) clay or silty clay; strong, fine, subangular blocky structure; firm; thick, continuous clay films; medium acid; common fine iron-manganese concretions of an oxide; abrupt, wavy boundary.

IIR—27 inches +, limestone bedrock.

These soils have moderate horizonation. In areas that are not eroded, the A1 horizon ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. In many areas that are cultivated, part or all of the A2 horizon is mixed with the plow layer. In areas that are not eroded, the A2 horizon ranges from 4 to 8 inches in thickness and from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) in color. The A horizons have a texture of silt loam.

The B horizons are not mottled and have values of 3, 4, and 5 and chromas of 3 or higher. The texture of the B horizons centers on light silty clay loam. The profile has no loess-derived C horizon above the residuum or limestone bedrock. The limestone residuum ranges from 1 to 6 inches in thickness. Its texture ranges from silty clay loam to silty clay or clay, but a texture of silty clay is most common. The residuum is predominantly reddish, but it is brownish or yellowish in some places. In places the lower B horizon contains chert or small fragments of limestone, and the bedded limestone is fractured in places. The most acid part of the solum is strongly acid or very strongly acid.

Fayette Series

In the Fayette series are well-drained soils formed in loess. These soils are gently sloping to very steep and are on convex ridgetops and side slopes. The native vegetation was trees.

The Fayette soils have a thin, moderately dark colored A1 horizon of silt loam; a distinct A2 horizon; and brownish B horizons that have a texture of silty clay loam and are free of mottles to a depth of 30 inches. The B horizons contain clay films and silt coats.

The Fayette soils have a thinner A1 horizon and a more distinct A2 horizon than the Downs soils. Their solum is less variable in thickness than those of the Dubuque and Palsgrove soils. Also, unlike the Dubuque and Palsgrove soils, they developed in a layer of loess more than 50 inches thick. The Fayette soils have B horizons that are more uniform in thickness than those of the Bertrand soils, and unlike some Bertrand soils, they lack stratification in the lower part of the solum. In contrast to the Renova soils, which formed in glacial till, the Fayette soils formed in loess and lack coarse particles in their solum.

The Fayette soils form a biosequence with the Tama soils, which are in the Brunizem great soil group, and with the Downs soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of Fayette silt loam in a cultivated field, 250 feet west and 45 feet south of a NE. fence corner of the NW¼NE¼ sec. 21, T. 100 N., R. 8 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) and some very dark gray (10YR 3/1) silt loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A21—7 to 10 inches, yellowish-brown (10YR 5/4) and brown to dark-brown (10YR 4/3) silt loam; very weak, thin, platy structure; very friable; medium acid; clear, smooth boundary.

A22—10 to 16 inches, brown to dark-brown (10YR 4/3) silt loam; weak, thin, platy structure breaking to weak, very fine, subangular blocky structure; very friable; coatings of silt that are light gray (10YR 7/1) when dry and some coatings that are dark brown (10YR 3/3); medium acid; clear, smooth boundary.

B21t—16 to 27 inches, brown to dark-brown (10YR 4/3) light silty clay loam; moderate, fine, subangular blocky structure; friable; few ped coats of dark yellowish brown (10YR 4/4), some of which are clay; some silt coats; common pinhole pores; strongly acid; clear, smooth boundary.

B22t—27 to 39 inches, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) light silty clay loam; weak, medium, prismatic structure breaking to strong, fine and medium, subangular blocky structure; friable to firm; common, thin, discontinuous, dark yellowish-brown (10YR 3/4) clay films; some silt coats; common fine pinhole pores; strongly acid; clear, smooth boundary.

B3—39 to 46 inches, yellowish-brown (10YR 5/4) silt loam; very weak, fine, subangular blocky structure; friable; some brown to dark-brown (10YR 4/3) ped coats and some silt coats; common pinhole pores; strongly acid; clear, smooth boundary.

C—46 to 80 inches, dominantly yellowish-brown (10YR 5/4) with some yellowish-brown (10YR 5/6 and 5/8) and brown to dark-brown (10YR 4/3) silt loam; massive; friable; common pinhole pores to a depth of 60 inches; a very few fragments of chert and limestone and two glacial pebbles observed between a depth of 60 and 80 inches; few iron concretions in streaks and in nodules; medium acid.

Where these soils have not been cultivated, they have a thin A1 horizon (1 to 4 inches thick) of silt loam that ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. The A2 horizon ranges from 4 to 10 inches in thickness and has values of 4 and 5 and chromas of 2, 3, and 4. In cultivated areas part of the A2 horizon is mixed with the plow layer and colors of 4 value are common in the surface horizon.

The texture of the B horizons centers on light silty clay loam, and the B horizons contain distinct clay films and silt coats. Mottles are absent to a depth of 30 inches. Where these soils grade to gray variants of the Fayette series (not mapped separately in this county), the B3 or C horizon contains some grayish mottles that are considered to be relict. The solum is free of limestone residuum, glacial till, and sand and gravel to a depth of 50 inches. The most acid part of the solum is strongly acid.

Fayette Series, Gray Variants [6]

The gray variants of the Fayette series are well drained or moderately well drained. They have developed in 20 to 30 inches of oxidized loess over relict, gleyed (deoxidized) loess. These soils are on narrow, convex ridgetops and on the shoulders of side slopes. The native vegetation was trees.

Gray variants of the Fayette series have a thin A1 horizon of moderately dark colored silt loam. In areas that are not eroded, they have an A2 horizon. Their B horizons developed in brownish and grayish loess. A few clay films are evident in places in the B horizons.

These soils differ from the Fayette soils in that they have B horizons developed in oxidized and deoxidized

[6] Areas of gray variants of the Fayette series were not retained as separate mapping units in Winneshiek County, but these soils are included with some of the Fayette mapping units.

loess. They are not calcareous like the Dow soils, and they lack gray colors to a depth of 20 inches. The gray variants of the Fayette series have a thinner, lighter colored A1 horizon than the gray subsoil variants of the Franklin series. Also, unlike the gray subsoil variants of the Franklin series, they have B horizons developed entirely in loess instead of being underlain by glacial till between a depth of 15 and 40 inches.

Representative profile of Fayette silt loam, gray variant, in a cultivated field, 300 feet east and 200 feet north of the SW. corner of SE¼SE¼ sec. 25, T. 96 N., R. 9 W.:

- Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) and dark-brown to brown (10YR 4/3) silt loam; very weak, very fine, subangular blocky structure breaking to granular structure; friable; neutral; abrupt, smooth boundary.
- B1t—6 to 13 inches, yellowish-brown (10YR 5/4) and grayish-brown (10YR 5/2) silt loam to silty clay loam; weak, very fine, subangular blocky structure; friable; very few, thin, discontinuous, brown to dark-brown (10YR 4/3) clay films; common fine iron-manganese concretions of an oxide; slightly acid; clear, smooth boundary.
- B21t—13 to 22 inches, mottled light olive-gray (5Y 6/2) silt loam to silty clay loam, with some brown (10YR 5/3), yellowish-brown (10YR 5/4 and 5/8), and dark-brown (10YR 3/3) colors; weak, fine and medium, subangular blocky structure; friable; very few, thin, discontinuous, dark-brown to brown (10YR 4/3) clay films; common pinhole pores; dark-brown (10YR 3/3) and yellowish-brown (10YR 5/8) iron coatings and streaks on the peds; common, fine and medium, iron-manganese concretions of an oxide; medium acid; clear, smooth boundary.
- B22—22 to 30 inches, mottled gray (5Y 6/1) and light olive-gray silt loam, (5Y 6/2), with some yellowish-brown (10YR 5/8) coloring; weak, fine and medium, subangular blocky structure; friable; few dark-brown (10YR 3/3) coatings on the peds; common fine root channels and pinhole pores; medium acid; clear, smooth boundary.
- B3—30 to 40 inches, gray (5Y 6/1) coarse silt loam, with vertical segregated areas of yellowish red (5YR 5/8), dark reddish brown (5YR 3/4), and some strong brown (7.5YR 5/8); weak, fine and medium, subangular blocky structure; friable; common pinhole pores; slightly acid; clear, smooth boundary.
- C—40 to 90 inches, gray (5Y 6/1) coarse silt loam; prominent, soft and hard, yellowish-red (5YR 5/8) and dark reddish-brown (5YR 3/4) iron segregations that have vertical and horizontal orientation; very weak, coarse, subangular blocky structure to massive; friable; common pinhole pores; neutral.

The A1 horizon ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. In areas that are not eroded, the profile contains an A2 horizon that ranges from 4 to 8 inches in thickness and from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) in color. In cultivated or eroded areas, the Ap horizon has a value of 4 and chromas of 2 or higher.

The texture of the B horizons ranges from heavy silt loam to light silty clay loam. In the upper B horizon, the colors have a value of 5 and chromas of 3 and 4. Between a depth of 20 and 30 inches, the predominant color has a hue of 5Y, values of 5 and 6, and chromas of 1 and 2. These colors are considered to be relict and indicative of an older and wetter climatic regime. The gray loess of the underlying material contains many iron segregations that occur as hard tubules in places. From 5 to 12 percent of the loess is very fine sand and fine sand. In the most acid part of the solum, the soil reaction is medium acid.

Festina Series

In the Festina series are soils that are well drained. These soils formed in medium-textured alluvium derived mainly from areas of soils developed in loess. The texture throughout the profile centers on silt loam. These soils are nearly level or gently sloping and are on benches along the major rivers and their tributaries. The native vegetation was trees and grasses.

The Festina soils have a thin to moderately thick, dark-colored A1 horizon of silt loam; a somewhat distinct A2 horizon; and brownish B horizons that are free of mottles to a depth of 30 inches or more. Most profiles contain very few clay films.

The Festina soils have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the Bertrand soils. They are better drained than the Canoe soils, as evidenced by the higher chroma and general lack of mottles to a depth of 30 inches. The profile of the Festina soils is similar in development to that of the deep Sattre soils, but the content of sand is lower throughout their solum. The Festina soils have B horizons that are less variable in thickness than those of the Sattre soils, and they are not uniformly underlain by sand and gravel at a depth of 24 to 45 inches as are the Sattre soils. The Festina soils have B horizons that are more variable than those of the Downs soils. Unlike the Downs soils, they are stratified in some places below a depth of 36 inches.

The Festina soils are the intermediate members of the biosequence that includes the Richwood soils, which are Brunizems not mapped separately in this county, and the Bertrand soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Festina silt loam in a permanent pasture, 660 feet east and 500 feet south of the NW. corner of the SW¼SE¼ sec. 4, T. 97 N., R. 8 W.:

- Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; weak, fine, granular structure; friable; coatings of dark grayish brown (10YR 4/2); medium acid; abrupt, smooth boundary.
- A2—7 to 12 inches, dark grayish-brown (10YR 4/2) and some very dark grayish-brown (10YR 3/1), brown to dark-brown (10YR 4/3), and brown (10YR 5/3) silt loam; weak, thin, platy structure breaking to very weak, very fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.
- B1—12 to 21 inches, silt loam; dark-brown to brown (10YR 4/3) ped exteriors; yellowish-brown (10YR 5/4) ped interiors; weak, very fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.
- B21—21 to 28 inches, dark-brown to brown (10YR 4/3) heavy silt loam; weak, very fine, subangular blocky structure; friable; ped coatings of very fine sand or silt that is white (10YR 8/1) when dry; medium acid; clear, smooth boundary.
- B22t—28 to 38 inches, yellowish-brown (10YR 5/4) and dark yellowish-brown (10YR 4/4) heavy silt loam; moderate, very fine, subangular blocky structure; friable; ped coatings of very fine sand or silt that is white (10YR 8/1) when dry; thin, discontinuous clay films; few iron-manganese concretions of an oxide; medium acid; gradual, smooth boundary.

B3—38 to 47 inches, yellowish-brown (dominantly 10YR 5/6 and some 10YR 5/8) silt loam; weak, very fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

C—47 to 68 inches, yellowish-brown (10YR 5/6) silt loam; massive; friable; slight increase in content of very fine sand; (content of sand estimated to be 10 to 15 percent); slightly acid.

The Festina soils have weak to moderate horizonation. The A1 horizon ranges from 5 to 10 inches in thickness, has a texture of silt loam, and typically has a color of very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). The A2 horizon ranges from distinct to incipient. In places it is incorporated in the Ap horizon but is discernible because of its dark grayish-brown (10YR 4/2) color.

The texture of the B2 horizons is centered on silt loam. The range of texture, however, includes light silty clay loam that has a maximum content of clay of about 29 percent or less. The B2 horizons are typically free of mottles and have chromas of 3 and 4. The bulk texture is typically silt loam, but textures of very fine sandy loam, sandy loam, loamy fine sand, silt loam, and light silty clay loam occur in very thin bands. Stratification commonly occurs below a depth of 3 feet, but generally at a depth above 5 feet. Only very thin lenses of coarse-textured material occur above a depth of 4 feet. Light-gray to white, grainy ped coats are common in places in the B horizons when the soil material is dry, but they are not easily discernible when the soil material is moist. The solum ranges from slightly acid to medium acid in reaction. In most places the profile is leached of carbonates to a depth of at least 5 feet.

Floyd Series

The Floyd series consists of somewhat poorly drained soils formed in 30 to 40 inches of loamy glacial sediments over friable glacial till. These soils are nearly level or gently sloping and are in slightly concave areas adjacent to upland drainageways. The native vegetation was prairie grasses.

The Floyd soils have a thick, dark-colored A1 horizon of loam to silty clay loam. They have weakly defined, mottled B horizons that are stratified and that contain thin layers of silty and loamy material in the lower part.

The Floyd soils, unlike the Clyde, lack gleyed B horizons that have values of 4 or higher and chromas of 1. They have a more stratified solum than the Kenyon soils, and they have chromas of 2 in the B horizons rather than chromas of 3 or higher. Their solum is underlain by glacial till instead of being uniformly underlain by loamy sand and sand like that of the Kato soils.

The Floyd soils developed mainly in glacial sediments instead of in glacial till like the Oran soils. Also, they have a thicker A1 horizon than the Oran soils, and they lack an A2 horizon. Unlike the Donnan soils, the Floyd soils lack an A2 horizon, and they are underlain by glacial till rather than by a gray paleosol that has a texture of clay and developed in till. Also, the Floyd soils have chromas of 2 and are mottled below the A horizon instead of having chromas of 3 below the A horizon. The Floyd soils have a thicker solum than the Jacwin soils. Also unlike those soils, they are underlain by glacial till rather than by shale. They lack an A2 horizon and are not uniformly underlain by leached, coarse-textured material as are the Hayfield soils.

Representative profile of Floyd loam in a permanent pasture, 150 feet north of the SW. corner of the NW¼ SW¼ sec. 4, T. 96 N., R. 10 W., on a fence line along a new road:

A11—0 to 11 inches, black (N 2/0) loam to gritty light silty clay loam; moderate, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A12—11 to 15 inches, black (10YR 2/1) loam to gritty light silty clay loam; very dark gray (10YR 3/1) if kneaded; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

B1—15 to 19 inches, very dark grayish-brown (2.5Y 3/2) loam to gritty light silty clay loam; dark grayish brown if kneaded (2.5Y 4/2); weak, very fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

B21—19 to 29 inches, loam; dark grayish-brown (2.5Y 4/2) ped exteriors grading to grayish brown (2.5Y 5/2) with increasing depth; mottled grayish-brown (2.5Y 5/2) and olive-brown (2.5Y 4/4) ped interiors; brown (10YR 5/3) to olive (5Y 5/3) if kneaded; few olive-brown (2.5Y 4/4) mottles on the exteriors of peds; lower part of horizon has a few yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure and some vertical cleavage; friable; neutral; gradual, smooth boundary.

B22—29 to 39 inches, mottled yellowish-brown (10YR 5/6) and some grayish-brown (2.5Y 5/2) to light brownish-gray (2.5Y 6/2) loam; yellowish brown (10YR 5/4) if kneaded; very weak, coarse, prismatic structure breaking to weak, fine, subangular blocky structure; friable; a thin discontinuous rind of olive gray (5Y 5/2) on ped exteriors; neutral; gradual, smooth boundary.

IIB31—39 to 42 inches, mottled yellowish-brown (10YR 5/8) and olive-gray (5Y 5/2) gravelly loamy sand; weak, coarse, subangular blocky structure; very friable; has a water table; neutral; gradual, smooth boundary.

IIIB32—42 to 50 inches, mottled strong-brown (7.5YR 5/8) and gray to light-gray (5Y 6/1) light clay loam containing some stones and pebbles; weak, coarse, subangular blocky structure to massive; friable to firm; neutral; few stones and pebbles.

The Floyd soils have weak horizonation. The combined A1 horizons range from 12 to 18 inches in thickness and from black (N 2/0) to very dark gray (10YR 3/1) in color. The texture of the A1 horizons ranges from loam to gritty silty clay loam. In many places colors that have a value of 3 and a chroma of 2 extend below a depth of 20 inches.

The B horizons typically have a hue of 2.5Y, but the hues range from 10YR in the B1 horizon to 5Y in the B3 or C horizon. The color of the B1 and B21 horizons centers on very dark grayish brown (2.5Y 3/2) and dark grayish brown (2.5Y 4/2) with some mottling. The mottles are strong brown, yellowish brown, olive brown, and olive gray and increase in size and abundance with increasing depth. The texture of the solum is predominantly loam, but it is gritty silty clay loam, light clay loam, or sandy clay loam in many places. The solum contains thin layers of moderately coarse textured material. Soil material that was derived from glacial till and that has a texture of loam to light clay loam occurs between a depth of 30 and 40 inches. In most places the solum is underlain by a stone line that is just above the till. These soils range from slightly acid to neutral in reaction. The C horizon, where present, generally contains carbonates.

Franklin Series, Gray Subsoil Variants

The gray subsoil variants of the Franklin series are somewhat poorly drained. They formed in 15 to 40 inches of loess or well-sorted material over loam to clay loam glacial till that has moderate structure and contains distinct gray coats. These soils are gently sloping and are in and adjacent to drainageways in the uplands. The native vegetation was trees and prairie grasses.

These soils have a thin to moderately thick, dark-colored A1 horizon of silt loam; an indistinct or distinct A2 horizon that has a texture of silt loam; and mottled B horizons developed in loess and glacial till. The glacial till has strongly contrasting gray coats on the surfaces of the structural peds.

The gray subsoil variants of the Franklin series, unlike the soils of the Frankville, Dubuque, Nasset, and Palsgrove series, have a mottled subsoil that has values of 3 and 4 and chromas of 2. Also, they are underlain by glacial till rather than by residuum and limestone bedrock. The gray subsoil variants of the Franklin series have a solum that is less variable in thickness than that of the Hayfield soils. Also, they have B horizons that formed in loess and glacial till, and they are not underlain by leached, coarse-textured material as are the Hayfield soils.

Representative profile of Franklin silt loam, gray subsoil variant, in a cultivated field, 250 feet south and 150 feet west of the NE. corner of the SE¼SE¼ sec. 29, T. 99 N., R. 10 W.:

Ap—0 to 6 inches, very dark gray (10YR 3/1) silt loam; weak, very fine, subangular blocky structure breaking to weak, fine, granular structure; friable; abundant worm casts; some fine sand noted; medium acid; abrupt, smooth boundary.

A2—6 to 14 inches, silt loam that is mainly dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) but has some very dark gray (10YR 3/1), dark-brown (7.5YR 4/4), and strong-brown (7.5YR 5/8) colors; very weak, thin, platy structure breaking to weak, fine, granular structure; friable; abundant worm casts; some fine sand noted; very strongly acid; clear, smooth boundary.

B1t—14 to 26 inches, mottled grayish-brown (2.5Y 5/2) and some yellowish-brown (10YR 5/6) light silty clay loam; weak, very fine, subangular blocky structure; friable; has some shiny structural surfaces; very strongly acid; clear, smooth boundary.

IIB21t—26 to 33 inches, light clay loam; ped exteriors light gray (10YR 7/1) when moist, and white (10YR 8/1) when dry; ped interiors light gray (10YR 7/1) and strong brown (7.5YR 5/8); weak, fine, subangular blocky structure; friable; pebble band at a depth of 33 inches; strongly acid; clear, smooth boundary.

IIB22t—33 to 40 inches, clay loam that contains some pebbles; same colors as IIB21 horizon; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable; some of the ped coats that are white (10YR 8/1) when dry appear to be thin, discontinuous clay films; slightly acid; clear, smooth boundary.

IIB23—40 to 54 inches, clay loam that contains some pebbles; ped exteriors light gray (10YR 7/1) when moist and white (10YR 8/1) when dry; ped interiors mottled dark brown (7.5YR 4/4) with some strong brown (7.5YR 5/6 and 5/8) and olive gray (5Y 5/2); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable to firm; prism surfaces coated with fine white sand; common, fine, concretions of an iron-manganese oxide; slightly acid; clear, wavy boundary.

IIC—54 to 68 inches, mottled yellowish-brown (10YR 5/6 and 5/8) and some olive-gray (5Y 5/2) clay loam containing some pebbles; massive; friable to firm; slightly acid.

These soils have moderate to strong horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from very dark gray (10YR 3/1) to black (10YR 2/1) in color. The A2 horizon ranges from 4 to 10 inches in thickness and from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) in color. In places part of the A2 horizon is incorporated in the plow layer. The texture of the A horizon centers on silt loam that is low in content of sand, but profiles that contain 5 to 15 percent very fine sand and fine sand are not excluded.

The B horizons developed in loess and glacial till. The color of the B horizons that formed in loess centers on dark grayish brown (10YR 4/2 to 2.5Y 4/2) with some mottles. In places, however, those horizons have higher values and chromas and have common grayish mottles. The peds in the B horizons that formed in glacial till have exterior colors of a prominent gray and have mottled interior colors. The texture of the till is variable and includes loam, sandy clay loam, and light clay loam with some stones and pebbles. The most acid part of the solum is very strongly acid. In most places calcareous till is below a depth of 48 inches.

Frankville Series

In the Frankville series are well-drained soils formed in loess that is 15 to 30 inches thick over limestone bedrock. In many places a thin horizon of moderately fine textured or fine textured material that is generally less than 8 inches thick lies above the bedrock. These soils have moderate horizonation, and their subsoil contains clay films. They are on sloping ridges and on the sloping to steep side slopes of ridges. The native vegetation was trees and prairie grasses.

In areas that have not been cultivated, the Frankville soils have a thin to moderately thick, dark-colored A1 horizon of silt loam; a thin, indistinct A2 horizon; and brownish B horizons of variable thickness underlain by residuum and limestone bedrock. Clay films are evident in the B horizons.

The Frankville soils occur with the Nasset and Nordness soils. They have a thicker solum than the Nordness soils but a thinner solum than the Nasset. The Frankville soils have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the Dubuque soils. They contain less sand than the Winneshiek and Waucoma soils, and they formed in loess rather than in glacial material over bedrock and residuum. The B horizons of the Frankville soils are more variable in thickness than those of the Downs soils. Unlike the Downs soils, they are underlain by limestone and residuum.

The Frankville soils are the intermediate members of a biosequence that includes the Dubuque soils of the Gray-Brown Podzolic great soil group.

Representative profile of a moderately eroded Frankville silt loam in a cultivated field, 580 feet north and 165 feet west of the center of sec. 12, T. 97 N., R. 7 W., (A2 horizon incorporated in the Ap):

Ap—0 to 6 inches, silt loam that is very dark gray (10YR 3/1), with some dark grayish brown (10YR 4/2) and dark brown to brown (10YR 4/3); weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

B1—6 to 14 inches, silt loam; dark-brown (10YR 3/3) ped exteriors and dark-brown to brown (10YR 4/3) ped interiors; very weak, very fine, subangular blocky structure; friable; whitish very fine sand or silt common on the ped surfaces when dry; slightly acid; clear, smooth boundary.

B21t—14 to 18 inches, heavy silt loam that is dark brown to brown (10YR 4/3), with some dark yellowish brown (10YR 4/4); weak, very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; common whitish silt coats on the ped surfaces when dry; slightly acid; clear, smooth boundary.

B22t—18 to 23 inches, silty clay loam that is dark yellowish brown (10YR 4/4), with some dark brown to brown (10YR 4/3) and some yellowish brown (10YR 5/6); moderate, fine and very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; common whitish silt coats on the ped surfaces when dry; slightly acid; abrupt, wavy boundary.

IIB23t—23 to 28 inches, yellowish-brown (10YR 5/6) clay interspersed with unweathered fragments of limestone; moderate, fine to medium, subangular blocky structure; very firm; thick continuous clay films; pinhole pores common; weathered limestone; neutral; abrupt, wavy boundary.

IIR—28 inches, limestone bedrock.

The A1 horizon is typically very dark gray (10YR 3/1) and ranges from 4 to 8 inches in thickness. The Ap horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color, and some mixing takes place of colors that have a value of 4 and a chroma of 2 or 3. The texture of the A horizon is commonly silt loam, but the range of texture includes silty clay loam in areas that are eroded. The A2 horizon, where present, is weakly defined. It is incorporated in the surface horizon in places.

The texture of the B horizons above the lithologic discontinuity centers on light to medium silty clay loam, but it ranges to include heavy silt loam. The loess overburden is typically about 2 feet thick, but it ranges from 15 to 30 inches in thickness. The layer of residuum is absent in places. Where present, it is commonly 1 to 6 inches thick, but it is nearly a foot thick in places. The texture of the residuum ranges from heavy silty clay loam to silty clay or clay. In many places the layer of residuum has a more reddish hue than the overburden of loessal material. The reaction in the most acid part of the solum ranges from slightly acid to medium acid.

Hagener Series

In the Hagener series are excessively drained soils that formed in wind-deposited loamy sand and sand. These soils are on upland ridgetops, side slopes, and stream benches that are nearly level to sloping. The native vegetation was prairie grasses.

The Hagener soils have a dark-colored, moderately thick A1 horizon of loamy sand, and they also have very weakly defined color B horizons of loamy sand and sand. In places dark-colored loamy sand extends to a depth of 20 inches.

The Hagener soils, unlike the Dickinson, have B horizons that formed in loamy sand. They have a thicker, darker colored A1 horizon than the Chelsea soils. In contrast to the Backbone soils and the till subsoil variants of the Lamont series, which have B horizons of sandy loam, the Hagener soils have B horizons of loamy sand and sand. Also, they are not underlain by residuum and limestone bedrock as are the Backbone soils, nor are they uniformly underlain by glacial till at a depth of 15 to 40 inches as are the till subsoil variants of the Lamont series. The Hagener soils have a thicker A1 horizon than the Lamont soils, and unlike those soils, they lack an A2 horizon and have B horizons that have a texture of sand.

Representative profile of Hagener loamy sand in a cultivated field, 25 feet east and 310 feet north of the SW. corner of the SE¼ sec. 9, T. 97 N., R. 10 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) and very dark gray (10YR 3/1) loamy sand; single grain; loose; neutral; abrupt, smooth boundary.

A1—7 to 9 inches, same as Ap horizon, except for gradual, smooth boundary.

A3—9 to 18 inches, very dark brown (10YR 2/2) and some brown to dark-brown (10YR 4/3) loamy sand; single grain; loose; medium acid; gradual, wavy boundary.

B—18 to 25 inches, very dark grayish-brown (10YR 3/2) and brown to dark-brown (10YR 4/3) sand; single grain; loose; medium acid; clear, smooth boundary.

C1—25 to 32 inches, yellowish-brown (10YR 5/4) sand; single grain; medium acid; gradual, smooth boundary.

C2—32 to 60 inches, brownish-yellow (10YR 6/6) and yellow (10YR 7/6) sand; single grain; loose; medium acid.

In areas that are not eroded, the A1 horizon ranges from 6 to 12 inches in thickness and from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) in color. In many places these soils have values of 3 to a depth of 20 inches or more.

These soils have a color B horizon that ranges from 3 to 4 in value and from 2 to 3 in chroma. In places the texture of the B horizon is loamy sand instead of sand, but it grades to sand with increasing depth. The B horizon is free of mottles, but the individual sand grains are coated with iron in many places. The most acid part of the profile is medium acid.

Hayfield Series

In the Hayfield series are somewhat poorly drained soils that formed in 24 to 45 inches of loamy material over leached sand and gravel. These soils are nearly level or gently sloping. They are on benches in the valleys of the major streams and in a few broad drainageways in the uplands. The native vegetation was trees and prairie grasses.

The Hayfield soils have a thin to moderately thick, dark-colored A1 horizon of loam and a somewhat distinct A2 horizon. Their B horizons vary in thickness, contain mottles or concretions of an oxide, and have a texture of loam to clay loam. The B horizons are underlain by sand and gravel. They contain a few discontinuous, shiny, grainy coats.

The Hayfield soils have a thinner A1 horizon than the Kato soils, and unlike those soils, they have an A2 horizon. In contrast to the Sattre soils, which are well drained, they are somewhat poorly drained. Also, in the B horizons they have chromas of 2 and mottles instead of having chromas of 3 and no mottles. The Hayfield soils have a thinner A1 horizon than the Waukegan soils, and they have an A2 horizon. Also, they have chromas of 2 and mottles in the B horizons, and they are somewhat poorly drained instead of well drained.

The Hayfield soils form a biosequence with the Kato soils, which are Brunizems.

Representative profile of Hayfield loam, deep, in a cultivated field, 630 feet west of the center of T-road intersection and 45 feet south of the road fence, all from the NE. corner of sec. 28, T. 98 N., R. 10 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam, about 20 percent mixing of very dark grayish brown (10YR 3/2) and 10 percent dark grayish brown (10YR 4/2), mainly in lower part of horizon; very dark grayish brown (10YR 3/2) if kneaded; soft clods breaking to weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—7 to 11 inches, dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) loam; dark brown to olive brown (10YR 4/3 to 2.5Y 4/3) if kneaded; common, fine, distinct, yellowish-brown (10YR 5/6) and few, fine, faint, dark yellowish-brown (10YR 3/4) mottles; weak, thick, platy structure breaking to very weak, fine, subangular blocky structure; friable; common, very dark gray (10YR 3/1) worm casts; neutral; clear, smooth boundary.

B1—11 to 16 inches, mottled grayish-brown (2.5Y 5/2) and brown (10YR 5/3) loam; grayish brown to light olive brown (2.5Y 5/3) if kneaded; common, fine, distinct, yellowish-brown (10YR 5/6) and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

B2t—16 to 29 inches, mottled yellowish-brown (10YR 5/8) and grayish-brown (2.5Y 5/2) light clay loam; grayish brown to light olive brown (2.5Y 5/3) if kneaded; few, medium, distinct, yellowish-brown (10YR 5/4) ped exteriors; weak, coarse, subangular blocky structure breaking to weak, fine, subangular blocky structure; friable; slight concentration of stones ¼ to 1 inch in diameter at a depth of 24 to 25 inches; thin, discontinuous, grayish-brown (2.5Y 5/2) silt coats on peds; common black oxides; medium acid; clear, smooth boundary.

B3—29 to 40 inches, mottled strong-brown (7.5YR 5/6 and 5/8) and grayish-brown to light brownish-gray (2.5Y 5/2 to 6/2) sandy loam; yellowish brown (10YR 5/4) if kneaded; weak, coarse, subangular blocky structure; very friable; some gravel ¼ to ¾ inch in diameter; few black oxides; medium acid; clear, smooth boundary.

IIC—40 to 45 inches, sand and some gravel; colors same as those in B3 horizon; single grain; loose; medium acid.

Two depth phases of the Hayfield series occur in Winneshiek County. In the moderately deep Hayfield loams, 24 to 36 inches of loamy material overlies the sand and gravel. The deep Hayfield loams have 36 to 45 inches of loamy material over the sand and gravel.

The Hayfield soils have moderate horizonation. The A1 horizon ranges from 4 to 10 inches in thickness and from black (10YR 2/1) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1) in color. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) and contains some mottles or concretions of an oxide.

The texture of the solum centers on loam, but in places the B horizons have a texture of heavy sandy loam, loam, light sandy clay loam, and light clay loam. The upper B horizons have hues of 10YR and 2.5Y with values of 4 and 5 and chromas of 2 and higher. The lower B horizons have hues of 7.5YR to 10YR. The mottles are yellowish brown, olive brown, and strong brown. The exterior and interior colors are somewhat contrasting in the lower B horizon. The most acid part of the solum is medium acid.

Huntsville Series

The Huntsville series consists of well-drained soils that have a very thick surface layer and weak horizonation. These soils formed in medium-textured, silty alluvium. They are in gently sloping areas at the base of the uplands and on nearly level alluvial fans where water from the uplands drains onto bottom lands and benches. The native vegetation was prairie grasses.

The Huntsville soils have dark-colored, thick A horizons of silt loam and weakly defined, brownish B horizons. The B horizons contain some coatings of organic matter.

Unlike the Lawson soils, which are mottled and have chromas of 2 below the A horizons, the Huntsville soils are free of mottles and have chromas of 3 below the A horizons. In contrast to the Kennebec soils, they have chromas of 3 above a depth of 40 inches. The Huntsville soils have brownish B horizons that are free of mottles, in contrast to the Otter and Ossian soils, which have gleyed, mottled B horizons. They have darker A horizons than the Chaseburg soils. Unlike the Terril soils, in which the content of fine and medium sand is as great as 20 to 50 percent, the Huntsville soils have a content of fine and medium sand of less than 15 percent.

The Huntsville soils are the well-drained members of a hydrosequence that includes the Lawson soils, which are somewhat poorly drained.

Representative profile of Huntsville silt loam in a cultivated field, reached by going 560 feet along road that extends northward from north end of bridge across Upper Iowa River, then 120 feet west in the SE¼SW¼ sec. 6, T. 98 N., R. 8 W.:

Ap—0 to 7 inches, black (10YR 2/1) and very dark gray (10YR 3/1) silt loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A11—7 to 18 inches, black (10YR 2/1) silt loam; weak, fine, granular structure; very friable; mildly alkaline; gradual, wavy boundary.

A-12—18 to 31 inches, black (10YR 2/1) and some very dark brown (10YR 2/2) silt loam; weak, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B1—31 to 37 inches, very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) silt loam; weak, fine, prismatic structure breaking to fine, subangular blocky structure; friable; few coats and peds of black (10YR 2/1) material from A horizons; neutral; gradual, wavy boundary.

B2—37 to 52 inches, dark-brown (10YR 3/3) and some very dark grayish-brown (10YR 3/2) silt loam; moderate, very fine, subangular blocky structure; friable; few coats and peds of black (10YR 2/1) and very dark brown (10YR 2/2); neutral; clear, smooth boundary.

B3—52 to 64 inches, dark-brown to brown (10YR 4/3) and some dark-brown (10YR 3/3) silt loam; very weak, very fine, subangular blocky structure to massive; weakly calcareous; friable.

The Huntsville soils have weak to moderate horizonation. In places they have 18 inches or less of recently deposited material on the surface. The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1) in color and from 20 to 30 inches in thickness. In places to a depth of 40 inches, coatings of organic matter that have a value of 3 or less and chroma of 2 or less mask soil material of higher chroma in the ped interiors.

The B horizons are dark brown (10YR 3/3) or very dark grayish brown (10YR 3/2) grading to brown and dark brown (10YR 4/3) and are free of mottles. No clay films are evident. In many places the boundaries of the horizons are gradual. The texture of the solum centers on silt loam that is low in content of sand (less than 15 percent), but the B horizons have a texture of light silty clay loam in many places. The soil reaction is variable and ranges from medium acid to neutral or mildly alkaline above a depth of 40 inches.

Jacwin Series

In the Jacwin series are soils that are somewhat poorly drained. These soils formed in loamy glacial material that is 15 to 30 inches thick over moderately fine textured or fine textured, neutral to calcareous shale. They are on nearly level structural benches and in sloping talus positions on side slopes in the uplands. The native vegetation was grasses.

The Jacwin soils have thick, dark-colored A horizons of loam. They have mottled B horizons that vary in thickness and are uniformly underlain by shale.

The Jacwin soils have a thicker solum than the Marlean soils, and a thinner solum than the Floyd and deep Kato soils. Also, they are underlain by shale rather than by limestone, glacial till, or coarse-textured material. The Jacwin soils have a thinner solum than the Atkinson soils. Also, they are more mottled and are less well drained than the Rockton and Atkinson soils, and unlike those soils, which are underlain by limestone, they are underlain by shale. Unlike the clay shale substratum phases of the deep Kato loams, which are underlain by shale below a depth of 42 inches and have 6 to 18 inches of coarse-textured material above the shale, the Jacwin soils are underlain by shale at a depth of 15 to 30 inches. The Jacwin soils are only moderately extensive in Winneshiek County, but locally they are important for farming.

Representative profile of Jacwin loam in a cultivated field, in the NE. corner of sec. 29, T. 96 N., R. 9 W., about 24 feet west of fence on west side of north-south road:

Ap—0 to 6 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; numerous worm casts and holes; neutral; abrupt, smooth boundary.

A1—6 to 13 inches, black (N 2/0) loam; black (10YR 2/1) if kneaded; moderate to very fine, granular structure; friable; neutral; clear, smooth boundary.

A3—13 to 19 inches, black (10YR 2/1) and some very dark grayish-brown (2.5Y 3/2) loam; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B21—19 to 23 inches, very dark grayish-brown (2.5Y 3/2) and some light olive-brown (2.5Y 5/4) and black (10YR 2/1) loam; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B22—23 to 27 inches, light olive-brown (2.5Y 5/4) and some yellowish-brown (10YR 5/6) sandy clay loam; weak, very fine, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

IIB3—27 to 48 inches, brownish-yellow (10YR 6/6) and greenish-gray (5GY 5/1) heavy silty clay loam or silty clay; moderate to strong, fine, prismatic structure; structure breaks to prismaticlike peds that become finer and finer to where their size is about 1/8 inch by 1/2 inch; very firm; springy when pressed; calcareous.

The A1 horizon ranges from black (N 2/0 to 10YR 2/1) to very dark gray (10YR 3/1) in color and from 10 to 15 inches in thickness. The A3 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR to 2.5Y 3/2) in color. The texture of the A horizons centers on loam but includes gritty silt loam. The major part of the solum has developed in the loamy overburden above the shale or shale residuum. The overburden ranges from 15 to 30 inches in thickness. The content of sand in the solum ranges from 20 to 45 percent.

The B horizons above the lithologic discontinuity have hues of 10YR and 2.5Y, values of 3 to 5, and chromas of 2 to 6, and they range from loam or sandy clay loam to light clay loam in texture. In places a thin band (6 inches or less thick) of coarser textured material is directly above the shale or shale residuum.

The shale is commonly of mixed colors and has hues of 10YR to 5G, values of 5 and 6, and chromas of 1 to 6. It ranges from heavy silty clay loam or silty clay to clay in texture. In places a minor part of the substratum consists of thin layers of fractured limestone that are interbedded with the shale. The upper part of the solum ranges from neutral to slightly acid in reaction, but the shale in the lower part is calcareous.

Kato Series

In the Kato series are soils that are somewhat poorly drained. These soils have formed in medium-textured to moderately fine textured, loamy material over leached, coarse-textured material that is at a depth between 20 and 42 inches. The Kato soils are on gently sloping benches and within broad upland drainageways. The native vegetation was prairie grasses.

The Kato soils have a moderately thick, dark-colored A1 horizon of loam. Their B horizons consist of mottled loam to light clay loam of variable thickness, and they are underlain by sand and gravel. The B horizons contain discontinuous, shiny, grainy coats.

The Kato soils have thicker A horizons than the Hayfield soils, and they do not have an A2 horizon. Their B horizons are mottled and have chromas of 2, unlike those of the Sattre soils, which lack mottles in the upper part and have chromas of 3. The Kato soils have a thicker A1 horizon than the Canoe soils; they lack the A2 horizon that is typical in the profile of the Canoe soils; and unlike the Canoe soils, they are underlain by coarse-textured material. The Kato soils are underlain by sandy material, rather than by shale like the Jacwin soils. They have more variable B horizons than the

Floyd soils, and in contrast to those soils, they have B horizons that are underlain by coarse-textured material.

The Kato soils are the Brunizemic members of a biosequence that includes the Hayfield soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems. They form a hydrosequence with the Sattre soils, which are well drained.

Representative profile of Kato loam, moderately deep, in a cultivated field, 900 feet west of the NE–SW road from the T-road intersection on the east edge of NE¼ NE¼ sec. 29, T. 96 N., R. 9 W., then 75 feet north of road right-of-way:

Ap—0 to 7 inches, black (N 2/0) loam; weak to moderate, fine and coarse, granular structure; friable; mildly alkaline; clear, smooth boundary.

A11—7 to 15 inches, black (N 2/0) loam; very weak, fine, prismatic structure breaking to weak, fine and very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2—15 to 21 inches, very dark grayish-brown (2.5Y 3/2) and some dark grayish-brown (2.5Y 4/2) to olive-gray (5Y 4/2) heavy loam; a few, fine, distinct, yellowish-brown (10YR 5/6) mottles; very weak, fine, prismatic structure breaking to weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

B3—21 to 27 inches, olive (5Y 5/3) heavy sandy loam; common yellowish-brown (10YR 5/8) mottles; very weak, fine, prismatic structure breaking to very weak, very fine, subangular blocky structure; friable; distinct, thin, discontinuous, very dark grayish-brown (10YR 3/2) coatings; neutral; clear, smooth boundary.

IIC1—27 to 34 inches, yellowish-brown (10YR 5/6), brownish-yellow (10YR 6/6), and light yellowish-brown (10YR 6/4) loamy sand; very weak, fine, subangular blocky structure breaking to single grain; very friable; neutral; clear, smooth boundary.

C2—34 to 42 inches, light brownish-gray (10YR 6/2), gray (10YR 6/1), brownish-yellow (10YR 6/6), and yellowish-brown (10YR 5/6) sand; single grain; loose; neutral; the sand extends to a depth of at least 60 inches.

Representative profile of Kato loam, deep, clay shale substratum, on a gently sloping, high structural bench, approximately 2 miles northwest of Spillville, Iowa, 325 feet south and 120 feet west of the NE. corner of the SE¼ sec. 14, T. 97 N., R. 10 W.:

A1—0 to 14 inches, black (N 2/0) gritty loam; friable; weak, very fine, subangular blocky and moderate, fine, granular structure; slightly acid; clear, smooth boundary.

A3—14 to 19 inches, black (10YR 2/1) and some very dark grayish-brown (2.5Y 3/2) loam; friable; weak, very fine, subangular blocky structure; slightly acid; clear, smooth boundary.

B1—19 to 24 inches, very dark grayish-brown (2.5Y 3/2) and some black (10YR 2/1) loam to clay loam; friable; common, fine, distinct, olive-brown (2.5Y 4/4) mottles; very fine subangular blocky structure; slightly acid; clear, smooth boundary.

B2—24 to 30 inches, very dark grayish-brown (2.5Y 3/2) and olive-brown (2.5Y 4/4) loam, very dark grayish brown (2.5Y 3/2) to dark grayish brown (2.5Y 4/2) crushed; friable; few very dark gray (10YR 3/1), discontinuous ped coatings; weak, very fine, subangular blocky structure; neutral; abrupt, wavy boundary.

IIB3—30 to 38 inches, light olive-brown (2.5Y 5/4) sandy loam; very friable; few very dark gray (10YR 3/1), discontinuous ped coatings; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; neutral; clear, wavy boundary.

IIC—38 to 44 inches, mixed brownish-yellow (10YR 6/6), yellow (10YR 7/6), and reddish-yellow (7.5YR 6/6) fine sand; very friable to loose; massive; calcareous; clear, wavy boundary.

IIIR—44 inches, shale that has a very thin cap of limestone bedrock.

Three phases of Kato loam are recognized in Winneshiek County. In the first, Kato loam, deep, the soil is underlain by coarse-textured material at a depth between 36 and 42 inches. In the second, Kato loam, moderately deep, the soil is underlain by coarse-textured material between a depth of 24 and 36 inches. In the third, Kato loam, deep, clay shale substratum, the soil is underlain by coarse-textured material between a depth of 36 and 42 inches, and the coarse-textured material overlies fine-textured shale.

The A1 horizon of the Kato soils is black (N 2/0 to 10YR 2/1) and ranges from 12 to 18 inches in thickness. The B1 horizon has color hues that center on 2.5Y, with values of 3 and 4 and chromas of 2. The B horizons are mottled. The colors are variable above the IIB3 horizon. The mottles increase in size and abundance with increasing depth.

The solum of the Kato soils typically has a texture of loam, but a texture of light clay loam or sandy clay loam is common in the B horizons. Sand that contains a higher proportion of medium-size and coarse-size fractions than the material above it occurs in thin layers below a depth of 20 to 42 inches. Some gravel occurs in places. The soil reaction is variable, but in this county it centers on slightly acid to neutral.

Kennebec Series

The Kennebec series consists of soils that are moderately well drained. These soils formed in dark-colored material that has a texture of silt loam. They are nearly level and are on first bottoms. The native vegetation was prairie grasses.

The Kennebec soils have very thick, dark-colored A horizons that have a texture of silt loam. Beneath the A horizons, their texture is also silt loam, and material of that texture extends to a depth of 40 inches or more.

In contrast to the Lawson and Huntsville soils, which have higher values and chromas between a depth of 20 and 40 inches, the Kennebec soils are dark colored and have values of 3 or less and chromas of 1 to a depth of 40 inches or more. They lack the gleyed B horizons that are typical in the profile of the Otter soils, and in contrast to those soils, they are moderately well drained instead of poorly drained. Unlike the Arenzville and Dorchester soils, which have a light-colored surface layer, they have a very thick, dark-colored A1 horizon. They are not calcareous like the Dorchester soils. The Kennebec soils are similar to the Spillville soils in color, but their solum contains less than 15 percent fine sand.

Representative profile of Kennebec silt loam in a permanent pasture, 350 feet south of the NW. corner of the NW¼SW¼ sec. 5, T. 97 N., R. 7 W.:

A11—0 to 26 inches, very dark brown (10YR 2/2) silt loam; weak, fine, granular structure; friable; neutral; clear, smooth boundary.

A12—26 to 47 inches, black (10YR 2/1) silt loam; weak, fine, subangular blocky structure breaking to moderate, fine, granular structure; friable; neutral.

The Kennebec soils have very weak horizonation. Their A horizons range from black (10YR 2/1) to very dark brown (10YR 2/2). In places as much as 5 inches of recent very dark grayish-brown (10YR 3/2) or lighter colored soil material has been deposited on the surface. In many places the combined A horizons are as thick as 40 inches or more.

In places a B horizon of very dark gray (10YR 3/1) silt loam to light silty clay loam is at a depth of 30 inches or below. Little or no stratification of silty or loamy material has taken place above a depth of 40 inches. No mottles are evident in the solum, but there are a few concretions of an oxide in many places. These soils range from slightly acid to neutral in reaction.

Kenyon Series

In the Kenyon series are soils that are moderately well drained. These soils formed in loam that is 14 to 24 inches thick over loam to clay loam, friable glacial till. They are on gently sloping, convex ridges and side slopes. The native vegetation was prairie grasses.

The Kenyon soils have a dark-colored, moderately thick A horizons range from black (10YR 2/1) to very dark clay loam. The uppermost B horizons are free of mottles, but the lower ones contain a few mottles and clay films. Their B/A clay ratio is low. In many places the C horizon is calcareous. The solum contains some stones and pebbles.

The Kenyon soils, unlike the Ostrander, have a few yellowish-brown and strong-brown mottles in the B2 horizons and some grayish mottles in the B3 and C horizons. In contrast to the Floyd soils, which have chromas of 2 and some mottles in the upper B horizon, the Kenyon soils have values of 4 and chromas of 3 in the upper B horizon. Also, they commonly have thinner A horizons and contain less stratified material than the Floyd soils. The Kenyon soils have a thicker A1 horizon than the Bassett soils and lack the A2 horizon that is typical in the profile of the Bassett soils. Unlike the Racine soils, they have mottles in the lower B horizon and lack an A2 horizon. Their solum is less variable in thickness than that of the Rockton and Atkinson soils, and they are not stratigraphically underlain by limestone residuum and bedrock like those soils. The solum of the Kenyon soils contains more sand than that of the Tama soils, and it also contains some stones or pebbles.

The Kenyon soils form a biosequence with the Bassett soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems, and with the Coggon soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Kenyon loam, in a cultivated field, 1,000 feet north and 40 feet east of the SW. corner of the NW¼ sec. 6, T. 96 N., R. 10 W.:

Ap—0 to 8 inches, black (10YR 2/1) loam; very dark brown (10YR 2/2) if kneaded; cloddy and breaks to weak, fine, granular and fine, subangular blocky structure; friable to firm; neutral; clear, smooth boundary.

A3—8 to 12 inches, loam; very dark grayish-brown (10YR 3/2) and black (10YR 2/1) ped exteriors, and very dark grayish-brown (10YR 3/2) ped interiors; very dark grayish brown (10YR 3/2) if kneaded; weak, fine, subangular blocky structure; friable; few dark-brown to brown (10YR 4/3) worm casts; strongly acid; clear, smooth boundary.

B1—12 to 16 inches, heavy loam; dark-brown to brown (10YR 4/3) and very dark grayish-brown (10YR 3/2) ped exteriors, and dark-brown to brown (10YR 4/3) ped interiors; dark brown to brown (10YR 4/3) if kneaded; weak, fine, subangular blocky structure; friable; strongly acid; gradual, smooth boundary.

IIB21—16 to 20 inches, heavy loam; contains many stones and pebbles; dark-brown to brown (10YR 4/3) ped exteriors, and dark yellowish-brown (10YR 4/4) ped interiors; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine, subangular blocky structure; friable; few, patchy, brown (10YR 5/3) ped coats; pebble band in top of horizon; very strongly acid; gradual, smooth boundary.

IIB22t—20 to 27 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; contains some stones and pebbles; yellowish brown (10YR 5/6) if kneaded; few, fine, faint, strong-brown (7.5YR 5/6) mottles; weak, fine, prismatic structure breaking to moderate, fine and medium, subangular blocky structure; friable; thin, discontinuous, grayish-brown (2.5Y 5/2) ped coats; very few, discontinuous, dark-gray (10YR 4/1) clay films; few, soft, dark-colored concretions of an oxide; strongly acid; gradual, smooth boundary.

IIB23t—27 to 41 inches, yellowish-brown (10YR 5/8) heavy loam; some stones and pebbles; few, medium, distinct, yellowish-brown (10YR 5/8) mottles on ped exteriors; common, fine, distinct, grayish-brown (2.5Y 5/2) and a few, fine, faint, strong-brown (7.5YR 5/8) mottles in ped interiors; yellowish brown (10YR 5/6) if kneaded; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable; thin, discontinuous, gray (5Y 5/1 to 6/1) coats on the surfaces of the prisms and very thin rind of olive gray (5Y 5/2) on the surfaces of the blocky peds; very few, thin, discontinuous, dark-gray (10YR 4/1) clay films; few very dark gray (10YR 3/1) clay fills in root channels; slightly acid; gradual, smooth boundary.

IIB3t—41 to 55 inches, yellowish-brown (10YR 5/8) heavy loam; some stones and pebbles; many, fine, distinct, gray (5Y 5/1) and olive-gray (5Y 5/2) mottles and a few, fine, faint, strong-brown (7.5YR 5/8) mottles; yellowish brown (10YR 5/4) if kneaded; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; friable to firm; thin rind of discontinuous, olive-gray (5Y 5/2) ped color coats, mainly on the prisms; very few, thin, discontinuous, dark-gray (10YR 4/1) clay films; few, soft, fine, black and few, soft, medium, yellowish-red concretions of an oxide; neutral; abrupt, smooth boundary.

IIC—55 to 65 inches, mottled yellowish-brown (10YR 5/8) and gray (5Y 5/1) loam; some pebbles; yellowish brown (10YR 5/4) if kneaded; massive; friable; few, soft, black and yellowish-red concretions of an oxide; calcareous.

The Kenyon soils have moderate horizonation. Their A1 horizon has a texture of loam. It ranges from black (10YR 2/1) to very dark brown (10YR 2/2) or very dark gray (10YR 3/1) in color and from 6 to 12 inches in thickness. In some places colors that have a value of 3 and chroma of 2 extend to a depth of 20 inches. The texture of the B horizons centers on heavy loam.

The B1 horizon generally has values of 4 and chromas of 3, but the values and chromas are higher at increasing depths. The B1 horizon is free of mottles, but in places yellowish-brown and strong-brown mottling occurs above a depth of 30 inches. The Kenyon soils in Winneshiek County commonly have a very thin or thin, discontinuous, grayish coating on the cleavage or prism surfaces in the

IIB3t and IIC horizons. The solum is predominantly friable, but the consistence is friable to firm in some horizons. The most acid part of the solum is very strongly acid.

Lamont Series

In the Lamont series are well-drained to excessively drained soils formed in 24 to 48 inches of material that has a texture of sandy loam and loam. These soils are on nearly level or gently sloping stream benches and on sloping to steep upland ridges and side slopes. The native vegetation was trees.

The Lamont soils have a thin, moderately dark colored A1 horizon of sandy loam; a light-colored A2 horizon; and B horizons that have a texture of sandy loam to light loam and that contain a few clay films. In many places the texture is sand below a depth of 42 inches.

The Lamont soils have a thinner, lighter colored A1 horizon than the Dickinson soils, and unlike the Dickinson soils, they have an A2 horizon. In contrast to the Chelsea soils, which have color B horizons that have a texture of loamy sand and sand and are free of clay films, the Lamont soils have B horizons that have a texture of sandy loam to loam and contain clay films. Their B horizons are more uniform in thickness than those of the Backbone soils, and their solum is not underlain by a layer of residuum and limestone bedrock like that under the solum of the Backbone soils. The Lamont soils have a thinner, lighter colored A1 horizon than the till subsoil variants of the Lamont series, and their B horizons are less variable in thickness. Also, they are not underlain by glacial till above a depth of 40 inches as are the till subsoil variants of the Lamont series.

The Lamont soils are the Gray-Brown Podzolic members of a biosequence that includes the Dickinson soils, which are Brunizems.

Representative profile of Lamont sandy loam in a cultivated field 380 feet south and 80 feet west of the NE. corner of the NW¼SE¼ sec. 8, T. 98 N., R. 7 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) and very dark grayish-brown (10YR 3/2) sandy loam; very weak granular structure; very friable; neutral; abrupt, smooth boundary.

A2—7 to 12 inches, dark grayish-brown (10YR 4/2) sandy loam; weak, thin, platy structure; very friable; neutral; clear, smooth boundary.

B1—12 to 21 inches, brown to dark-brown (10YR 4/3) sandy loam; very weak, very fine, subangular blocky structure; very friable; slightly acid; clear, smooth boundary.

B21—21 to 31 inches, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) light loam; weak, very fine, subangular blocky structure; very friable; common fine ped coatings of white sand; medium acid; clear, smooth boundary.

B22t—31 to 40 inches, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) light loam; moderate, fine, subangular blocky structure; friable; few, thin, discontinuous, dark-brown (7.5YR 4/4) clay films; strongly acid; clear, smooth boundary.

B23t—40 to 47 inches, dark yellowish-brown (10YR 3/4 and 10YR 4/4) light loam; moderate, medium, subangular blocky structure; friable; very few, thin, discontinuous, dark yellowish-brown (10YR 3/4) clay films; medium acid; abrupt, smooth boundary.

B3—47 to 54 inches, yellowish-brown (10YR 5/6) sand; some fine gravel; very weak, coarse, subangular blocky structure to single grain; loose; medium acid.

The A1 horizon is very dark gray (10YR 3/1) or very dark grayish-brown (10YR 3/2) sandy loam that ranges from 2 to 4 inches in thickness. The A2 horizon is generally dark grayish brown (10YR 4/2) and ranges from 4 to 8 inches in thickness. In areas that have been plowed, part of the A2 horizon is incorporated in the plow layer.

The B horizons generally have color values of 4 and chromas of 3, but the values and chromas are higher at increasing depths. The texture of the B horizons centers on sandy loam to light loam. A few thin, discontinuous clay films are evident in parts of the B horizons. The B3 or C horizon has a texture of sandy loam, loamy sand, or sand. The most acid part of the solum is medium acid to strongly acid. The profile is acid to a depth of 48 inches and below.

Lamont Series, Till Subsoil Variants

The till subsoil variants of the Lamont series are well drained. They formed in moderately coarse textured material that is 15 to 36 inches thick over leached, medium-textured or moderately fine textured glacial till. These soils are on sloping ridges and side slopes in the uplands. The native vegetation was trees and grasses.

These soils have a thin to moderately thick, dark-colored A1 horizon of sandy loam; an indistinct A2 horizon; and brownish B horizons that developed partly in material that has a texture of sandy loam and partly in loamy glacial till. The part of the solum formed in the material that has a texture of sandy loam is free of mottles.

The till subsoil variants of the Lamont series occur with the Bassett and Racine soils. They have a coarser texture and generally more friable consistence in the upper part of their solum than the Bassett, Racine, Kenyon, and Ostrander soils. They also have a thinner A1 horizon than the Kenyon and Ostrander soils, and unlike those soils, they have an A2 horizon. Unlike the Backbone soils, which are underlain by bedrock, the till subsoil variants of the Lamont series have a substratum of glacial till. They are similar to the Lamont soils but are underlain by glacial till at a depth between 15 and 36 inches. They have a thicker or darker colored surface layer than the Chelsea soils, and unlike those soils, they have B horizons that developed in sandy loam material and in glacial till. The till subsoil variants of the Lamont series, in contrast to the Dickinson and Hagener soils, have an A2 horizon and a substratum of medium textured glacial till.

Representative profile of Lamont sandy loam, till subsoil variant, in a cultivated field, 35 feet west and 70 feet south of the NE. corner of the NW¼NW¼ sec. 22, T. 97 N., R. 10 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) sandy loam; very dark grayish brown (10YR 3/2) if kneaded; cloddy; very friable; neutral; abrupt, smooth boundary.

A2—7 to 12 inches, dark grayish-brown (10YR 4/2) and a small amount of very dark gray (10YR 3/1) and brown to dark-brown (10YR 4/3) heavy sandy loam; weak, thin, platy structure; very friable; neutral; clear, smooth boundary.

B1t—12 to 20 inches, brown to dark-brown (10YR 4/3) sandy loam; dark yellowish brown (10YR 4/4) if kneaded; weak, very fine, subangular blocky structure; very friable; few, thin, discontinuous clay films; common fine, tubular pores; medium acid; clear, smooth boundary.

B21t—20 to 25 inches, dark yellowish-brown (10YR 4/4) light loam to sandy loam; weak, very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; common fine, tubular pores; very strongly acid; clear, smooth boundary.

IIB22t—25 to 32 inches, loam and some pebbles; brown (10YR 5/3) ped exteriors, and yellowish-brown (10YR 5/4) ped interiors; few, fine, faint, yellowish-brown (10YR 5/8) mottles; weak, very fine, subangular blocky structure; friable; common fine, tubular pores; stone line in upper part of horizon; very strongly acid; clear, smooth boundary.

IIB23t—32 to 54 inches, coarse loam; some pebbles; light brownish-gray (2.5Y 6/2) ped exteriors and mixed strong-brown (7.5YR 5/6) and light brownish-gray (2.5Y 6/2) ped interiors; dark yellowish brown (10YR 5/6) crushed; weak, very fine, subangular blocky structure; very friable; few, thin, discontinuous clay films; common fine iron-manganese concretions; very strongly acid; clear, smooth boundary.

IIC—54 to 72 inches, mixed light brownish-gray (2.5Y 6/2) and strong-brown (7.5YR 5/6) light clay loam; some pebbles; massive; firm; common fine iron-manganese concretions; slightly acid.

The till subsoil variants of the Lamont series have moderate horizonation. Their texture centers on sandy loam in the part of the solum that developed in the moderately coarse textured material. It ranges from heavy loam to sandy clay loam or light clay loam in the part developed in the glacial till. In places the profile has a thin (less than 6 inches thick) zone of coarse-textured material just above the glacial till. The A1 horizon is commonly very dark gray (10YR 3/1) and ranges from 4 to 8 inches in thickness. In general, the color of the Ap horizon is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). Where the A2 horizon has been incorporated in the plow layer, however, the color of the Ap horizon is dark grayish brown (10YR 4/2) in some places. The color of the A2 horizon centers on dark grayish brown (10YR 4/2), and that horizon ranges from 2 to 6 inches in thickness.

The B1t horizon is typically brown or dark brown (10YR 4/3) to dark yellowish brown (10YR 4/4). On the exteriors of the peds, the IIB2 horizons commonly have colors of lower chroma than those on the interiors. The exterior colors typically have values of 4 to 6 and chromas of 2 to 4 in hues of 10YR to 2.5YR. The interior colors generally have values of 5 and chromas of 4 to 6 in hues of 10YR to 7.5YR. The lower chromas are more pronounced on the peds in the lower than in the upper B horizons.

In places mottles are absent from the part of the profile formed in glacial till. Where mottles occur, they increase in number with increasing depth below the B21t horizon, and they range from few to common in the lower B horizon and in the C horizon. The color of the mottles is typically strong brown, yellowish brown, grayish brown, and gray to olive gray. The texture of the IIC horizon ranges from loam or sandy clay loam to light clay loam. The most acid horizon in the solum is medium acid to very strongly acid.

Lawson Series

In the Lawson series are somewhat poorly drained soils formed in alluvium that has a texture of silt loam. These soils are nearly level or gently sloping and are at the base of upland slopes that grade to bottom lands and low benches. In some places they are on natural levees. The native vegetation was prairie grasses.

The Lawson soils have thick, dark-colored A horizons of silt loam; grayish, mottled B horizons that also have a texture of silt loam; and stratified silty and loamy C horizons.

In contrast to the Huntsville soils, which have a subsoil that has chromas of 3 and lacks mottles, the Lawson soils have a mottled subsoil that has chromas of 2. Unlike the Kennebec soils, the Lawson soils have colors that have values of 4 and chromas of 2 above a depth of 40 inches. They have a thicker, darker colored A1 horizon than the Canoe soils, and they also lack an A2 horizon. They have darker colored A horizons than the Caneek soils, and they also lack stratification and are not calcareous like the Caneek soils. The Lawson soils have a thicker A1 horizon than the Kato soils. Also, they are not underlain by coarse-textured material at a depth between 20 and 42 inches. Unlike the Huntsville soils, which have chromas of 3 and lack mottles in the subsoil, the Lawson soils have chromas of 2 and mottles in the subsoil. In contrast to the Turlin soils, they have less than 15 percent fine sand in their solum. The Lawson soils have a thicker A1 horizon and less well defined B horizons than the Rowley soils.

The Lawson soils form a hydrosequence with the Huntsville soils, which are well drained, and with the Otter soils, which are poorly drained.

Representative profile of Lawson silt loam in a cultivated field, 165 feet south of a fence along an east-west road and 70 feet west of a fence along a north-south road in the NW¼SE¼ sec. 21, T. 98 N., R. 7 W.:

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

A12—7 to 20 inches, same as Ap horizon but has clear, smooth boundary.

A13—20 to 29 inches, black (10YR 2/1) silt loam; very weak, very fine, subangular blocky structure breaking to weak, fine, granular structure; friable; neutral; clear, smooth boundary.

B1—29 to 37 inches, silt loam that is dark grayish brown (2.5Y 4/2) or very dark grayish brown (2.5Y 3/2) with some black (10YR 2/1) coloring; weak, very fine and fine, subangular blocky structure; friable; when dry, common very fine sand grains or silt grains on ped surfaces; neutral; clear, smooth boundary.

B2—37 to 50 inches, mottled dark grayish-brown (2.5Y 4/2), light olive-brown (2.5Y 5/4), and very dark grayish-brown (2.5Y 3/2) silt loam; moderate, fine, subangular blocky structure; friable; when dry, common very fine sand grains or silt grains on ped surfaces; neutral.

The Lawson soils have weak horizonation. They have black (10YR 2/1) A1 horizons that range from 20 to 30 inches in combined thickness. In places the soil material has values of 3 and chromas of 2 to a depth of 40 inches.

A hue of 2.5Y is dominant in the B horizons. The color of the B horizons centers on values of 4 and chromas of 2, and the values commonly increase with increasing depth. In many places the subsoil has common mottles of light olive brown, olive, and olive gray. The texture throughout the solum is generally silt loam, but thin layers of other loamy material occur in places below a depth of 40 inches. The soil reaction ranges from slightly acid to mildly alkaline.

Marlean Series

In the Marlean series are soils that are well drained to excessively drained. These soils formed in a thin layer of loamy material of glacial origin over fragmented, chalky, and earthy limestone (fig. 15). The underlying material contains some fragments of hard limestone and a small proportion of chert. These soils are on gently sloping ridgetops and on sloping or steep side slopes, below stony areas and outcrops of limestone. The native vegetation was grasses.

***Figure 15.*—Typical profile of a Marlean soil. A large number of fragments of hard limestone and chert are mixed with the material from limestone.**

The Marlean soils have a moderately thick, dark-colored A horizon of loam and thin, brownish B horizons of variable thickness that are underlain by fragmented limestone. The subsoil is free of mottles and clay films.

The Marlean soils have a thicker, darker colored A1 horizon than the Nordness soils, and unlike those soils, they lack an A2 horizon. Also, their solum has a higher content of sand (20 to 45 percent) than that of the Nordness soils. Their solum is thinner than those of the Rockton, Winneshiek, and Atkinson soils, and it lacks the A2 horizon that is typical in the solum of the Winneshiek soils. The Marlean soils have a solum that is thinner and higher in content of sand than that of the Frankville soils. They also have a thicker A1 horizon than those soils, lack an A2 horizon, and were derived from material of glacial origin over limestone instead of from loess.

Representative profile of Marlean loam in a cultivated field, 245 feet west and 60 feet north of the southeast fence corner of the SW¼SW¼ sec. 5, T. 97 N., R. 9 W.:

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

A1—6 to 9 inches, very dark brown (10YR 2/2) loam; weak, very fine, subangular blocky structure breaking to weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

B2—9 to 12 inches, very dark grayish-brown (10YR 3/2) and some very dark brown (10YR 2/2) and dark brown (10YR 3/3) to dark brown and brown (10YR 4/3) loam; weak, very fine, subangular blocky structure; friable; neutral; abrupt, wavy boundary.

IIC—12 to 48 inches, bed of fragmented shaly limestone; 70 to 80 percent fragments of limestone ¼ inch to 3 inches in diameter; very dark grayish-brown (10YR 3/2), dark-brown (10YR 3/3), dark-brown to brown (10YR 4/3), and dusky-red (2.5YR 3/2) loamy material in fillings between the fragments; the fragments are calcareous, and the fillings between the fragments are mildly alkaline; common roots between fragments; the material between fragments becomes more nearly yellowish brown with increasing depth.

The Marlean soils have weak horizonation. The A1 horizon ranges from 6 to 10 inches in thickness. Its color is commonly black (10YR 2/1) to very dark brown (10YR 2/2), but the range of color includes very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) where the soil has been plowed. The texture of the A horizon ranges from loam to gritty silt loam.

The B2 horizon has values of 3 to 5 and chromas of 2 to 4, grading to higher chroma with increasing depth. The texture of the B2 horizon centers on loam, but the texture is sandy clay loam or light clay loam in places.

Fine-textured residuum is absent above the earthy limestone in most places, and it is not a characteristic of the series. The thickness of the layer of material of glacial origin ranges from 5 to 15 inches. Beneath that material is typically soft, earthy limestone that also contains harder fragments of limestone and chert. Hard, level-bedded limestone is commonly at a depth between 10 and 12 feet. Thin layers of shale interbedded with limestone make up a minor part of the substratum. The solum ranges from neutral to slightly acid in reaction.

Nasset Series

In the Nasset series are soils that are well drained. These soils formed in 30 to 50 inches of loess over limestone bedrock or in a thin layer of residuum over limestone bedrock. The residuum is moderately fine textured or fine textured. It is typically 1 to 6 inches thick, but the thickness ranges from 0 to 10 inches. These soils are on sloping ridgetops and on sloping to steep side slopes. The native vegetation was trees and grasses.

The Nasset soils have a thin to moderately thick, dark-colored A1 horizon of silt loam; an indistinct to distinct A2 horizon; and brownish B horizons that vary in thickness and that are stratigraphically underlain by bedrock or by a thin layer of residuum over bedrock. Parts of the B horizons contain clay films.

The Nasset soils occur with Downs and Frankville soils. Their profile is similar to that of the Downs soils, but they have B horizons that vary in thickness. Also, their subsoil is underlain by limestone bedrock. The Nasset soils have a thicker solum than the Frankville soils. Also, they developed in 30 to 50 inches of loess over residuum or limestone bedrock instead of in 15 to 30 inches of loess over a thin layer of limestone residuum or bedrock. The Nasset soils are lower in content of sand (less than 10 percent) than the Winneshiek and Waucoma soils. They have a thicker, darker colored A1 horizon than the Palsgrove soils. Also unlike the Palsgrove soils, the Nasset soils have only a weak A2 horizon or distinct, grayish, grainy coats on the surfaces of the peds in the upper B horizon.

The Nasset soils are the intermediate members of a biosequence that includes the Palsgrove soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Nasset silt loam in a cultivated field, 330 feet east and 35 feet south of the center of sec. 12, T. 97 N., R. 7 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) and some dark grayish-brown (10YR 4/2) silt loam; weak, fine, granular structure; friable; medium acid; abrupt, smooth boundary.

A2—8 to 15 inches, silt loam; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) when moist and light brownish gray (10YR 6/2) when dry; very weak, thin, platy structure breaking to weak, fine, granular structure; friable; when dry, has white very fine sand or silt on cleavage planes; strongly acid; clear, smooth boundary.

B11—15 to 21 inches, silt loam; dark-brown to brown (10YR 4/3) ped exteriors; yellowish-brown (10YR 5/4) ped interiors; weak, very fine, subangular blocky structure; friable; when dry, has white very fine sand or silt grains on ped surfaces; medium acid; clear, smooth boundary.

B12—21 to 27 inches, silt loam; dark-brown to brown (10YR 4/3) ped exteriors; yellowish-brown (10YR 5/4) ped interiors; weak, very fine and fine, subangular blocky structure; friable; when dry, has very abundant white very fine sand or silt on ped surfaces; medium acid; clear, smooth boundary.

B21—27 to 34 inches, silt loam; dark-brown to brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; weak, very fine and fine, subangular blocky structure; friable; when dry, has abundant, white, very fine sand or silt coats on ped surfaces; medium acid; clear, smooth boundary.

B22t—34 to 37 inches, light silty clay loam; dark-brown (7.5YR 3/2 to 4/2) ped exteriors; dark-brown to brown (10YR 4/3) ped interiors; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable to firm; common thin, discontinuous clay films; medium acid; abrupt, wavy boundary.

IIB23t—37 to 42 inches, yellowish-brown (10YR 5/6) and reddish-yellow (7.5YR 6/6) clay; moderate, fine and medium, subangular blocky structure; very firm; thick, continuous clay films; weathered limestone; neutral; abrupt, wavy boundary.

IIR—42 inches, limestone bedrock.

The Nasset soils have moderate to strong horizonation. Except in eroded areas, where in places the texture of the Ap horizon is light silty clay loam, the texture of the A1 or Ap horizon is commonly silt loam. The A1 horizon ranges from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) in color and from 4 to 8 inches in thickness. In general, the Ap horizon is between a very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) in color, but in places it contains mixings of dark grayish brown (10YR 4/2) and of dark brown to brown (10YR 4/3). In places all of the A2 horizon has been incorporated in the Ap horizon.

The B horizons above the lithologic discontinuity typically have a hue of 10YR, values of 4 or 5, and chromas of 3 to 6, but the hue is 7.5YR in places. The texture of the B horizons above the residuum ranges from heavy silt loam to medium silty clay loam. The residuum is commonly neutral in reaction and ranges in texture from heavy silty clay loam or silty clay to clay. In many places it is more reddish than the material derived from loess. The layer of residuum is typically between 1 and 6 inches thick, but the thickness ranges from 0 to 10 inches. The soil reaction is variable. The most acid part of the solum is medium acid to strongly acid.

Nordness Series

The soils of the Nordness series are well drained. They formed in 5 to 15 inches of silty material, dominantly loess, over limestone bedrock or a thin layer of residuum and limestone bedrock. These soils are on sloping ridgetops, on sloping to steep side slopes, and in areas of escarpments in the uplands. The native vegetation was trees.

The Nordness soils have a thin, moderately dark colored A1 horizon of silt loam; a distinct or moderately distinct A2 horizon; and thin, but recognizable, B horizons of variable thickness. In many places there are a few clay films. The solum is underlain by hard, level-bedded limestone bedrock.

The Nordness soils have a thinner, lighter colored A1 horizon than the Marlean soils. Also, in areas that are not eroded, they have an A2 horizon that is lacking in the Marlean soils. They have a silty rather than a loamy solum like that of the Marlean soils. Also, they are underlain by a thin layer of residuum and hard, fractured limestone bedrock instead of by softer material that contains a larger proportion of interfragments of loamy material. The Nordness soils have a thinner solum and a less well defined B horizon than the Whalan soils and a thinner solum than the Palsgrove and Dubuque soils. They occur with Dubuque soils and with areas of Steep rock land.

Representative profile of Nordness silt loam in open timber, reached by going 140 feet along road from center of T-road intersection, then 15 feet east of road right-of-way to extreme SW. corner of SE¼ sec. 21, T. 99 N., R. 7 W.:

A1—0 to 2 inches, very dark gray (10YR 3/1) and dark grayish-brown (10YR 4/2) silt loam; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A2—2 to 5 inches, dark grayish-brown (10YR 4/2) silt loam; moderate, thin and medium, platy structure breaking to weak, very fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B1—5 to 9 inches, dark-brown to brown (10YR 4/3) silt loam; moderate, very fine, subangular blocky structure; friable; common, thin, very dark grayish-brown (10YR 3/2) ped coats; neutral; clear, smooth boundary.

IIB2t—9 to 12 inches, dark-brown (7.5YR 3/2) and reddish-brown (5YR 4/4) silty clay loam; moderate, very fine, subangular blocky structure; friable; few, thin, discontinuous, black (10YR 2/1) clay films; neutral; abrupt, wavy boundary.

IIR1—12 to 18 inches, bed of clean limestone or slabs of limestone; the slabs of rock are 8 to 10 inches and larger in diameter and 2 to 5 inches thick; horizontally between the slabs is a very thin (less than one-fourth inch) accumulation of reddish, calcareous silty clay loam, and vertically as much as 2 inches of reddish, calcareous silty clay loam.

IIR2—18 inches, dense, hard, level-bedded limestone bedrock.

The Nordness soils have weak to moderate horizonation. The color of their A1 horizon is centered on very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). In areas that have been cultivated, however, the color of the Ap horizon includes dark gray (10YR 4/1) and dark grayish brown (10YR 4/2). The thickness of the A1 horizon ranges from 2 to 5 inches. The A2 horizon is typically dark grayish brown (10YR 4/2), but that horizon is not discernible in many areas that have been cultivated. The texture of the A1 and A2 horizons ranges from loam to silt loam.

The B horizons are weakly to moderately defined, and they were derived from two-storied parent material in places. From 25 to 35 percent of the B1 horizon is clay. Typically, the material in which the lower B horizon formed includes a layer of residuum that is less than 6 inches thick. Residual material is absent in some places, however, and in other places the thickness ranges to 10 inches or more. In many places the color of the material below the lithologic discontinuity has a more reddish hue than that above. The soil reaction is variable; the soils range from neutral to medium acid in reaction.

Oran Series

In the Oran series are somewhat poorly drained soils that formed in 14 to 24 inches of loamy material over loam to clay loam glacial till. These soils are nearly level or gently sloping and are on slopes in the uplands and in areas adjacent to drainageways. The natural vegetation was trees and prairie grasses.

The Oran soils have a thin to moderately thick, dark-colored A1 horizon of loam; a somewhat distinct A2 horizon; and mottled B horizons that have a texture of loam to clay loam and that contain some stones and pebbles. In parts of the B horizon, there are some clay films or clay flows. The interior and exterior colors of the peds are distinctly contrasting in the B2 and B3 horizons. In many places a stone line lies between the loam sediment and the glacial till.

The Oran soils have a thinner A1 horizon than the Floyd soils, and unlike those soils, they have an A2 horizon. Also, they formed in a thinner layer of loamy sediments over glacial till than did the Floyd soils. Unlike the Bassett soils, they have colors that have a chroma of 2, and they have mottles in the B1 horizon. The combined thickness of the B horizons is less variable in the Oran than in the Hayfield soils. Also, the Oran soils are not underlain by a uniform layer of coarse-textured material like the Hayfield soils. The Oran soils were derived from glacial till instead of alluvium and have a higher content of sand than the Canoe soils, which are silty. Also, unlike the Canoe soils, they contain some stones and pebbles. The Oran soils have a higher content of sand in the upper part of their solum than do the gray subsoil variants of the Franklin series, which have formed in 15 to 40 inches of loess.

The Oran soils form a hydrosequence with the Bassett soils, which are moderately well drained.

Representative profile of Oran loam in a cultivated field, 400 feet north and 65 feet east of the SW. corner of the SW¼NW¼ sec. 29, T. 97 N., R. 10 W.:

Ap—0 to 8 inches, very dark gray (10YR 3/1) loam; weak, fine, subangular blocky to weak, fine, granular structure; friable; a few dark grayish-brown (10YR 4/2) mixings from A2 horizon; neutral; abrupt, smooth boundary.

A2—8 to 14 inches, dark grayish-brown (10YR 4/2) loam; moderate, thin, platy structure; friable; common, fine, distinct, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) worm casts and mixings; strongly acid; clear, smooth boundary.

B1—14 to 19 inches, dark grayish-brown (10YR 4/2) heavy loam; weak, fine, subangular blocky structure; common, fine, faint, yellowish-brown (10YR 5/4) mottles; friable; many, fine, inped tubular pores; numerous stones 1 to 3 inches in diameter in lower part of horizon; strongly acid; clear, smooth boundary.

IIB2—19 to 28 inches, heavy loam; some stones and pebbles; grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) colors in a finely mottled pattern on ped exteriors; weak, fine, subangular blocky structure; friable; insides of peds have higher proportion of yellowish-brown (10YR 5/6) colors than exteriors; many, fine, inped tubular pores; strongly acid; clear, smooth boundary.

IIB3t—28 to 42 inches, heavy loam; some stones and pebbles; grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) ped interiors; weak to moderate, medium, prismatic structure breaking to weak, fine to medium, prismatic structure; the grayish-brown (2.5Y 5/2) color more distinct on prism surfaces than on peds; prisms and ped exteriors have thin, grayish-brown (2.5Y 5/2) coats of very fine sand or silt and common, fine, distinct, yellowish-brown (10YR 5/6) mottles; many fine pores; a few, distinct, very dark gray (10YR 3/1) clay flows in vertical root channels; a few, fine, dark-colored oxide concretions; slightly acid to neutral; clear, wavy boundary.

IIC—42 to 50 inches, yellowish-brown (10YR 5/6) loam; some stones and pebbles; massive; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; firm; a few fine and medium pores; a few soft carbonate concretions; calcareous.

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The Oran soils have moderate horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1) in color. The color of the A2 horizon centers on a value of 4 and a chroma of 2, but the values are lower or higher than 4 in some places. The A2 horizon is generally between 4 and 8 inches thick. In some areas that have been plowed, part of the A2 horizon is incorporated in the surface layer. In the uppermost 14 to 24 inches of the solum, the texture is loam to silt loam.

The texture of the B horizons centers on heavy loam, but it ranges from light clay loam to sandy clay loam. Those horizons contain some stones and pebbles. In many places in the B horizons, the hue is 2.5Y, but the hues range from 10YR in the upper B horizons to 5Y on some exterior coats in the lower B horizon. Color values of 4 grading to 5 and chromas of 2 are most common in the B horizons. The lower B horizon has contrasting exterior and interior colors. The mottles range from yellowish brown to olive gray and grayish brown in color. In the most acid part of the solum, the reaction is strongly acid or very strongly acid. In places, however, the glacial till is calcareous below a depth of 42 inches.

Orwood Series

In the Orwood series are well-drained soils that formed in wind-deposited material that has a texture of loam or silt loam. These soils are gently sloping to steep and are on ridgetops and side slopes in the uplands. The native vegetation was trees and prairie grasses.

The Orwood soils have a thin to moderately thick, dark colored or moderately dark colored A1 horizon of silt loam to loam; an indistinct A2 horizon in areas that are not eroded; and B horizons of brownish silt loam to loam. Some clay films are in the B horizons. The B1 and B2 horizons are free of mottling.

The Orwood soils have a higher content of sand than the Downs soils, which were derived from loess. They have a lower content of sand and a darker, thicker A1 horizon than the Lamont soils. The Orwood soils have a lower content of sand and a thinner A1 horizon than the Dickinson soils, and they have an A2 horizon in areas that are not eroded. They have a higher content of sand and a thicker solum than the Nasset soils, and their solum is not underlain by limestone and limestone residuum like that of the Nasset soils. Unlike the Racine and Bassett soils, which were derived from till, the Orwood soils were derived from windblown material and have a solum that is free of stones and pebbles.

Representative profile of Orwood silt loam in a cultivated field, about 30 feet north and 160 feet east of the SW. corner of the NW¼NW¼ sec. 23, T. 100 N., R. 10 W.:

Ap—0 to 8 inches, silt loam to loam; very dark grayish brown (10YR 3/2) when moist and grayish brown (10YR 5/2) when dry; weak, very fine, granular structure; friable; neutral; abrupt, smooth boundary.

B1—8 to 13 inches, dark-brown (10YR 3/3 to 10YR 4/3) silt loam to loam; weak, fine, subangular blocky structure; friable; some peds and coats of very dark grayish brown (10YR 3/2); neutral; clear, smooth boundary.

B21t—13 to 23 inches, heavy silt loam to loam; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; moderate, fine, subangular blocky structure; friable; common, fine, inped tubular pores; distinct, discontinuous, dark-brown (10YR 3/3) clay films and a few black oxide stains on the peds; neutral; clear, smooth boundary.

B22t—23 to 29 inches, silt loam to loam; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; moderate, fine, subangular blocky structure; friable; common, thin, discontinuous, dark-brown (10YR 3/3) clay films and a few black oxide stains on the ped surfaces; common, fine, inped tubular pores; medium acid; clear, smooth boundary.

B31t—29 to 42 inches, loam; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4//4) ped interiors; weak, medium, subangular blocky structure and some tendency toward prismatic structure; friable; thin, distinct, discontinuous clay films and a few black oxide stains; common, fine, inped tubular pores; prism surfaces have prominent, very thin coatings of sand grains that are very pale brown (10YR 7/3) when dry and that can be seen only when soil material is dry; medium acid; clear, smooth boundary.

B32—42 to 50 inches, silt loam; dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/4) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; weak, medium to coarse, prismatic structure; friable; many, fine, inped tubular pores; prism surfaces have distinct coatings of sand grains that are very pale brown (10YR 7/3) when dry and that can be seen only when soil material is dry; medium acid; clear, smooth boundary.

C—50 to 60 inches, yellowish-brown (10YR 5/4) silt loam; massive; friable.

The Orwood soils have moderate horizonation. The A1 horizon ranges from 4 to 8 inches in thickness, from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in color, and from silt loam to loam in texture. Where an A2 horizon is present, it is 2 to 4 inches thick and is mainly dark grayish brown (10YR 4/2) but contains some material that is very dark grayish brown (10YR 3/2). In areas that are cultivated or that are eroded, the A2 horizon is commonly mixed with the plow layer. In many areas that are cultivated, an abrupt boundary separates the Ap horizon from the B1 horizon, where the colors have a value of 4 and chroma of 3. An abrupt boundary also separates the A1 horizon from the B horizons. Grainy coats are evident in many places in the B horizons.

The B horizons have color values of 4 or higher and chromas of 3 or higher with increasing depth. In some places yellowish-brown and strong-brown mottles are below a depth of 30 inches. The texture of the B horizons centers on loam or silt loam, but it is very light clay loam in places. The content of sand in the solum ranges from 20 to 40 percent, and the sand is predominantly fine. The solum contains a few very thin layers of fine sandy loam. The soils range from neutral to strongly acid in reaction.

Ossian Series

In the Ossian series are soils that are poorly drained. These soils formed in medium-textured, silty alluvium derived mainly from soils of the uplands that developed in loess. These soils typically contain less than 10 percent sand. They are on nearly level first bottoms and in upland drainageways. The native vegetation was grasses and sedges that are tolerant of excessive wetness.

The Ossian soils have an A1 horizon of dark or moderately dark colored silt loam. This A1 horizon is separated from a distinctly gleyed and mottled B horizon of silt loam by an abrupt boundary.

The texture and horizon development of the Ossian soils are similar to those of the Otter soils. The Ossian soils have a thinner A horizon than the Otter, however, and they have gleyed colors above a depth of 20 inches. The Ossian soils have a thinner A horizon than the Rowley soils, and unlike the Rowley soils, they have distinctly gleyed B horizons. They have a thinner A horizon than the Huntsville soils. Also, they have gleyed B horizons and are poorly drained instead of well drained. In contrast to the Kennebec soils, which are dark colored to a depth of 40 inches or more, the Ossian soils are dark colored to a depth of about 18 inches. Also, they have more strongly defined B horizons than the Kennebec soils. The Ossian soils have less sand throughout the solum than the Clyde soils, which formed in glacial material.

Representative profile of Ossian silt loam along the Yellow River in a cultivated field, 725 feet south and 115 feet east of the northwest corner of sec. 12, T. 96 N., R. 7 W.:

Ap—0 to 7 inches, black (N 2/0) heavy silt loam; cloddy but breaks to weak, medium, subangular blocky structure; friable; neutral; abrupt, smooth boundary.

A12—7 to 15 inches, black (N 2/0) heavy silt loam; moderate, fine, granular structure; friable; neutral; gradual, smooth boundary.

A13—15 to 18 inches, black (10YR 2/1) heavy silt loam; black (10YR 2/1) to very dark gray (10YR 3/1) if kneaded; moderate, fine and very fine, granular structure; friable; few, fine, distinct, olive-gray (5Y 5/2) peds or mixings; neutral; gradual, smooth boundary.

B1g—18 to 23 inches, very dark gray (2.5Y 3/1) and 10 percent olive-gray (5Y 5/2) silt loam to silty clay loam; weak, fine and very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2g—23 to 32 inches, dark-gray (5Y 4/1) to olive-gray (5Y 5/2) silt loam to silty clay loam; olive gray (5Y 5/2) to olive (5Y 5/3) if kneaded; weak, medium, prismatic structure breaking to weak, fine, subangular blocky structure; friable; few, patchy, dark ped surfaces; neutral; gradual, smooth boundary.

B3g—32 to 42 inches, silt loam to light silty clay loam; olive-gray (5Y 5/2) ped exteriors; olive-gray (5Y 5/2) to olive (5Y 5/3) interiors; common, fine, distinct, yellowish-brown mottles inside peds; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; friable; few, fine, distinct concretions of iron and manganese; few dark coats in pores; neutral; clear, wavy boundary.

Cg—42 to 50 inches, olive-gray (5Y 5/2) and yellowish-brown (10YR 5/8) silt loam; some vertical cleavage; very friable; few, fine, distinct concretions of iron and manganese; weakly calcareous; moderately alkaline.

The Ossian soils have moderate horizonation. The A1 horizon is commonly black (N 2/0 to 10YR 2/1), but it is very dark gray (10YR 3/1 and 5Y 3/1) in places. The A1 horizon ranges from 10 to 20 inches in thickness. Colors that have values of 4 to 6, chromas of 1 or 2, and a hue of 5Y are typical in the B horizons, but the range of color includes a hue of 2.5Y. In many places yellowish-brown mottles occur throughout the B horizons.

Soils that lack a gleyed horizon immediately below the A horizons are considered to be outside the range of the Ossian series. Throughout the solum, the texture is centered on silt loam. The range of texture includes light silty clay loam, however, and soil material that is approximately 25 to 35 percent clay and generally less than 10 percent sand. In most places the solum is free of stratification. Coarse-textured underlying material is generally below a depth of 5 feet. The soils range from neutral to slightly acid in reaction.

Ostrander Series

The Ostrander series consists of well-drained soils that formed in friable, loamy glacial material and glacial till. A pebble band separates the loamy overburden from the glacial till. These soils are gently sloping to sloping and are on upland highs or ridgetops and on convex side slopes. The native vegetation was prairie grasses.

The Ostrander soils have moderately thick, dark-colored A horizons of loam. They have brownish B horizons of loam to clay loam that are free of mottles above a depth of 30 inches. The B and C horizons are friable, and contrasting exterior and interior colors are not pronounced in those horizons. In places there are a few clay films, but their B/A clay ratio is low. Cobbles and pebbles are common in the solum below the pebble band.

The Ostrander soils have more brownish IIB3t and IIC horizons than the Kenyon soils, and they lack the grayish mottles that are slightly evident in the profile of the Kenyon soils. They have a thicker, darker colored A1 horizon than the Renova and Racine soils, and they lack the A2 horizon that is typical in the profiles of the Renova and Racine soils. The Ostrander soils have a thicker solum than the Rockton and Atkinson soils, and they are not underlain by limestone and limestone residuum like those soils. They have a thicker solum than the Waukegan soils, and they are underlain by finer textured material than those soils.

The Ostrander soils form a biosequence with the Racine soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems, and with the Renova soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Ostrander loam in a cultivated field on the western edge of the NE¼SE¼ of sec. 30, T. 99 N., R. 10 W., reached by going 60 feet north of road fence and 25 feet east:

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; very weak, very fine, subangular blocky structure breaking to granular structure; friable; strongly acid; abrupt, smooth boundary.

A1—8 to 12 inches, same as Ap horizon but has a clear, smooth boundary.

A3—12 to 18 inches, very dark grayish-brown (10YR 3/2) and some very dark brown (10YR 2/2) loam; very weak, very fine, subangular blocky structure breaking to granular structure; friable; medium acid; clear, smooth boundary.

B11t—18 to 22 inches, brown to dark-brown (10YR 4/3) loam; weak, very fine, subangular blocky structure; friable; common, thin, discontinuous, dark yellowish-brown (10YR 4/4) clay films; medium acid; abrupt, smooth boundary.

IIB12t—22 to 24 inches, pebble band; pebbles 1 to 3 inches in diameter embedded in soil material; other characteristics similar to those of B11t horizon.

IIB21t—24 to 34 inches, dark yellowish-brown (10YR 4/4) light clay loam; some stones and pebbles; weak, fine, prismatic structure breaking to weak, very fine and fine, subangular blocky structure; friable; common, thin, discontinuous, brown to dark-brown (10YR 4/3) clay films; medium acid; clear, smooth boundary.

IIB22t—34 to 44 inches, light clay loam; some stones and pebbles; yellowish-brown (10YR 5/4) ped exteriors; yellowish-brown (10YR 5/6) ped interiors; moderate; fine, subangular blocky structure; friable; common, thin, discontinuous, brown to dark-brown (10YR 4/3) clay films and some very dark gray (10YR 3/1) clay flows; common fine iron-manganese concretions of an oxide; medium acid; gradual, smooth boundary.

IIB3t—44 to 55 inches, light clay loam; some stones and pebbles; yellowish-brown (10YR 5/4) ped exteriors; yellowish-brown (10YR 5/6) ped interiors; weak, medium, subangular blocky structure; friable; few, thin, discontinuous, brown to dark-brown (10YR 4/3) clay films; few dark-gray (10YR 3/1) clay accumulations; common fine iron-manganese concretions of an oxide; neutral; abrupt, smooth boundary.

IIC—55 inches, same color as IIB3t horizon; calcareous.

The Ostrander soils have moderate horizonation. The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) in color and from 8 to 15 inches in thickness. The texture of the A1 horizon is generally loam, but an A1 horizon that has a texture of silt loam and that is as much as 15 inches thick is not excluded. In places colors that have a value of 3 and chroma of 2 extend to a depth of 20 inches.

The B horizons have values of 4 and higher and chromas of 3 and higher with increasing depth. A pebble band at a depth of 18 to 24 inches is common. The texture of the B horizons centers on loam to clay loam. Clay films are evident in the B horizons, but their B/A clay ratio is low. Mottles are generally absent above a depth of 30 inches, but where they occur, they have a color of yellowish brown to strong brown. The entire solum is friable. The reaction centers on medium acid, but in places calcareous glacial till is below a depth of 48 inches.

Otter Series

In the Otter series are poorly drained soils that formed in medium-textured, silty alluvium. These soils are nearly level and occur in a complex pattern with the Colo soils on first bottoms. The native vegetation was sedges and grasses that tolerate excessive wetness.

The Otter soils have very thick, black A horizons of silt loam and gleyed, mottled B horizons, also of silt loam. The A and B horizons contain less than 20 percent fine sand. In places the solum contains stratified loamy and silty material below a depth of 40 inches.

The Otter soils, unlike the Kennebec, have a gleyed B horizon at a depth between 30 and 40 inches. They have more grayish hues than the Lawson soils and unlike those soils, they have color values of 5 and 6 and chromas of 1 and 2. They have a gleyed subsoil and less structural development than do the Rowley soils. The Otter soils are not gleyed like the Ossian soils above a depth of 20 inches. They have a texture of silt loam to a depth of 40 inches or more, rather than silty clay loam like that in the Colo soils.

Representative profile of Otter silt loam in a permanent pasture, 315 feet south and 60 feet west of the NE. corner of the NW¼NE¼ sec. 14, T. 98 N., R. 10 W.:

A11—0 to 8 inches, very dark gray (10YR 3/1) and black (10YR 2/1) silt loam; weak, very fine, subangular blocky structure breaking to fine granular structure; friable; recent deposition; neutral; abrupt, smooth boundary.

A12—8 to 26 inches, black (10YR 2/1) silt loam; weak, fine, granular structure; friable; few, fine, dark-brown (7.5YR 4/4) iron-manganese concretions of an oxide; neutral; gradual, smooth boundary.

A13—26 to 37 inches, black (10YR 2/1 to N 2/0) and some very dark gray (N 3/0) heavy silt loam; weak, very fine, subangular blocky structure; friable; few, fine, dark-brown (7.5YR 4/4) iron-manganese concretions of an oxide; neutral; gradual, smooth boundary.

Bg—37 to 47 inches, dark-gray (5Y 4/1), olive-gray (5Y 4/2), and some very dark grayish-brown (2.5Y 3/2) silt loam; weak, very fine, subangular blocky structure; friable; few, fine, dark-brown (7.5YR 4/4) iron-manganese concretions of an oxide; neutral; gradual, smooth boundary.

Cg—47 to 58 inches, mottled light olive-gray (5Y 6/2), gray (5Y 6/1), olive-gray (5Y 5/2), and yellowish-brown (10YR 5/8) silt loam; massive; friable; neutral.

The A1 horizon is black (10YR 2/1 to N 2/0) and ranges from 30 to 40 inches in thickness. The Bg horizon is distinctly gleyed and has a hue of 5Y, values of 4 to 6, and chromas of 1 and 2. In many places the B and C horizons contain strongly contrasting mottles. The structure is weakly expressed. The texture of the solum centers on medium to heavy silt loam. The content of fine sand increases with increasing depth, but it ranges from 10 to 20 percent above a depth of 40 inches. The reaction is generally neutral, but these soils are slightly acid to mildly alkaline in places.

Palsgrove Series

In the Palsgrove series are well-drained soils formed in 30 to 50 inches of loess over limestone residuum and limestone bedrock. In most places the layer of residuum is thin. These soils are on gently sloping ridgetops in the uplands and on steep, convex side slopes. The native vegetation was trees.

These soils have a thin, moderately dark colored A1 horizon. In areas that are not eroded, they have a distinct A2 horizon. They have brownish B horizons that developed mainly in loess, but in some places part of the lower B horizon formed in residuum.

The Palsgrove soils have a thinner, lighter colored A1 horizon and in many places a more distinct A2 horizon than the Nasset soils. They have a thicker solum than the Dubuque soils and a thicker solum and a thinner, lighter colored A1 horizon than the Frankville soils. The Palsgrove soils have a more silty profile (less than 10 percent fine sand) than the Whalan soils. They formed in loess over limestone residuum and bedrock, rather than in glacial material.

The Palsgrove soils form a biosequence with the Nasset soils, which are also in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of a moderately eroded Palsgrove silt loam that has slopes of 11 percent and that has the A2 horizon incorporated in the Ap, in a cultivated field 750 feet east and 360 feet north of the SW. corner of the SE¼ sec. 14, T. 100 N., R. 8 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam; weak granular structure; friable; when dry, common coatings of white silt or very fine sand noted; slightly acid; abrupt, smooth boundary.

B1—6 to 11 inches, brown to dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) silt loam; weak, very fine, subangular blocky structure; friable; when dry, common coatings of white silt or very fine sand noted; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

B21t—11 to 22 inches, silty clay loam; brown to dark-brown (10YR 4/3) ped exteriors; yellowish-brown (10YR 5/4) ped interiors; moderate, fine, subangular blocky structure; friable; when dry, common coatings of white silt or very fine sand noted; common, thin, discontinuous clay films; strongly acid; few iron-manganese concretions of an oxide; clear, smooth boundary.

B22t—22 to 34 inches, silt loam that is yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/4), and brown to dark brown (10YR 4/3), with streaks of strong brown (7.5YR 5/8); moderate, fine, subangular blocky structure; friable; when dry, prominent coatings of white silt or very fine sand noted; few, thin, discontinuous clay films; strongly acid; few iron-manganese concretions of an oxide; clear, smooth boundary.

B31t—34 to 40 inches, silt loam that is mixed yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/4), and brown to dark brown (10YR 4/3), with streaks of strong brown (7.5YR 5/8); weak, coarse, subangular blocky structure; friable; when dry, prominent coatings of white silt or very fine sand noted; very few, thin, discontinuous clay films; medium acid; few iron-manganese concretions of an oxide; abrupt, smooth boundary.

IIB32t—40 to 42 inches, dark-brown to brown (7.5YR 4/4) gritty silty clay; few, fine, faint, yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) mottles; moderate, very fine, subangular blocky structure; firm; few very dark grayish-brown (10YR 3/2) clay balls; neutral; abrupt, wavy boundary.

IIR—42 inches, fractured hard limestone.

The Palsgrove soils have moderate to strong horizonation. Their A1 horizon is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and ranges from 2 to 4 inches in thickness. In areas that are eroded or that have been cultivated, the color of the Ap horizon is dark gray (10YR 4/1) or dark grayish brown (10YR 4/2). The A2 horizon, where present, ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) in color. In areas that are not eroded or that have not been cultivated, it ranges from 4 to 8 inches in thickness. The A2 horizon is incorporated in the surface layer in many areas that have been plowed. The A horizons have a texture of silt loam.

The texture of the B horizons centers on silty clay loam. Those horizons formed predominantly in loess. In places, however, the B3 horizons or the lower B2 horizon formed in a thin layer of moderately fine textured or fine textured residuum. This layer is a paleo B horizon or a B horizon formed in limestone residuum. The color of the B horizons is generally brown to dark brown (10YR 4/3), but it grades to yellowish brown (10YR 5/4) with increasing depth. In many places the part of the B horizon that contains the most clay has a more reddish hue than indicated in the profile described as typical. In places the lower B horizon contains fragments of limestone. The most acid part of the solum is strongly acid.

Peaty Muck

Peaty muck consists of an accumulation, 10 inches or more thick, of partly decomposed plant remains that are underlain by gleyed, moderately fine textured mineral material. Seepage and a high water table have made the soil material very wet. Peaty muck is on first bottoms, in depressions, and on slightly elevated highs in broad drainageways in the uplands.

The surface layer is dark colored and is high in content of organic matter. The lower part of the subsoil grades to gleyed silty or loamy material.

Peaty muck, unlike Peaty muck, overwashed, has had less than 5 inches of light-colored material deposited on the surface. In contrast to the other soils of this county, it has more than 10 inches of partly decomposed organic matter in the upper part of the profile. Soils in which Peaty muck extends to a depth of less than 10 inches are classified according to the characteristics of the underlying solum.

Representative profile of Peaty muck, 320 feet north and 160 feet east of the SW. corner of the NE¼SE¼ sec. 3, T. 98 N., R. 10 W.:

O11—0 to 13 inches, black (N 2/0) muck; massive; very friable; neutral; clear, smooth boundary.

O12—13 to 37 inches, black (10YR 2/1) muck that has brownish fibrous peat mixed in; very friable; neutral; abrupt, smooth boundary.

IIC—37 to 46 inches, very dark gray (N 3/0) silty clay loam; massive; very friable; neutral.

Representative profile of Peaty muck, overwashed, 175 feet south and 350 feet east of the NW. corner of the SE¼ sec. 36, T. 97 N., R. 7 W.:

C1—0 to 10 inches, dark-gray (10YR 4/1) and dark grayish-brown (10YR 4/2) silt loam; common, fine, prominent, red mottles; weak, fine, granular structure; very friable; neutral; abrupt, smooth boundary.

IIO1—10 to 21 inches, dark-brown (10YR 2/2) muck and brownish fibrous peat; very friable; neutral; abrupt, smooth boundary.

IIC2—21 to 37 inches, dark-gray (5Y 4/1) silty clay loam; massive; friable; neutral.

In soils classified as Peaty muck, 30 percent or more of the surface layer is organic matter. In places the thickness of the layer of organic matter is as little as 10 inches or as much as 48 inches. The color is variable, but it is black (N 2/0 to 10YR 2/1) in the mucky areas and dark brown to brown (7.5YR 4/4) in the peaty areas. The underlying material ranges from silty clay loam to sandy clay loam in texture. The mineral material is gleyed and ranges from very dark gray (N 3/0) to gray (5Y 5/1) in color. The soil reaction centers on neutral, but the soils range from slightly acid to neutral.

Racine Series

In the Racine series are soils that are well drained. These soils formed in friable, loamy glacial material over loam to clay loam glacial till. A pebble band separates the loamy material from the glacial till. These

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soils are on gently sloping upland highs or ridgetops and on sloping to steep, convex side slopes. The native vegetation was trees and prairie grasses.

The Racine soils have a thin to moderately thick, dark-colored A1 horizon of loam and an indistinct A2 horizon. They have B horizons that lack mottling above a depth of 30 inches and that consist of friable loam to clay loam. Contrasting interior and exterior colors are not distinct in the lower B horizon. Some gray, grainy coats are visible when the soil material is dry. Thin clay films or clay flows occur in many places. Stones and pebbles are common in the solum.

The Racine soils have a thinner A1 horizon than the Ostrander soils, and unlike those soils, they have an A2 horizon. Unlike the Bassett soils, they lack mottles in the upper B horizons. Also, they lack the somewhat distinct, contrasting interior and exterior colors in the lower B horizon that are typical in the Bassett profile.

The Racine soils, unlike the Oran, have chromas of 3 or higher in the B horizons and are free of mottles above a depth of 30 inches. They have thicker, less variable B horizons than the Waucoma soils, and their solum is not underlain by a thin, uniform layer of residuum over limestone bedrock. The Racine soils do not have mottles in the upper B horizons like those in the upper B horizons of the Donnan soils. Also, they are not stratigraphically underlain by a gray paleosol at a depth of 20 to 40 inches as are the Donnan soils. The Racine soils contain stones and pebbles and have a higher content of sand in their solum than the Downs soils, which formed in loess.

The Racine soils are the intermediate members in a biosequence that includes the Ostrander soils, which are in the Brunizem great soil group, and the Renova soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Racine loam, 265 feet west and 50 feet south of the NE. corner of the NE¼NW¼ sec. 29, T. 96 N., R. 10 W.:

A1—0 to 8 inches, very dark gray (10YR 3/1) loam; slightly higher chroma if kneaded; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A2—8 to 12 inches, loam that is dark grayish brown (10YR 4/2), with very dark grayish brown (10YR 3/2), very dark gray (10YR 3/1), and dark brown to brown (10YR 4/3) in about equal parts; very dark grayish brown (10YR 3/2) to dark grayish brown (10YR 4/2) if kneaded; very weak, medium, platy structure breaking to weak, fine, subangular blocky structure; friable; strongly acid; abrupt, smooth boundary.

IIB1—12 to 18 inches, dark-brown to brown (10YR 4/3) heavy loam; some stones and pebbles; weak, fine and medium, subangular blocky structure; friable; pebble band starts at a depth of about 15 inches; stones from 1 to 6 inches in diameter; strongly acid; clear, smooth boundary.

IIB21—18 to 28 inches, heavy loam; some stones and pebbles; dark-brown to brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; weak, medium, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

IIB22t—28 to 34 inches, yellowish-brown (10YR 5/6) sandy clay loam; some stones and pebbles; weak, fine, subangular blocky structure; friable; few, thin, discontinuous clay films and grayish-brown (10YR 5/2), grainy silt coats; few dark concretions of an oxide; medium acid; clear, smooth boundary.

IIB23t—34 to 44 inches, yellowish-brown (10YR 5/8) and some grayish-brown (2.5Y 5/2) sandy clay loam; some stones and pebbles; yellowish brown (10YR 5/8) if kneaded; thin grayish-brown (2.5Y 5/2 to 10YR 5/2) clay films and grainy coats on blocky peds; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; friable; slightly acid; thin, discontinuous, grainy ped coats confined to prism surfaces, with a few yellowish-brown (10YR 5/6) colors showing through; slightly acid.

The Racine soils have moderate to strong horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1) in color. In undisturbed areas the A2 horizon is dominantly dark grayish brown (10YR 4/2) and ranges from 2 to 6 inches in thickness. The boundary between the A and B horizons is abrupt. In some places the soil material has colors of lower value and chroma than those shown in the profile described. In places the texture of the A horizons is silt loam instead of loam. Some areas that have as much as 15 inches of an overburden of silt loam are included in the Racine series.

The B horizons have values of 4 or 5 and chromas of 3 to 6, and the values and chromas become higher with increasing depth. In places yellowish-brown and a few grayish-brown mottles are below a depth of 30 inches. In many places the B horizon contains grayish, grainy silt coats and clay films. The texture of the B horizons ranges from loam to clay loam, and those horizons contain stones and pebbles. In the most acid part of the solum, the soil reaction is strongly acid. In many places the glacial till is calcareous below a depth of 48 inches.

Renova Series

The Renova series consists of well-drained soils that formed in friable, loamy glacial material and in loam to clay loam till. A pebble band separates the overburden of loamy glacial material from the glacial till. These soils are on gently sloping upland highs and ridgetops and on steep side slopes.

The Renova soils have a thin, moderately dark colored A1 horizon of loam, a distinct A2 horizon, and brownish, friable B horizons that have a texture of loam to clay loam. Distinct interior and exterior colors are not pronounced in the B horizons, but grainy gray coats are evident when the soil material is dry. Parts of the B horizons contain clay films. Stones and pebbles are common in the solum.

The Renova soils have a thinner A1 horizon and a more distinct A2 horizon than the Racine soils. They have a thinner, lighter colored A1 horizon than the Ostrander soils, and they have an A2 horizon that is absent in the Ostrander soils. The Renova soils have less contrasting interior and exterior colors in the lower B horizon than the Coggon soils, and they have less gray mottling below a depth of 30 inches than those soils. They have a thicker, less variable solum than the Bixby soils, and they are underlain by till instead of by leached sand and gravel. The Renova soils have B horizons that are less variable in thickness than those of the Whalan and Waucoma soils, and they are not underlain by residuum and limestone bedrock like the Whalan and Waucoma soils. Also, the Renova soils have a thinner A1 horizon than the Waucoma soils.

The Renova soils form a biosequence with the Ostrander soils, which are in the Brunizem great soil group, and with the Racine soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of Renova loam in a cultivated field, 400 feet south and 175 feet east of the NW. corner of the NE¼NE¼ sec. 20, T. 97 N., R. 10 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—7 to 11 inches, brown to dark-brown (10YR 4/3) loam; weak, thin, platy structure; friable; slightly acid; clear, smooth boundary.

B11—11 to 14 inches, loam; brown (10YR 5/3) ped exteriors; brown to dark-brown (10YR 4/3) ped interiors; weak and moderate, very fine, subangular blocky structure; friable; very few, thin, discontinuous clay films; strongly acid; abrupt, wavy boundary.

IIB12—14 to 16 inches, gravelly loam; same color and structure as soil material in B11 horizon; friable; strongly acid; clear, smooth boundary.

IIB21t—16 to 19 inches, loam; some stones and pebbles; brown to dark-brown (10YR 4/3) ped exteriors; dark yellowish-brown (10YR 4/4) ped interiors; moderate, fine, subangular blocky structure; friable; common, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

IIB22t—19 to 35 inches, heavy loam to light sandy clay loam; a few stones and pebbles; brown (10YR 5/3) ped exteriors; yellowish-brown (10YR 5/4) ped interiors; very few, very fine, strong-brown (7.5YR 5/8) mottles in lower part of horizon; weak, medium, prismatic structure breaking to moderate, fine and medium, subangular blocky structure; friable; few, thin, discontinuous clay films; few fine iron-manganese concretions of an oxide; strongly acid; clear, smooth boundary.

IIB31t—35 to 39 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; a few stones and pebbles; yellowish brown (10YR 5/4) if kneaded; very few, fine, grayish-brown (2.5Y 5/2) mottles; weak, medium, prismatic structure breaking to weak, fine, subangular blocky structure; very friable; light brownish-gray (2.5Y 6/2) to light yellowish-brown (2.5Y 6/4) grainy coats and few dark-brown (7.5YR 3/2) and black (10YR 2/1) stains on peds; strongly acid; abrupt, smooth boundary.

IIB32t—39 to 50 inches, strong-brown (7.5YR 5/6) loam; a few stones and pebbles; yellowish brown (10YR 5/6) if kneaded; few, fine, grayish-brown (2.5Y 5/2) mottles; weak, fine and medium, subangular blocky structure; friable; some light brownish-gray (2.5Y 6/2) to light yellowish-brown (10YR 5/6) grainy coats; very few, thin, discontinuous clay films in places; few fine iron-manganese concretions of an oxide; medium acid.

The Renova soils have moderate to strong horizonation. The A1 horizon ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. The A2 horizon is 4 to 8 inches thick and ranges from dark grayish brown (10YR 4/2) to brown and dark brown (10YR 4/3) in color. The texture of the A horizons is generally loam, but A horizons that have a combined thickness of as much as 15 inches and a texture of silt loam occur in places.

The upper part of the B horizon has color values of 4 and 5 and chromas of 3, but higher chromas occur at increasing depths. The B horizons have textures of heavy sandy loam, heavy loam, light sandy clay loam, and light clay loam, but the texture centers on heavy loam in most places. Stones and pebbles are common below the lithologic discontinuity. In places a few, fine, yellowish-brown, strong-brown, and grayish-brown mottles are below a depth of 30 inches. Distinctly contrasting interior and exterior colors are absent from the lower B3 horizon. The most acid part of the solum is strongly acid, but the glacial till is calcareous in places below a depth of 48 inches.

Riceville Series

In the Riceville series are moderately well drained soils formed in 14 to 24 inches of loamy glacial material over clay loam till. These soils are gently sloping to sloping and are on ridges and side slopes. The native vegetation was trees and prairie grasses.

The Riceville soils have a moderately thick, dark-colored A1 horizon of loam; a distinct, light-colored A2 horizon, also of loam; and moderately well defined B2 horizons that have a texture of clay loam and contain some clay films. At a depth of 15 to 30 inches or below, the subsoil is firm or very firm. The glacial till contains some stones and pebbles.

In contrast to the Kenyon, Racine, and Renova soils, the Riceville soils have B horizons of firm or very firm clay loam that have distinctly contrasting interior and exterior colors. They also have a thicker, darker colored A1 horizon and a less well defined A2 horizon than the Coggon and Renova soils. Unlike the Donnan soils, which have a subsoil of gray clay developed in weathered till, the Riceville soils have B horizons of clay loam. They have an A2 horizon that is lacking in the Kenyon soils, have firmer B horizons than those soils, and unlike those soils, they have distinctly contrasting interior and exterior colors in the B horizons.

Representative profile of Riceville loam under a new fence along a road; in a field that was formerly cultivated, 580 feet north of the SW. corner of sec. 3, T. 96 N., R. 10 W.:

A1—0 to 8 inches, black (10YR 2/1) loam; very weak, medium and coarse, subangular blocky structure breaking to weak, very fine, subangular blocky and weak, fine, granular structure; friable; some dark grayish-brown (10YR 4/2) ped coats; strongly acid; abrupt, smooth boundary.

A2—8 to 12 inches, dark grayish-brown (10YR 4/2), brown to dark-brown (10YR 4/3), and some very dark brown (10YR 2/2) loam; weak, thin, platy structure breaking to weak, very fine, subangular blocky structure; friable; abundant worm casts; strongly acid; abrupt, wavy boundary.

B1t—12 to 16 inches, brown to dark-brown (10YR 4/3), some very dark brown (10YR 2/2), and some reddish-gray (5YR 5/2) loam; moderate, very fine, subangular blocky structure; friable; thin, continuous, brown to dark-brown (10YR 4/3) clay films; pebble band that contains cobbles 3 to 5 inches in diameter in lower part; strongly acid; abrupt, wavy boundary.

IIB21t—16 to 20 inches, clay loam, olive-gray (5Y 5/2) ped exteriors; dark-brown (7.5YR 4/4) ped interiors; moderate, fine, subangular blocky structure; firm; thin, continuous, olive-gray (5Y 5/2) clay films; strongly acid; clear, smooth boundary.

IIB22t—20 to 42 inches, gray (5Y 5/1) and dark-brown (7.5YR 4/4) light clay loam; weak, medium, prismatic structure breaking to strong, medium, subangular and angular blocky structure; very firm; thin, continuous, gray (5Y 5/1) clay films; few pebbles up to 1 inch in diameter; medium acid; gradual, wavy boundary.

IIB23t—42 to 56 inches, gray (5Y 5/1) and strong-brown (7.5YR 5/8) light clay loam; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; some vertical cleavage; firm; thin, continuous, gray (5Y 5/1) clay films; common very dark brown (10YR 2/2) clay fills; slightly acid.

The Riceville soils have strong horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1) in color. The color of the Ap horizon ranges to very dark grayish brown (10YR 3/2). The A2 horizon has values of 3 and 4 and chromas of 2 and 3. The texture of the A horizons is silt loam or loam.

A pebble band is at a depth of 14 to 24 inches in the lower part of the B1 horizon or in the upper IIB2 horizon. The IIB horizons consist of firm or very firm clay loam, and there are continuous or nearly continuous grainy coatings that have color of 5Y 5/1 or 6/1 on the ped exteriors. Colors of 5Y 5/1 mixed with colors of 7.5YR 4/4 to 10YR 5/8 are dominant in the IIB horizons. The structure of the IIB2 horizons is prismatic breaking to subangular blocky. Vertically elongated sandy wedges are typical throughout the B horizons. The most acid part of the solum is strongly or very strongly acid.

Rockton Series

The Rockton series consists of well-drained soils formed in 15 to 30 inches of loamy glacial material. Below this material is a thin layer of residuum that is underlain by limestone bedrock. These soils are nearly level to sloping and are on ridgetops, side slopes, and very high benches. The native vegetation was prairie grasses.

The Rockton soils have a thick, dark-colored A horizon of loam, and brownish B horizons that in places have a few mottles of high chroma above the limestone. The B horizons vary in thickness and are underlain by a uniform layer of limestone bedrock. Clay films are evident in the B horizons. Part of the lower B horizon formed in a layer of moderately fine textured or fine textured material that lies above the limestone in most places. The soil material contains pebbles and a few stones.

The Rockton soils have a thinner solum than the Atkinson soils but a thicker solum than the Marlean. They have darker, thicker A horizons than the Whalan soils and lack the A2 horizon that is typical of those soils. They have a thicker A1 horizon than the Winneshiek soils, and unlike those soils, they lack an A2 horizon. In contrast to the Jacwin soils, which have mottled B horizons that have a chroma of 2 and that are underlain by shale, the Rockton soils have chromas of 3 or higher in the B horizons. Also, the B horizons have only a few mottles above the limestone and are underlain by limestone. The Rockton soils, unlike the Waucoma, lack an A2 horizon, and they have a thinner solum than the Waucoma soils. Their solum is more variable in thickness than those of the Kenyon and Ostrander soils. Also, it is underlain by limestone residuum and bedrock rather than by till.

The Rockton soils form a biosequence with the Whalan soils, which are in the Gray-Brown Podzolic great soil group, and with the Winneshiek soils, which also are in that great soil group but are intergrading toward Brunizems.

Representative profile of Rockton loam in a cultivated field, center of the SW¼SE¼NE¼ sec. 15, T. 98 N., R. 10 W.:

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

A12—7 to 18 inches, black (10YR 2/1) loam; few pebbles; weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

B1t—18 to 23 inches, dark yellowish-brown (10YR 3/4) and some dark-brown (10YR 3/3) light clay loam; few pebbles; weak, very fine, subangular blocky structure; friable; common, thin, discontinuous clay films; common, black, fine and medium sand grains; a few black (10YR 2/1) peds from A horizons; neutral; clear, smooth boundary.

B21t—23 to 26 inches, dark yellowish-brown (10YR 3/4) light clay loam; some pebbles; moderate to strong, fine, subangular blocky structure; firm; common, thin, discontinuous clay films; common, black, fine and medium sand grains; neutral; clear, smooth boundary.

IIB22t—26 to 28 inches, dark yellowish-brown (10YR 4/4) heavy clay loam; weak, very fine, subangular blocky structure; firm; thick, discontinuous clay films; common, black, fine and medium sand grains; neutral; abrupt, wavy boundary.

IIIB23—28 to 30 inches, reddish-brown (5YR 4/4) clay; moderate, very fine, subangular blocky structure; very firm; weathered limestone; common, thin, discontinuous clay films; calcareous.

IIIR—30 inches, hard limestone bedrock.

The Rockton soils have moderate horizonation. The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) in color. In areas that are not eroded, it ranges from 12 to 18 inches in thickness. In places the texture of the A horizons is silt loam instead of loam. The upper B horizons have values and chromas of 3, but the values and chromas increase to 4 or higher with increasing depth. Light clay loam is the dominant texture of the B horizon. The lower B horizon developed partly in a layer of limestone residuum that is 1 to 8 inches thick in places. This layer is moderately fine textured or fine textured, and it may be a paleo B horizon or weathered limestone. In places the IIB22t or IIIB23 horizon contains a few yellowish-brown or strong-brown mottles. The soil reaction is variable and ranges from neutral to medium acid.

Roseville Series[7]

In the Roseville series are soils that are well drained. These soils developed in loamy glacial material that is 30 to 50 inches thick over limestone bedrock. In many places they are separated from the limestone by a thin layer of moderately fine textured or fine textured material. They are in intermediate positions on gently sloping benches, on gently sloping to steep upland highs or ridgetops, and on side slopes or in talus areas.

These soils have a thin, moderately dark colored A1 horizon of loam, a distinct A2 horizon, and B horizons of brownish-colored loam and sandy clay loam of variable thickness. Clay films are evident in the B horizons.

[7] Areas of Roseville soils were not retained as separate mapping units in Winneshiek County but were included with some of the Whalan soils.

The Roseville soils have a thinner A1 horizon than the Waucoma soils, and they have a more distinct A2 horizon in many places. They have a thinner, lighter colored A1 horizon than the Atkinson soils, and they have a distinct A2 horizon that is lacking in the Atkinson soils. The Roseville soils have a thicker solum (30 to 50 inches thick) than the Whalan soils, which have a solum 15 to 30 inches thick. They also have a thicker solum, a thinner A1 horizon, and a more distinct A2 horizon than the Winneshiek soils. In contrast to the Palsgrove soils, which were derived from loess, the Roseville soils have a solum that is 20 to 45 percent sand.

The B horizons of the Roseville soils are more variable in thickness than those of the Renova soils, and they are underlain by limestone bedrock instead of by glacial till. The Roseville soils have thicker B horizons than the Bixby soils, and their B horizons are underlain by limestone instead of by leached sand and gravel.

The Roseville soils form a biosequence with the Atkinson soils, which are Brunizems, and with the Waucoma soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of Roseville loam, 380 feet west and 140 feet south of NE¼ sec. 10, T. 99 N., R. 10 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) and some dark grayish-brown (10YR 4/2) loam; fine granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—6 to 9 inches, dark grayish-brown (10YR 4/2) loam; weak, thin, platy structure; friable; slightly acid; clear, smooth boundary.

B1t—9 to 21 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) loam; moderate, fine, subangular blocky structure; friable to firm; abundant, thin, discontinuous, dark yellowish-brown (10YR 3/4) clay films; few fine iron-manganese concretions of an oxide; strongly acid; clear, smooth boundary.

B2t—21 to 27 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) gravelly loam; moderate, fine, subangular blocky structure; friable to firm; thin, continuous, dark yellowish-brown (10YR 3/4) clay films; strongly acid; clear, smooth boundary.

B31t—27 to 31 inches, yellowish-brown (10YR 5/4) gravelly sandy clay loam; weak, fine to medium, subangular blocky structure; friable; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

B32t—31 to 38 inches, yellowish-brown (10YR 5/8) and dark yellowish-brown (10YR 4/4) gravelly sandy clay loam; weak, medium, subangular blocky structure; friable to firm; common clay films next to stone surfaces; medium acid; abrupt, wavy boundary.

IIR—38 inches, hard limestone bedrock.

The Roseville soils have moderate to strong horizonation. In areas that have not been cultivated or that are not eroded, they have an A1 horizon that ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color. The A2 horizon ranges from 4 to 8 inches in thickness and is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). The texture of the A horizons centers on loam, but silt loam is within the range of the series. In some places these soils have as much as 15 inches of silty material on the surface.

The B horizons have values of 4 and higher and chromas of 3 and higher with increasing depth. In places there are a few yellowish-brown and strong-brown mottles below a depth of 30 inches. In most places a thin layer (1 to 8 inches thick) of moderately fine textured or fine textured material lies above the limestone bedrock. However, profiles without this layer are not excluded from the Roseville series. This moderately fine textured or fine textured layer above the bedrock may be a paleo B horizon, or it may be weathered limestone. The soil reaction centers on strongly acid but is variable.

Rowley Series

The Rowley series consists of somewhat poorly drained soils that formed in silty alluvium. These soils are nearly level or gently sloping and are on low benches along the valleys of the major rivers and their tributaries. The native vegetation was prairie grasses.

The Rowley soils have a moderately thick, moderately dark colored A1 horizon of silt loam and friable, mottled B horizons, also of silt loam. Their B horizons have moderate structure. The peds in the lower B horizons have grayish exterior colors. Clay films are present in parts of the B horizons.

The Rowley soils have thinner A1 horizons and stronger structure in the B horizons than the Lawson soils. Their solum is lower in content of sand and is less variable in thickness than that of the Kato soils, and they are not stratigraphically underlain by sand and gravel as are the Kato soils. The Rowley soils have stronger structural development and have less sand throughout their solum than the Turlin soils. They have thicker A1 horizons than the Canoe and Curran soils. Unlike those soils, they lack an A2 horizon.

The Rowley soils form a biosequence with the Canoe soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward the Brunizem great soil group.

Representative profile of Rowley silt loam in a permanent bluegrass pasture, 660 feet north and 185 feet east of the SW. corner of sec. 17, T. 97 N., R. 7 W.:

A11—0 to 10 inches, black (10YR 2/1) silt loam; moderate, fine, granular structure; friable; many fine roots; slightly acid; clear, smooth boundary.

A12—10 to 13 inches, very dark brown (10YR 2/2) silt loam; moderate, fine, granular and weak, very fine, subangular blocky structure; friable; few, discontinuous, black (10YR 2/1) exterior coats; many fine roots; medium acid; gradual, smooth boundary.

B1—13 to 17 inches, dark grayish-brown (10YR 4/2 to 2.5Y 4/2) silt loam; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; moderate, fine, subangular blocky structure; friable; few, discontinuous, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) exterior coats; few fine roots; medium acid; gradual, smooth boundary.

B21—17 to 23 inches, silt loam; grayish-brown (2.5Y 5/2) ped exteriors; grayish-brown (2.5Y 5/2) to light olive-brown (2.5Y 5/4) ped interiors; brown (10YR 5/3) to light olive brown (2.5Y 5/4) if kneaded; few, fine, faint, light olive-brown (2.5Y 5/4) and yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky structure; friable; few black concretions of an oxide; medium acid; gradual, smooth boundary.

B22—23 to 30 inches, grayish-brown (2.5Y 5/2) silt loam; slightly higher chroma if kneaded; many, fine, faint, light olive-brown (2.5Y 5/4) and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; few, fine, soft, black concretions of an oxide; medium acid; gradual, smooth boundary.

B31t—30 to 41 inches, mottled grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) silt loam; grayish brown (2.5Y 5/2) to light olive brown (2.5Y 5/4) if kneaded; weak, fine, prismatic structure; friable; nearly continuous, olive-gray (5Y 5/2) exterior coats; few, thin, discontinuous clay films; few, fine, soft, black concretions of an oxide; medium acid; gradual, smooth boundary.

B32t—41 to 46 inches, mottled olive-gray (5Y 5/2) and some light olive-brown (2.5Y 5/6) silt loam; light olive brown (2.5Y 5/4) if kneaded; weak, coarse, subangular blocky structure; friable; few, thin, discontinuous clay films; many, fine, soft, dark reddish-brown concretions of an oxide; slightly acid; gradual, smooth boundary.

The Rowley soils have moderate horizonation. The A1 horizons range from black (10YR 2/1) or very dark gray (10YR 3/1) to very dark brown (10YR 2/2) in color and from 8 to 15 inches in combined thickness. In places colors that have a value of 3 and chroma of 2 or less extend to a depth of 20 inches. The texture throughout the solum centers on silt loam, but the content of clay is slightly higher in the B horizons than in the rest of the solum.

The color of the B1 horizon is dominantly dark grayish brown (10YR 4/2 to 2.5Y 4/2). Grayish-brown (2.5Y 5/2) ped exteriors, and ped interiors that have a value of 5 and chroma of 4 or higher are common, however, with increasing depth. The B1 and B2 horizons contain a few, fine, yellowish-brown, olive-brown, and grayish-brown mottles. In many places olive-gray (5Y 5/2) mottles or coats are evident below a depth of 30 inches. These soils range from slightly acid to medium acid in reaction.

Sattre Series

In the Sattre series are soils that are well drained. These soils formed in loamy material that is 24 to 45 inches thick over leached sand and gravel. They are nearly level to sloping and are on stream benches and on the escarpments of benches. In a few places, they are also on ridgetops and side slopes in the uplands. The native vegetation was trees and prairie grasses.

The Sattre soils have a thin to moderately thick, dark colored or moderately dark colored A1 horizon, an indistinct A2 horizon, and brownish B horizons of variable thickness. The solum is free of mottling to a depth of 30 inches, but clay films are evident.

The Sattre soils have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the Bixby soils. They have a thinner A1 horizon than the Waukegan soils, and unlike the Waukegan soils, they contain an A2 horizon. The Sattre soils have higher chroma in the B horizons than the Hayfield soils. Also, they are well drained instead of somewhat poorly drained, and they lack mottles above a depth of 30 inches. Their solum is more variable in thickness than that of the Racine soils. Also, unlike the Racine soils, which are underlain by glacial till and have B and C horizons formed in glacial till, the Sattre soils are underlain by sand and gravel. They have more sand in the solum than do the Festina soils. Unlike the Festina soils, they are underlain by sand and gravel between a depth of 24 and 45 inches. The Sattre soils have a higher content of sand (25 to 45 percent) in their solum than the Camden soils, and they have a thinner A1 horizon and a less distinct A2 horizon than those soils.

The Sattre soils are the intermediate members in a biosequence that includes the Waukegan soils, which are in the Brunizem great soil group, and the Bixby soils, which are in the Gray-Brown Podzolic great soil group.

Representative profile of Sattre loam, deep, 200 feet north of the north road fence, in a cultivated field, 650 feet west of the east edge of the NE¼SE¼ sec. 24, T. 97 N., R. 10 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) and some dark grayish-brown (10YR 4/2) loam; weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A2—8 to 11 inches, brown to dark-brown (10YR 4/3) and dark grayish-brown (10YR 4/2) loam; very weak, thin, platy structure; friable; few very dark brown (10YR 2/2) peds; slightly acid; clear, smooth boundary.

B1t—11 to 17 inches, loam; very dark grayish-brown (10YR 3/2) ped exteriors; dark-brown (10YR 3/3) and very dark grayish-brown (10YR 3/2) ped interiors; weak, very fine, subangular blocky structure; friable; very few, thin, discontinuous clay films; slightly acid; clear, smooth boundary.

B21t—17 to 22 inches, brown to dark-brown (10YR 4/3) heavy loam; weak, very fine, subangular blocky structure; friable; abundant, thin, discontinuous, dark grayish-brown (10YR 3/2) clay films; medium acid; clear, smooth boundary.

B22t—22 to 29 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam to loam; moderate, fine, subangular blocky structure; friable; few, thin, discontinuous clay films; few rounded stones, 2 to 4 inches in diameter, and a very few smaller pebbles in a hole 12 inches in diameter; some dark-brown (10YR 3/2) iron accumulations; medium acid; clear, smooth boundary.

B31—29 to 38 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; very weak, fine to medium, subangular blocky structure; friable; few rounded stones, 2 to 4 inches in diameter, and a very few smaller pebbles in a hole 12 inches in diameter; medium acid; clear, smooth boundary.

B32—38 to 44 inches, dark yellowish-brown (10YR 4/4) and strong-brown (7.5YR 5/8) light sandy clay loam; very weak, medium to coarse, subangular blocky structure; very friable; strongly acid; abrupt, smooth boundary.

IIC—44 to 56 inches, yellowish-brown (10YR 5/8) sand; single grain; loose; strongly acid.

Two depth phases of Sattre soils are mapped in Winneshiek County. In the moderately deep phase, the loamy material is 24 to 36 inches thick over sand and gravel, and in the deep phase it is 36 to 45 inches thick.

The Sattre soils have moderate horizonation. The A1 horizon ranges from 4 to 8 inches in thickness and from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) in color. The A2 horizon ranges from dark grayish brown (10YR 4/2) to dark brown or brown (10YR 4/3). The texture of the A horizons is loam or silt loam that is high in content of sand.

The B horizons have values of 4 or higher and chromas of 3 or higher, but the values and chromas become higher with increasing depth. In places the deep Sattre soils have a few yellowish-brown and strong-brown mottles below a depth of 30 inches. The texture of the B horizons is variable; the range of texture includes loam, heavy sandy loam, and light sandy clay loam. The content of sand above the leached sand and gravel ranges from 25 to 45 percent, and most of the sand is fine or medium in size. The sandy underlying material is leached below a depth of 60 inches. In the most acid part of the solum, the reaction is strongly acid.

Spillville Series

In the Spillville series are moderately well drained soils that formed in dark-colored loam alluvium. These soils are nearly level and are on first bottoms. The native vegetation was prairie grasses.

The Spillville soils have very thick, dark-colored A horizons of loam. Their subsoil is dark colored and loamy to a depth of 40 inches or more.

The Spillville soils have thicker A1 horizons than the Turlin and Terril soils. Also, their colors have values of 3 or less and a chroma of 1 to a depth of 40 inches or more, and the Turlin and Terril soils have higher values and chromas in the B horizons, or above a depth of 40 inches. The Spillville soils have less clay throughout their solum than the Colo soils, and unlike the Colo soils, they lack gleyed B horizons.

In contrast to the Kennebec soils, which have less than 15 percent sand in their solum, the Spillville soils have a content of sand of 20 to 45 percent. The Spillville soils have a higher content of sand and a thicker A1 horizon than the Otter soils, and unlike those soils, they lack gleyed B horizons. They are darker colored than the Dorchester and Arenzville soils. Also, they are not calcareous like the Dorchester soils, and the upper part of their solum is not stratified like that of the Arenzville soils.

Representative profile of Spillville loam about 8 feet southeast of gate in a permanent pasture, 575 feet west and 10 feet south of the NE. fence corner of the NW¼ NE¼ sec. 11, T. 97 N., R. 10 W.:

A11—0 to 20 inches, black (10YR 2/1) loam; very weak, very fine, subangular blocky structure breaking to weak, fine, granular structure; very friable; neutral; gradual, smooth boundary.

A12—20 to 36 inches, black (10YR 2/1) loam; weak, very fine, subangular blocky structure breaking to weak, fine, granular structure; very friable; neutral; gradual, smooth boundary.

A13—36 to 54 inches, black (10YR 2/1) and very dark brown (10YR 2/2) loam; weak to moderate, very fine, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

C—54 to 60 inches, very dark grayish-brown (10YR 3/2) loam; common, fine, faint, dark yellowish-brown (10YR 4/4) and very dark gray (10YR 3/1) mottles; massive; friable; slightly acid.

The Spillville soils have very weak horizonation. The combined A1 horizons range from 20 to 40 inches in thickness and from black (10YR 2/1) to very dark brown (10YR 2/2) in color. In many places colors that have a value of 3 and a chroma of 2 or less extend below a depth of 40 inches. The texture of the solum centers on loam. The soil material is not stratified above a depth of 30 inches, but the lower part of the profile is stratified in places. Below the A horizons, the texture is variable and ranges from sandy loam to light clay loam. The soil reaction ranges from slightly acid to medium acid in the most acid part of the solum.

Tama Series

The Tama series consists of well-drained soils that formed in loess. These soils are on nearly level or gently sloping ridgetops and on sloping or strongly sloping side slopes in the uplands. The native vegetation was prairie grasses.

The Tama soils have a moderately thick, dark-colored A1 horizon of silt loam; brownish B horizons of light silty clay loam; and C horizons that have a texture of silt loam. Mottling is absent in the B2 horizon. In most places the profile contains a very few, very thin clay films.

The Tama soils have a thicker A1 horizon than the Downs soils, and unlike the Downs soils, they lack an A2 horizon. In contrast to the Atterberry soils, they are well drained, lack an A2 horizon, and have a chroma of 3 and lack mottles in the B2 horizon. The Tama soils have a thicker, more uniform solum than the Waukegan soils, and they contain less sand than those soils. Also, they are not underlain by sand and gravel like the Waukegan soils. They have less sand in their profile than the Ostrander soils, which were derived from till, and their profile contains no stones or pebbles. The Tama soils have a thinner A1 horizon (less than 20 inches thick) than the Huntsville soils, and they have slightly more clay in the B horizons than do the Huntsville soils.

The Tama soils form a biosequence with the Fayette soils, which are in the Gray-Brown Podzolic great soil group, and with the Downs soils, which are also in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of Tama silt loam in a cultivated field, 40 feet south and 10 feet west of the NE. corner of the SE¼ sec. 21, T. 97 N., R. 7 W.:

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

A3—8 to 15 inches, very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silt loam; very weak, very fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B2t—15 to 33 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; weak, very fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

B3—33 to 47 inches, yellowish-brown (10YR 5/4) silt loam; very weak, medium, subangular blocky structure to massive; friable; strongly acid.

The Tama soils have moderate horizonation. In areas that are not eroded, the A1 horizon ranges from 8 to 12 inches in thickness and from black (10YR 2/1) to very dark brown (10YR 2/2) in color. In many places the profile contains a transitional zone between the surface horizon and the B horizon. Colors that have a value of 3 and chroma of 2 extend to a depth of 18 inches in places. The texture of the A horizon ranges from silt loam to light silty clay loam.

The colors in the B horizons have values of 4 to 5 and chromas of 3 to 6, with the higher values and chromas at increasing depths. The texture of the B2t horizon centers on light silty clay loam. In places there are a few, fine, yellowish-brown and strong-brown mottles below a depth of 30 inches. Also, there are a few relict gray mottles in places below a depth of 42 inches. In the most acid part of the solum, the soil reaction is medium acid to strongly acid.

Terril Series

In the Terril series are soils that are well drained or moderately well drained. These soils formed in loamy alluvium that contains more than 20 percent, but less than 50 percent, fine and medium sand. They are nearly level and are on first bottoms along small drainageways, on alluvial fans at the base of the uplands, or on low benches. The native vegetation was prairie grasses.

The Terril soils have a very thick, dark-colored A1 horizon and a weakly defined, dark-colored B horizon that has a texture of loam. In places colors that have a value of 3 extend to a depth of 40 inches. The solum is not stratified, but layers of silty or loamy material occur below a depth of 40 inches in some places.

Unlike the Turlin soils, which are mottled and have chromas of 2, the Terril soils lack mottling and have chromas of 3. They have more sand throughout the solum (20 to 50 percent) than the Huntsville soils, which have less than 15 percent sand. In contrast to the Spillville and Kennebec soils, the Terril soils have chromas of 3 between a depth of 20 and 40 inches. Also, they are less silty than the Kennebec soils.

The Terril soils form a hydrosequence with the Turlin soils, which are somewhat poorly drained.

Representative profile of Terril loam in a cultivated field, 150 feet west of the eastern edge of the northeast-southwest road and 150 feet north of the northern edge of east-west road in the SW. corner of the NE¼SW¼ sec. 7, T. 98 N., R. 7 W.:

- Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.
- A1—7 to 24 inches, black (10YR 2/1) loam; weak, very fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.
- A3—24 to 32 inches, black (10YR 2/1), very dark brown (10YR 2/2), and very dark grayish-brown (10YR 3/2) loam; weak, very fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.
- B—32 to 40 inches, very dark grayish-brown (10YR 3/2) and brown to dark-brown (10YR 3/3 and 4/3) loam; weak, very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.
- C—40 to 48 inches, brown to dark-brown (10YR 4/3 and 3/3) loam; massive; very friable; neutral.

The Terril soils have very weak horizonation. They have a black (10YR 2/1) to very dark brown (10YR 2/2) A1 horizon that is 20 inches or more thick. To a depth of 40 inches in some places, colors that have values of 3 or less and chromas of 2 may mask colors of higher chroma in the interiors of the peds. In most places these soils have chromas of 3 and values of 3 and 4 within 20 to 40 inches of the surface. In many places the boundaries between horizons are gradual. To a depth of 40 inches, the texture centers on loam that contains 30 to 40 percent fine and medium sand. These soils range from slightly acid to neutral in reaction.

Turlin Series

In the Turlin series are soils that are somewhat poorly drained. These soils formed in medium-textured, noncalcareous alluvial deposits that contain from 20 to 50 percent fine and medium sand. The alluvium was derived mainly from areas where the soils developed in glacial material. The soils are nearly level and are on first bottoms near the base of upland slopes. The native vegetation was grasses.

The Turlin soils have very thick, dark-colored A horizons of loam. They have weakly defined, mottled B horizons, also of loam.

The Turlin soils are similar to the Terril soils in the color, horizonation, and thickness of their solum, but they lack the browner colors (chroma of 3) in their subsoil. They have a thicker, darker colored surface horizon than the Kato soils, and they are not stratigraphically underlain by uniform layers of sand and gravel like the Kato soils. The Turlin soils have colors of higher value and chroma to a depth of 40 inches than do the Spillville soils. The colors in the uppermost 20 to 40 inches of the Turlin profile are centered on 2/1 and 2/2, unlike those in the Spillville profile, which are centered on 2/1 and 2/2 to a depth of 40 inches or more. Turlin soils have more sand throughout the solum than the Lawson soils.

Representative profile of Turlin gritty silt loam in a cultivated field, 425 feet south and 160 feet west of the center of sec. 34, T. 96 N., R. 9 W.:

- Ap—0 to 9 inches, very dark brown (10YR 2/2) gritty silt loam; weak, fine, granular structure; friable; few black (10YR 2/1) worm casts; neutral; abrupt, smooth boundary.
- A12—9 to 17 inches, black (N 2/0 to 10YR 2/1) loam; very weak, fine, prismatic structure breaking to weak, fine, granular structure; friable; kneaded color black (10YR 2/1); common fine, clean sand grains throughout the matrix; neutral; gradual, smooth boundary.
- A13—17 to 26 inches, black (10YR 2/1) loam; very weak, fine, prismatic structure breaking to weak, fine, granular structure; friable; kneaded color black (10YR 2/1) to very dark brown (10YR 2/2); common fine, clean sand grains throughout the matrix; neutral; gradual, smooth boundary.
- A3—26 to 34 inches, black (10YR 2/1) to very dark brown (10YR 2/2) loam with about 30 percent mixing of very dark grayish brown (10YR 3/2); few, fine, faint, dark-brown (10YR 3/3) and dark yellowish-brown (10YR 4/4) mottles; weak, fine, prismatic structure breaking to weak, very fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.
- B2—34 to 41 inches, dark grayish-brown (2.5Y 4/2) to very dark grayish-brown (2.5Y 3/2) loam; common, fine, distinct, dark yellowish-brown (10YR 3/4) and dark-brown to brown (7.5YR 4/4) mottles; weak, fine, prismatic structure breaking to weak, fine, subangular blocky structure; friable; kneaded color dark grayish brown (2.5Y 4/2); few, fine, dark, soft concretions of an oxide; neutral; gradual, smooth boundary.
- B3—41 to 52 inches, dark grayish-brown (10YR 4/2) to very dark grayish-brown (2.5Y 3/2) loam; common, fine, distinct, strong-brown (7.5YR 5/6) and dark yellowish-brown (10YR 4/4) mottles; very weak, coarse, prismatic structure; friable; few, fine, soft, dark concretions of an oxide; neutral.

The Turlin soils have weak horizonation. The color of the A1 horizon is commonly black (10YR 2/1) or very dark brown (10YR 2/2), but it ranges to very dark gray (10YR 3/1) with increasing depth. Typically, the soil material has colors of very dark grayish brown (2.5Y

3/2) to dark grayish brown (2.5Y 4/2) between a depth of 20 and 40 inches. In some places, however, the colors have a hue of 10YR. The texture throughout the solum is centered on loam. Mottles are common below the A horizon, but the A3 horizon also has some mottling in places. In many places stratification is not evident within the solum, but coarse-textured material occurs in places below a depth of 4 feet. The solum ranges from neutral to slightly acid in reaction.

Volney Series

In the Volney series are soils that are well drained. These soils formed in calcareous, medium-textured alluvium containing numerous fragments of limestone. The alluvium is underlain by translocated limestone rocks and by some soil material. These soils are nearly level or gently sloping and are on alluvial fans and first bottoms. The native vegetation was variable but was most commonly prairie grasses.

The Volney soils have a very thick, dark colored or moderately dark colored A horizon that has a texture of silt loam to loam. The A horizon contains fragments of rock and is underlain by limestone, chert, and some sandstone. These soils lack a B horizon.

The Volney soils, unlike the Chaseburg, have a rather high proportion of fragments of limestone and sandstone throughout their solum, and they have a darker colored surface layer than the Chaseburg soils. The Volney soils are darker colored and less stratified than the Dorchester soils. Also, they contain a much higher proportion of rock fragments than do those soils.

Representative profile of Volney channery silt loam in a permanent pasture, 665 feet northwest of a road intersection in the NE¼NE¼NW¼ sec. 21, T. 98 N., R. 7 W.:

A11—0 to 7 inches, very dark gray (10YR 3/1) channery silt loam; weak, fine, granular structure; friable; many fragments of limestone; calcareous; moderately alkaline; gradual, wavy boundary as a result of the rock fragments.

A12—7 to 30 inches, very dark gray (10YR 3/1) channery silt loam; very dark grayish brown (10YR 3/2) if kneaded; weak, fine, granular structure; friable; many fragments of limestone; calcareous; moderately alkaline; clear, wavy boundary.

IIC—30 to 50 inches, dominantly fragments of limestone, but some interbedded silt loam; calcareous.

The color of the A1 horizons is commonly very dark gray (10YR 3/1) to very dark brown (10YR 2/2), but it grades to very dark grayish brown (10YR 3/2) with increasing depth. In many places these soils are covered by a layer of recent, medium-textured overwash that is as much as 20 inches thick. The solum is medium textured and has a texture of silt loam or channery silt loam. The solum contains a large proportion of rock fragments; the number of fragments of limestone and sandstone varies greatly within a short distance. Generally, the percentage of coarse fragments increases with increasing depth. It ranges from 20 to 60 percent, by volume, in the uppermost 30 inches to as much as 75 percent, by volume, below a depth of 30 inches. The solum ranges from neutral to moderately alkaline in reaction.

Waucoma Series

In the Waucoma series are well-drained soils formed in loamy glacial material over limestone bedrock. In many places these soils have a thin zone of moderately fine textured or fine textured material above the bedrock. Depth to bedrock or to residuum weathered from bedrock ranges from 30 to about 50 inches. These soils are on nearly level or gently sloping ridgetops and high structural benches and on sloping to steep upland side slopes and high foot slopes. The native vegetation was trees and prairie grasses.

These soils have a thin to moderately thick, dark colored or moderately dark colored A1 horizon that has a texture of loam or silt loam. They also have a somewhat distinct, thin A2 horizon and B horizons that have a brownish color and that vary in thickness. The B horizons contain a few clay films.

The Waucoma soils have a thinner, lighter colored A1 horizon than the Atkinson soils, and also they have an A2 horizon that is lacking in the Atkinson soils. They have a thicker solum than the Winneshiek soils. The B horizons of the Waucoma soils are more variable in thickness than those of the Racine and Bassett soils, and unlike the Racine and Bassett soils, the Waucoma soils are underlain by limestone bedrock. The Waucoma soils have a higher content of sand throughout their solum than the Nasset soils, and they formed in glacial material over limestone instead of in loess.

The Waucoma soils are the intermediate members of a biosequence that includes the Roseville soils (not mapped in Winneshiek County) of the Gray-Brown Podzolic great soil group and the Atkinson soils of the Brunizem great soil group.

Representative profile of Waucoma loam, 160 feet west and 65 feet north of the SE. corner of the SW¼ sec. 29, T. 98 N., R. 10 W.:

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

A21—7 to 14 inches, very dark gray (10YR 3/1), dark grayish-brown (10YR 4/2), and dark-brown to brown (10YR 4/3) loam to silt loam; very weak, thin, platy structure breaking to weak, very fine, granular structure; very friable; medium acid; clear, smooth boundary.

A22—14 to 18 inches, loam that is dark grayish brown (10YR 4/2), with some dark brown to brown (10YR 4/3) and very dark gray (10YR 3/1); weak, thin, platy structure breaking to weak, very fine, granular structure; very friable; medium acid; clear, smooth boundary.

B1t—18 to 23 inches, dark-brown to brown (10YR 4/3) loam; some pebbles; weak, very fine, subangular blocky structure; friable; few, thin, discontinuous, very dark grayish-brown (10YR 3/2) clay films; weak pebble band; medium acid; clear, smooth boundary.

B2t—23 to 30 inches, sandy clay loam that has colors of dark brown to brown (10YR 4/3), dark yellowish brown (10YR 4/4), and some yellowish brown (10YR 5/4); weak, fine, prismatic structure breaking to moderate, very fine, subangular blocky structure; friable; few, thin, discontinuous clay films; medium acid; clear, smooth boundary.

B31t—30 to 36 inches, loam; some pebbles; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6); when dry, has some grayish, grainy ped coatings; very weak, fine, subangular blocky structure; friable; thin, discontinuous clay films; medium acid; abrupt, wavy boundary.

IIB32t—36 to 39 inches, dark-brown to brown (10YR 4/3) clay; strong, very fine, subangular blocky structure; firm; thin, continuous clay films; neutral; abrupt, wavy boundary.

IIR—39 inches, hard limestone bedrock.

The Waucoma soils have moderate horizonation. The A1 horizon is typically very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges from 5 to 9 inches in thickness. In some areas that have not been disturbed, however, the A1 horizon is black (10YR 2/1 and 2/2). The A2 horizon is typically dark grayish brown (10YR 4/2); however, all of it is incorporated in the Ap horizon in places. The texture of the A1 and A2 horizons ranges from loam to gritty silt loam. The texture of the soil material above the lithologic discontinuity ranges from loam or sandy clay loam to light clay loam.

The IIB32t horizon ranges from about 1 to 8 inches in thickness and from heavy clay or silty clay to clay in texture. In many places that horizon has more reddish hues than the soil material above it. Depth to limestone bedrock ranges from 30 to about 45 or 50 inches. The B horizons extend to bedrock. The limestone bedrock is hard, is typically level bedded, and in places contains numerous vertical or horizontal fractures. Interbedded shale, with the limestone, makes up a minor part of the substratum. In most places the residuum is neutral.

Waukegan Series

In the Waukegan series are soils that are well drained. These soils formed in a layer of material that has a texture of loam to gritty silt loam. The loam to gritty silt loam is between 24 and 45 inches thick and is underlain by leached sand and gravel. These soils are on nearly level or gently sloping benches and on a few upland ridges and side slopes. The native vegetation was prairie grasses.

The Waukegan soils have a moderately thick, dark-colored A1 horizon of loam to silt loam and B horizons of brownish heavy loam that vary in thickness. They are free of mottles and are underlain by uniform layers of sand and gravel.

The Waukegan soils have a thicker A1 horizon than the Sattre soils, and unlike those soils, they lack an A2 horizon. They lack an A2 horizon and have a darker, thicker A1 horizon than the Bixby and Camden soils. The Waukegan soils are well drained instead of somewhat poorly drained like the Kato soils. Unlike the Kato soils, they have chromas of 3 or higher and lack mottles in the B horizon. In contrast to the Dickinson soils, the Waukegan soils have medium-textured A and B horizons. Also, they are stratigraphically underlain by sand and gravel rather than by sand and loamy sand.

The Waukegan soils form a biosequence with the Bixby soils, which are in the Gray-Brown Podzolic great soil group, and with the Sattre soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems.

Representative profile of Waukegan loam, moderately deep, in a cultivated field, 40 feet west of road fence in the extreme NE. corner of sec. 23, T. 98 N., R. 8 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; granular; friable; neutral; abrupt, smooth boundary.

A1—7 to 9 inches, black (10YR 2/1) loam; granular; friable; slightly acid; clear, smooth boundary.

A3—9 to 14 inches, very dark grayish-brown (10YR 3/2) and a small amount of black (10YR 2/1) loam; weak, very fine, subangular blocky structure; friable; abundant worm holes and worm casts; slightly acid; clear, smooth boundary.

B2—14 to 22 inches, dark-brown (10YR 3/3) and dark yellowish-brown (10YR 3/4) heavy loam; very weak, very fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B3—22 to 25 inches, dark yellowish-brown (10YR 3/4 and 4/4) coarse loam; very weak, medium, subangular blocky structure; very friable; medium acid; abrupt, smooth boundary.

IIC—25 to 50 inches, yellowish-brown (10YR 5/6) and some dark yellowish-brown (10YR 3/4 and 4/4) fine gravel; single grain; loose; slightly acid.

Two depth phases of Waukegan soils are mapped in Winneshiek County. In the deep Waukegan soils, 36 to 45 inches of loamy material overlies the sand and gravel. In the moderately deep soils, the loamy material is only 24 to 36 inches deep.

The Waukegan soils have moderate horizonation. The A1 horizon ranges from 8 to 15 inches in thickness and from black (10YR 2/1) to very dark brown (10YR 2/2) in color. Colors that have a value of 3 commonly extend to a depth of 20 inches, and they extend to a depth of 24 inches in many places. The texture of the A horizons ranges from loam to silt loam that is high in content of sand.

The color of the B horizons varies, but typically those horizons have values and chromas of 3 or 4 and higher. The soil material below the A horizons is free of mottling. The texture of the B horizons centers on heavy loam. In many places the texture of the B3 horizon varies from that in the horizons above, and in most places a slight increase in sand is evident. The texture of the IIC horizon ranges from fine gravel or sand and gravel to loamy sand and gravel. This underlying gravel is leached to a depth of 48 inches or more. These soils range from neutral or slightly acid to medium acid in reaction.

Whalan Series

The Whalan series consists of soils that are well drained. These soils formed in 15 to 30 inches of loamy glacial material over a thin layer of moderately fine textured or fine textured material that, in turn, is underlain by limestone bedrock. They are on gently sloping ridges and high benches and on sloping to steep side slopes in the uplands. The native vegetation was trees.

The Whalan soils have a thin, moderately dark colored A1 horizon of loam to silt loam and a distinct A2 horizon. Their B horizons generally have a texture of loam to clay loam, vary in thickness, and contain clay films. The lower B horizons formed in moderately fine textured or fine textured residuum, and they are stratigraphically underlain by hard limestone bedrock.

These soils have a thinner, typically lighter colored A1 horizon and a more distinct A2 horizon than the Winneshiek soils. They have a thinner, lighter colored A1 horizon than the Rockton soils, and they have a distinct A2 horizon that is lacking in the Rockton soils. The Whalan soils have more sand and gravel in their solum than the Palsgrove soils, which were derived from loess. Their B horizons are more variable in combined thickness than those of the Renova soils. Unlike the Renova soils, they are underlain by residuum and by limestone bedrock. The Whalan soils are not underlain by sand and gravel as are the Bixby soils.

The Whalan soils form a biosequence with the Winneshiek soils, which are in the Gray-Brown Podzolic great soil group but are intergrading toward Brunizems, and with the Rockton soils, which are Brunizems.

Representative profile of Whalan loam in a timbered field, 660 feet north and 20 feet west of the SE. corner of the NE¼SE¼ sec. 4, T. 97 N., R. 10 W.:

A1—0 to 2 inches, black (10YR 2/1) loam to silt loam; weak, fine, granular structure; very friable; medium acid; abrupt, smooth boundary.

A2—2 to 7 inches, dark grayish-brown (10YR 4/2) loam to silt loam; weak, thin, platy structure; very friable; medium acid; clear, smooth boundary.

B11—7 to 10 inches, brown (10YR 5/3) loam to silt loam; weak, very fine, subangular blocky structure; very friable; medium acid; clear, smooth boundary.

B12—10 to 15 inches, brown to dark-brown (10YR 4/3) loam that contains some pebbles; weak, very fine, subagular blocky structure; very friable; medium acid; clear, smooth boundary.

B21t—15 to 26 inches, dark yellowish-brown (10YR 4/4) light clay loam that contains some pebbles; weak, very fine, subangular blocky structure; some ped coatings of whitish very fine sand or silt noted when soil material is dry; few, thin, discontinuous clay films; friable; medium acid; clear, smooth boundary.

B22t—26 to 28 inches, brownish-yellow (10YR 6/6) light clay loam that contains some pebbles; weak, very fine, subangular blocky structure; few, thin, discontinuous clay films; common, fine iron-manganese concretions of an oxide; friable; medium acid; abrupt, wavy boundary

IIB23t—28 to 30 inches, dark-brown to brown (7.5YR 4/4) gritty clay; weak, fine, subangular blocky structure; firm; common, thin, discontinuous clay films; neutral; abrupt, wavy boundary.

IIR—30 inches, hard limestone bedrock.

The Whalan soils have moderate to strong horizonation. The A1 horizon ranges from 2 to 4 inches in thickness and from very dark gray (10YR 3/1) to black (10YR 2/1) in color. The A2 horizon ranges from 4 to 8 inches in thickness and from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) or brown (10YR 5/3) in color. The texture of the A horizons ranges from gritty silt loam to loam. In places these soils have as much as 15 inches of silty material on the surface.

The B horizons have color values of 4 or higher and chromas of 3 or higher with increasing depth. They are free of mottles. The texture of the B horizons ranges from loam or silt loam to light clay or sandy clay loam. Beneath the B horizons is a layer of moderately fine textured or fine textured material that is 1 to 8 inches thick. In places this material is a paleo B horizon, or it consists of weathered limestone in places. This layer is neutral in reaction. In many places the most acid part of the solum is medium acid, but the soil reaction is variable.

Winneshiek Series

In the Winneshiek series are soils that are well drained. These soils formed in 15 to 30 inches of loamy glacial material over a thin layer of residuum, which, in turn, is underlain by limestone bedrock. They are on nearly level or gently sloping, moderately low to high structural benches, on gently sloping upland ridgetops, and on steep side slopes. The native vegetation was trees and prairie grasses.

The Winneshiek soils have a thin to moderately thick, dark colored or moderately dark colored A1 horizon that has a texture of loam; an indistinct to distinct A2 horizon; and B horizons of loam to clay loam that vary in thickness. The B horizons developed predominantly in glacial material. The lower B horizon, however, formed in moderately fine textured or fine textured residuum. In places the B horizons contain clay films. Pebbles and a few stones are evident.

The Winneshiek soils have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the Whalan soil. They have thinner B horizons than the Waucoma soils. Their solum contains a larger proportion of sand than that of the Frankville soils, and it contains some stones and pebbles that are absent in the solum of the Frankville soils. Also, the Winneshiek soils formed in glacial material and residuum instead of in loess like the Frankville soils. They have thinner B horizons that are more variable in thickness than those of the Racine soils. Also, their solum is underlain by limestone bedrock instead of by glacial till.

The Winneshiek soils are the intermediate members of a biosequence that includes the Whalan soils, which are in the Gray-Brown Podzolic great soil group, and the Rockton soils, which are Brunizems.

Representative profile of Winneshiek loam in a cultivated field, 390 feet north and 35 feet east of the SW. corner of the NW¼SE¼ sec. 22, T. 98 N., R. 10 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) and some dark grayish-brown (10YR 4/2) loam; weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—7 to 11 inches, brown to dark-brown (10YR 4/3), dark grayish-brown (10YR 4/2), and some very dark gray (10YR 3/1) loam; weak, thin, platy structure; abundant worm casts; friable; neutral; clear, smooth boundary.

B1—11 to 16 inches, dark-brown (10YR 4/3 to 3/3) and dark yellowish-brown (10YR 4/4) loam; contains pebbles and a few stones; very weak, very fine, subangular blocky structure; friable; weak pebble band; neutral; abrupt, smooth boundary.

I-IIB21t—16 to 21 inches, dark yellowish-brown (10YR 4/4) clay loam; contains pebbles; strong, very fine and fine, subangular blocky structure; common, thin, discontinuous, reddish-brown (5YR 4/4) and dark reddish-brown (5YR 3/3) clay films; common woody roots, although the field has been under cultivation for more than 20 years; neutral; friable to firm; abrupt, wavy boundary.

IIB22t—21 to 24 inches, dark-brown (7.5YR 4/4) clay; strong, fine and very fine, subangular blocky structure; moderate, thick, continuous, reddish-brown (5YR 4/4) and black (10YR 2/1) clay films; firm; slightly acid; abrupt, wavy boundary.

IIR—24 inches, white, rather soft limestone, in which some fragmentation has taken place; calcareous; underlain by hard limestone bedrock at a depth of 26 inches.

The Winneshiek soils have moderate to strong horizonation. Their A1 horizon ranges from very dark brown (10YR 2/2) to very dark gray(10YR 3/1) in color and from 4 to 9 inches in thickness. The A2 horizon is dark grayish brown (10YR 4/2) and dark brown to brown (10YR 4/3), and it ranges from 3 to 6 inches in thickness. The A horizons generally have a texture of loam, but in places these soils have a thin surface layer that has a texture of silt loam.

The B horizons formed mainly in glacial material, but partly in a layer of residuum that is generally between 1 and 6 inches thick. The color of the B horizons centers on a hue of 10YR and values and chromas of 3 and 4. In many places the part of the solum formed in residuum has a more reddish color than the part formed in glacial material, but the soil material varies in color. These soils are neutral to medium acid. The reaction centers on medium acid in the most acid part of the solum.

General Nature of the Area

This section was prepared mainly for those not familiar with the county. It describes the climate, drainage, physiography, water supply, and vegetation. It also gives facts about the agriculture of the county and discusses the recreational facilities.

Climate [8]

Because of its inland location, Winneshiek County has a stimulating continental climate. The summers are warm and the winters are cold, but prolonged periods of intense cold or of intense heat are rare. The climate at Decorah, located near the center of the county, is considered representative for this area.

Of the elements of climate that are measured in this county, the minimum temperatures and shower activity are the most variable. On calm, clear nights, the temperatures in valleys and other areas of lowlands vary from those in higher areas and are usually a few degrees lower. The amount of moisture received from showers varies considerably over short distances, but the seasonal total is about the same throughout the county. Showers fall mostly in the warmer half of the year.

Tables 8, 9, and 10 give more detailed information about the climate of Winneshiek County. Table 8 gives a summary of facts about temperatures and precipitation in the county; table 9 shows the approximate frequency of rains of stated duration and intensity; and table 10 shows the probabilities of the last freezing temperatures in spring and the first in fall.

PRECIPITATION: About 72 percent of the annual amount of precipitation for this county falls during the 6 months of April through September (see table 8), when crops make the greatest amount of growth. Occasionally during spring and summer, excessive rainfall results in local flooding. The largest amount of rainfall recorded in 1 day fell mainly on May 29, 1941, when 7.7 inches was received, mostly between the hours of 2 p.m. and 11 p.m. This large amount of rainfall caused the Upper Iowa River to rise to the highest level ever recorded for that stream. It also caused damaging flooding at Decorah, when Dry Run overflowed.

In this county a measurable amount of precipitation is received on an average of about 110 days each year. Precipitation of 0.1 of an inch or more is received on about 40 days during the growing season and on a total of about 62 days each year. Rainfall is most abundant during the peak of the growing season. Occasionally, drought develops to some extent during that season. Usually, however, drought occurs late in the season, when the amount of moisture originally stored in the soils has been depleted by the growing crops. The probability of receiving an inch or more of rain per week—about the requirement of a well-developed crop of growing corn—is approximately 2 in 5 during May and June and 1 in 3 during most of the rest of the season. Late in August, this probability drops to 1 in 4.

A total of 42 thunderstorms occur on the average each year, and slightly more than half that number occur during June, July, and August. Hailstorms also occur most frequently during June, July, and August.

Because planning construction of soil and water conservation projects, especially of roads and drains, is affected by the frequency of various precipitation intensities, such frequencies are given in table 9. About once each year, 1.0 inch or more of rain may be expected in 30 minutes. Only about once in 100 years can a rainfall of 2.4 inches be expected. Again, in a 24-hour period, 2.6 inches may fall once a year; 5.6 inches, about once in 50 years; and 6.3 inches, once in 100 years.

The average amount of snowfall received annually in this county is about 40 inches. In about half of the years, a snowfall of 8 inches or more is received in 1 day. In about 30 percent, a snowfall of 10 inches or more is received in 1 day. The average date of the first 1-inch snowfall is November 26.

TEMPERATURES: In this county temperatures of 90° or higher occur on an average of 22 days each year. Such temperatures are above the level for the optimum growth of most plants and above the comfort level for most animals. Temperatures of zero or colder occur about 27 days each year. The average coldest temperature in winter is about −27° F., and the average hottest temperature in summer is about 95° F.

Table 10 shows the probabilities of the last freezing temperatures in spring and the first freezing temperatures in fall in this county. It shows, for example, that there is a 10-percent chance of a temperature of 32° or lower occurring after April 27. That is, once in 10 years a temperature of 32° or lower may occur after April 27. The average date of the last temperature of 32° or lower in spring is May 10, and the average date of the first temperature of 32° or lower in fall is September 25, making a growing season of approximately 138 days.

WIND: Except for gusts, wind velocities of 55 miles per hour can be expected at a height of 30 feet above the ground about once every other year. Velocities of 90 miles per hour can be expected about once in 50 years, and velocities of 95 miles per hour can be expected about

[8] Prepared by PAUL J. WAITE, State climatologist, U.S. Weather Bureau.

once each century. In exposed areas winds of such high velocity may reach the ground.

Tornadoes are most frequent in this county in May and June. On the average, about one tornado occurs every 5 years. The most destructive to strike this county during the 20th century occurred on May 9, 1918, when a tornado that killed 8 persons and injured 20 others touched down between Pearl Rock and Calmar.

HUMIDITY: In this county the average relative humidity ranges from about 60 percent in the afternoon to 80 percent in the morning. The relative humidity is highest in January, February, and December, and it is lowest in April, May, and October. August is normally the most humid of the months in summer.

SUNSHINE: The amount of sunshine received ranges from only about 41 percent of the total amount possible in December, to 73 percent of the total amount possible in July. The total incoming solar radiation increases by about fourfold in July over that in December.

Drainage and Physiography

All parts of Winneshiek County have well-defined drainage systems that have good outlets (fig. 16). The major streams are narrow and winding. The Upper Iowa River drains all of the county but the southwestern corner. That river flows from the northwestern corner of the county southeastward past the town of Decorah. It then curves east-northeast across the eastern part of the county.

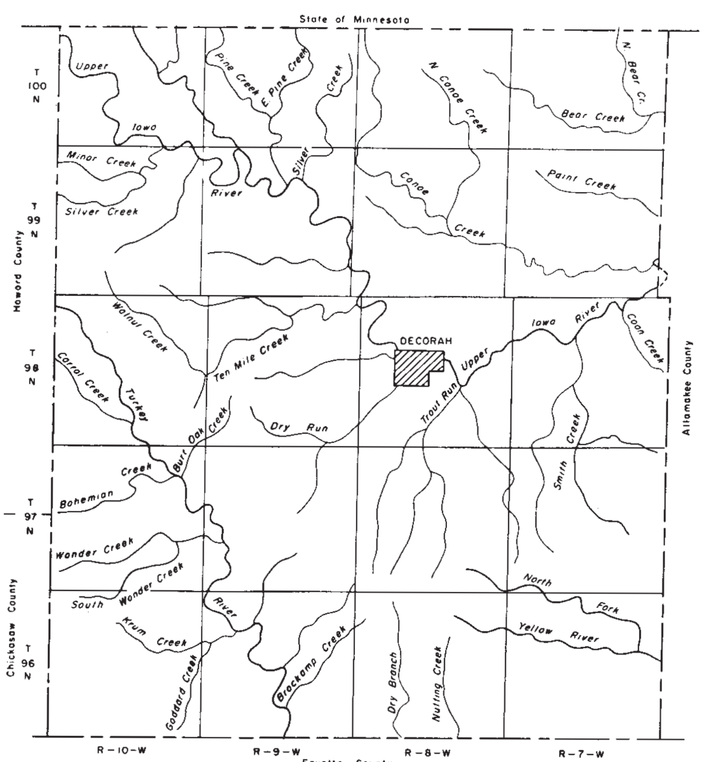

Figure 16.—**Principal drainage systems in Winneshiek County.**

An area about 4 miles wide, extending from the town of Conover north and east of the ridge on which the towns of Conover and Ridgeway are located, is in the part of the county drained by the Upper Iowa River and its tributaries. In that area the soils formed mainly in glacial drift that is less than 38 inches thick over bedrock. The topography of the area is dominated by several short, steep risers of bedrock and by gently rolling, rolling, or strongly rolling areas between the risers. The area bordering the river and its tributaries is dominated by steep, nearly bare bedrock and by moderately steep slopes that are covered by a layer of loess less than 42 inches thick. The rest of the area is covered mainly by a deep layer of loess. In only a minor part is the loess less than 42 inches thick. In Pleasant and Highland Townships and in the parts of Canoe and Hesper Townships immediately adjoining, several short, steep risers of bedrock occur at different levels.

In the southwestern corner of the county, the Turkey River and its tributaries drain the area south of a high, continuous ridge on which are located the towns of Castalia, Ossian, Calmar, Conover, and Ridgeway. That part of the area east of the Turkey River and south of a line between the towns of Conover and Spillville is covered mainly by loess and is mostly rolling or moderately steep. The rest of the area drained by the Turkey River is mostly nearly level, gently rolling, or rolling and is underlain mainly by glacial drift. In most places in that area, the glacial drift is less than 42 inches thick over bedrock. The soils in many of the upland drainageways are somewhat poorly drained or poorly drained.

The Yellow River drains that part of Bloomfield Township north of the ridge on which the town of Castalia is located. The area drained by the Yellow River extends westward from the river to a point about one-half mile west of the town of Ossian, north roughly 3 miles, then east to a point about 1 mile north of the town of Frankville, and northeast approximately 2 miles to the county line. Most of the soils in this drainage area are rolling or moderately steep and developed in loess that is less than 42 inches thick.

About six of the northern tier of sections that extend about 3 miles east and west from the town of Hesper drain into the Root River in Minnesota. The part of this area west of Hesper is dominantly gently rolling or rolling, and in that area the soils developed in deep loess. In the part of the area at Hesper and eastward from Hesper, short, steep risers of nearly bare sandstone are common. Both above and below these steep risers, the soils are mainly gently rolling, rolling, or moderately steep, and they developed in loess. In fairly large areas above the steep risers, the loess is less than 42 inches thick.

Water Supply

Winneshiek County has a good supply of underground water. Rarely do wells that are properly drilled fail because of seasonal lack of water or because of periods of drought. Many of the wells are less than 100 feet deep, but few are more than 350 feet deep. Shallow wells and sand-point wells are dependable sources of water in some areas where the substratum is gravelly.

TABLE 8.—*Summary of temperatures and precipitation*

[Based on a 30-year period,

Month	Precipitation (in inches)								Temperature (° F.)		
	Average	Greatest daily		Snow and sleet					Average		
		Inches	Year	Average	Greatest monthly		Greatest daily		Daily maximum	Daily minimum	Monthly
					Inches	Year	Inches	Year			
January	1.08	1.80	1946	8.9	24.0	1937	10.5	1949	27.9	7.1	17.5
February	.88	1.46	1948	7.2	22.2	1936	10.0	1937	31.2	9.8	20.5
March	2.01	1.97	1956	10.6	28.3	1959	13.0	1959	41.5	20.9	31.2
April	2.57	2.12	1941	1.3	9.0	1952	6.0	1949 [2]	58.8	34.5	46.7
May	4.12	7.70	1941	(3)	3.2	1947	3.2	1947	71.1	46.0	58.6
June	4.94	6.40	1942	0	0	--------	0	--------	80.2	56.4	68.3
July	4.24	4.50	1933	0	0	--------	0	--------	85.7	59.7	72.7
August	4.33	4.40	1940	0	0	--------	0	--------	83.4	57.8	70.6
September	3.42	4.08	1946	0	(4)	1942	(4)	1942	74.8	49.1	62.0
October	2.03	2.68	1942	(3)	.3	1952	.3	1952	63.5	37.8	50.7
November	1.89	2.30	1958	4.5	13.5	1947	12.0	1934	44.7	24.5	34.8
December	1.07	1.30	1932	7.1	19.9	1950	8.0	1932	31.6	13.1	22.4
Year	32.59	7.70	1941	39.6	28.3	1959	13.0	1959	57.9	34.7	46.3

[1] Degree-days based on 65° F. The heating degree-days for a day are determined by subtracting the average daily temperature from 65. These daily values are totaled to obtain the number of degree-days in a month. For example, to determine the average degree-days for January in an 8-year period, determine the total of degree-days for each January in that period and divide by eight.

at Decorah Station, Winneshiek County, Iowa

from 1931 through 1960]

Temperature (° F.)—Continued				Average heating degree-days [1]	Average number of days with—				
Extreme					Precipitation of 0.10 inch or more	Maximum temperature of—		Minimum temperature of—	
Record highest		Record lowest				90° and above	32° and below	32° and below	0° and below
Degrees	Year	Degrees	Year						
59	1944	−43	1951	1, 473	3	0	20	30	10
58	1958 [2]	−38	1951	1, 257	3	0	14	28	8
80	1939 [2]	−26	1948	1, 048	5	0	7	27	2
91	1939	10	1954	549	5	(3)	(3)	14	0
102	1945	21	1943	260	8	1	0	3	0
105	1945	27	1946	99	8	4	0	(3)	0
111	1936	36	1947	22	6	8	0	0	0
104	1955 [2]	33	1934	28	7	7	0	0	0
100	1955 [2]	20	1942	159	6	2	0	2	0
90	1953	10	1952	459	4	(3)	0	10	0
79	1933	−22	1947	906	4	0	5	23	1
60	1951 [2]	−36	1950	1, 321	3	0	15	29	6
111	1936	−43	1951	7, 581	62	22	61	166	27

[2] Also on earlier dates, months, or years.
[3] Less than one half.
[4] Trace.

Table 9.—*Frequency of rains of stated duration and intensity in Winneshiek County*

Frequency [1]	Duration of—						
	½ hour	1 hour	2 hours	3 hours	6 hours	12 hours	24 hours
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Once in—							
1 year	1. 0	1. 3	1. 5	1. 7	1. 8	2. 2	2. 6
2 years	1. 2	1. 5	1. 8	1. 9	2. 2	2. 6	3. 0
5 years	1. 5	1. 9	2. 2	2. 4	2. 8	3. 3	3. 8
10 years	1. 7	2. 1	2. 6	2. 7	3. 3	3. 9	4. 4
25 years	1. 9	2. 5	2. 9	3. 2	3. 7	4. 3	5. 0
50 years	2. 1	2. 7	3. 2	3. 6	4. 2	4. 9	5. 6
100 years	2. 4	3. 0	3. 6	3. 9	4. 7	5. 5	6. 3

[1] Expresses the frequency of the specified number of inches of rainfall at given time intervals. For example, 1.0 inch of rain can be expected to fall in one-half hour once each year (100 percent probability), but 2.4 inches can be expected to fall in one-half hour only once n 100 years (1 percent probability).

Table 10.—*Probabilities of last freezing temperatures in spring and first freezing temperatures in fall*

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	Mar. 11	Mar. 20	Apr. 5	Apr. 17	Apr. 27
3 years in 10 later than	Mar. 21	Mar. 31	Apr. 14	Apr. 26	May 8
5 years in 10 later than	Mar. 28	Apr. 7	Apr. 20	May 3	May 16
7 years in 10 later than	Apr. 4	Apr. 14	Apr. 26	May 10	May 24
9 years in 10 later than	Apr. 14	Apr. 25	May 5	May 19	June 4
Fall:					
1 year in 10 earlier than	Oct. 24	Oct. 6	Sept. 28	Sept. 17	Sept. 8
3 years in 10 earlier than	Nov. 2	Oct. 18	Oct. 9	Sept. 26	Sept. 18
5 years in 10 earlier than	Nov. 9	Oct. 26	Oct. 17	Oct. 3	Sept. 25
7 years in 10 earlier than	Nov. 16	Nov. 3	Oct. 25	Oct. 10	Oct. 2
9 years in 10 earlier than	Nov. 25	Nov. 15	Nov. 15	Oct. 19	Oct. 12

Springs are common in this county. Their sizes range from very large to small seepy areas. Most of the springs in the county have never been developed. Two have been developed, however, and serve as a source of water for fish hatcheries. Several other springs are fully as large as these two, and many of them serve as a source of water for livestock in pastures. Many farmsteads are near a spring that supplies water for livestock. Some springs are also the source of water for use in the household. A few springs are near recreational areas.

Vegetation

While the soils of Winneshiek County were developing, the native vegetation on the somewhat poorly drained and poorly drained soils consisted mainly of plants native to the prairie. Grasses were dominant on somewhat poorly drained sites, and trees, sedges, and grasses grew in small areas. Sedges and grasses were dominant on the poorly drained soils, but sedges grew more extensively on the soils that were the most poorly drained.

On a large part of the acreage of well drained and moderately well drained soils, the vegetation consisted of plants native to both forest and prairie. Where the soils were developing in loess, forest vegetation was dominant over fairly large areas; only in minor, spotty areas did the soils form under prairie vegetation. Nearly all of this minor acreage was in soil association 1, where the Downs and Tama soils are dominant.

Where the soils were developing a glacial drift, prairie vegetation alone was dominant in fairly large areas. It was far more common than forest vegetation alone.

Agriculture

The agricultural economy of Winneshiek County is based largely on the production of corn, oats, hay, and pasture and on the production and marketing of hogs, cattle, milk, and cream. The county had a total of 2,442 farms in 1959, according to the U.S. Bureau of the Census. In the same year, 418,925 acres was in farms and the average size of the farms was 171.5 acres.

The total acreage in farms has been fairly stable from year to year. The number of farms has gradually decreased and the size of farms has increased. Occasionally, by clearing a wooded area, a fairly small acreage is added to the area that is cultivated. Most of the cultivated acreage that is added, however, consists of areas that were formerly wet land but that have been drained.

Many of the farmers are using their land to better advantage than they formerly did. The practices used to control erosion help to conserve the soils. Because of lack of erosion control in the past, however, the soils in about a quarter of the cultivated acreage have lost more than half of their surface layer. In about half of this same acreage, between a quarter and a half of the surface layer has been lost.

In the following paragraphs, some facts about the agriculture of the county are given. The figures are mainly from the 1960 Assessor's Annual Farm Census of Iowa.

Crops.—The acreage of the various crops grown in this county is constantly changing. For example, the acreage in alfalfa has increased greatly during the past few years, and the acreage in wheat has decreased greatly during the same period. Following is a listing of the acreages in various crops in 1960.

	Acres
Corn for all purposes	109, 848
Oats	55, 108
Wheat (spring and fall)	38
Soybeans	3, 407
Hay:	
Alfalfa	47, 138
Clover and timothy	17, 047
All other hay	412
All other land used for crops	16, 260

According to figures obtained from local sources, a total of 64,614 acres was in pasture, 58,615 acres was in wooded tracts, and 10,116 acres was in farmsteads in 1961.

Livestock and livestock products.—Most of the farm income in Winneshiek County is derived from the sale of livestock and livestock products. Following is a listing of the various kinds of livestock in the county in 1960.

	Number
Grain-fed cattle sold	5, 964
Grain-fed sheep and lambs sold	530
Calves born	35, 248
Lambs born	5, 506
Sows farrowing:	
Spring	26, 358
Fall	14, 904
Milk cows	29, 913
Beef cows	9, 486
Hens and pullets on hand	373, 683
Chickens raised	348, 452
Turkeys raised	135, 408

Farm facilities and equipment.—Most of the farms in the county have at least one tractor, and grain combines, cornpickers, pickup bailers, field forage harvesters, and motortrucks are numerous. Most of the farms have electrical and telephone service. A large proportion have a water pressure system, a septic tank, and a furnace heating system. Fuel oil and LP gas are the common heating fuels.

Transportation.—Every farm in the county is served by a graded and surfaced road. Most of the roads are surfaced with crushed rock from the numerous limestone quarries. In the last 10 years, however, many of the main farm-to-market roads have been surfaced with bituminous material. All State and Federal highways are concrete, except for one short spur that is surfaced with bituminous material.

Two concrete highway systems cross the county from east to west and one crosses from north to south. A second north-south system extends about halfway across the county from the north and joins one of the east-west systems.

Recreational Facilities

This county has high potential for recreation. It is a scenic area. The bluffs and outcrops of bedrock, as well as the hills, valleys, springs, and rivers, are all picturesque. The many trees and their multicolored leaves in fall have great esthetic value.

The streams are fed by cool springs and are clear and fast moving. They are ideally suited to trout and are well stocked. An increasing number of persons fish the rivers for trout, bass, and catfish. Fox, deer; pheasant, and rabbit offer variety in the kinds of hunting.

Canoeing and camping have become popular. Also, the numerous open limestone pits are of interest, for they contain pre-Pleistocene deposits that can be studied in detail. Many kinds of birds, animals, geologic formations, and plants can be studied and enjoyed in this county.

Parks, golf courses, fish hatcheries, game refuges, and ponds have been developed in various parts of the county. Additional recreational facilities and rest areas, however, are needed near the points where Federal Highway 52 and State Highways 9, 24, and 150 cross the major rivers.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available moisture capacity. The difference between the amount of water in a soil at field capacity and the amount in the same soil at the permanent wilting point. Commonly expressed as inches of water per inch depth of soil. (Also called moisture-holding capacity or water-holding capacity.)

Bench position. A high, shelflike position.

Biosequence. A sequence of soils whose properties are functionally related to differences in organisms as a soil-forming factor.

Bottom land. The normal flood plain of a stream and the old alluvial plain that is seldom flooded. (See Bottoms, first, and Bottoms, second.)

Bottoms, first. The normal flood plain of a stream; land along the stream subject to overflow.

Bottoms, second. An old alluvial plain, generally flat or smooth, that borders a stream but is seldom flooded.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

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; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour tillage. Cultivation that follows the contour of the land, generally almost at right angles to the slope.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Friable. (See Consistence, soil.)

Hydrosequence. A sequence of soils whose properties are functionally related to differences in drainage and moisture content as a soil-forming factor.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major soil horizons:

A horizon.—The mineral horizon at the surface. It has an accumulation of organic matter, has been leached of soluble minerals and clay, or shows the effects of both.

B horizon.—The horizon in which clay minerals or other material has accumulated, that has developed a characteristic blocky or prismatic structure, or that shows the effects of both processes.

C horizon.—The unconsolidated material immediately under the true soil. In chemical, physical, and mineral composition, this material is presumed to be similar to the material from which at least part of the overlying solum has developed.

Leaching, soil. The removal of materials in solution by the passage of water through soil.

Moisture-holding capacity. See Available moisture capacity.

Mulch tillage. Tillage of the soil and treatment of the crop residue in ways that leave plant material within or on the soil surface to form a mulch.

Parent material. The weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability, soil. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Reaction. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline.	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline.	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. As a soil separate, individual rock or mineral fragments ranging from 0.05 to 2.0 millimeters in diameter. Most sand grains consist of quartz, but they may be of any mineral composition. As a textural class, soil that is 85 percent or more sand and not more than 10 percent clay.

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 textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting upon parent material, as conditioned by relief over periods of time.

Solum, soil. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in a mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structural bench. A degradational feature in which the underlying, nearly horizontal strata (limestone, other kinds of bedrock, residuum, or shale) control the attitude of the landscape.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Substratum. Any layer lying beneath the solum, or true soil; the C or R horizon.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (structural). An embankment or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surplus runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Toposequence. A sequence of soils whose properties are functionally related to topography as a soil-forming factor.

Variant. A soil that has many characteristics of the series in which it is placed but that differs in at least one important characteristic, indicated by its name. The acreage of a variant is of too small extent to justify establishing a new series. A new series may be designated and replace the variant, however, if sufficient acreage is later found.

Water-holding capacity. See Available moisture capacity.

Accessibility Statement