SOIL SURVEY

Bremer County Iowa

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
Iowa Agricultural Experiment Station

Issued October 1967

Major fieldwork for this soil survey was done in the period 1957–1961. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1965. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agricultural Experiment Station, as part of the technical assistance furnished to the Bremer County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Bremer County 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 Bremer County are shown on the detailed map at the back of this survey. This map consists of many sheets 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 soil descriptions and from the discussions of the interpretative groupings.

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

Engineers and builders will find in the section "Engineering" tables that name soil features and give data that affect 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 Bremer County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives additional information about the county.

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NOTICE TO LIBRARIANS

Series year and series number are no longer shown on soil surveys. See explanation on the next page.

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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 BREMER COUNTY, IOWA

REPORT BY RUSSELL L. BUCKNER SOIL CONSERVATION SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

FIELDWORK BY RUSSELL L. BUCKNER, EDWARD L. BRUNS, GARWIN T. CARLSON, WILLIAM L. FOUTS, WAYNE D. FREDERICK, ELLSWORTH M. RICHLEN, DAVID F. SLUSHER, AND KERMIT D. VOY, SOIL CONSERVATION SERVICE; AND WAYNE ARNOLD, JAMES S. BRASFIELD, AND J. MILLARD SOILEAU, IOWA AGRICULTURAL EXPERIMENT STATION

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

BREMER COUNTY is in the northeastern part of Iowa (fig. 1). It has an area of 280,960 acres. Waverly, the county seat, is in the southwestern corner of the county about 100 miles northeast of Des Moines, the State capital.

Bremer County is agricultural. Dairying and livestock production are the main kinds of farming, and livestock farms far outnumber the other kinds. Corn, the principal grain crop, and soybeans, oats, hay, and pasture are the main crops. Except for soybeans, the crops produced are fed to livestock.

The soils of Bremer County, for the most part, are deep, level to gently sloping, and loamy or silty. They are productive, but many of the level or nearly level soils would benefit from artificial drainage. Crops grown on all the soils respond well to fertilizer, and they respond to lime on all except the poorly drained soils.

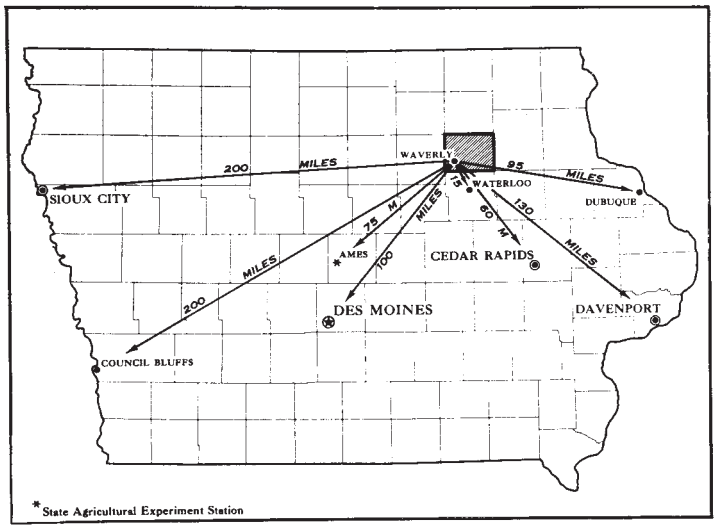

Figure 1.—**Location of Bremer County in Iowa.**

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Bremer 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 or bored 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 to the rock 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 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, the major horizons of all the soils of one series 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. Waukegan and Clyde, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the natural, undisturbed landscape. Soils of one series can differ somewhat in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in the texture of their surface layer. According to this difference 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. Waukegan silt loam and Waukegan loam are two soil types in the Waukegan 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 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, Waukegan loam, moderately deep, 2 to 5 percent slopes, is one phase of Waukegan loam, a soil type that is divided into phases according to depth and slope range.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew boundaries of individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this 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 occur in such small individual tracts that it is not practical to show them separately on the map. They show such a mixture of soils as one mapping unit and call it a soil complex. Ordinarily a soil complex is named for the major soils in it, for example, Spillville-Colo complex.

Some soils are similar enough in characteristics and in use so that their separation is not important to the survey. Such soils are mapped as an undifferentiated group. Each group consists of soils of one or more series that occur together without regularity in pattern and proportion. At least one of the component soils occurs in every delineated area, and all may occur in some delineated areas. The individual bodies of the component soils are large enough to be delineated on a detailed soil map. The Sogn soils have been mapped as an undifferentiated group.

On most soil maps, there are areas to be shown that are so rocky, so shallow, or so frequently worked by wind and water that they cannot be called soils. These areas are shown on the map like other mapping units, but they are given descriptive names, such as Alluvial 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 the 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 is readily useful to different groups of readers, among them farmers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil surveys. On the basis of the yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust them 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 Bremer County. A soil association is a landscape that has a distinctive 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 eight soil associations in Bremer County are described in this section of the survey.

1. Readlyn-Tripoli association

Nearly level, dark-colored loamy soils that are somewhat poorly drained and poorly drained

This association is on broad, nearly level uplands that have only a few distinct drainageways. The topography along the first 2 miles of the county road south of Tripoli is representative of this association, which makes up about 21 percent of the county.

Readlyn and Tripoli soils are about equal in extent and make up about 90 percent of the association. Readlyn soils are somewhat poorly drained and have slightly convex slopes. Tripoli soils are poorly drained and are nearly level or slightly concave.

Dickinson, Hagener, Oran, and Clyde soils are minor in the association. Dickinson and Hagener soils are sandy and occur as small, low, dunelike mounds. The mounds have a slope range of 1 to 5 percent, and many of them are used as sites for farm buildings. There are some large areas of the somewhat poorly drained Oran soils and the poorly drained Clyde soils.

All of this association is used for cultivated crops, except for a few small areas that are in permanent pasture. The principal management problems are improvement of drainage and fertility. The topography is well suited to the use of large farm equipment.

2. Kenyon-Clyde-Floyd association

Level to moderately sloping, dark-colored loamy soils that are moderately well drained, poorly drained, and somewhat poorly drained

This association is on uplands characterized mainly by long, gentle slopes, slightly rounded hills, and many

drainageways and small streams. The western third of it has slightly more rolling topography than the rest. The area for a mile and a half along the county road west of Bremer Station is representative of most of this association, which makes up about 37 percent of the county area. Kenyon soils make up about 18 percent of the association, Clyde soils about 20 percent, and Floyd soils about 15 percent (fig. 2). Kenyon soils are moderately well drained. They are on the broad ridgetops and convex upper slopes. Floyd soils are somewhat poorly drained and are in most of the concave downslope positions. Clyde soils are nearly level. They are poorly drained and are in and along most of the drainageways and on some of the lower side slopes.

Readlyn, Ostrander, Dickinson, and Hagener are the most extensive minor soils. The well-drained Ostrander soils are prominent in the landscape north of Sumner. Most areas of them are gently sloping, but a few are nearly level. The sandy Dickinson and Hagener soils occur in a number of small areas, generally on east and southeast slopes.

Readlyn, Bassett, Oran, Atkinson, Rockton, Chelsea, Lamont, Terril, Winneshiek, Coggon, Klinger, and Dinsdale soils and Peaty muck are also minor parts of this association. Along the east side of the Cedar River are a few areas of the minor soils that are steep and hilly. Also, there are a few small areas of soils underlain by sand or gravel.

Most of this association is used for cultivated crops. Because of boulders that interfere with cultivation, the Clyde soils are generally used for permanent pasture. The principal management problems are control of erosion and improvement of drainage and fertility.

3. *Bassett-Clyde-Oran association*

Level to gently sloping, dark-colored loamy soils that are moderately well drained, poorly drained, and somewhat poorly drained

This association is characterized by long, gently sloping, slightly rounded hills and many drainageways (fig. 3). The topography around Frederika is typical of this association, which makes up about 2 percent of the county area.

Bassett, Clyde, and Oran soils are about equal in extent and make up about 60 percent of the association. Bassett soils are moderately well drained and are in the more strongly sloping, convex areas. Oran soils are in the gently sloping, convex areas and are somewhat poorly drained. The nearly level Clyde soils are poorly drained. They are in and along most of the drainageways and on some of the lower side slopes.

The minor soils are the Coggon, Floyd, Kenyon, Readlyn, and Tripoli soils and the sandy Dickinson, Hagener, and Lamont soils, which occur in a number of small areas.

Most of this association is used for cultivated crops. Some of it is used for permanent pasture and some for timber. Because of boulders that interfere with cultivation and tile drainage, many areas of the Clyde soils are used only for permanent pasture. Potential yields of crops are high except on the more sandy soils. The principal management problems are control of erosion and improvement of drainage and fertility.

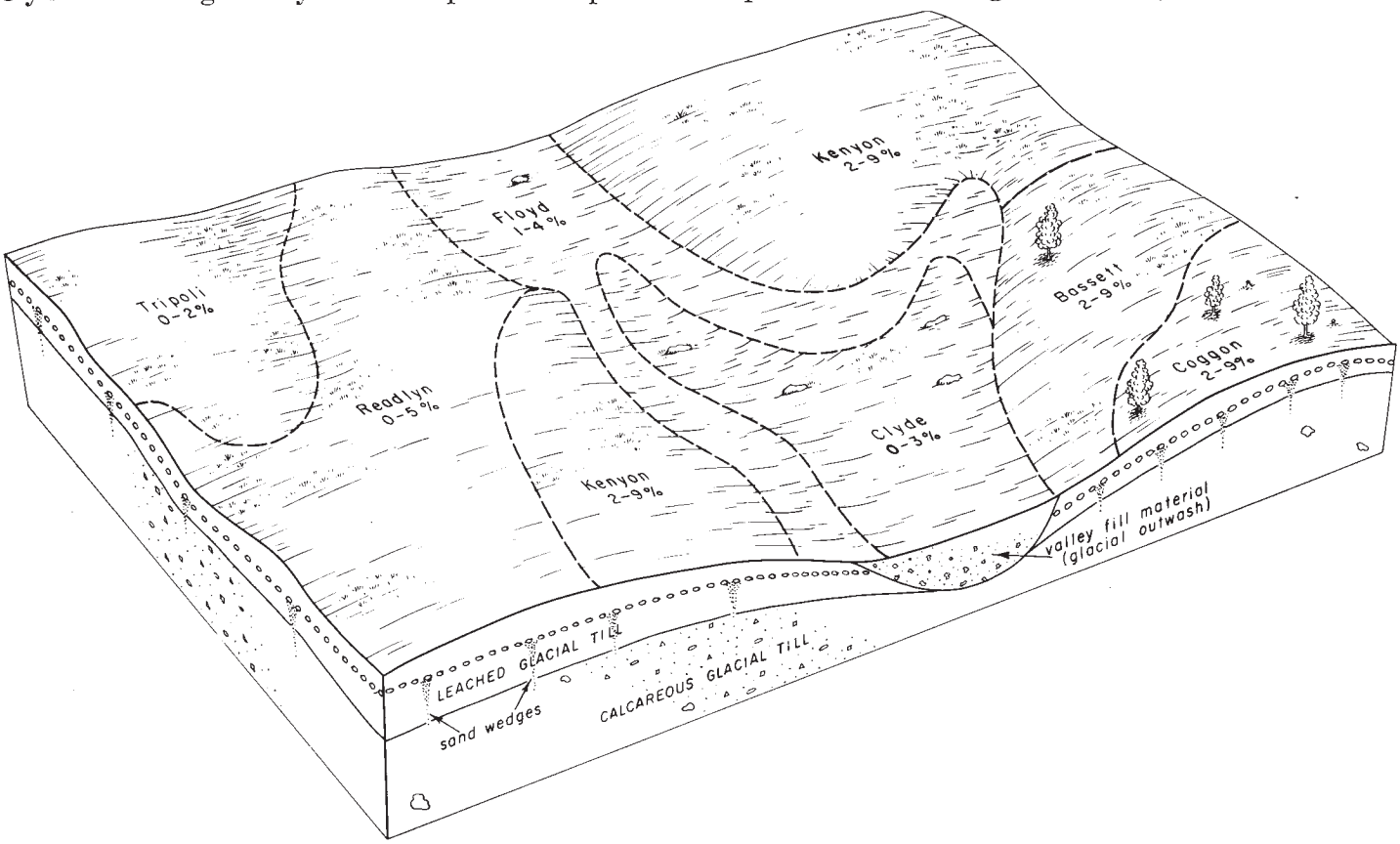

***Figure 2.*—Relationship of slope, vegetation, and parent material to the major soils and some of the minor soils in soil association 2.**

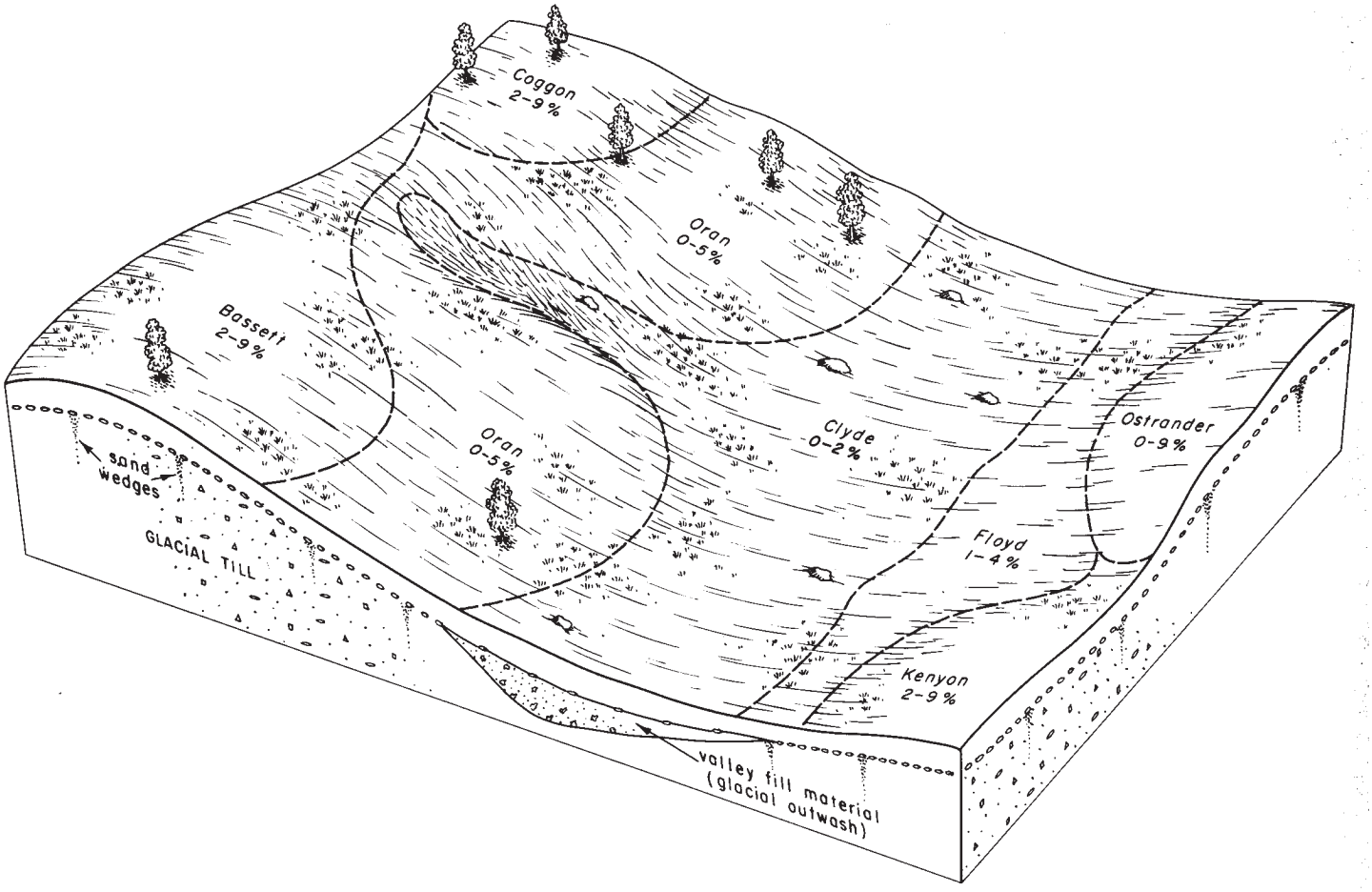

Figure 3.—**Relationship of slope, vegetation, and parent material to soils of soil association 3.**

4. *Klinger-Maxfield-Port Byron association*

Level to moderately sloping, dark-colored silty soils that are somewhat poorly drained, poorly drained, and well drained

Most of this association is on long, gently sloping, slightly rounded hills and broad, level areas (fig. 4). The part around Klinger is typical of the more nearly level topography, and that around Denver is typical of the moderately sloping. The system of drainageways is fairly well developed. This association makes up about 4 percent of the county. Most of it is in the southern half of Maxfield Township.

Klinger soils make up about 30 percent of the association, Maxfield soils about 25 percent, and Port Byron soils about 10 percent. Port Byron soils are well drained and are in the more strongly sloping, convex areas, commonly in the southwestern part of the association. Klinger soils are somewhat poorly drained. They are in slightly convex and gently sloping, concave areas. The poorly drained Maxfield soils are in the more nearly level and slightly concave positions.

The minor soils are the well-drained Dinsdale, the poorly drained Sable, and the somewhat poorly drained Muscatine and Franklin soils.

A larger proportion of this association is used for cultivated crops than of any other association in the county. Under present methods of farming, it is the most productive association. The principal management needs are control of erosion and improvement of drainage and fertility. Most of the association is well suited to the use of large farm equipment.

5. *Seaton-Fayette association*

Gently sloping to steep and hilly, light-colored silty soils that are well drained

This association is characterized by gently sloping and moderately sloping ridgetops, steep side slopes, and narrow valleys (fig. 4). The topography along the first 2 miles of County Road N west of Denver is representative. This association makes up about 1 percent of the county, and all of it is in Jefferson Township.

Seaton soils make up about 70 percent of the association and Fayette soils about 24 percent. Fayette soils are well drained. They are on many of the gently sloping and moderately sloping ridgetops (fig. 5). Seaton soils are also well drained and are on ridgetops and moderate to steep side slopes. The Nodaway, a minor soil in the association, is commonly in the narrow valleys.

Much of this association is in timber or permanent pasture, but many of the gently and moderately sloping ridgetops are cultivated. A few steep slopes are cultivated, but the erosion hazard is severe. Control of ero-

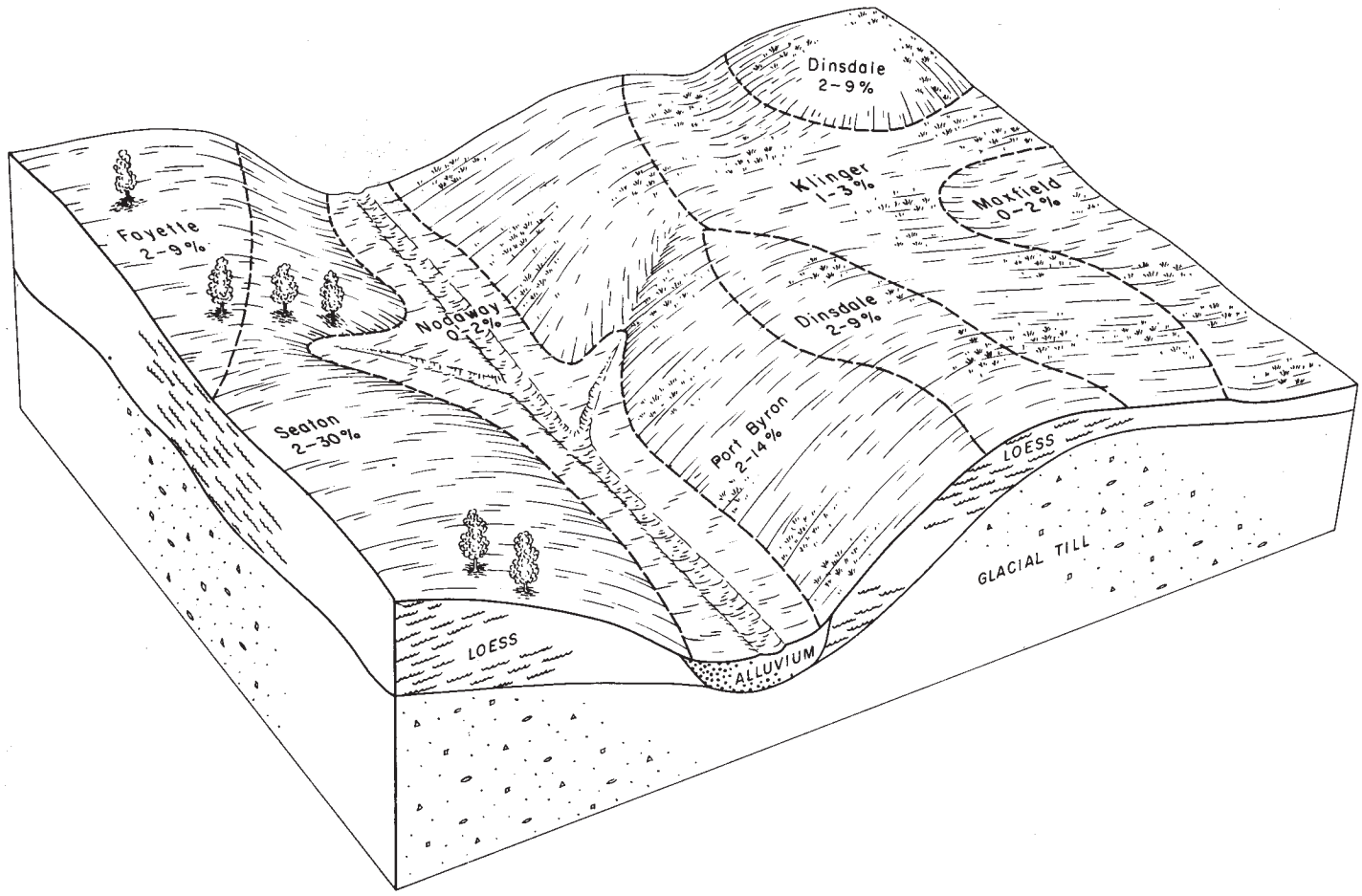

***Figure 4.*—Relationship of the major silty (loess) soils to slope and native vegetation.**

sion and improvement of fertility are the principal management problems.

6. Lamont-Hagener-Port Byron association

Gently sloping to steep, light-colored and dark-colored sandy and silty soils that are excessively drained and well drained

This association consists of gently sloping to steep soils that occur in an irregular pattern. It is on uplands near the Cedar and Shell Rock Rivers except for a small part northeast of Denver. The topography along County Road G north of Waverly is representative. This association makes up about 5 percent of the county area.

Lamont soils make up about 10 percent of the association, Hagener soils about 35 percent, and Port Byron soils 10 percent. Lamont soils are sandy and light colored. Hagener soils also are sandy but are dark colored. Port Byron soils are dark colored and medium textured except where they are severely eroded. The soils of this association are generally steeper where the uplands blend with the stream terraces. Many of these steeper areas are in pasture and timber. As distance from the streams increases, the soils are less sloping and are used more extensively for cultivated crops.

Chelsea, Dickinson, Aredale, and Terril are minor soils in this association. Aredale soils are dark colored, medium textured, and well drained. They are in the gently and moderately sloping positions. Terril soils are along many of the drainageways.

Potential yields in this association are variable and are generally lower than those in other associations. The principal management problems are control of wind and water erosion and improvement of fertility.

7. Rockton-Winneshiek-Sogn association

Nearly level to steep, dark-colored and light-colored loamy soils that are well drained and are moderately deep to shallow over limestone

This association consists of nearly level to steep, well-drained soils that form an irregular pattern. Most of it is on uplands near the Shell Rock and Cedar Rivers. A small part near Frederika is on both uplands and benches, and most of the nearly level soils are in this part. The topography west of the Wapsipinicon River and northwest of Frederika is typical. This association makes up about 2 percent of the county area.

Rockton soils make up about 25 percent of the association, Winneshiek soils 12 percent, and Sogn soils 12 percent. Sogn soils are shallow and have many outcrops of bedrock (fig. 6). They commonly occur near the breaks between uplands and benches and are more strongly sloping than the associated soils. Rockton and Winneshiek

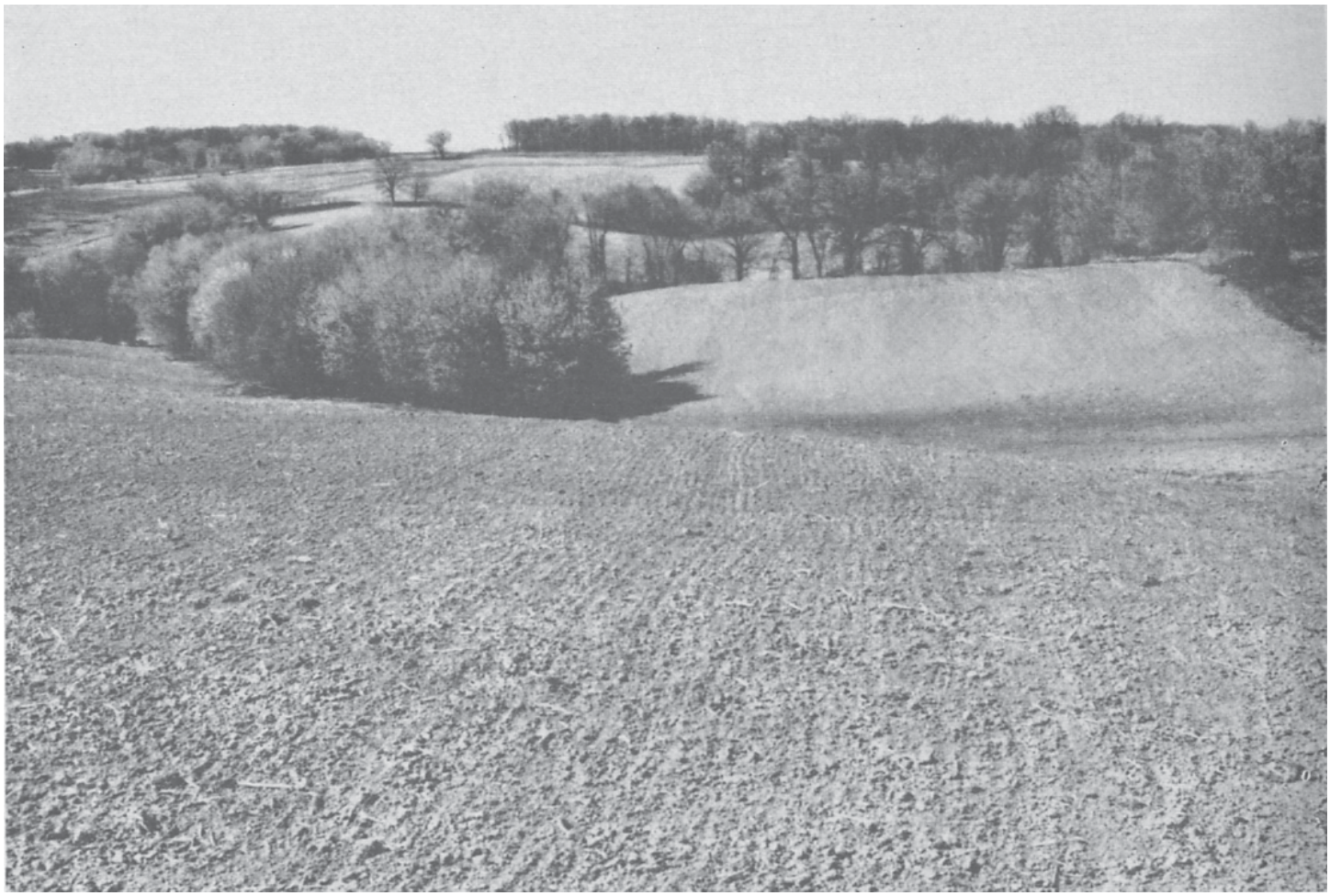

Figure 5.—**Typical landscape in soil association 5.**

soils are medium textured and moderately deep to limestone bedrock. They are gently sloping and moderately sloping.

Atkinson, Backbone, and Terril soils are minor in the association. Atkinson soils are medium textured, are deep to limestone bedrock, and are generally nearly level to moderately sloping. Backbone soils differ from the other soils in having formed in sandy material that is moderately deep over bedrock. Terril soils generally occur in the drainageways.

Potential yields are variable. Sogn soils are mostly in pasture; if cultivated, they produce low yields. Atkinson soils are highly productive. The principal management problems are control of erosion and improvement of fertility.

8. *Waukegan-Hayfield-Marshan-Spillville association*

Level to gently sloping, dark-colored loamy soils that are well drained to poorly drained

This association is predominantly level, although some areas are gently sloping and a few along stream bench escarpments are strongly sloping to steep. Some of the bottom lands are dissected by old river channels and are frequently flooded; others are permanently flooded. The benches have depressions that impound water and are difficult to drain. The topography along Highway 188 between Plainfield and Horton is typical of this association, which makes up about 28 percent of the county area.

Waukegan soils make up about 15 percent of the association, Hayfield soils 7 percent, Marshan soils 11 percent, and Spillville soils 7 percent. The minor soils are Colo, Lawler, Hagener, Sattre, Chelsea, Dickinson, Burkhardt, and Lamont, and there are areas of Alluvial land and Marsh.

Spillville soils, which are the most extensive of the soils on bottom lands, are dark colored, somewhat poorly drained, and level. They are slightly higher than the other bottom-land soils and therefore are less subject to flooding. Colo soils are dark colored, poorly drained, and subject to flooding. Also on bottom lands are Alluvial land and Marsh.

The most extensive of the soils on benches are Waukegan, Hayfield, Lawler, and Marshan soils. Waukegan soils are dark colored, well drained, and level to gently sloping. The moderately dark colored Hayfield and the dark-colored Lawler soils are somewhat poorly drained and are level and nearly level. Marshan soils are poorly drained. They are level or are in depressions that frequently impound water.

Figure 6.—**Sogn soils with many outcrops of limestone bedrock.**

Hagener, Dickinson, Sattre, Chelsea, Burkhardt, and Lamont soils are also on stream benches. The sandy Hagener and Dickinson soils are dark colored and excessively drained or somewhat excessively drained. The Chelsea, Burkhardt, and Hagener are the most droughty soils in the county.

Along the Wapsipinicon River and Plum Creek, the stream benches are lower in relation to the river and creek bed than the benches in other parts of the county. In some seasons, especially during a wet spring, the water table is high, even in well-drained and excessively drained soils.

Most of the soils in this association are used for cultivated crops, but large acreages on bottom lands and some of the lower benches are used for permanent pasture and timber. Most of the Alluvial land is in timber. Yields of crops are high or moderately high except on the sandy soils and in areas where flooding damages crops. Soils in this association are well adapted to the use of large farm equipment. The principal management problems are improvement of drainage and fertility. Some erosion control measures are needed on the sloping soils. The sandy soils are subject to slight wind erosion.

Descriptions of the Soils

In this section the soil series and the individual soils, or mapping units, in each series are described. The mapping units are the areas identified by symbols on the detailed soil map at the back of this survey.

In the descriptions of the series, such general features as drainage, parent material, physiographic location, texture, fertility, and reaction are given for the soils as a group. Each mapping unit in the series is then briefly described, mainly according to features that affect farming and other uses. For complete information about any soil it is necessary to refer to the description of the series as well as that of the mapping unit. Table 1 in this section lists the acreage and proportionate extent of each mapping unit in the county.

For more general information about the soils, the reader can refer to the section "General Soil Map," in which broad patterns of soils are described. 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 section "How This Survey Was Made." Other terms are described in the Glossary at the back of this survey.

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

Map symbol	Soil	Area	Extent
		Acres	*Percent*
Ab	Alluvial land	9, 599	3. 4
ArB	Aredale loam, 2 to 5 percent slopes	712	. 2
ArC	Aredale loam, 5 to 9 percent slopes	252	. 1
AtA	Atkinson loam, 0 to 2 percent slopes	164	. 1
AtB	Atkinson loam, 2 to 5 percent slopes	989	. 3
AtC	Atkinson loam, 5 to 9 percent slopes	302	. 1
BaB	Backbone loamy sand, 2 to 5 percent slopes	183	. 1
BaC	Backbone loamy sand, 5 to 9 percent slopes	188	. 1
BaD	Backbone loamy sand, 9 to 14 percent slopes	162	. 1
BeB	Bassett loam, 2 to 5 percent slopes	2, 116	. 7
BeC	Bassett loam, 5 to 9 percent slopes	197	. 1
BeC2	Bassett loam, 5 to 9 percent slopes, moderately eroded	292	. 1
Bk	Blockton silty clay loam, dark gray subsoil variant	210	. 1
BuA	Burkhardt sandy loam, 0 to 2 percent slopes	371	. 1
BuC	Burkhardt sandy loam, 2 to 9 percent slopes	357	. 1
ChB	Chelsea sand, 0 to 5 percent slopes	961	. 3
ChC	Chelsea sand, 5 to 9 percent slopes	780	. 3
ChE	Chelsea sand, 9 to 18 percent slopes	442	. 2
Ck	Clyde clay loam	29, 608	10. 5
CmB	Coggon loam, 2 to 5 percent slopes	580	. 2
CmC	Coggon loam, 5 to 9 percent slopes	63	(1)
Cn	Colo silty clay loam	2, 249	. 8
CoB	Colo-Terril complex, 0 to 5 percent slopes	105	(1)
CrB	Cresco loam, 2 to 5 percent slopes	211	. 1
CrC	Cresco loam, 5 to 9 percent slopes	164	. 1
DcB	Dickinson sandy loam, 2 to 5 percent slopes	5, 269	1. 9

See footnote at end of table.

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

Map symbol	Soil	Area	Extent
		Acres	*Percent*
DcC	Dickinson sandy loam, 5 to 9 percent slopes	1, 081	. 4
DdA	Dickinson sandy loam, benches, 0 to 2 percent slopes	3, 521	1. 2
DdB	Dickinson sandy loam, benches, 2 to 5 percent slopes	1, 521	. 5
DgA	Dickinson sandy loam, gravelly substratum, 0 to 2 percent slopes	505	. 2
DgB	Dickinson sandy loam, gravelly substratum, 2 to 5 percent slopes	159	. 1
DoA	Dickinson-Ostrander complex, 0 to 2 percent slopes	163	. 1
DoB	Dickinson-Ostrander complex, 2 to 5 percent slopes	1, 582	. 6
DoC	Dickinson-Ostrander complex, 5 to 9 percent slopes	709	. 2
DsB	Dinsdale silty clay loam, 2 to 5 percent slopes	1, 369	. 5
DsC	Dinsdale silty clay loam, 5 to 9 percent slopes	144	. 1
FaB	Fayette silt loam, 2 to 5 percent slopes	124	(1)
FaC2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded	797	. 3
FoB	Floyd loam, 1 to 4 percent slopes	18, 294	6. 5
Fr	Franklin silt loam	457	. 2
HaB	Hagener loamy sand, 2 to 5 percent slopes	3, 959	1. 4
HaC	Hagener loamy sand, 5 to 9 percent slopes	2, 377	. 8
HaD	Hagener loamy sand, 9 to 14 percent slopes	178	. 1
HbA	Hagener loamy sand, benches, 0 to 2 percent slopes	1, 236	. 4
HbB	Hagener loamy sand, benches, 2 to 5 percent slopes	1, 133	. 4
Hc	Harpster silt loam	64	(1)
Hd	Hayfield loam, deep	1, 396	. 5
Hm	Hayfield loam, moderately deep	2, 805	1. 0
Hv	Hayfield loam, dark brown variant	423	. 1
KeB	Kenyon loam, 2 to 5 percent slopes	14, 291	5. 1
KeC	Kenyon loam, 5 to 9 percent slopes	3, 746	1. 3
KeC2	Kenyon loam, 5 to 9 percent slopes, moderately eroded	1, 253	. 4
Kg	Klinger silty clay loam	4, 026	1. 4
LaB	Lamont sandy loam, 2 to 5 percent slopes	923	. 3
LaC	Lamont sandy loam, 5 to 9 percent slopes	508	. 2
LaD	Lamont sandy loam, 9 to 14 percent slopes	59	(1)
LbA	Lamont sandy loam, benches, 0 to 2 percent slopes	493	. 2
Ld	Lawler loam, deep	2, 948	1. 0
Lm	Lawler loam, moderately deep	1, 859	. 7
Ma	Marsh	786	. 3
Mr	Marshan clay loam, deep	5, 762	2. 0
Ms	Marshan clay loam, depressional	1, 200	. 4
Mt	Marshan clay loam, moderately deep	1, 399	. 5
Mx	Maxfield silty clay loam	3, 754	1. 3
My	Muscatine silty clay loam	596	. 2
No	Nodaway silt loam	370	. 1
OrA	Oran loam, 0 to 2 percent slopes	3, 678	1. 3
OrB	Oran loam, 2 to 5 percent slopes	2, 260	. 8
OsA	Ostrander loam, 0 to 2 percent slopes	168	. 1
OsB	Ostrander loam, 2 to 5 percent slopes	8, 070	2. 9
OsC	Ostrander loam, 5 to 9 percent slopes	1, 858	. 7
Pe	Peaty muck, deep	150	. 1
Pm	Peaty muck, moderately deep	350	. 1
PoB	Port Byron silt loam, 2 to 5 percent slopes	721	. 3
PoC2	Port Byron silt loam, 5 to 9 percent slopes, moderately eroded	556	. 2
PoD2	Port Byron silt loam, 9 to 14 percent slopes, moderately eroded	269	. 1
ReA	Readlyn loam, 0 to 2 percent slopes	30, 811	11. 0
ReB	Readlyn loam, 2 to 5 percent slopes	16, 338	5. 8
RfB	Riceville loam, 1 to 3 percent slopes	206	. 1
RkB	Rockton loam, 2 to 5 percent slopes	399	. 1
RkC	Rockton loam, 5 to 9 percent slopes	838	. 3
RkD	Rockton loam, 9 to 14 percent slopes	264	. 1
Ro	Rolfe silt loam	246	. 1
Sa	Sable silty clay loam	1, 009	. 4
SbA	Sattre loam, deep, 0 to 2 percent slopes	269	. 1
SbB	Sattre loam, deep, 2 to 5 percent slopes	171	. 1
SdA	Sattre loam, moderately deep, 0 to 2 percent slopes	1, 471	. 5
SeB	Seaton silt loam, 2 to 5 percent slopes	158	. 1
SeC2	Seaton silt loam, 5 to 9 percent slopes, moderately eroded	277	. 1
SeD2	Seaton silt loam, 9 to 14 percent slopes, moderately eroded	156	. 1
SeD3	Seaton silt loam, 9 to 14 percent slopes, severely eroded	227	. 1
SeE2	Seaton silt loam, 14 to 18 percent slopes, moderately eroded	395	. 1
SeF2	Seaton silt loam, 18 to 30 percent slopes, moderately eroded	1, 268	. 4
SoD	Sogn soils, 5 to 14 percent slopes	398	. 1
SoF	Sogn soils, 14 to 30 percent slopes	386	. 1
Sp	Spillville loam	2, 804	1. 0
Sv	Spillville-Colo complex	3, 513	1. 2
TxA	Terril loam, 0 to 2 percent slopes	2, 632	. 9
TxB	Terril loam, 2 to 5 percent slopes	1, 017	. 4
Tr	Tripoli clay loam	36, 112	12. 8
WaA	Waukegan loam, deep, 0 to 2 percent slopes	3, 269	1. 2
WaB	Waukegan loam, deep, 2 to 5 percent slopes	720	. 3
WgA	Waukegan loam, moderately deep, 0 to 2 percent slopes	3, 895	1. 4
WgB	Waukegan loam, moderately deep, 2 to 5 percent slopes	1, 883	. 7
WgC	Waukegan loam, moderately deep, 5 to 9 percent slopes	180	. 1
WkA	Waukegan silt loam, deep, 0 to 2 percent slopes	836	. 3
WnB	Winneshiek loam, 2 to 5 percent slopes	177	. 1
WnC	Winneshiek loam, 5 to 9 percent slopes	184	. 1
	Gravel pit	175	. 1
	Water	2, 920	1. 0
	Urban	2, 564	. 9
	No symbol	306	. 1
	Total	280, 960	100. 0

[1] Less than 0.1 of 1 percent.

Alluvial Land

Alluvial land (Ab) consists of moderately fine textured to coarse-textured soil material that has been deposited by streams. It is characterized by meandering channels and swales. Floods are frequent, and water stands in some of the deeper swales the year round.

The moderately dark colored surface material is mixed with light-colored, recently deposited sand (fig. 7). The texture of the subsoil, though generally loamy, varies between silty clay loam and gravelly sand. Permeability, drainage, and moisture-supplying capacity are also variable.

***Figure 7.*—Alluvial land that has been cleared of trees. Sand in the foreground was deposited during a single flood.**

Most of this unit is on the flood plains of the Cedar River, the Wapsipinicon River, and Plum Creek. The areas along the Cedar River consist mainly of mixed soils on bottom lands, but those along the Wapsipinicon River consist of soils on bottom lands and on benches.

Because of flooding, this land type is not suitable for row crops. Only a few areas are cultivated. Most of it is covered with timber. It can be used for pasture. *Capability unit Vw–1.*

Aredale Series

The Aredale series consists of dark-colored, well-drained soils on uplands. These soils developed from loamy, medium-textured eolian material 36 to 70 inches thick over glacial till. In many places a pebble band separates the loamy material from the glacial till.

Soils of this series occur in the southwestern third of Bremer County. They are predominantly gently sloping, but in some places they are moderately sloping.

Aredale soils generally have a surface layer of black to very dark brown loam or silt loam 8 to 16 inches thick. The subsoil consists of loam or silt loam and is dark brown grading to yellowish brown with depth. In places the underlying glacial till consists of loam or light clay loam that is yellowish brown mottled with brownish gray.

These soils are moderately permeable and have a high moisture-supplying capacity. They are low in available nitrogen, phosphorus, and potassium and are slightly acid to medium acid. The depth to calcareous material ranges from 60 to 90 inches.

Aredale loam, 2 to 5 percent slopes (ArB).—This soil is on convex upland ridges. In places it adjoins Port Byron, Dinsdale, Ostrander, and Dickinson soils.

The surface layer is black to very dark brown and is 10 to 16 inches thick. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Aredale loam, 5 to 9 percent slopes (ArC).—This soil is on convex side slopes. It commonly adjoins Port Byron, Dinsdale, Dickinson, and other Aredale soils. Included in the areas mapped are a few moderately steep slopes.

The surface layer is black to very dark brown and is 7 to 12 inches thick. In a few small moderately eroded patches, the surface layer is only 2 to 6 inches thick and is very dark brown or very dark grayish brown. Productivity is high, and tilth is usually good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe–1.*

Atkinson Series

The Atkinson series consists of dark-colored, well-drained soils on uplands. These soils formed in 36 to 50 inches of loamy material underlain by limestone bedrock or a thin layer of residuum and bedrock. They are on nearly level and gently sloping, high, structural benches and moderate, convex side slopes.

Atkinson soils have a surface layer of black to very dark brown loam 7 to 11 inches thick. The subsoil is generally brown, dark-brown, or yellowish-brown loam. Beginning at a depth of about 24 inches, there is a layer of brown, dark-brown, or yellowish-brown clay loam that may grade to clay just above the limestone. The depth to bedrock is 36 to 50 inches.

These soils are moderately permeable and have a high moisture-supplying capacity. They are low in available nitrogen, phosphorus, and potassium and are generally slightly acid.

Atkinson loam, 0 to 2 percent slopes (AtA).—This soil is on ridges and on the high part of structural benches. In places it adjoins Rockton, Kenyon, and Ostrander soils. Included in the areas mapped are soils that have a thinner surface layer and a light-colored subsoil.

The surface layer of this soil is black to very dark brown loam and is 8 to 10 inches thick. The depth to limestone is generally 40 to 50 inches, but in a few places it is as much as 56 inches. Productivity is high, and tilth usually is good. Surface runoff is slow. There are no serious limitations and no major management problems. *Capability unit I–2.*

Atkinson loam, 2 to 5 percent slopes (AtB).—This soil is on narrow ridges or on the high part of benchlike areas. It adjoins Rockton, Ostrander, Kenyon, and other Atkinson soils. Included in the areas mapped are a few areas that have a thinner surface layer and a light-colored subsurface layer and also a few areas that have a silt loam surface layer and subsoil.

The surface layer of this soil is black to very dark brown and is 7 to 11 inches thick. The depth to limestone is typically 36 to 50 inches, but it may be as much as 56 inches. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Atkinson loam, 5 to 9 percent slopes (AtC).—This soil is on side slopes, below other Atkinson soils and above Sogn soils. Rockton, Ostrander, and Kenyon soils commonly occur on adjoining slopes. Included in the areas mapped are a few areas that are moderately eroded and have a very dark grayish-brown to dark-brown surface layer and also some areas that have a silt loam surface layer and a light-colored subsurface layer.

The surface layer of this soil is very dark brown and is 7 to 11 inches thick. The depth to limestone is generally between 36 to 50 inches. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe–1.*

Backbone Series

The Backbone series consists of light-colored, somewhat excessively drained soils on uplands. These soils developed from sandy loam and loamy sand over a moderately fine textured layer underlain by limestone bedrock. They are on gently sloping ridges and moderate to steep, convex side slopes. Nearly all of the Backbone soils in Bremer County are east of and within 3 miles of the Cedar River.

Backbone soils have a very dark gray loamy sand surface layer that is 6 to 8 inches thick. The subsurface layer consists of brown to dark grayish-brown loamy sand and is about 2 to 6 inches thick. In some places a narrow column or pocket of this loamy sand extends down to the bedrock. Cultivated areas have a plow layer of very dark grayish-brown loamy sand or sandy loam. In many places the upper part of the subsoil is dark-brown to dark yellowish-brown light to heavy sandy loam. The sandy loam grades to clay loam, and the clay loam may grade to clay immediately above the limestone. The depth to bedrock is 20 to 40 inches.

These soils have a low moisture-supplying capacity. Permeability is moderately rapid in the sandy material and moderate in the loamy material. The supplies of available nitrogen, phosphorus, and potassium are very low. The reaction ranges from slightly acid to strongly acid.

Backbone loamy sand, 2 to 5 percent slopes (BaB).—This soil is on ridges and on the higher parts of slopes, above more strongly sloping Backbone, Chelsea, Lamont, and Sogn soils.

The surface layer is very dark gray loamy sand or sandy loam and is 6 to 8 inches thick. In cultivated areas the surface layer is very dark grayish brown and dries to a somewhat lighter color. It is underlain by a distinct, lighter colored subsurface layer. The depth to limestone generally is between 20 and 30 inches, but in many places it is more than 30 inches. Productivity is low or moderate. Surface runoff is slow, but drainage is excessive.

If cultivated, this soil is subject to wind and water erosion. Tillage should be on the contour, and residue should be left on the surface if row crops are grown. *Capability unit IVs–2.*

Backbone loamy sand, 5 to 9 percent slopes (BaC).—This soil occurs as small areas on rather short side slopes below less strongly sloping Backbone, Chelsea, Lamont, and Sogn soils.

The surface layer is very dark gray, except where eroded, and the subsurface layer is lighter colored. In many cultivated areas, the plow layer is very dark grayish brown. The depth to limestone is 20 to 40 inches. Productivity is relatively low. Surface runoff is medium.

If cultivated, this soil is subject to wind and water erosion. It should be tilled on the contour if row crops are grown. *Capability unit IVs–2.*

Backbone loamy sand, 9 to 14 percent slopes (BaD).—This soil occurs as small areas on short side slopes. It commonly adjoins Chelsea, Lamont, and Sogn soils and in a few places adjoins Hagener soils.

The surface layer is very dark grayish brown to very dark gray and is about 6 inches thick. The subsurface layer is lighter colored. The depth to limestone ranges from 20 to 40 inches. In many places it is less than 30 inches. Productivity is low. Surface runoff is medium or rapid, and drainage is excessive.

This soil is subject to wind and water erosion. It is not suited to row crops. *Capability unit VIs–1.*

Bassett Series

The Bassett series consists of moderately dark colored, moderately well drained soils that developed from loamy material 14 to 21 inches thick over glacial till. In most places a band of pebbles or stones separates the loamy material from the glacial till. These soils occur on long, gently sloping upland ridges, or highs, and on moderate, convex side slopes.

The surface layer is very dark brown, very dark grayish-brown, or dark-brown loam 4 to 7 inches thick. The subsurface layer is brown to dark-brown loam about 8 inches thick. Beginning at a depth of about 14 to 21 inches is a heavy loam subsoil that is brown to dark yellowish brown and is slightly mottled with grayish brown at a depth below 24 to 34 inches. Discontinuous lenses of sandy material occur in the subsoil in some places.

Bassett soils are friable to a depth of about 30 inches and are friable to firm below this depth. They have a high moisture-supplying capacity and moderately slow

permeability. They are low in available nitrogen, phosphorus, and potassium. The surface layer is slightly acid to medium acid, but the subsoil is strongly acid in the upper part and very strongly acid in the lower part. The depth to calcareous material generally is between 60 and 80 inches.

Bassett loam, 2 to 5 percent slopes (BeB).—This soil is on long, convex ridges, or highs. In many places it is above Oran and Floyd soils or above moderately sloping Coggon and Bassett soils. Included in the areas mapped are a few areas that have a sandy loam surface layer.

The surface layer of this soil is very dark brown and is 4 to 7 inches thick. It is underlain by a lighter colored subsurface layer. Most cultivated areas have a very dark brown plow layer. In a few small, moderately eroded areas, the surface layer is very dark grayish brown to dark brown. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Bassett loam, 5 to 9 percent slopes (BeC).—This soil is on long, convex side slopes. In many places it is above Oran and Floyd soils and below gently sloping Coggon and Bassett soils.

The surface layer is very dark brown and is 4 to 6 inches thick. Below it is a lighter colored subsurface layer. Cultivated areas have a very dark brown to very dark grayish-brown plow layer that is somewhat light colored when dry. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe–1.*

Bassett loam, 5 to 9 percent slopes, moderately eroded (BeC2).—This soil is on long, convex side slopes. It is above Oran and Floyd soils and below gently sloping Coggon and Bassett soils. Included in the areas mapped are a few moderately steep slopes and a few small areas that have a sandy loam surface layer.

The surface layer of this soil is very dark grayish brown and is 6 to 8 inches thick. When dry, it is somewhat lighter colored. In cultivated areas, the subsurface layer is part of the plow layer. Some spots are severely eroded. In these places the subsoil is exposed and a few stones or pebbles are evident. Productivity is moderate, and tilth is usually good. Surface runoff is rapid.

If cultivated, this soil is subject to severe erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe–1.*

Blockton Series, Dark Gray Subsoil Variant

This variant of the Blockton series consists of dark-colored, poorly drained soils that developed from fine textured and moderately fine textured, silty alluvium. These soils are on nearly level stream benches and in depressions.

The surface layer of light silty clay loam is black and is 6 to 10 inches thick. The subsurface layer is dark-gray to very dark grayish-brown silt loam and is 6 to 12 inches thick. Beginning at a depth of 16 inches or more, this layer grades to a medium to heavy silty clay subsoil, which is very dark gray to light olive and is mottled. The lower part of the subsoil is medium silty clay loam to medium silty clay that is light olive brown and pale olive and is mottled. Brown and yellowish-brown sand or gravel is below a depth of 40 to 60 inches in most places.

These soils are very slowly permeable and have a high moisture-supplying capacity. They are low in available nitrogen, phosphorus, and potassium and are medium to strongly acid.

Blockton silty clay loam, dark gray subsoil variant (0 to 2 percent slopes) (Bk).—Most of this soil is on stream benches in sections 30 and 32 of Jackson Township.

The surface layer is black and is about 10 inches thick. The subsurface layer is lighter colored silt loam, and the subsoil is clayey and firm. Productivity is moderate, except where surface drainage is inadequate and where runoff from higher areas accumulates. Tilth is usually good, but the surface layer puddles readily if worked when wet. An occasional grass-legume crop helps to keep this layer granular. Surface runoff is generally slow. Surface drainage is beneficial, but tile drains may not work well enough to be worthwhile. *Capability unit IIIw–2.*

Burkhardt Series

The Burkhardt series consists of excessively drained soils derived from shallow sandy loam to light loamy material overlying gravelly material (fig. 8). These soils are on level to gently sloping stream benches and in outwash areas on uplands. In a few places they are on sloping bench escarpments.

Burkhardt soils have a surface layer of sandy loam or loam that is generally very dark brown. It is underlain by dark-brown or very dark brown sandy loam. The

***Figure 8.*—Profile of Burkhardt sandy loam exposed in a gravel pit.**

depth to yellowish-brown gravelly material is generally 10 to 16 inches.

These soils have a very low moisture-supplying capacity and very rapid permeability. They are very low in available nitrogen, phosphorus, and potassium. The reaction ranges from slightly acid to strongly acid.

Burkhardt sandy loam, 0 to 2 percent slopes (BuA).—This soil is on stream benches, next to more strongly sloping Burkhardt soils and Dickinson, Hagener, and Waukegan soils.

The surface layer is generally very dark brown and is 8 to 12 inches thick. Many noncultivated areas have a very thin, black surface layer that grades to very dark brown with depth. In places the surface layer and subsoil contain some gravel. The depth to the gravel substratum is generally 14 to 20 inches. Productivity is low. Surface runoff is very slow, but drainage is excessive.

This soil is subject to slight wind erosion. If row crops are grown, residue should be left on the surface. *Capability unit IVs–2.*

Burkhardt sandy loam, 2 to 9 percent slopes (BuC).—Most of this soil is on sloping bench escarpments, but some of it is on gently sloping benches and in outwash areas on uplands. In places it adjoins Hagener, Dickinson, and Waukegan soils.

The surface layer is very dark brown or very dark grayish brown. Generally it is about 7 inches thick, but it is thicker in some noncultivated areas. The surface layer and subsoil contain some gravel. The depth to the gravel substratum is 10 to 16 inches in most places. Productivity is very low. Surface runoff is medium to slow, but drainage is excessive.

If cultivated, this soil is subject to slight wind and water erosion. It should be tilled on the contour, and residue should be left on the surface if row crops are grown. *Capability unit IVs–2.*

Chelsea Series

The Chelsea series consists of light-colored, excessively drained soils that developed from deep sands and loamy sands. These soils are on gently sloping to steep upland ridges and side slopes, on nearly level or gently sloping benches, and in outwash areas.

The surface layer is generally very dark grayish-brown or dark grayish-brown sand and is 2 to 6 inches thick. In some places there is a subsurface layer of brown or dark grayish-brown sand that grades to dark yellowish brown with depth. Very thin lenses of dark-brown loamy sand occur below a depth of 40 inches in some areas.

These soils have a low moisture-supplying capacity and are rapidly permeable. They are very low in available nitrogen, phosphorus, and potassium. The reaction ranges from neutral to strongly acid.

Chelsea sand, 0 to 5 percent slopes (ChB).—This soil is on upland slopes that face east, south, or southeast. It is also in mound or dunelike positions on uplands and benches.

The surface layer is very dark gray or very dark brown sand or loamy sand and is 1 to 3 inches thick. It is underlain by a lighter colored subsurface layer and subsoil. Many cultivated areas have a very dark grayish-brown plow layer. In some places on benches, the texture grades to sandy gravel below a depth of 30 inches. Productivity is low. Surface runoff is very slow, but drainage is excessive.

If cultivated, this soil is subject to wind and water erosion. *Capability unit IVs–2.*

Chelsea sand, 5 to 9 percent slopes (ChC).—This soil is in mound or dunelike positions on uplands and benches and in outwash areas. Included in the areas mapped are a few moderately eroded areas that have a dark grayish-brown to dark-brown surface layer.

The surface layer of this soil is very dark brown or very dark gray and is 1 to 3 inches thick. The subsurface layer is lighter colored. In cultivated areas, the surface layer is dark grayish brown or very dark grayish brown. Productivity is very low. Surface runoff is medium, but drainage is excessive.

If cultivated, this soil is subject to wind and water erosion. Row crops should be grown on the contour. *Capability unit IVs–2.*

Chelsea sand, 9 to 18 percent slopes (ChE).—This soil is on short, convex upland side slopes. Most of it is along the east side of and within 3 miles of the Cedar River. A few areas are eroded.

The color of the surface layer ranges from very dark brown to dark grayish brown. Noncultivated or eroded areas have a dark-brown, very thin surface layer and a lighter colored subsurface layer. Cultivated areas have a distinct, light-colored plow layer. Productivity is very low. Surface runoff is medium to rapid, and drainage is excessive.

This soil is subject to severe wind and water erosion. It is not suited to row crops. *Capability unit VIs–1.*

Clyde Series

The Clyde series consists of dark-colored, poorly drained soils that formed in 20 to 40 inches of moderately fine textured loamy material over stratified glacial till or water-deposited material. In places a layer of pebbles and stones separates the loamy material and the till. These soils are in nearly level drainageways and in low concave parts of uplands.

Clyde soils have a surface layer of black and very dark gray light clay loam about 20 inches thick. The subsoil is mottled heavy loam that ranges from very dark gray to olive brown. Beginning at a depth of about 30 inches is yellowish-brown and gray loam. In many places this loam is stratified with sandy material.

These soils have a high moisture-supplying capacity and are moderately permeable. They are medium in available nitrogen and low in phosphorus and potassium. The reaction is generally neutral.

Clyde clay loam (0 to 3 percent slopes) (Ck).—This soil is in drainageways and in low, concave parts of uplands.

The surface layer is normally black or very dark gray and is 20 to 24 inches thick. In a few areas adjoining bottom lands, this layer is darker and thicker. The subsoil generally is mottled heavy loam that ranges from very dark gray to olive brown. It is stratified in the lower part. In small areas at the upper end of draws, the subsoil is less gray and the lower part is less stratified. Some stones and boulders are on the surface (fig. 9).

Productivity is high if this soil is properly drained. Tilth usually is good, but the soil puddles if worked when wet. The major limitation is wetness caused by seepage from soils upslope. *Capability unit IIw–1.*

***Figure 9.*—Clyde clay loam. Stones and boulders occur in some areas of Clyde soils.**

Coggon Series

The Coggon series consists of light-colored, moderately well drained soils on uplands. These soils developed from loamy material 14 to 21 inches thick over glacial till. In many places a layer of pebbles and stones separates the loamy material from the glacial till. These soils are on gently sloping, convex ridges, or highs, and on long, gentle or moderate side slopes.

Coggon soils have a very dark gray loam surface layer 1 to 4 inches thick. The subsurface layer is dark grayish-brown or brown loam 4 to 10 inches thick. Many cultivated areas have a dark grayish-brown plow layer. Beginning at a depth of 14 to 21 inches is a heavy loam subsoil that is brown to yellowish-brown and is mottled with grayish brown in the lower part. In places there are small pockets or discontinuous lenses of sandy material in the subsoil.

These soils are friable to a depth of about 30 inches and friable to firm below that depth. They have a high moisture-supplying capacity and moderately slow permeability. The supply of available phosphorus and potassium is low, and that of available nitrogen is very low. The surface layer is slightly acid or medium acid, and the subsoil is strongly acid or very strongly acid. Generally, the depth to calcareous material is between 60 and 85 inches.

Coggon loam, 2 to 5 percent slopes (CmB).—This soil is on convex ridges, or highs, and on long, convex side slopes. It occurs above Oran and Floyd soils or above moderately sloping Coggon or Bassett soils.

Normally, the surface layer is very dark gray and is 1 to 4 inches thick. Below it is a distinct, lighter colored subsurface layer. Where the soil has been cultivated, the plow layer is dark grayish brown or very dark grayish brown. Productivity is moderate to high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Coggon loam, 5 to 9 percent slopes (CmC).—This soil is on long side slopes, except in a few places near streams where the slopes are short and moderately steep. It is above Oran and Floyd soils and below gently sloping Bassett and Coggon soils. Included in the areas mapped are some moderately eroded areas that have a dark grayish-brown or brown surface layer.

The surface layer of this soil is normally very dark gray and is 1 to 3 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Cultivated areas have a dark grayish-brown plow layer that is much lighter in color when dry. Productivity is moderate, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced if used for cultivated crops. *Capability unit IIIe–1.*

Colo Series

The Colo series consists of dark-colored, poorly drained soils on nearly level flood plains of rivers and narrow, intermittent streams. These soils developed from moderately fine textured alluvial deposits.

Colo soils are black or very dark gray to a depth of 40 inches or more. Below this the colors range from very dark gray to gray. The texture is typically silty clay loam, but in places it is light clay loam to loam below a depth of 30 inches.

These soils have a high moisture-supplying capacity and moderately slow permeability. They are medium in available nitrogen, phosphorus, and potassium and are neutral or slightly acid.

Colo silty clay loam (0 to 2 percent slopes) (Cn).—This soil is on level or nearly level flood plains. It adjoins Terril and Spillville soils in many places, and some of it is near Clyde and Marshan soils. Included in the areas mapped are small areas that have a loam to clay loam surface layer and dark colors to a depth of only about 24 inches.

The surface layer of this soil is black or very dark gray to a depth of 40 inches or more. Productivity is high if the soil is properly drained. Tilth usually is good. An occasional grass-legume crop helps to maintain the granular structure. Surface runoff is slow.

Wetness, caused by flooding and in some places by a high water table, is the major limitation. *Capability unit IIw–3.*

Colo-Terril complex, 0 to 5 percent slopes (CoB).—The soils of this complex occur as such small areas and are so intermingled that they are not mapped separately. They are associated with Fayette and Seaton soils on narrow flood plains of small streams and in drainageways. Most of the complex is west of Denver.

The surface layer is silty clay loam or loam that is dark colored when moist or dry. Productivity is high, and tilth usually is good.

Runoff from soils upslope and a frequently high water table are management problems. Some gullying may occur in waterways, but the waterways can be shaped and reseeded. Because of the shape and location of the areas, soils of this complex are generally farmed with surrounding soils or are left in pasture. If tile drained, they are row cropped with adjoining soils. *Capability unit IIw–3.*

Cresco Series

The Cresco series consists of dark-colored, moderately well drained soils on uplands. These soils developed from loamy material 14 to 21 inches thick over firm glacial till. A pebble band generally occurs between the loamy material and the till. These soils are on long, convex side slopes that are gently sloping or moderately sloping.

Cresco soils have a loam surface layer about 8 to 16 inches thick that grades from black or very dark brown to very dark grayish brown with depth. At a depth of 14 to 21 inches is a dark yellowish-brown subsoil of heavy loam to light clay loam that has distinct, grayish-brown mottles and coatings beginning at a depth of about 20 inches. The subsoil is firm.

These soils have a high moisture-supplying capacity and moderately slow permeability. They are low in available nitrogen, phosphorus, and potassium and are medium acid or strongly acid. The depth to calcareous material is more than 45 inches.

Cresco loam, 2 to 5 percent slopes (CrB).—This soil is on long, convex side slopes. It commonly occurs above Readlyn soils or above moderately sloping Kenyon and Cresco soils.

The surface layer grades from black or very dark brown to very dark grayish brown with depth. It is 12 to 16 inches thick. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Cresco loam, 5 to 9 percent slopes (CrC).—This soil is on long, convex side slopes. It commonly occurs above gently sloping Kenyon or other Cresco soils. Included in the areas mapped are a few moderately eroded areas in which the surface layer is dark grayish-brown to dark-brown, and some small areas in which the surface layer is only 4 to 8 inches thick and the subsurface layer is somewhat lighter colored.

The surface layer of this soil is very dark brown or very dark grayish brown and is 8 to 12 inches thick. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced. *Capability unit IIIe–1.*

Dickinson Series

The Dickinson series consists of dark-colored, somewhat excessively drained soils. These soils developed from deep sandy loam over sand or over gravelly coarse material. They occur on gently sloping upland ridges, or highs, on moderately steep, convex side slopes, on nearly level or gently sloping stream benches, and in outwash areas.

The surface layer is generally very dark brown sandy loam 8 to 12 inches thick. The subsoil is dark-brown and dark yellowish-brown sandy loam. Beginning at a depth of 20 to 40 inches is yellowish-brown sand. On benches the subsoil is underlain by gravel at a depth of 20 to 40 inches.

These soils have a low or moderately low moisture-supplying capacity and moderately rapid permeability. They are very low in available nitrogen, phosphorus, and potassium. The reaction ranges from slightly acid to strongly acid.

Dickinson sandy loam, 2 to 5 percent slopes (DcB).—This soil is on ridges, or highs, and on upland slopes that face east, south, and southeast. It adjoins Hagener, Aredale, and Ostrander soils. It also occurs in mound or dunelike positions. Although the range of slope is 2 to 5 percent, a few areas are nearly level. Included in the areas mapped are small areas that have a loamy subsoil and a few areas that have limestone at a depth of more than 40 inches.

The surface layer of this soil is very dark brown and is 10 to 16 inches thick. This layer and the subsoil are free of gravel. The depth to sand generally is 20 to 30 inches, but in places it is 40 inches. Productivity is moderate, and tilth is generally good. Surface runoff is slow, but drainage is somewhat excessive.

If this soil is cultivated, it is subject to slight wind and water erosion. It should be tilled on the contour or terraced if row crops are grown, and residue should be left on the surface. *Capability unit IIIs–2.*

Dickinson sandy loam, 5 to 9 percent slopes (DcC).—This soil commonly occurs on upland slopes that face south or east. It adjoins Hagener, Aredale, and Ostrander soils. Some of it is in mound or dunelike positions on narrow bench escarpments. Included in the areas mapped are a few areas of loamy sand, a few small, moderately steep areas, and some soils that have limestone at a depth of more than 40 inches.

The surface layer of this soil is very dark brown to very dark grayish brown and is typically 8 to 12 inches thick. In some moderately eroded areas it is only 3 to 6 inches thick. Productivity is moderate, and tilth usually is good. Surface runoff is medium, and drainage is somewhat excessive.

If cultivated, this soil is subject to wind and water erosion. It should be tilled on the contour if used for row crops, and residue should be left on the surface. *Capability unit IIIs–2.*

Dickinson sandy loam, benches, 0 to 2 percent slopes (DdA).—This soil occurs mainly along the larger streams and rivers. It commonly adjoins Hagener and Waukegan soils and Dickinson soils that have a gravelly substratum.

The surface layer is 12 to 16 inches thick and is very dark brown. The depth to sand is 30 to 40 inches and, in places, gravelly material is below a depth of 40 inches. No

gravel occurs in the surface layer or subsoil. Productivity is moderate, and tilth is good. Surface runoff is very slow, but drainage is somewhat excessive.

This soil is subject to slight wind erosion. Residue should be left on the surface if row crops are grown. *Capability unit IIIs-1.*

Dickinson sandy loam, benches, 2 to 5 percent slopes (DdB).—Most of this soil is on gently sloping benches along the larger streams and rivers. Some of it is on narrow terrace escarpments. It commonly adjoins Hagener soils, Waukegan soils, and Dickinson soils that have a gravelly substratum.

The surface layer is very dark brown to very dark grayish brown and is 8 to 12 inches thick. The depth to sand is 24 to 36 inches. In places gravelly material occurs below a depth of 40 inches, but there is no gravel in the surface layer or subsoil. Productivity is moderate, and tilth is good. Surface runoff is slow, but drainage is somewhat excessive.

If cultivated, this soil is subject to slight wind and water erosion. It should be tilled on the contour, and residue should be left on the surface. *Capability unit IIIs-2.*

Dickinson sandy loam, gravelly substratum, 0 to 2 percent slopes (DgA).—This soil is on stream benches. Some individual areas are large. The depth to sand and gravel ranges from 20 to 40 inches and is commonly more than 30 inches. There is some gravel on the surface and in the subsoil.

Productivity is moderate, and tilth is good. Surface runoff is very slow, but drainage is excessive. As wind erosion is a slight hazard, crop residue should be left on the surface. *Capability unit IIIs-1.*

Dickinson sandy loam, gravelly substratum, 2 to 5 percent slopes (DgB).—This soil is on gently sloping stream benches and on the high parts of a few convex outwash areas.

The surface layer is very dark brown or very dark grayish brown and is 8 to 14 inches thick. The depth to sand and gravel ranges from 20 to 40 inches but is commonly less than 30 inches. In places the surface layer contains some gravel. Productivity is moderate, and tilth is good. Surface runoff is slow, but drainage is excessive.

If cultivated, this soil is subject to slight wind and water erosion. It should be tilled on the contour, and residue should be left on the surface. *Capability unit IIIs-2.*

Dickinson-Ostrander complex, 0 to 2 percent slopes (DoA).—The two kinds of soils in this complex are too intricately mixed to be mapped separately. They are on nearly level or slightly undulating ridges, or highs, and on gentle or moderate side slopes. They commonly adjoin Hagener and Kenyon soils and other Dickinson and Ostrander soils. Individual areas of the complex are small. Normally, an area is about 40 percent Ostrander loam and 60 percent Dickinson sandy loam, but the proportion of either soil may be as much as 70 percent. Included are a few areas of loamy sand, some of which are underlain by glacial till.

The surface layer is dark-colored loam or sandy loam and is 12 to 16 inches thick. Productivity is moderate to high, and tilth usually is good. Although there is little or no surface runoff, some areas are slightly droughty.

There are no major management problems. If cultivated, the sandy areas are subject to some wind erosion. Crop residue should be left on the surface. *Capability unit IIs-1.*

Dickinson-Ostrander complex, 2 to 5 percent slopes (DoB).—The two kinds of soils in this complex are too intricately mixed to be mapped separately. Normally, a given area of the complex is about 40 percent Ostrander loam and about 60 percent Dickinson sandy loam, but the proportion of either soil may be as much as 70 percent. Included are a few areas of moderately dark colored loamy sand that may be underlain by glacial till.

These soils occur with Hagener, Kenyon, and other Dickinson and Ostrander soils on convex ridges and on side slopes of varying length.

The surface layer is dark-colored loam or sandy loam and is 8 to 12 inches thick. Productivity is moderate to high, and tilth usually is good. Surface runoff is slow to medium, but some areas are slightly droughty.

If cultivated, these soils are subject to slight erosion. They should be tilled on the contour if row crops are grown. *Capability unit IIe-2.*

Dickinson-Ostrander complex, 5 to 9 percent slopes (DoC).—The two kinds of soils in this complex are too intricately mixed to be mapped separately. Normally, any area of the complex is about 40 percent Ostrander loam and about 60 percent Dickinson sandy loam, but the proportion of either soil may be as much as 70 percent. Included in the areas mapped are a few moderately steep slopes, a few moderately eroded areas in which the surface layer is only 2 to 6 inches thick, and a few areas of loamy sand that may be underlain by glacial till.

These soils occur with Hagener, Kenyon, and other Dickinson and Ostrander soils on convex side slopes.

The surface layer of this complex is dark-colored loam or sandy loam and is 7 to 10 inches thick. Productivity is moderate, and tilth usually is good. Surface runoff is medium, and some areas are slightly droughty.

If cultivated, these soils are subject to moderate erosion. They should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe-3.*

Dinsdale Series

The Dinsdale series consists of dark-colored, well-drained soils on gently or moderately sloping, convex ridges and side slopes on uplands. These soils developed in 20 to 40 inches of loess over glacial till. In many places a pebble band separates the loess from the till. In Bremer County these soils are south of State Highway No. 3 and are mostly in Maxfield Township.

Dinsdale soils have a light silty clay loam surface layer 10 to 18 inches thick. The color of this layer grades from black or very dark brown to very dark grayish brown with increasing depth. The upper part of the subsoil is brown or dark-brown light silty clay loam. The lower part, beginning at a depth of 20 to 40 inches, is yellowish-brown loam. This is underlain by a yellowish-brown or strong-brown substratum. Some light brownish-gray mottles occur in the lower subsoil and in the substratum.

These soils have a high moisture-supplying capacity. Permeability is moderate in the loess and moderately slow in the till. The content of available nitrogen and phosphorus is low, but that of available potassium is medium. The reaction is slightly acid to medium acid.

The depth to calcareous material is generally between 50 and 65 inches.

Dinsdale silty clay loam, 2 to 5 percent slopes (DsB).—This soil is on gently sloping ridges, commonly adjoining Klinger, Aredale, and Ostrander soils.

The surface layer is 14 to 16 inches thick, and grades from black or very dark brown to very dark grayish brown with depth. This layer is dark colored both when moist and when dry. The depth to glacial till ranges from 20 to 40 inches but is generally between 30 and 40 inches. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe-1.*

Dinsdale silty clay loam, 5 to 9 percent slopes (DsC).—This soil is on convex side slopes below other Dinsdale soils and adjoining Ostrander, Aredale, and Port Byron soils. Included in the areas mapped are a few moderately eroded areas that have a very dark grayish-brown to dark-brown surface layer.

The surface layer of this soil is 10 to 14 inches thick, and it grades from very dark brown to very dark grayish brown with depth. The depth to glacial till is 20 to 40 inches. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe-1.*

Fayette Series

The Fayette series is made up of light-colored, well-drained soils that developed from very thick loess. These soils are on gently and moderately sloping ridgetops and convex side slopes on uplands.

Fayette soils have a surface layer of black to very dark gray silt loam 1 to 4 inches thick. The subsurface layer is dark grayish-brown or brown to dark-brown silt loam 6 to 11 inches thick. Cultivated areas have a dark grayish-brown plow layer. The subsoil is yellowish-brown and dark yellowish-brown light silty clay loam that grades to silt loam with depth.

These soils have a high moisture-supplying capacity and are moderately permeable. They are low in available nitrogen and phosphorus but medium in available potassium. Eroded areas are very low in available nitrogen. The reaction ranges from strongly acid to very strongly acid.

Fayette silt loam, 2 to 5 percent slopes (FaB).—This soil is on ridgetops above other Fayette soils. In places it adjoins Seaton soils. Included in the areas mapped are a few areas in which the surface layer is as much as 4 to 8 inches thick and some moderately eroded areas that have a dark grayish-brown to dark-brown surface layer.

The surface layer of this soil is black or very dark gray and is 1 to 4 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Cultivated areas have a dark gray or very dark gray plow layer. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe-1.*

Fayette silt loam, 5 to 9 percent slopes, moderately eroded (FaC2).—This soil is on convex side slopes below other Fayette soils and, in many places, adjoining Seaton soils. Included in the areas mapped are some severely eroded patches that have a brown or dark-brown surface layer and a few areas that have a dark-colored surface layer 4 to 8 inches thick.

The surface layer of this soil is very dark gray or very dark grayish brown and is 1 to 3 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Cultivated areas have a dark grayish-brown or dark-brown to brown plow layer. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe-1.*

Floyd Series

This series consists of dark-colored, somewhat poorly drained soils on uplands. These soils developed in loamy material 18 to 36 inches thick over friable and commonly stratified glacial till. A layer of pebbles and stones is between the overlying material and the till in places. These soils occupy slightly convex and concave lower slopes and coves. The range of slope is 1 to 4 percent.

These soils have a loam surface layer 9 to 18 inches thick. The color of this layer grades from black in the upper part to very dark grayish brown and very dark gray at a depth of about 24 inches. The upper part of the subsoil is very dark grayish-brown to olive-brown loam and may have a few mottles. Beginning at a depth of about 30 inches, the subsoil is yellowish-brown loam that is commonly stratified with sandy material and mottled with grayish brown and light olive brown.

Floyd soils have a high moisture-supplying capacity and are moderately permeable. They are medium in available nitrogen and low in phosphorus and potassium. They range from slightly acid to neutral in reaction. The depth to calcareous material is 45 to 60 inches.

Floyd loam, 1 to 4 percent slopes (FoB).—This soil occupies concave and slightly convex lower slopes that form coves of drainageways. It adjoins Ostrander or Kenyon soils upslope and Clyde soils downslope.

The surface layer is 18 to 24 inches thick. It grades from black to very dark grayish brown and very dark gray with depth. There are a few pebbles in the surface layer or subsoil. Productivity is high, and tilth usually is good. Surface runoff is slow.

Tile drainage is not necessary, but it is beneficial and makes earlier field operations possible. *Capability unit IIw-1.*

Franklin Series

The Franklin series consists of moderately dark colored, somewhat poorly drained soils on uplands. These soils developed from loess 20 to 40 inches thick over glacial till. In most places a pebble band separates the loess from the till. These soils are on nearly level, broad ridges and gentle side slopes.

Franklin soils have a black to very dark brown silt loam surface layer 4 to 8 inches thick. The subsurface layer is about 8 inches thick and consists of gray to very

dark grayish-brown silt loam. The subsoil is mottled dark grayish-brown and olive-brown silty clay loam in the upper part. Beginning at a depth of 20 to 40 inches, it is yellowish-brown, mottled loam glacial till.

These soils have a high moisture-supplying capacity. Permeability is moderate in the loess and moderately slow in the till. The content of available nitrogen and phosphorus is low, but that of potassium is medium. The reaction is generally medium acid to strongly acid. The depth to calcareous till ranges from 45 to 70 inches.

Franklin silt loam (1 to 3 percent slopes) (Fr).—This soil is in the southern part of Bremer County, mostly in Maxfield Township. It is on ridges or side slopes and adjoins Klinger and Maxfield soils in places.

The black surface layer is 4 to 8 inches thick. It is underlain by a lighter colored subsurface layer. Many cultivated areas have a very dark brown plow layer. There are no stones or pebbles on the surface. Productivity is high, and tilth usually is good. Surface runoff is slow.

Most of this soil is farmed without tile drainage, but crops are benefited and earlier field operations are possible if tile is installed. Erosion generally is not a problem but contouring of long slopes is advisable if row crops are grown intensively. *Capability unit I–2.*

Hagener Series

The Hagener series consists of dark-colored, excessively drained soils. These soils developed from loamy fine sand and fine and medium sand. They are on nearly level or gently sloping stream benches and on gently sloping to moderately steep upland ridges and side slopes.

The surface layer is generally very dark brown to dark grayish-brown loamy sand 8 to 16 inches thick. The subsoil is brown or dark-brown loamy fine sand and fine sand that grades to yellowish-brown sand with depth.

These soils have a low moisture-supplying capacity and are rapidly permeable. They are very low in available nitrogen, phosphorus, and potassium. The reaction ranges from neutral to strongly acid.

Hagener loamy sand, 2 to 5 percent slopes (HaB).—This soil generally occurs on gentle upland slopes that face east, south, or southeast. In places it is on mounds or dunes. It commonly adjoins Chelsea, Dickinson, and Tripoli soils. Included in the areas mapped are a few nearly level areas.

The surface layer is 12 to 16 inches thick and consists of very dark brown loamy sand. This layer and the subsoil are free of gravel. The texture grades from loamy sand to fine sand with depth. Productivity is generally low. Surface runoff is slow, but drainage is excessive.

If cultivated, this soil is subject to slight wind and water erosion. It should be tilled on the contour, and crop residue should be left on the surface if row crops are grown. *Capability unit IVs–2.*

Hagener loamy sand, 5 to 9 percent slopes (HaC).—This soil is on uplands and on stream benches. On benches it occurs on mounds or dunes and on a few narrow escarpments. On uplands it occurs on mounds or dunes and on side slopes that face south or east. It commonly adjoins Dickinson, Chelsea, and other Hagener soils. Included in the areas mapped are a few areas of sandy loam and a few moderately eroded areas in which the surface layer is only 2 to 6 inches thick.

The surface layer of this soil is 8 to 12 inches thick and consists of very dark brown to very dark grayish-brown loamy sand. This layer and the subsoil are free of gravel. Productivity is low. Surface runoff is medium, and drainage is excessive.

If cultivated, this soil is subject to wind and water erosion. It should be tilled on the contour, and crop residue should be left on the surface if row crops are grown. *Capability unit IVs–2.*

Hagener loamy sand, 9 to 14 percent slopes (HaD).—This soil generally occurs with other Hagener soils on convex side slopes along the Cedar and Shell Rock Rivers. Most of the slopes are moderately steep, but a few steep slopes are included in the areas mapped. Also included are a few areas of sandy loam and some moderately eroded areas in which the surface layer is only 2 to 6 inches thick.

The surface layer of this soil is very dark brown to very dark grayish brown and is 6 to 10 inches thick. Neither the surface layer nor the subsoil contains gravel. Productivity is very low. Surface runoff is medium to rapid, and drainage is excessive.

This soil is subject to wind and water erosion. It is not suited to row crops. *Capability unit VIs–1.*

Hagener loamy sand, benches, 0 to 2 percent slopes (HbA).—This soil occurs on benches along the larger streams. In places it adjoins Burkhardt, Dickinson, and Chelsea soils. A few areas of sandy loam were included in mapping.

The surface layer of this soil is very dark brown and is 10 to 14 inches thick. Gravelly sand is below a depth of 40 inches in places, but the surface layer and subsoil are free of gravel. Productivity is relatively low. Surface runoff is very slow, but drainage is excessive.

If cultivated, this soil is subject to wind erosion. Crop residue should be left on the surface. *Capability unit IVs–2.*

Hagener loamy sand, benches, 2 to 5 percent slopes (HbB).—This soil is on benches and narrow bench escarpments bordering the larger streams. It adjoins Chelsea, Dickinson, and other Hagener soils. A few areas of sandy loam were included in mapping.

The surface layer of this soil is very dark brown to very dark grayish brown and is 8 to 12 inches thick. In places gravelly sand occurs below a depth of 40 inches, but the surface layer and subsoil are free of gravel. Productivity is low. Surface runoff is slow, but drainage is excessive.

If cultivated, this soil is subject to slight wind and water erosion. Crop residue should be left on the surface, and the soil should be tilled on the contour if row crops are grown. *Capability unit IVs–2.*

Harpster Series

The Harpster series consists of dark-colored, poorly drained soils that are high in content of lime. These soils developed from a thick deposit of loess or local alluvium. They are in level areas or slight depressions on uplands.

Harpster soils generally have a silt loam surface layer, 20 to 26 inches thick, that grades from black to very dark gray with depth. The subsoil is very dark gray or olive-gray silt loam or silty clay loam. Some mottles occur in

the subsoil. The substratum is olive-gray, grayish-brown, or olive-brown, mottled silt loam. Lime is abundant throughout the soil profile.

These soils have a high moisture-supplying capacity and moderately slow permeability. They are medium in available nitrogen but low in phosphorus and potassium. The reaction is moderately or mildly alkaline.

Harpster silt loam (0 to 2 percent slopes) (Hc).—This soil is on uplands in the southern part of Bremer County, most of it in Maxfield Township. It is slightly lower on the landscape than the associated Sable soil.

The surface layer is 20 to 26 inches thick or more and grades from black to very dark gray with depth. This layer and the subsoil are free of pebbles and stones. All of the soil layers contain lime. Productivity is high if the soil is drained and fertilized. Tilth usually is good. Surface runoff is very slow, and drainage is poor. Tile drainage works well in this soil *Capability unit IIw-1.*

Hayfield Series

The Hayfield series consists of dark colored and moderately dark colored, somewhat poorly drained soils that developed from loamy alluvial material over sand and gravel. These soils are on nearly level stream benches.

Hayfield soils generally have a black or very dark brown loam surface layer 5 to 7 inches thick. In some places the texture is silt loam. The subsurface layer is loam and is about 8 inches thick. This layer is dark grayish brown, grayish brown, or dark brown and is mottled with dark reddish brown in places. The subsoil, in some places, is dark grayish-brown and brown or dark-brown loam that is slightly mottled. It grades to a substratum of pale-brown, strong-brown, and yellowish-brown sand and gravel at a depth of 24 to 45 inches. In other places the subsoil is dark-brown, dark-gray, and gray loam mottled with reddish brown to yellowish brown, and it grades to gray sand and gravel at a depth of 33 to 60 inches.

These soils have a medium to high moisture-supplying capacity. Permeability is moderate in the medium-textured material and very rapid in the coarse-textured substratum. The supplies of available nitrogen, phosphorus, and potassium are low. The reaction ranges from medium acid to very strongly acid.

Hayfield loam, deep (0 to 2 percent slopes) (Hd).—This soil adjoins Sattre and other Hayfield soils on stream benches. Near the southern border of the county, between the Wapsipinicon River and Crane Creek, a few small areas of soils that have a silt loam surface layer and subsoil are included in the areas mapped. Also included are some areas in which sand and gravel occur at a depth of more than 45 inches.

The surface layer is black to very dark brown and is 4 to 7 inches thick. It is underlain by a distinct, lighter colored subsurface layer. The depth to sand and gravel is generally 36 to 45 inches. Productivity is high, and tilth usually is good. Surface runoff is slow.

The problems in farming this soil are minor. In some seasons the soil may be slightly wet. Along the Wapsipinicon River and Plum Creek, the water table may be high and spring plowing may have to be delayed. *Capability unit I-2.*

Hayfield loam, moderately deep (0 to 2 percent slopes) (Hm).—This soil adjoins Sattre and other Hayfield soils on stream benches. Included in the areas mapped are some areas in which the depth to coarse material is only 20 inches.

The surface layer is black to very dark brown and is 4 to 7 inches thick. Underlying it is a distinct, lighter colored subsurface layer. Many cultivated areas have a very dark grayish-brown plow layer, and areas that are now in timber have a thinner surface layer than normal.

Productivity is moderate to high, and tilth usually is good. Surface runoff is slow. Droughtiness or wetness may be a problem, depending on the season. Along the Wapsipinicon River and Plum Creek, the water table may be high and spring plowing may have to be delayed. *Capability unit IIs-1.*

Hayfield loam, dark brown variant (0 to 2 percent slopes) (Hv).—This soil is on benches along the Wapsipinicon River north of U.S. Highway No. 3. It adjoins Sattre and other Hayfield soils.

The surface layer is very dark brown loam or silt loam and is 4 to 7 inches thick. It is underlain by a distinct, lighter colored subsurface layer of loam. The subsoil also is loam and is underlain by sand and gravel at a depth of 33 to 60 inches. Productivity is high, and tilth usually is good. Surface runoff is slow.

In some seasons this soil may be slightly wet, but there are no serious management problems. *Capability unit I-2.*

Kenyon Series

The Kenyon series consists of dark-colored, moderately well drained soils on uplands. These soils developed from loamy material 14 to 21 inches thick over glacial till. A layer of pebbles and stones generally occurs between the glacial till and the overlying material. These soils are on long, convex, gently sloping ridges and gentle to moderate side slopes.

Kenyon soils have a loam surface layer, 8 to 16 inches thick, that grades from black or very dark brown to very dark grayish brown with depth. Beginning at a depth of about 14 to 21 inches is a heavy loam subsoil that is brown, dark yellowish brown, or yellowish brown and slightly mottled below a depth of 24 inches. These soils are friable to a depth of about 30 inches and friable to firm below. In places there are small pockets, thin discontinuous lenses, or vertical wedges of sandy material in the subsoil.

These soils have a high moisture-supplying capacity and moderately slow permeability. They are low in available phosphorus, potassium, and nitrogen. The surface layer is slightly acid or medium acid. The subsoil ranges from strongly acid to slightly acid with depth. The depth to calcareous material is generally between 55 and 65 inches.

Kenyon loam, 2 to 5 percent slopes (KeB).—This soil is on long, convex side slopes. It commonly occurs above Floyd soils or above moderately sloping Kenyon soils. In some places it is downslope from nearly level Readlyn soils. Included in the areas mapped are a few small moderately eroded patches in which the surface layer is very dark grayish brown, brown, or dark brown.

The surface layer of this soil is 12 to 16 inches thick. It grades from black or very dark brown to very dark grayish brown with depth. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe-1.*

Kenyon loam, 5 to 9 percent slopes (KeC).—This soil is on long convex side slopes. It is commonly above Floyd soils and below the gently sloping Kenyon soils. Some short, moderately steep slopes are included in the mapped areas that are near streams.

The surface layer is 8 to 12 inches thick and grades from black or very dark brown to very dark grayish brown with depth. This layer is slightly thicker at the base of slopes. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced. *Capability unit IIIe-1.*

Kenyon loam, 5 to 9 percent slopes, moderately eroded (KeC2).—This soil is on long, convex side slopes. It is above Floyd soils and below gently sloping Kenyon soils. Some short, moderately steep slopes are included in the mapped areas that are near streams. Also included are some severely eroded spots where the subsoil is exposed.

The surface layer is very dark grayish-brown to dark-brown loam 8 inches thick. Stones or pebbles are on the surface in places. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to severe erosion. It should be tilled on the contour or terraced. *Capability unit IIIe-1.*

Klinger Series

The Klinger series consists of dark-colored, somewhat poorly drained soils that developed from loess 20 to 40 inches thick over glacial till. In many places a pebble band separates the loess and the till. These soils are on nearly level, broad ridges, on flats, and on gentle side slopes on uplands.

Klinger soils have a surface layer of light silty clay loam 8 to 16 inches thick. It is black or very dark gray. The upper part of the subsoil is mottled, dark grayish-brown and olive-brown silty clay loam. Beginning at a depth of 20 to 40 inches, the subsoil is yellowish-brown loam glacial till mottled with brownish gray.

These soils have a high moisture-supplying capacity. Permeability is moderate in the loess, and moderately slow in the till. The supplies of available nitrogen, phosphorus, and potassium are medium. The reaction generally is slightly acid or medium acid. In most places the depth to calcareous material is 40 to 50 inches.

Klinger silty clay loam (1 to 3 percent slopes) (Kg).—This soil is in the southern part of Bremer County, mostly in Maxfield Township. It adjoins Dinsdale, Maxfield, Franklin, and Muscatine soils. In some places it is near Readlyn and Floyd soils.

The surface layer is black or very dark gray and is 8 to 16 inches thick. The surface is free of stones and pebbles. Productivity is high, and tilth usually is good. Surface runoff is slow.

Tile drainage is beneficial and makes earlier field operations possible, but most of this soil is farmed without tile drainage. Erosion ordinarily is not a problem; nevertheless, contouring long slopes is advisable if row crops are grown intensively. An occasional grass-legume crop helps to maintain the granular structure of the soil. *Capability unit I-2.*

Lamont Series

In the Lamont series are light-colored, somewhat excessively drained soils that developed from sandy loam 20 to 40 inches thick over sand. These soils occupy level to moderately steep uplands, benches, and outwash areas.

Lamont soils have a surface layer of black or very dark gray sandy loam 2 to 5 inches thick. The subsurface layer is dark grayish-brown or brown sandy loam to loamy sand 6 to 14 inches thick. On stream benches the subsurface layer is generally sandier than on uplands. Many cultivated areas have a dark grayish-brown plow layer. The subsoil is brown or dark-brown heavy sandy loam and light sandy clay loam that grades to brown and yellowish-brown sand at a depth of 24 to 30 inches. In many places there are thin, 1/8-inch to 2-inch horizontal lenses of brown or dark-brown sandy loam to light sandy clay loam below a depth of 40 inches. On some stream benches the texture grades to gravel below a depth of 40 inches.

These soils have a low or moderately low moisture-supplying capacity and moderately rapid permeability. They are very low in available nitrogen, phosphorus, and potassium. The reaction ranges from slightly acid to strongly acid.

Lamont sandy loam, 2 to 5 percent slopes (LaB).—Most of this soil is on upland ridges and hilltops. Some of it is on benches. On the lower parts of uplands and on benches, many areas of it are on mounds or dunes. A few upland areas are nearly level. In places it adjoins Chelsea, Backbone, and Sattre soils. Included in the areas mapped on benches are spots of soils that have gravelly sand below a depth of 40 inches.

The surface layer of this soil is black to very dark gray and is 2 to 5 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Cultivated areas have a dark grayish-brown sandy loam plow layer, which is a mixture of the original surface and subsurface layers. Both the surface layer and the subsoil are free of gravel. Sand is at a depth of 24 to 40 inches in most places.

Productivity is moderate, and tilth usually is good. Surface runoff is slow, but drainage is somewhat excessive. If cultivated, this soil is subject to slight wind and water erosion. It should be tilled on the contour, and crop residue should be left on the surface. *Capability unit IIIs-2.*

Lamont sandy loam, 5 to 9 percent slopes (LaC).—This soil is on side slopes that face south or east and on mounds or dunes on uplands. It is associated with Chelsea, Dickinson, and Backbone soils. Included in the areas mapped are some moderately eroded areas in which the surface layer is dark grayish brown or dark brown and is 2 to 7 inches thick.

The surface layer of this soil is black or very dark gray and is 1 to 3 inches thick. It is underlain by a lighter colored subsurface layer. Cultivated areas have a dark

grayish-brown plow layer. Neither the surface layer nor the subsoil contains gravel. Sand is at a depth of 20 to 40 inches. Productivity is relatively low. Surface runoff is medium, and drainage is somewhat excessive.

If cultivated, this soil is subject to wind and water erosion. It should be tilled on the contour or terraced if row crops are grown, and residue should be left on the surface. *Capability unit IIIs–2.*

Lamont sandy loam, 9 to 14 percent slopes (LaD).—Most of this soil is east of and within 3 miles of the Cedar River. In places it adjoins Dickinson, Backbone, and less strongly sloping Lamont soils. Individual areas are small. Included in the areas mapped are some moderately eroded soils that have a dark grayish-brown to dark-brown surface layer.

The surface layer of this soil is very dark gray or very dark grayish brown and is 1 to 3 inches thick. This layer is underlain by a distinct, lighter colored subsurface layer. Cultivated areas have a dark grayish-brown plow layer that is the same color when moist or dry. Neither the surface layer nor the subsoil contains gravel. Sand is at a depth of 20 to 30 inches in most places, but it is at a depth of 20 to 40 inches in some places.

Productivity is low. Surface runoff is medium to rapid, and drainage is excessive. If cultivated, this soil is subject to wind and water erosion. It should be tilled on the contour, and residue should be left on the surface. *Capability unit IVe–2.*

Lamont sandy loam, benches, 0 to 2 percent slopes (LbA).—This soil is on benches, mainly along the larger streams. There are large areas of it between Horton Creek and Dry Run Creek south of the town of Horton.

The surface layer is black or very dark gray and is 2 to 5 inches thick. It is underlain by a lighter colored subsurface layer. Cultivated areas have a dark grayish-brown plow layer. Gravelly sand is below a depth of 40 inches in some places, but the surface layer and subsoil are free of gravel. Productivity is moderate, and tilth usually is good. Surface runoff is very slow, but drainage is somewhat excessive.

If cultivated, this soil is subject to slight wind erosion. Crop residue should be left on the surface. *Capability unit IIIs–1.*

Lawler Series

The Lawler series consists of dark-colored, somewhat poorly drained soils that developed from loamy alluvial material 24 to 45 inches deep over sand and gravel. These soils are mainly on level or nearly level benches. They are also in small areas of outwash on uplands.

These soils have a loam surface layer 18 to 22 inches thick that generally grades from black to very dark grayish brown with depth. The subsoil also is loam. It is very dark grayish brown, yellowish brown, and light olive brown and has some mottles. It grades to a substratum of yellowish-brown, brown or dark-brown, and dark-gray sand and gravel at a depth of 24 to 45 inches.

Lawler soils have a moderate to high moisture-supplying capacity. They are moderately permeable in the medium-textured material and very rapidly permeable in the coarse-textured substratum. They are medium in available nitrogen and low in phosphorus and potassium and are generally medium acid.

Lawler loam, deep (0 to 2 percent slopes) (Ld).—This soil commonly adjoins Marshan and Waukegan soils on benches. Included in the areas mapped are some patches of silt loam to silty clay loam and some areas in which the depth to sand and gravel is as much as 45 to 60 inches.

The surface layer is 18 to 22 inches thick and grades from black to very dark grayish brown with depth. The depth to sand and gravel generally is 36 to 45 inches. Productivity is high, and tilth usually is good. Surface runoff is slow.

This soil is slightly wet in some seasons, but there are no serious management problems. *Capability unit I–2.*

Lawler loam, moderately deep (0 to 2 percent slopes) (Lm).—This soil adjoins Marshan and Waukegan soils on stream benches. In a few places it adjoins Hayfield soils. Included in the areas mapped are some areas in which the depth to sand and gravel is only 20 inches.

The surface layer is black or very dark gray and is 16 to 20 inches thick. The depth to sand and gravel is 24 to 36 inches. Productivity is high, and tilth usually is good. Surface runoff is slow.

Either droughtiness or wetness may cause a slight problem, depending on the season. Along the Wapsipinicon River and Plum Creek, the water table is sometimes high and spring plowing has to be delayed. *Capability unit IIs–1.*

Marsh

Marsh (Ma) occurs as depressions or flats, intermingled with ponds and small lakes, where the water table is at or near the surface the year round. The natural vegetation consists of cattails, rushes, sedges, and other water-tolerant grasses. In Bremer County most of this land type occurs within and around Sweet Marsh and near the Cedar River. Some of it is near the Wapsipinicon River and the smaller streams. In places it is surrounded by Colo, Marshan, and Lawler soils.

Marsh has no distinct soil layers. When the water recedes, a layer of old plant residue can be seen at the surface.

This land is suitable for use as wildlife habitats. In places it can be diked so that small areas are under water the year round. Some areas in and around Sweet Marsh were once farmed, pastured, or timbered before the building of dikes and the subsequent flooding. These areas have a continuous high water table, and most of the vegetation is dying out. *Capability unit VIIw–1.*

Marshan Series

The Marshan series consists of dark-colored, poorly drained soils that developed from loamy alluvial material 24 to 45 inches thick over coarse-textured material. These soils are on stream benches, mostly in level areas, but also in some depressions.

Marshan soils have a surface layer of light clay loam. It is black and is 15 to 24 inches thick. The subsoil is dark-gray, gray, and light olive-brown, mottled light clay loam to loam. This grades to a substratum of grayish-brown, yellowish-brown, and gray sand or gravel at a depth of 24 to 45 inches.

Marshan soils have a high moisture-supplying capacity. Permeability is moderately slow in the finer tex-

tured material and rapid in the substratum. The supply of available nitrogen is medium, and that of phosphorus and potassium is low. The reaction generally is neutral.

Marshan clay loam, deep (0 to 2 percent slopes) (Mr).—This soil is on stream benches. Most of it adjoins Lawler and other Marshan soils; some of it adjoins Clyde and Colo soils. Included in the areas mapped are a few areas in which the surface layer and subsoil are light silty clay loam. These inclusions occur between the Wapsipinicon River and Crane Creek near the southern border of the county.

The surface layer of this soil is black and is 15 to 24 inches thick. The depth to sand and gravel is 36 to 45 inches in most places. Productivity is high if the soil is properly drained. Tilth usually is good, although the soil puddles if worked when wet. Surface runoff is slow.

Artificial drainage is needed, and tile is satisfactory if there is an adequate outlet. An occasional grass-legume crop helps to maintain the granular structure of the soil. *Capability unit IIw-1.*

Marshan clay loam, depressional (Ms).—Most of this soil is on benches along the Wapsipinicon River. It is in distinct depressions and has a hummocky surface (fig. 10). Included in the areas mapped are a few small areas of marsh and a few areas in which the depth to the coarse substratum is as much as 45 to 60 inches.

The surface layer of this soil is black and is 20 to 24 inches thick. In places a thin organic layer covers the surface. The depth to sand and gravel generally is 36 to 45 inches.

A high water table and ponded surface water limit suitability for cultivation. Drainage is difficult because of the lack of an outlet. *Capability unit IIIw-1.*

Marshan clay loam, moderately deep (0 to 2 percent slopes) (Mt).—This soil adjoins Lawler and other Marshan soils on stream benches. Included in the areas mapped are some areas in which the depth to coarse material is no more than 20 inches.

The surface layer is black and is 15 to 22 inches thick. The depth to sand and gravel is generally 24 to 36 inches. Productivity is high if artificial drainage is installed. Tilth usually is good, although the soil puddles if worked when wet. Surface runoff is slow.

Artificial drainage is needed if this soil is used for crops. An occasional grass-legume crop helps to maintain the granular structure. *Capability unit IIw-1.*

Maxfield Series

The Maxfield series consists of dark-colored, poorly drained soils that developed from loess 20 to 40 inches thick over glacial till. In most places a pebble band separates the loess and the till. These soils are on level or nearly level uplands.

Maxfield soils have a surface layer of light silty clay loam. It is black and is 16 to 20 inches thick. The subsoil is dark grayish-brown, olive-gray, and olive, mottled silty clay loam in the upper part. The lower part, beginning at a depth of 20 to 40 inches, is yellowish-brown and strong-brown loam glacial till mottled with light brownish gray.

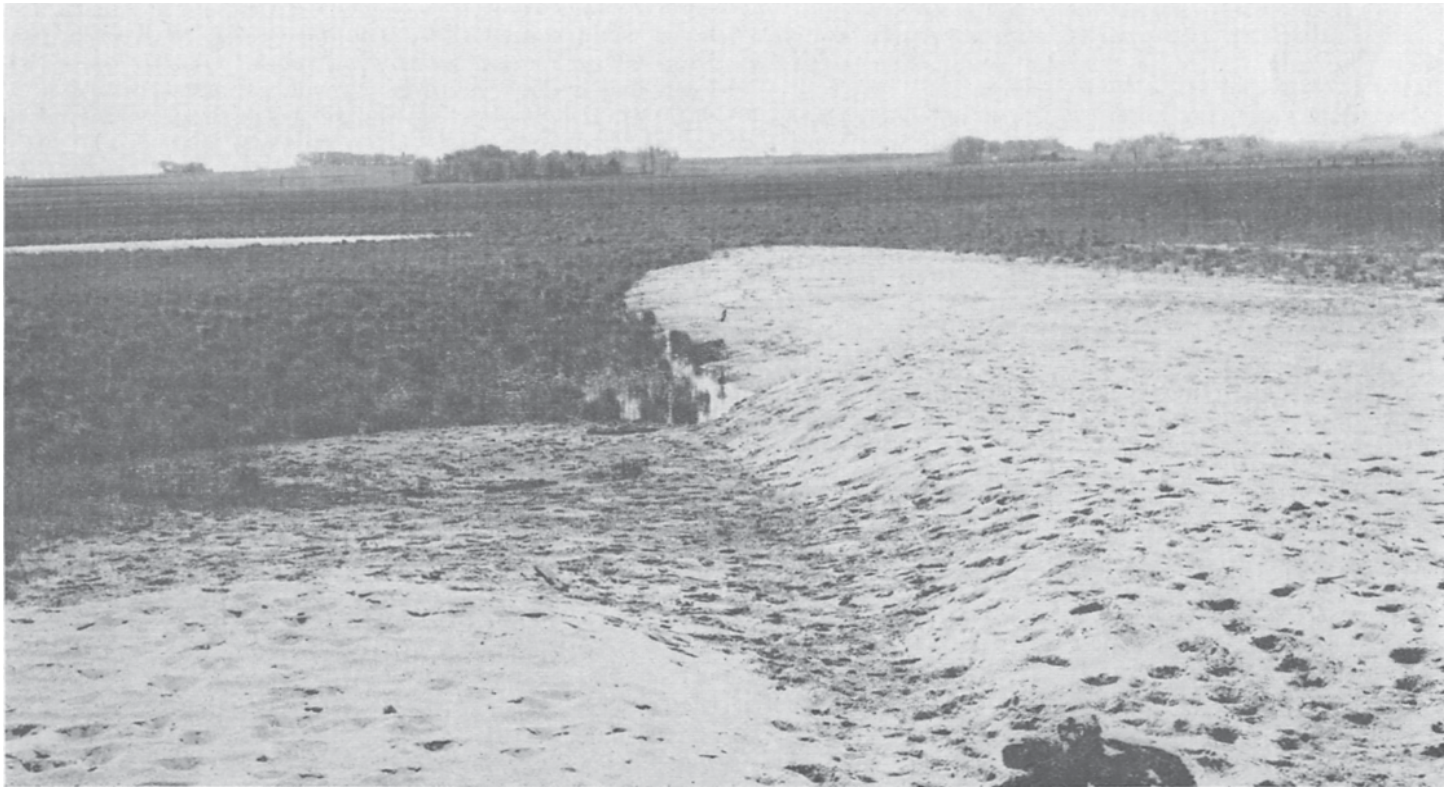

***Figure 10.*—Marshan clay loam, depressional, covered by flood-deposited sand in foreground.**

These soils have a high moisture-supplying capacity and moderately slow permeability. They are medium in available nitrogen, phosphorus, and potassium. The reaction generally is neutral. The depth to calcareous material is 40 to 60 inches.

Maxfield silty clay loam (0 to 2 percent slopes) (Mx).—This soil is in the southern part of Bremer County, mainly in Maxfield Township. It commonly adjoins Klinger soils on broad uplands; a few areas adjoin Clyde soils in drainageways.

The surface layer is black and is 16 to 20 inches thick. No stones or pebbles are on the surface. The depth to glacial till generally is 24 to 36 inches, although it ranges from 20 to 40 inches. Productivity is high if the soil is properly drained. Tilth usually is good, but the soil puddles if worked when wet. Surface runoff is slow.

An occasional grass-legume crop helps to maintain the granular structure of the soil. Tile drainage is beneficial. *Capability unit IIw-1.*

Muscatine Series

In the Muscatine series are dark-colored, somewhat poorly drained soils that developed from thick deposits of loess. These soils are on broad, nearly level or gently sloping ridges and near drainageways on uplands.

Muscatine soils have a light silty clay loam surface layer 18 to 22 inches thick. This layer grades from black to very dark gray with depth. The subsoil is mottled, very dark gray, olive-brown, light olive-brown, and dark grayish-brown silty clay loam and silt loam. This grades to grayish brown and yellowish brown, mottled silt loam.

These soils have a high moisture-supplying capacity and are moderately permeable. They are medium in available nitrogen, phosphorus, and potassium and are generally slightly acid to medium acid. The depth to calcareous material is 50 to 70 inches.

Muscatine silty clay loam (0 to 2 percent slopes) (My).—This soil is on upland ridges in the southern part of Bremer County, mainly in Maxfield Township. It generally is below Port Byron soils and adjoins Sable soils and some of the Klinger soils. Most of it is nearly level.

The surface layer is black and is 18 to 22 inches thick. It is dark colored when moist or dry. Both the surface layer and the subsoil are free of stones and pebbles. Productivity is high, and tilth usually is good. Surface runoff is slow.

Cultivated crops can be grown on this soil with little risk. An occasional grass-legume crop helps to maintain the granular structure of the surface layer. Although tile drainage benefits corn and makes earlier fieldwork possible, most of this soil is farmed without it. Erosion is not ordinarily a problem, but contouring long slopes is advisable if row crops are grown intensively. *Capability unit I-2.*

Nodaway Series

The Nodaway series consists of moderately well drained, moderately dark colored to light colored soils derived from recently deposited, medium-textured, stratified silty alluvium. These soils are on nearly level or gently undulating bottom lands and gently sloping alluvial fans in association with steep, medium-textured, loess soils.

Nodaway soils are generally silt loam throughout and are dark grayish brown except for the plow layer, which is very dark grayish brown. They are stratified with thin lenses of very dark grayish-brown and brown silt loam. A dark-colored subsoil occurs below a depth of 34 inches in some places.

These soils have a high moisture-supplying capacity and are moderately permeable. They are low in available nitrogen and medium in available phosphorus and potassium. They are generally neutral in reaction.

Nodaway silt loam (0 to 2 percent slopes) (No).—This soil is on undulating or nearly level bottom lands and on alluvial fans. It is downslope from the Seaton and Fayette soils.

The surface layer or plow layer grades from very dark grayish brown silt loam to lighter colored, stratified material. It is free of stones and pebbles. Productivity is high, and tilth usually is good. Surface runoff is slow.

Local floods of short duration occur. *Capability unit I-1.*

Oran Series

The Oran series consists of moderately dark colored, somewhat poorly drained soils that developed in 14 to 24 inches of loamy material over glacial till. A layer of pebbles and stones generally separates the glacial till and the overlying material. These soils are on nearly level ridges, high flats, and long, gentle, convex or concave slopes on uplands.

Oran soils generally have a black or very dark brown loam surface layer 5 to 8 inches thick. The subsurface layer is dark grayish-brown and brown or dark-brown loam 4 to 8 inches thick. The subsoil consists of heavy loam that is dark yellowish brown, yellowish brown, and dark grayish brown. It is mottled with grayish brown to light brownish gray. Oran soils are friable to a depth of about 24 inches and are friable to firm below this depth. In places there are small pockets or discontinuous lenses of sandy material in the subsoil.

These soils have a high moisture-supplying capacity and moderately slow permeability. They are low in available nitrogen, phosphorus, and potassium. The surface layer is slightly acid to strongly acid, and the subsoil is strongly acid to very strongly acid. The depth to calcareous material is generally between 40 and 60 inches.

Oran loam, 0 to 2 percent slopes (OrA).—This soil generally is on broad ridgetops above Bassett soils, but in the northeastern part of the county it is on broad upland flats in association with Readlyn soils. Included in the areas mapped are some areas of silt loam and some patches that have a thinner, lighter colored surface layer.

The surface layer is black and is 5 to 8 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Cultivated areas commonly have a very dark brown plow layer. Productivity is high, and tilth usually is good.

Cultivated crops can be grown on this soil with little risk. Although tile drainage is beneficial and makes earlier fieldwork possible, most of this soil is farmed without it. *Capability unit I-2.*

Oran loam, 2 to 5 percent slopes (OrB).—Most of this soil is on long, convex slopes and broad, rounded ridge

crests. Some of it is on concave slopes just above drainageways occupied by Clyde soils. In places it adjoins Bassett, Readlyn, and Floyd soils. Included in the areas mapped are a few areas of silt loam, a few areas of sandy soil, and a few areas of soils that have a very dark grayish-brown surface layer only 2 to 5 inches thick.

The surface layer of this soil is very dark brown and is 4 to 8 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. Some areas benefit from tile drainage. *Capability unit IIe-1.*

Ostrander Series

The Ostrander series consists of dark-colored, well-drained soils that developed in 14 to 24 inches of loamy material over friable glacial till. In most places a layer of pebbles and stones separates the glacial till and the overlying material. These soils are on uplands. They occupy nearly level ridgetops and long, convex, gentle or moderate side slopes.

Ostrander soils have a black to very dark brown loam surface layer 10 to 18 inches thick. The subsoil also is loam. It is dark yellowish brown and yellowish brown and in places is slightly mottled with grayish brown below a depth of 36 inches. These soils are generally friable throughout, but in places they are friable to firm below a depth of 45 inches. Small pockets or discontinuous lenses of sandy material are common in the subsoil.

These soils have a high moisture-supplying capacity and are moderately permeable. They are low in available phosphorus, potassium, and nitrogen. The surface layer is slightly acid to medium acid. The subsoil grades from strongly acid to slightly acid with increasing depth. The depth to calcareous material generally is between 45 and 65 inches.

Ostrander loam, 0 to 2 percent slopes (OsA).—This soil generally is on the high, nearly level parts of uplands, commonly in association with sloping areas of Ostrander, Kenyon, and Atkinson soils.

The surface layer is 12 to 18 inches thick and grades from black to very dark grayish brown with depth. Some stones or pebbles are in the subsoil. Productivity is high, and tilth usually is good. Surface runoff is slow.

There are no serious problems in managing this soil. *Capability unit I-2.*

Ostrander loam, 2 to 5 percent slopes (OsB).—This soil is on long, convex side slopes. On the lower slopes, it commonly occurs above Floyd soils; near the ridgetops, it is above moderately sloping Kenyon and other Ostrander soils. Included in the areas mapped are some moderately eroded spots in which the surface layer is very dark brown or very dark grayish brown.

The surface layer of this soil is black to very dark brown and is 10 to 16 inches thick. Some stones and pebbles are in the subsoil. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe-1.*

Ostrander loam, 5 to 9 percent slopes (OsC).—This soil is on long side slopes. It is above Floyd soils and below gently sloping Kenyon and other Ostrander soils. Included in the areas mapped are some moderately steep slopes near streams and some moderately eroded places in which the surface layer is very dark grayish brown to dark brown.

The surface layer of this soil is very dark brown and is 8 to 16 inches thick. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate erosion. It should be contoured or terraced if row crops are grown. *Capability unit IIIe-1.*

Peaty Muck

Peaty muck is a dark-colored, very poorly drained organic soil underlain by stratified glacial till or alluvial sediments. Most of the Peaty muck in Bremer County is in hillside seepage areas adjoining outwash or bench soils. Some of it is in upland drainageways. It is nearly level or gently sloping.

This soil has 20 to 40 inches or more of black and very dark brown peaty muck underlain by gray, medium-textured or moderately coarse textured, stratified till or alluvium.

The moisture-supplying capacity is high. Permeability is moderate or moderately rapid. The supply of available nitrogen is high, but the supplies of phosphorus and potassium are low. The reaction is generally slightly acid or neutral.

Peaty muck, deep (1 to 4 percent slopes) (Pe).—This soil is in hillside seeps and in level or hummocky upland drainageways. It has a black and very dark brown organic layer 40 inches thick or more.

Artificial drainage is needed to make this soil suitable for cultivation. Drained areas are moderately to highly productive. Tile drainage systems may be hard to maintain because the tile lines are likely to settle. *Capability unit IIIw-3.*

Peaty muck, moderately deep (1 to 4 percent slopes) (Pm).—Some of this soil is on nearly level outwashes or benches, and some of it is in upland drainageways and hillside seeps. It has a black and very dark brown organic layer 20 to 40 inches thick. Included are a few small areas that have less than 20 inches of organic material.

Artificial drainage is needed to make this soil suitable for cultivation. Drained areas are moderately to highly productive. Tile drainage systems may be hard to maintain because the tile is likely to settle. *Capability unit IIIw-3.*

Port Byron Series

The Port Byron series consists of dark-colored, well-drained soils that developed from very thick, medium-textured loess of local origin. These soils are on gently sloping upland ridges, or highs, and on convex, moderately steep side slopes.

Port Byron soils have a surface layer of silt loam that is very dark brown and is 7 to 13 inches thick. The subsoil also is silt loam. It grades from brown, dark brown, and dark yellowish brown in the upper part to yellowish brown at a depth of about 50 inches. A few grayish-brown mottles are below a depth of 48 inches in places.

These soils have a high moisture-supplying capacity and are moderately permeable. They are low in available nitrogen and phosphorus but medium in available potassium. They are generally medium acid.

Port Byron silt loam, 2 to 5 percent slopes (PoB).—This soil is on rounded ridges, or highs, above other Port Byron soils and adjoining Seaton, Muscatine, or Dinsdale soils.

The surface layer is black to very dark brown and is 9 to 13 inches thick. This layer and the subsoil are free of stones and pebbles. Productivity is high and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Port Byron silt loam, 5 to 9 percent slopes, moderately eroded (PoC2).—This soil is on narrow, convex ridges, or highs, and on side slopes. It adjoins Aredale, Dinsdale, Seaton, Muscatine, and other Port Byron soils. Included in the areas mapped are a few soils that have a darker, thicker surface layer than typical and a few severely eroded spots where the subsoil is exposed.

The surface layer of this soil is about 7 inches thick and is generally very dark brown to very dark grayish brown. In places it is dark brown. The surface layer and subsoil are free of pebbles and stones. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe–1.*

Port Byron silt loam, 9 to 14 percent slopes, moderately eroded (PoD2).—This soil is on convex side slopes below other Port Byron soils. In places it adjoins Aredale and Seaton soils. Included in the areas mapped are a few soils that have a thicker surface layer than typical and some severely eroded patches where the dark-brown or brown and dark yellowish-brown subsoil is exposed.

The surface layer of this soil is very dark grayish brown to very dark brown and is about 6 inches thick. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to severe erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe–2.*

Readlyn Series

The Readlyn series consists of dark-colored, somewhat poorly drained soils that developed in 14 to 24 inches of loamy material over friable to firm glacial till. In most places a layer of pebbles and stones separates the glacial till and the overlying material. These soils are on broad, nearly level upland ridges and on long, gentle convex side slopes.

Readlyn soils have a loam surface layer that is black or very dark brown and is 7 to 14 inches thick. The subsoil is heavy loam. It is dark grayish brown, olive brown, and dark yellowish brown and is mottled. These soils are friable to a depth of about 24 inches and are friable to firm below this depth. Some pockets and discontinuous lenses of sandy material occur in the subsoil in places.

These soils have a high moisture-supplying capacity and moderately slow permeability. They are low in available phosphorus, potassium, and nitrogen. The surface layer is slightly acid to strongly acid. The subsoil grades from strongly acid to neutral with increasing depth. The depth to calcareous material is generally between 40 and 60 inches.

Readlyn loam, 0 to 2 percent slopes (ReA).—Most of this soil is on broad upland flats. Some nearly level, convex areas of it are upslope from adjoining Tripoli soils, and other areas are on broad ridgetops above gently sloping Kenyon soils. Included in the areas mapped are a few spots of soils that have a firm subsoil and a few poorly drained areas in which the subsoil is gray.

The surface layer of this soil is black and is 10 to 14 inches thick. The subsoil contains some stones and pebbles. Productivity is high, and tilth usually is good. Surface runoff is slow.

This soil has few limitations. Most of it is farmed without being tiled, but tile drainage works well and makes earlier field operations possible. *Capability unit I–2.*

Readlyn loam, 2 to 5 percent slopes (ReB).—This soil is on long, convex slopes and broad, rounded ridge crests. On the ridge crests, it is above Floyd soils. Near drainageways in the long slopes, it is above Clyde soils. Included in the areas mapped are some moderately well drained soils that have a browner subsoil.

The surface layer of this soil is black to very dark brown and is 7 to 12 inches thick. The subsoil is firm in some places and friable in others. It contains stones and pebbles. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. The gentler slopes benefit from tile drainage. *Capability unit IIe–1.*

Riceville Series

The Riceville series consists of moderately dark colored, somewhat poorly drained soils on uplands. These soils developed in 14 to 24 inches of loamy material over firm glacial till of light clay loam texture. A layer of pebbles and stones separates the glacial till and the overlying material in most places. These soils are in nearly level to gently sloping, convex and concave areas below ridges.

The surface layer typically is very dark brown loam 5 to 8 inches thick. Underlying this is a subsurface layer of dark grayish-brown, grayish-brown, or dark-brown loam or silt loam 4 to 8 inches thick. The upper part of the subsoil is dark grayish-brown and brown, mottled heavy loam. At a depth of about 24 inches the subsoil is grayish-brown and yellowish-brown, firm clay loam with dark-gray clay films.

These soils have a high moisture-supplying capacity and slow permeability. They are low in available nitrogen and phosphorus and very low in available potassium. The reaction is strongly acid or very strongly acid. The depth to calcareous material is 40 to 70 inches.

Riceville loam, 1 to 3 percent slopes (RfB).—This soil is on the lower part of long, convex slopes and on slightly concave slopes. It adjoins Bassett, Coggon, Floyd, and other Riceville soils.

The surface layer in noncultivated areas is black or very dark gray and generally is 4 to 7 inches thick, although it

is thinner in some places. Cultivated areas have a plow layer of very dark brown loam 5 to 8 inches thick. Productivity is moderate to high, and tilth usually is good. Surface runoff is slow to medium.

Because of the slowly permeable subsoil, this soil is slightly wet and seepy during wet seasons. Tile drainage is needed in places. There is a slight hazard of erosion on most of the sloping areas. *Capability unit IIw-2.*

Rockton Series

The Rockton series consists of dark-colored, well-drained soils that developed in 18 to 24 inches of loamy glacial material over 2 to 12 inches of moderately fine textured material. These soils are underlain by limestone bedrock at a depth of 20 to 30 inches (fig. 11). They are on gently sloping benches and on sloping to moderately steep uplands.

Rockton soils have a surface layer of black to very dark brown and very dark grayish-brown loam that is 8 to 16 inches thick. The subsoil generally consists of loam, sandy clay loam, and clay loam. This layer is brown to dark brown and dark yellowish brown. A thin layer of clay loam or clay separates the limestone and the subsoil in most places.

These soils have a moderate moisture-supplying capacity and moderate permeability. They are low in available nitrogen, phosphorus, and potassium and are generally slightly acid.

Rockton loam, 2 to 5 percent slopes (RkB).—This soil is on high benches and on uplands. It adjoins Atkinson, Winneshiek, and Sogn soils.

The surface layer is black to very dark brown and is 12 to 16 inches thick. The depth to limestone generally is 24 to 30 inches, but it may be only 20 inches. In some places the limestone is fragmented. Productivity is moderate, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. It is somewhat droughty because of the limited root zone. *Capability unit IIe-2.*

Rockton loam, 5 to 9 percent slopes (RkC).—This soil is on side slopes. It is below Atkinson soils or other Rockton soils and, in many places, above Sogn soils. Included in the areas mapped are a few moderately eroded places where the surface layer is very dark grayish brown to dark brown. There are a few limestone outcrops or fragments on the surface.

The surface layer of this soil grades with depth from very dark brown to very dark grayish brown. It is 8 to 12 inches thick. Productivity is moderate, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate erosion. It should be tilled on the contour, stripcropped, or terraced if row crops are grown. Because of the shallowness to limestone, it is difficult to terrace in some places. Also, it is somewhat droughty. *Capability unit IIIe-3.*

Rockton loam, 9 to 14 percent slopes (RkD).—This soil is on side slopes. It is below Atkinson soils or other Rockton soils and above Sogn soils. Included in the areas mapped are a few short, steep slopes, some moderately eroded areas that have a very dark grayish-brown to dark-brown surface layer only about 7 inches thick, and a few severely eroded areas in which the dark-brown subsoil is exposed. There are a few limestone outcrops or fragments on the surface. Also included are a few places in which the depth to limestone is as much as 30 to 36 inches.

Figure 11.—**Profile of Rockton loam exposed in a road cut. Limestone bedrock is at a depth of about 2 feet.**

The surface layer is 8 to 12 inches thick. It grades with depth from black and very dark brown to very dark grayish brown. The depth to limestone generally is 15 to 30 inches. Productivity is low, but tilth is good. Runoff is rapid.

If cultivated, this soil is subject to severe erosion. It should be terraced or stripcropped if row crops are grown. Because of the shallowness to limestone, it is difficult to terrace and is somewhat droughty. *Capability unit IVe-3.*

Rolfe Series

The Rolfe series consists of dark-colored, poorly drained soils that developed from medium-textured and

moderately fine textured stratified glacial till or local alluvium. These soils are on flats or in slight depressions on stream benches or outwash areas. They are also in level to gently sloping positions in or along upland drainageways.

These soils have a black loam or silt loam surface layer 6 to 12 inches thick. The subsurface layer is very dark gray to dark grayish-brown silt loam 8 to 12 inches thick. Beginning at a depth of about 18 inches is a subsoil consisting of black to dark-gray medium clay loam to heavy silty clay loam that is commonly mottled. At a depth of 30 to 40 inches, the subsoil generally is light clay loam to heavy silt loam. The color of this lower part is dark grayish brown mixed with some strong brown to olive brown. In the uplands the material under the subsoil is grayish and brownish loam. On stream benches it is yellowish-brown and gray sand or gravel below a depth of 40 to 60 inches.

These soils have a high moisture-supplying capacity and slow permeability. They are low in available nitrogen, phosphorus, and potassium and are medium acid or strongly acid.

Rolfe silt loam (0 to 2 percent slopes) (Ro).—This soil is on uplands and benches. It occurs in level areas, in slight depressions, and in gently sloping parts of upland drainageways. It commonly adjoins Clyde and Marshan soils.

The surface layer is black loam or silt loam. It is underlain by a distinct, lighter colored subsurface layer. In places the plow layer is a mixture of the surface and subsurface layers.

Productivity is moderate if drainage is adequate. Tilth usually is good, but the surface layer puddles readily if worked when wet. Runoff is slow in most places and is very slow in depressions. Water is ponded in a few of the depressions after heavy rains. The water table usually is high. *Capability unit IIIw–2.*

Sable Series

In the Sable series are dark-colored, poorly drained soils that developed from a very thick deposit of loess. They are on broad, level or nearly level upland divides.

These soils have a black silty clay loam surface layer 16 to 20 inches thick. The upper part of the subsoil is very dark gray and olive-gray silty clay loam with some mottles. This grades to mottled light olive-gray and yellowish-brown silt loam with depth.

Sable soils have a high moisture-supplying capacity and moderately slow permeability. They are medium in available nitrogen, phosphorus, and potassium and are generally neutral in reaction. The depth to calcareous material is 50 to 85 inches.

Sable silty clay loam (0 to 2 percent slopes) (Sa).—This soil is in the southern part of the county, mostly in Maxfield Township. It is on broad upland ridges or divides, adjoining Muscatine soils or, in a few places, Harpster or Maxfield soils.

The surface layer is black and is about 20 inches thick. Both the surface layer and subsoil are free of stones and pebbles. Productivity is high if drainage is adequate. Tilth usually is good, although the soil puddles if worked when wet. An occasional grass-legume crop helps to maintain good tilth. Surface runoff is slow, and tile drainage is beneficial. *Capability unit IIw–1.*

Sattre Series

The Sattre series consists of moderately dark colored, well-drained soils that developed from medium-textured alluvial deposits 24 to 45 inches thick over sand and gravel. These soils are on level to gently sloping stream benches and in a few outwash areas in uplands.

Sattre soils have a very dark brown loam surface layer 5 to 8 inches thick. They have a subsurface layer of brown to dark-brown or dark grayish-brown loam 4 to 8 inches thick. The subsoil also is loam and is generally brown to dark brown. The depth to the yellowish-brown substratum of sand and gravel ranges from 24 to 36 inches in the moderately deep soils and from 36 to 45 inches in the deep soils.

These soils have a medium to high moisture-supplying capacity. Permeability is moderate in the medium-textured material and very rapid in the coarse-textured substratum. The supplies of available nitrogen, phosphorus, and potassium are low. The reaction ranges from medium acid to very strongly acid.

Sattre loam, deep, 0 to 2 percent slopes (SbA).—This soil is on stream benches, mostly along the Wapsipinicon River. Included in the areas mapped are some soils in which the depth to sand and gravel is as much as 45 to 60 inches. Also included, in the southwestern part of the county, are some areas that have a surface layer and subsoil of silt loam.

The surface layer of this soil generally is very dark brown loam 5 to 8 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Cultivated areas commonly have a very dark grayish-brown plow layer, and a few timbered areas have a thinner, lighter colored surface layer. The depth to sand and gravel generally is 36 to 45 inches. Productivity is high, and tilth usually is good. Surface runoff is slow.

There are no serious limitations on the use of this soil. *Capability unit I–2.*

Sattre loam, deep, 2 to 5 percent slopes (SbB).—This soil is on gently sloping benches and on a few upland outwashes. Included in the areas mapped are some areas in which the depth to sand and gravel is as much as 45 to 60 inches and, in the southwestern part of the county, a few areas in which the surface layer and subsoil are silt loam.

The surface layer of this soil is very dark brown or very dark grayish-brown loam 4 to 7 inches thick. It is underlain by a distinct, lighter colored subsurface layer. A few timbered areas have a thinner surface layer. The depth to sand and gravel generally is 36 to 45 inches. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Sattre loam, moderately deep, 0 to 2 percent slopes (SdA).—Most of this soil is on nearly level stream benches along the Wapsipinicon River. A few areas of it are gently sloping. In places it adjoins Waukegan, Hayfield, and Lamont soils. Included in the areas mapped are a few small areas in which the depth to sand and gravel is only 20 inches.

The surface layer is 5 to 8 inches thick and is very dark brown to very dark grayish brown. It is underlain by a distinct, lighter colored subsurface layer. Some timbered areas have a lighter colored, thinner surface layer. The depth to sand and gravel generally is 24 to 36 inches. Productivity is high, and tilth usually is good. Surface runoff is slow. Droughtiness causes a slight problem during extended dry spells. *Capability unit IIs–1.*

Seaton Series

The Seaton series consists of light-colored, well-drained soils on uplands. These soils developed from very thick, medium-textured loess of local origin. They are on gently sloping ridgetops and sloping or steep sides of ridges.

These soils have a high moisture-supplying capacity and moderate permeability. They are low in available nitrogen and phosphorus but medium in available potassium. If eroded, they are very low in available nitrogen. They are strongly acid or very strongly acid.

Seaton soils have a surface layer of black to very dark brown silt loam 1 to 4 inches thick. This is underlain by a 6-inch to 8-inch subsurface layer of silt loam that is dark grayish brown, brown, and dark brown. Cultivated areas have a dark grayish-brown silt loam plow layer. The subsoil is dark yellowish-brown and yellowish-brown silt loam (fig. 12).

Seaton silt loam, 2 to 5 percent slopes (SeB).—This soil is on gently sloping ridgetops. Most of it is in the rolling country west of Denver, but some is in the southwest corner of the county. It adjoins Fayette and Port Byron soils in places and is above other Seaton soils.

The surface layer is black to very dark brown and is 2 to 4 inches thick. It is underlain by a distinct, lighter-colored subsurface layer. Cultivated areas have a dark grayish-brown or very dark grayish-brown plow layer. The surface layer and subsoil are free of stones and pebbles. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe–1.*

Seaton silt loam, 5 to 9 percent slopes, moderately eroded (SeC2).—This soil is on narrow ridgetops and on side slopes. It is above and below other Seaton soils, and in places it adjoins Lamont, Fayette, and Port Byron soils.

The surface layer is dark grayish brown to dark brown and is about 7 inches thick. A few places that are not eroded have a darker colored surface layer and a distinct, lighter colored subsurface layer. In severely eroded spots, the subsoil is exposed. No stones or pebbles are in the surface layer or subsoil. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced if row crops are grown. *Capability unit IIIe–1.*

Seaton silt loam, 9 to 14 percent slopes, moderately eroded (SeD2).—This soil is on convex side slopes. It is below other Seaton soils and, in places, below Fayette soils. Port Byron and Lamont soils are on some of the adjoining slopes.

A few noncultivated areas have a very dark brown surface layer 1 to 3 inches thick, underlain by a distinct, lighter colored subsurface layer. The plow layer consists of dark grayish-brown to dark-brown silt loam about 6 inches thick. The surface layer and subsoil are free of stones and pebbles. Productivity is moderate to high, and tilth usually is good. Surface runoff is rapid.

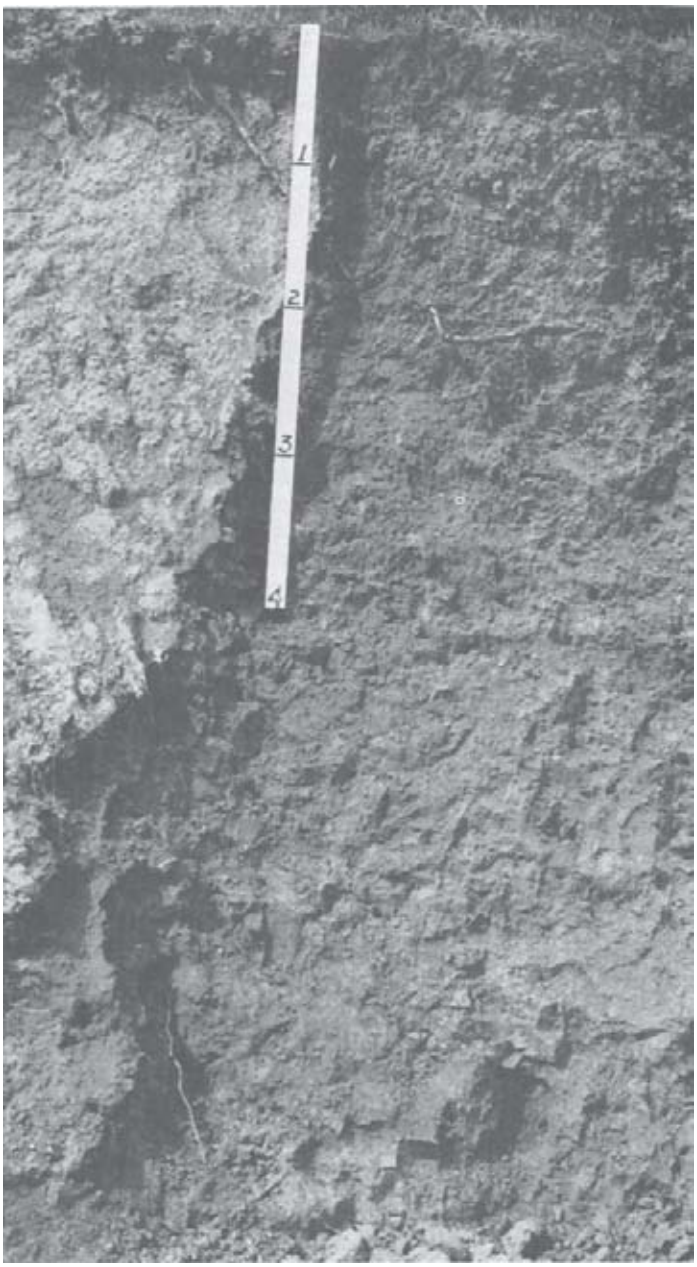

Figure 12.—**Profile of Seaton silt loam.**

If cultivated, this soil is subject to severe erosion. It should be tilled on the contour and terraced if row crops are grown. *Capability unit IIIe–2.*

Seaton silt loam, 9 to 14 percent slopes, severely eroded (SeD3).—This soil is on convex side slopes. It is below Fayette and other Seaton soils. Port Byron, Lamont, and Fayette soils occur on some of the adjoining slopes. Included in the areas mapped are a few spots in which the subsoil is silty clay loam.

The surface layer is dark yellowish-brown to dark grayish-brown silt loam that is lighter colored when dry. At the base of slopes and near waterways, the surface is slightly darker colored. The surface layer and subsoil are free of stones and pebbles. Productivity is high, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to very severe erosion. It should be tilled on the contour and terraced if row crops are grown. *Capability unit IIIe–2.*

Seaton silt loam, 14 to 18 percent slopes, moderately eroded (SeE2).—This soil is on convex side slopes below other Seaton soils and, in a few places, below Port Byron soils. A few areas that have a silty clay loam subsoil were included in mapping.

The plow layer of this soil is dark grayish-brown silt loam. Timbered areas commonly have a 1-inch to 3-inch very dark brown surface layer, underlain by a distinct, lighter colored subsurface layer. In a few severely eroded spots, the dark yellowish-brown to dark-brown subsoil is exposed. The surface layer and subsoil are free of stones and pebbles. Productivity is moderate, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to severe or very severe erosion. It should be tilled on the contour and terraced if row crops are grown. *Capability unit IVe–1.*

Seaton silt loam, 18 to 30 percent slopes, moderately eroded (SeF2).—This soil is on convex side slopes below Port Byron, Fayette, and other Seaton soils. In places it adjoins Lamont soils. Included in the areas mapped are a few areas in which the subsoil is silty clay loam and a few areas in which the surface layer is sandy.

The plow layer of this soil is dark grayish-brown silt loam. Wooded and other noncultivated areas have a 1-inch to 3-inch, very dark brown or very dark grayish-brown surface layer underlain by a distinct, lighter colored subsurface layer. In a few severely eroded spots, the dark yellowish-brown to dark-brown subsoil is exposed. Productivity is moderate, and tilth usually is good Surface runoff is very rapid.

Because of the steep slopes and the very severe hazard of erosion, this soil is not suited to cultivated crops. Most of the acreage is in permanent pasture or timber. *Capability unit VIe–1.*

Sogn Series

The Sogn series consists of dark colored or moderately dark colored, somewhat excessively drained soils. These soils developed in 4 to 15 inches of moderately coarse textured to moderately fine textured material over limestone bedrock. They are on moderate to steep upland slopes and escarpments.

These soils generally have a black or very dark brown loam surface layer, 4 to 12 inches thick, directly on bedrock. In places, a thin layer of dark grayish-brown sandy loam to clay loam separates the surface layer and the limestone.

Sogn soils have a low moisture-supplying capacity. They are low in available nitrogen, phosphorus, and potassium. They are generally neutral in reaction but contain lime in places.

Sogn soils, 5 to 14 percent slopes (SoD).—These soils occur together, though without regularity, and are so similar that they are mapped as an undifferentiated unit. They are on slopes and escarpments below Rockton, Winneshiek, and Backbone soils.

The surface layer is black or very dark brown loam to clay loam, 10 to 15 inches thick over limestone bedrock. Limestone outcrops are common, and limestone fragments are on the surface in some places.

Productivity is very low. Tilth usually is good, but tillage is difficult because of the many rock outcrops. Runoff is rapid and may cause severe erosion if it is not controlled. Shallowness and droughtiness are problems. Areas that have a slope range of 9 to 14 percent are suitable for pasture, woodland, and wildlife habitats. Those that have a slope range of 5 to 9 percent can be row cropped occasionally if stripcropping is used. *Capability unit IVs–1.*

Sogn soils, 14 to 30 percent slopes (SoF).—These soils occur together, though without regularity, and are so similar that they are mapped as an undifferentiated unit. They are on slopes and escarpments below Rockton, Winneshiek, and Backbone soils. Some very steep areas were included in mapping.

The surface layer is very dark brown to very dark grayish-brown loam to clay loam 4 to 12 inches thick over limestone. Limestone outcrops and fragments on the surface are common.

These soils are shallow, steep, and droughty. Although they are better suited to use as wildlife habitats, they are used also for pasture and woodland. Productivity is very low and erosion is a severe hazard. *Capability unit VIIs–1.*

Spillville Series

The Spillville series consists of dark-colored, somewhat poorly drained soils on nearly level flood plains of rivers and intermittent streams. These soils have developed in medium-textured, loamy alluvium.

Spillville soils are loam in texture throughout their profile, which extends to a depth of about 60 inches. They are black or very dark gray to a depth of 40 inches or more. The color then grades to dark grayish brown or grayish brown and is generally mottled. In some places below a depth of 45 inches, there are coarse-textured materials.

These soils have a high moisture-supplying capacity and moderate permeability. They are medium in available nitrogen, phosphorus, and potassium. They are generally slightly acid in reaction.

Spillville loam (0 to 2 percent slopes) (Sp).—This soil is on level or nearly level bottom lands. It commonly adjoins Colo soils and, in places, is near Terril soils.

The surface layer is black, very dark brown, and very dark gray to a depth of 40 inches or more.

Productivity is high, and tilth usually is good. Some areas are flooded occasionally. *Capability unit I–1.*

Spillville-Colo complex (0 to 2 percent slopes) (Sv).—The two kinds of soils in this complex are too intricately mixed to be mapped separately. Spillville soils are 60 to 70 percent of the complex. They are on bottom lands and in places are dissected by stream channels.

The surface layer is dark-colored loam or silty clay loam about 40 inches thick. Productivity is high, and tilth usually is good. Runoff is slow.

These soils are flooded occasionally, and the Colo soils are poorly drained. Flood control and tile drainage are beneficial. *Capability unit IIw-3.*

Terril Series

The Terril series consists of dark-colored, well drained to moderately well drained soils on nearly level or gently sloping flood plains, on alluvial fans on benches, and in narrow upland waterways. These soils are forming in loamy, medium-textured, alluvial deposits.

The surface layer is generally black or very dark brown loam 20 to 30 inches thick. The subsoil is dark-brown or dark yellowish-brown loam to a depth of about 40 inches.

These soils have a high moisture-supplying capacity and moderate permeability. They are medium in available nitrogen, phosphorus, and potassium. They are generally slightly acid or medium acid.

Terril loam, 0 to 2 percent slopes (TxA).—Most of this soil is on nearly level alluvial fans and on narrow flood plains. It adjoins Spillville and Waukegan soils in places. Included in the areas mapped are a few areas of silt loam and a few areas in which the subsoil is slightly mottled.

The surface layer of this soil is black or very dark brown and is 24 to 30 inches thick. Productivity is high, and tilth usually is good. Surface runoff is slow.

This soil is subject to flooding for short periods. *Capability unit I-1.*

Terril loam, 2 to 5 percent slopes (TxB).—Most of this soil is in narrow, gently sloping drainageways in uplands; some of it is on alluvial fans. Included in the areas mapped are a few areas of silt loam and a few areas near drainageways in which the subsoil is slightly mottled.

The surface layer is black or very dark brown and is 20 to 30 inches thick. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe-1.*

Tripoli Series

The Tripoli series consists of dark-colored, poorly drained soils that developed in 20 to 30 inches of moderately fine textured loamy material over friable to firm glacial till. These soils are on broad, level or nearly level, high flats on uplands.

Tripoli soils have a clay loam surface layer, about 20 inches thick, that grades with depth from black to very dark gray. Beginning at a depth of 20 to 30 inches is the loam and clay loam subsoil, which is dark grayish brown, olive brown, and yellowish brown and is mottled with strong brown and grayish brown. The surface layer and subsoil are friable to a depth of 24 to 40 inches and are friable to firm below this depth.

These soils have a high moisture-supplying capacity and moderately slow permeability. They are medium in available nitrogen and low in phosphorus and potassium. The reaction is generally neutral to slightly alkaline. The depth to calcareous material is 34 to 44 inches.

Tripoli clay loam (0 to 2 percent slopes) (Tr).—This soil is on broad, level or nearly level ridges and high upland flats. It adjoins Readlyn soils, and in a few slight depressions it occurs with Rolfe soils.

The surface layer is about 20 inches thick and grades with depth from black to very dark gray. Where this soil is downslope toward drainageways, the subsoil is stratified. Productivity is high if drainage is adequate. Tilth usually is good, but the soil puddles if worked when wet. An occasional grass-legume crop helps maintain good tilth. Surface runoff is very slow.

Artificial drainage is needed for this poorly drained soil. Tile drains work well if there is an adequate outlet. *Capability unit IIw-1.*

Waukegan Series

The Waukegan series consists of dark-colored, well-drained soils that developed from medium-textured alluvial deposits 24 to 48 inches thick over coarse-textured material. Most areas of these soils are on level to gently sloping stream benches, but some areas near bench escarpments are steeper. A few areas are on level to moderately sloping outwashes on uplands.

Waukegan soils have a loam or silt loam surface layer that is black or very dark brown and is 8 to 16 inches thick. The subsoil is loam or silt loam. It grades from dark brown, brown, and dark yellowish brown to a substratum of yellowish-brown sand, gravel, or sand and gravel at a depth of 24 to 48 inches.

These soils have a medium to high moisture-supplying capacity. Permeability is moderate in the medium-textured material and very rapid in the coarse-textured substratum. They are low in available nitrogen, phosphorus, and potassium. The loam soils are medium acid or strongly acid and the silt loam soils slightly acid or medium acid.

Waukegan loam, deep, 0 to 2 percent slopes (WaA).—This soil is on fairly large, level or nearly level stream benches. It adjoins Lawler and other Waukegan soils. In a few places it occurs with Hayfield and Sattre soils. Included in the areas mapped are a few areas in which the depth to coarse material is as much as 48 to 60 inches.

The surface layer is black or very dark brown and is 12 to 16 inches thick. The loam subsoil is underlain by sand and gravel at a depth of 36 to 48 inches. Productivity is high, and tilth usually is good. Surface runoff is slow.

There are no serious problems in managing this soil. *Capability unit I-2.*

Waukegan loam, deep, 2 to 5 percent slopes (WaB).—This soil is on gently sloping benches and on a few upland outwashes. It adjoins other Waukegan soils. The individual areas are much smaller than those of the level soil. Included in the areas mapped are a few areas in which the depth to coarse material is as much as 48 to 60 inches.

The surface layer is very dark brown and is 10 to 14 inches thick. The loam subsoil is underlain by sand and gravel at a depth of 36 to 48 inches. Productivity is high, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. *Capability unit IIe-1.*

Waukegan loam, moderately deep, 0 to 2 percent slopes (WgA).—This soil is on fairly large, level or nearly level stream benches. It adjoins Dickinson, Lawler, Sattre, and other Waukegan soils. Included are a few

areas in which the depth to sand and gravel is only 20 inches.

The surface layer is black or very dark brown and is 12 to 16 inches thick. The subsoil is loam, and the depth to sand and gravel is generally 24 to 36 inches. Productivity is moderate to high, and tilth usually is good. Surface runoff is slow, and there is no hazard of erosion. Droughtiness is somewhat of a problem during extended dry periods. *Capability unit IIs–1.*

Waukegan loam, moderately deep, 2 to 5 percent slopes (WgB).—This soil occurs on gently sloping benches along the larger streams and along some of the smaller streams. It also occurs in outwash areas on uplands. It adjoins other Waukegan soils and is near Sattre, Hayfield, and Lawler soils. Included in the areas mapped are some places in which the depth to coarse material is only 20 inches and some moderately eroded areas in which the surface layer is about 7 inches thick.

The surface layer of this soil is very dark brown and is 10 to 14 inches thick. The subsoil is loam and is underlain by sand and gravel at a depth of 24 to 36 inches. Productivity is moderate to high, and tilth usually is good. Surface runoff is medium, and drainage is somewhat excessive.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. Droughtiness is a slight problem during extended dry spells. *Capability unit IIe–2.*

Waukegan loam, moderately deep, 5 to 9 percent slopes (WgC).—Most of this soil is on bench escarpments. A few small areas are on uplands. It is downslope from other Waukegan soils. Included in the areas mapped are a few moderately eroded patches in which the surface layer is about 6 inches thick, a few places in which the depth to coarse material is only 20 inches, and a few moderately steep slopes.

The surface layer is very dark brown and is 8 to 12 inches thick. The subsoil is loam and is underlain by sand and gravel at a depth of 24 to 36 inches. Productivity is moderate, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate or severe erosion. It should be tilled on the contour or terraced if row crops are grown. It is droughty during extended dry periods. *Capability unit IIIe–3.*

Waukegan silt loam, deep, 0 to 2 percent slopes (WkA).—Most of this soil is on fairly large, level or nearly level benches along the Shell Rock River in the southwestern part of the county. Included in the areas mapped are some places in which the depth to coarse material is as much as 48 to 60 inches.

The surface layer is very dark brown or black silt loam, 12 to 16 inches thick, and the subsoil also is silt loam. It is underlain by sand and gravel at a depth of 36 to 48 inches. Productivity is high, and tilth usually is good. Surface runoff is slow. There are no major problems in managing this soil. *Capability unit I–2.*

Winneshiek Series

The Winneshiek series consists of moderately dark colored, well-drained soils that developed in 18 to 24 inches of loamy material over 2 to 12 inches of moderately fine textured material. They are underlain by limestone bedrock at a depth of 20 to 30 inches. These soils are on gently sloping and moderately sloping uplands.

Winneshiek soils generally have a very dark brown or very dark grayish-brown surface layer 4 to 7 inches thick. The subsurface layer is brown and dark-brown or dark grayish-brown loam about 6 inches thick. The subsoil generally is brown, dark-brown, and dark yellowish-brown loam and clay loam. A pebble band generally is at the base of the loamy material. In places a thin layer of clay separates the limestone from the overlying material. The depth to limestone bedrock is 20 to 30 inches.

These soils have a moderate moisture-supplying capacity and moderate permeability. They are low in available nitrogen, phosphorus, and potassium and are generally medium acid.

Winneshiek loam, 2 to 5 percent slopes (WnB).—This soil is on gently sloping uplands. It adjoins Rockton and Backbone soils and occurs upslope from Sogn and other Winneshiek soils. Included in the areas mapped are a few places in which the surface layer is only 1 inch to 3 inches thick.

The surface layer of this soil typically is very dark gray and is 4 to 7 inches thick. Cultivated areas have a very dark grayish-brown plow layer, which is underlain by a distinct, lighter colored subsurface layer. Limestone is at a depth of 24 to 30 inches in most places. Productivity is moderate, and tilth usually is good. Surface runoff is medium.

If cultivated, this soil is subject to slight erosion. It should be tilled on the contour if row crops are grown. It is also somewhat droughty because of the limited root zone. *Capability unit IIe–2.*

Winneshiek loam, 5 to 9 percent slopes (WnC).—This soil is on convex side slopes on uplands. It is below other Winneshiek soils and generally above Sogn soils. Included in the areas mapped are moderately eroded areas where the surface layer is very dark grayish brown to dark brown and is about 6 inches thick. The subsoil is exposed in some severely eroded patches.

The surface layer is very dark gray and is 4 to 7 inches thick. It is underlain by a distinct, lighter colored subsurface layer. Cultivated areas have a plow layer of very dark grayish-brown loam. Productivity is moderate, and tilth usually is good. Surface runoff is rapid.

If cultivated, this soil is subject to moderate erosion. It should be contoured, stripcropped, or terraced if row crops are grown. Because of the shallowness to bedrock in some places, however, terracing is difficult. It is somewhat droughty because of the limited root zone. *Capability unit IIIe–3.*

Management of Soils for Crops and Pasture

This section of the report is designed to help the farmers of Bremer County select improved practices that are suited to their soils and farming operations and thus achieve better use of their land. To aid in presenting this information, soils that have similar characteristics and require similar management have been grouped according to a system of capability classification used by the Soil

Conservation Service. In the subsections that follow, the capability classification system is defined, management by capability units is discussed, and estimated yields for each soil in the county are given.

Capability Classification

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 classification system, all kinds of soils are grouped at three levels: the capability class, the subclass, and the unit.

Capability Classes, the broadest groupings, 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 moderate 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 that are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and 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 unsuited to 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 restrict their use to recreation, wildlife, or water supply, or to esthetic purposes.

Capability Subclasses are soil groups within a capability class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* indicates that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* indicates that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* indicates that the soil is limited mainly because it is shallow, droughty, or stony; and *c* indicates that the chief limitation is climate that is too cold or too dry.

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In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in 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 a 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-1 or IIIs-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, the small letter indicates the subclass, or kind of limitation, and the Arabic numeral identifies the capability unit within each subclass.

Management of Soils by Capability Units

The soils of Bremer County have been placed in 26 capability units according to their suitability for crops and pasture, and the units are described in the following pages. For each unit, the important general characteristics of the soils are described, suitable uses are given, and management is suggested. The names of soil series represented are given in the description of each capability unit, but this does not mean that all the soils of a given series are in the unit. To find the names of all the soils in any given capability unit, refer to the table in the subsection "Estimated Yields" or to the "Guide to Mapping Units" at the back of this survey.

In the capability unit descriptions, only the general need for fertilizing and liming is indicated. Specific needs are best determined by testing samples of soils. The soil map, which shows the boundaries of the different soils, is a good guide for selecting areas to sample. The maximum size of a soil area that should be represented by one sample is about 10 acres. Each soil should be sampled separately. The county extension director can furnish information about soil testing and about fertilizer needs based on soil tests.

Class I. Soils that have few limitations that restrict their use

CAPABILITY UNIT I-1

This unit consists of level and nearly level, dark-colored and light-colored soils of the Terril, Nodaway, and Spillville series. These soils are well drained to somewhat poorly drained. They are on flood plains and in narrow upland valleys.

These soils have a thick surface layer. They are moderately permeable, are usually in good tilth, and have a high moisture-supplying capacity. The content of organic matter is moderately high in the Terril and Spillville soils but moderately low in the Nodaway soil. The reaction is neutral to medium acid.

Although these soils are well suited to row crops, about half of the Nodaway soil, half of the Spillville soil, and

one-fourth of the Terril soil are in permanent pasture. These soils produce above average yields of corn if a meadow crop or a green-manure crop is grown occasionally and they are otherwise well managed. They are also well suited to small grain and to alfalfa, red clover, bromegrass, and other hay and pasture plants.

These soils are flooded occasionally during spring runoff and after especially heavy rains, but crops and fences are seldom damaged appreciably. The Spillville soils are wet during cool, damp seasons, and cultivation often has to be delayed.

Surface erosion is not a problem. The main stream channels and waterways, especially in the Nodaway soil, are subject to gullying unless kept in grass.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume. The Nodaway soil is lower in nitrogen than the other soils in this group.

CAPABILITY UNIT I-2

This unit consists of level to gently sloping soils of the Atkinson, Franklin, Hayfield, Klinger, Lawler, Muscatine, Oran, Ostrander, Readlyn, Sattre, and Waukegan series. These soils are dark colored and moderately dark colored and are well drained and somewhat poorly drained. They occur on uplands and benches.

These soils are deep. They have moderate to moderately slow permeability, are usually in good tilth, and have a high moisture-supplying capacity. The content of organic matter is moderately high in the Lawler and Muscatine soils, medium in the Atkinson, Klinger, Ostrander, Readlyn, and Waukegan soils, and moderately low in the Sattre, Franklin, Hayfield, and Oran soils. The reaction ranges from slightly acid to very strongly acid.

These soils are used mostly for row crops, to which they are well suited. They produce above average yields of corn if a meadow crop or a green-manure crop is planted 1 year in 5 and they are otherwise well managed. They are also well suited to small grain and to alfalfa, red clover, bromegrass, and other hay and pasture plants.

The Atkinson, Sattre, Ostrander, and Waukegan soils are well drained. The other soils of this capability unit are somewhat poorly drained but generally are farmed without tile drainage, even though tile drains work well if properly installed and many of these somewhat poorly drained soils can be worked earlier in spring if tiled.

The Hayfield and Lawler soils are flooded occasionally for short periods, especially the areas along the Wapsipinicon River and Plum Creek. Damage to crops and fences is usually slight.

Erosion is not generally a problem. Nevertheless, under intensive row cropping, it is advisable to contour the longer slopes.

Phosphate and potash are needed for all crops. Less potash is needed on Franklin, Klinger, Muscatine, and Waukegan silt loams than on the other soils. Nitrogen is needed for corn, unless the corn follows a legume.

Class II. Soils that have moderate limitations that reduce the choice of plants or require moderate conservation practices

Subclass IIe. Soils That Are Subject to Moderate Erosion if They Are Not Protected

CAPABILITY UNIT IIe-1

This capability unit consists of gently sloping, dark-colored and light-colored soils of the Aredale, Atkinson, Bassett, Coggon, Cresco, Dinsdale, Fayette, Kenyon, Oran, Ostrander, Port Byron, Readlyn, Sattre, Seaton, Terril, and Waukegan series. These soils are somewhat poorly drained and well drained. They are on benches and on uplands and have long, uniform slopes.

These soils are deep. They have moderate or moderately slow permeability and a high moisture-supplying capacity. Tilth usually is good. The content of organic matter is low in the Coggon, Fayette, and Seaton soils, moderately low in the Bassett, Sattre, and Oran soils, moderately high in the Terril soils, and medium in the rest. The reaction ranges from slightly acid to very strongly acid.

The soils in this unit are well suited to row crops, to small grain, and to alfalfa, red clover, bromegrass, and other hay and pasture plants.

Erosion is a slight hazard and generally can be controlled by growing a grass-legume meadow crop about one-fourth of the time. If the soils of this unit are contoured, erosion can be controlled on all but the Atkinson soils by growing a grass-legume meadow crop 1 year in 5. Atkinson soils need a meadow crop 2 years in 5 whether contoured or not. A green-manure crop every fourth year could be substituted for the meadow crop on Terril, Port Byron, and Seaton soils. Drainageways that tend to gully should be sloped and kept in permanent pasture.

If these soils are terraced, they can be row cropped for 4 years or more, and only an occasional meadow crop or green-manure crop is needed to control erosion. To prevent gullying, grassed outlets are best constructed at least a year before the terraces. On most of these soils, terraces ought to be graded, but they can be level on the Port Byron and Seaton soils. Cuts and fills in the Atkinson soils must be kept shallow to avoid exposing underlying limestone in terrace channels. In plowing, turning the furrow uphill also helps to control erosion. Deterioration of soil structure can be halted by growing grass-legume crops.

The Bassett, Coggon, Kenyon, Oran, and Readlyn soils dry out more slowly after rains than the other soils. The Oran and Readlyn soils are usually farmed without tile drainage, but crops are benefited and earlier tillage is possible if tile is installed. It may be advisable to tile the Oran and Readlyn soils before terracing. The Bassett, Coggon, and Kenyon soils may also be improved by tile drainage if they are terraced.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume. Less potash is needed on the Dinsdale, Terril, Port Byron, Fayette, and Seaton soils than on the others.

CAPABILITY UNIT IIe-2

This unit consists of gently sloping, dark colored and moderately dark colored soils of the Rockton, Waukegan, and Winneshiek series and a complex of the Dickinson and Ostrander series. These soils are well drained and somewhat excessively drained. They are on uplands and benches.

Except for the Dickinson and Ostrander soils, these soils are moderately deep to limestone, sand, or gravel. They are moderately permeable in the loam and very rapidly permeable in the sand and gravel. The Dickinson and Ostrander soils are deep and have moderate to rapid permeability. All of these soils have a moderate moisture-supplying capacity and are usually in good tilth. The content of organic matter is medium in the Rockton, Ostrander, and Waukegan soils and moderately low in the Winneshiek and Dickinson soils. Reaction ranges from slightly acid to strongly acid.

These soils are suitable for row crops, for small grain, and for alfalfa, red clover, bromegrass, and other hay and pasture crops. In general, they are only moderately productive because of a limited root zone and slight droughtiness.

Erosion is a slight hazard. If no erosion controls are applied, the Rockton and Winneshiek soils can be row cropped 1 year in 4, and the Dickinson, Ostrander, and Waukegan soils 2 years in 5. If contoured, the Rockton and Winneshiek soils can be row cropped 2 years in 4, and the Dickinson, Ostrander, and Waukegan soils 3 years in 5. If terraced, the Rockton and Winneshiek soils can be row cropped 3 years in 5, and the Dickinson, Ostrander, and Waukegan soils can be row cropped 4 years in 5.

Drainageways that tend to gully should be reshaped and seeded to permanent vegetation. To prevent gullying, grassed outlets are best constructed at least a year before the terraces. Terraces should be on a gradient. Cuts and fills must be kept shallow in the Rockton and Winneshiek soils to avoid exposing bedrock in terrace channels. Turning furrows uphill helps to control erosion.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume.

Artificial drainage is not needed.

Subclass IIs. Soils That Are Moderately Limited By Low Moisture-supplying Capacity

CAPABILITY UNIT IIs-1

In this unit are level and nearly level, dark colored and moderately dark colored loamy soils of the Lawler, Sattre, Hayfield, and Waukegan series and a complex of the Dickinson-Ostrander series. These are well-drained to somewhat poorly drained soils on benches.

These soils are moderately deep to sand or gravel. They are moderately permeable in the loam and very rapidly permeable in the sand and gravel. Tilth usually is good, and the moisture-supplying capacity is moderate. The content of organic matter is moderately low in the Sattre and Hayfield soils, medium in the Waukegan soils, and moderately high in the Lawler soils. The reaction ranges from slightly acid to very strongly acid.

These soils can be row cropped intensively. They produce above average yields of corn if a meadow crop or green-manure crop is grown occasionally and they are otherwise well managed. They also produce good yields of small grain and of alfalfa, red clover, bromegrass, and other hay and pasture crops. Yields of all crops vary somewhat, because of the limited root zone and slight droughtiness.

The Hayfield and Lawler soils, especially the areas along the Wapsipinicon River and Plum Creek, are flooded occasionally for short periods, but damage to crops and fences is usually slight. These soils are also slightly wet in some seasons. Tiling is usually not needed, because the wetness and flooding commonly occur either before or after the growing season.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume.

Subclass IIw. Soils That Are Moderately Limited By Wetness if They Are Not Protected

CAPABILITY UNIT IIw-1

This unit consists of level and gently sloping, dark-colored soils of the Clyde, Floyd, Harpster, Marshan, Maxfield, Sable, and Tripoli series. These soils are somewhat poorly drained or poorly drained. They are on uplands and benches.

Most of these soils are deep, have moderately slow permeability, and are high in content of organic matter. One of the Marshan soils is only moderately deep. Clyde and Floyd soils are moderately permeable. The Clyde soil is very high in content of organic matter, and Floyd soils are moderately high. Clyde, Floyd, Sable, Marshan, and Maxfield soils are neutral to slightly acid; Tripoli soils are neutral to mildly alkaline; and Harpster soils are moderately alkaline.

Most of these soils can be row cropped intensively if adequately drained. Much of the Clyde soil is in permanent pasture but, if drained, it would be well suited to row crops. All of the soils in this unit produce above average yields of corn if they are fertilized and tile drained and if a meadow crop or green-manure crop is grown occasionally. They also are well suited to small grain and to alfalfa, red clover, bromegrass, and other hay and pasture plants.

All of these soils except the Floyd soil are poorly drained and need artificial drainage, generally by tile. The Floyd soil, which is somewhat poorly drained, is commonly farmed without tile drainage, although crops are benefited by it. Caution is needed in tiling the moderately deep Marshan clay loam because it is underlain by sand or gravel at a depth of only 24 to 36 inches. Boulders may interfere with the tiling of Clyde soils.

Marshan soils, especially the areas along the Wapsipinicon River and Plum Creek, are flooded occasionally for short periods. Damage to crops and fences usually is slight.

Erosion generally is not a problem, but contouring the longer slopes is advisable if row crops are grown intensively.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume.

CAPABILITY UNIT IIw-2

In this unit is a nearly level and gently sloping, moderately dark colored soil of the Riceville series. This soil has a firm subsoil and is somewhat poorly drained. It is on uplands.

This soil is deep, is slowly permeable, and has a high moisture-supplying capacity. Tilth usually is good. The content of organic matter is moderately low. The reaction is strongly acid or very strongly acid.

This soil is moderately productive and is well suited to row crops, to small grain, and to alfalfa, red clover, bromegrass, and other hay and pasture crops. It is generally farmed without artificial drainage, although it is slightly wet. Because of the slowly permeable subsoil, some areas are seepy, especially during wet seasons. Tile drainage is satisfactory. The spacing of the tile needs to be closer than in soils that are more permeable.

Erosion is a slight hazard. It can be controlled by growing a grass-legume meadow crop 1 year in 4. If the soil is contoured and tile drained, a meadow crop is needed only 1 year in 5. A meadow crop also helps to maintain good tilth and improves drainage.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume. Lime is needed also, especially for alfalfa.

CAPABILITY UNIT IIw-3

This unit consists of level and nearly level soils of the Colo, Spillville, and Terril series. These soils are on flood plains and in narrow upland valleys. They are dark colored and are moderately well drained to poorly drained.

These soils have a thick surface layer. Permeability is moderately slow in the Colo soils and moderate in the Terril and Spillville soils. The moisture-supplying capacity is high. Although tilth usually is good, an occasional meadow crop is needed to maintain the granular structure and good tilth of the Colo soils. The content of organic matter is high in the Colo soils and moderately high in the Terril and Spillville soils. The reaction is neutral to medium acid.

Occasional floods occur during spring runoff or after heavy rains, but crops and fences are seldom damaged. In some areas it may be practical to construct small dikes to protect these soils from overflow. The Colo soils are poorly drained, but they are cultivated to a large extent without artificial drainage. Crops are benefited, however, and fields can be tilled earlier in spring if tile is installed. Adequate outlets may be difficult to obtain in some areas.

Although these soils are well suited to row crops, about half the acreage is in permanent pasture. Yields are above average if an occasional meadow crop or green-manure crop is grown and the soils are otherwise well managed. Other suitable crops are small grain and alfalfa, red clover, bromegrass, and other hay and pasture plants.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume.

Erosion generally is not a problem. Waterways in the Colo and Terril soils tend to gully unless they are kept in grass.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both

SUBCLASS IIIe. SOILS THAT ARE SUBJECT TO SEVERE EROSION IF THEY ARE CULTIVATED AND NOT PROTECTED

CAPABILITY UNIT IIIe-1

This unit consists of moderately sloping soils of the Aredale, Atkinson, Bassett, Coggon, Dinsdale, Fayette, Kenyon, Cresco, Ostrander, Port Byron, and Seaton series. These soils are dark colored to light colored and are well drained and moderately well drained. They occur on uniform, fairly long upland slopes.

The soils in this unit are deep and have moderate or moderately slow permeability. They have a high moisture-supplying capacity and are usually in good tilth. The content of organic matter is low in the Coggon soil and in the moderately eroded soils; it is moderately low in the uneroded Bassett soils and medium in the others. The reaction ranges from slightly acid to very strongly acid.

These soils are well suited to row crops, to small grain, and to alfalfa, red clover, bromegrass, and other hay and pasture plants. They produce above average yields of corn if they are well managed. The Bassett, Coggon, and Kenyon soils dry out more slowly after rains than the other soils.

Erosion is a moderate hazard, but it can be controlled by growing a grass-legume meadow crop 1 year in 3. If the soils are contoured, a meadow crop is needed only 1 year in 4, except for the Atkinson soils, which need a meadow crop 2 years in 5. Drainageways that tend to gully should be reshaped and seeded to permanent vegetation.

Erosion can be controlled on terraced soils by growing a meadow crop 1 year in 5. Terraces on most of these soils should be graded, but they can be level on the Port Byron and Seaton soils. To prevent gullying, grassed outlets are best constructed at least a year before the terraces. Cuts and fills in the Atkinson soils should be held to a minimum depth so that the bedrock is not exposed in terrace channels.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless corn follows a legume.

CAPABILITY UNIT IIIe-2

This unit consists of strongly sloping, moderately and severely eroded soils of the Port Byron and Seaton series. These are light-colored and moderately dark colored, well-drained soils on uplands. The convex slopes are long, and many of them are irregular.

These soils are deep and moderately permeable. Except for the severely eroded Seaton soil, they have good tilth and a high moisture-supplying capacity. The severely eroded soils, however, are easily tilled. The content of organic matter is low in the Port Byron soils and very low in the Seaton soils. The reaction is slightly acid to strongly acid.

These soils are well suited to small grain and to alfalfa, red clover, bromegrass, and other hay and pasture plants. They are well suited to row crops if erosion is controlled.

Erosion is a severe hazard, and if no erosion control practices are applied, these soils should be kept in permanent pasture or hay. If the soils are contoured, a meadow crop is needed 2 years in 4. If they are strip-cropped, a meadow crop is needed 2 years in 5, or 3 years in 5 if the soils are severely eroded. On terraced soils, a meadow crop is needed 2 years in 5. The terraces can be level.

Phosphate and some potash are needed for all crops. Nitrogen is needed for corn, especially if the corn does not follow a legume.

CAPABILITY UNIT IIIe-3

This unit consists of moderately sloping, dark colored and moderately dark colored loamy soils of the Rockton, Waukegan, and Winneshiek series and a complex of the Dickinson and Ostrander series. These soils are well drained and somewhat excessively drained. They are on uplands and benches.

Most of these soils are moderately deep to limestone, sand, or gravel. The moderately deep soils are moderately permeable in the loam and very rapidly permeable in the sand and gravel. The soils of the Dickinson-Ostrander complex, however, are deep and have moderate to moderately rapid permeability. All of these soils have a moderate moisture-supplying capacity and usually have good tilth. The content of organic matter is medium in the Rockton, Ostrander, and Waukegan soils and moderately low in the Winneshiek and Dickinson soils. The reaction is slightly acid.

These soils can be used for row crops, for small grain, and for alfalfa, red clover, bromegrass, and other hay and pasture crops. In general, they are only moderately productive because of a limited root zone and slight droughtiness.

Erosion is a moderate hazard, and on many farms these soils are left in permanent pasture or hay. If no erosion controls are applied, the Dickinson, Ostrander, and Waukegan soils can be row cropped 1 year in 4, but the Rockton and Winneshiek soils ought to be left in grass-legume meadow most of the time. If contoured, the Dickinson-Ostrander complex and the Waukegan soils can be row cropped 2 years in 5, and the Rockton and Winneshiek soils 1 year in 4. If terraced or stripcropped, the Dickinson-Ostrander complex and the Waukegan soils can be row cropped 3 years in 5, and the Rockton and Winneshiek soils 2 years in 5. There may be some gullying in drainageways. If this occurs, the drainageways should be reshaped and seeded to grass.

Terraces should be built on a gradient. To prevent gullying, grassed outlets are best constructed at least a year before the terraces. Only shallow cuts and fills are possible on the shallow Rockton and Winneshiek soils.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume.

Subclass IIIs. Soils That Are Severely Limited By Low Moisture-supplying Capacity

CAPABILITY UNIT IIIs-1

This unit consists of level or nearly level, dark-colored and light-colored soils of the Dickinson and Lamont series. These soils are excessively drained or somewhat excessively drained. They are on benches.

The soils of this unit have moderately rapid permeability. They are generally in good tilth. The moisture-supplying capacity is low. The content of organic matter is moderately low in the Dickinson soils and very low in the Lamont soil. The reaction ranges from slightly acid to strongly acid.

These soils are row cropped intensively. They are suited to small grain and to alfalfa, red clover, bromegrass, and other hay and pasture crops. The yields vary because of the droughtiness.

Wind erosion is a common hazard in areas that are cropped intensively. Residue should be left on the surface. Local conditions determine whether these soils should be cropped intensively or left in long-term hay or pasture.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, especially for corn that does not follow a legume. Because of the droughtiness, however, heavy applications of fertilizer can not be utilized.

CAPABILITY UNIT IIIs-2

This unit consists of gently sloping and moderately sloping soils of the Dickinson and Lamont series. These soils are dark-colored and light-colored and are excessively drained or somewhat excessively drained. They are on uplands and benches.

These soils have moderately rapid permeability and a low moisture-supplying capacity. They are usually in good tilth. The content of organic matter is moderately low in the Dickinson soils and very low in the Lamont soils. The reaction ranges from slightly acid to strongly acid.

Row crops, small grain, and alfalfa and other hay or pasture plants can be grown on these soils, but yields vary because of droughtiness. Local needs determine whether these soils should be cropped intensively or left in long-term hay or pasture.

Wind erosion is a slight hazard if these soils are in row crops. To control wind erosion, as much residue as possible should be left on the surface. Water erosion is a slight or moderate hazard. It can be controlled by growing a grass-legume meadow crop 1 year in 4 on slopes of 2 to 5 percent and 2 years in 4 on slopes of 5 to 9 percent. On contoured soils, a meadow crop 1 year in 5 controls erosion on slopes of 2 to 5 percent and 1 year in 4 on slopes of 5 to 9 percent. If the soils are terraced or stripcropped, they can be row cropped intensively, but a meadow crop is needed 1 year in 5 on the steeper slopes. The terraces should be graded. If loose sand is present, terraces are difficult to maintain but generally work satisfactorily.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn, especially for corn that does not follow a legume. Because of the droughtiness, heavy applications of fertilizer are not utilized. Crops grown on these soils respond to barnyard manure.

Subclass IIIw. Soils That Are Severely Limited By Wetness

CAPABILITY UNIT IIIw-1

This unit consists of a dark-colored, very poorly drained soil of the Marshan series. This soil is in depressions on benches. It has moderately slow permeability. The content of organic matter is high, and the reaction is generally neutral.

Very little of this soil is cropped because water is ponded on the surface part of the year. If properly drained, this soil is moderately to highly productive and can be row cropped intensively. However, getting an adequate drainage outlet is generally very difficult. Pumping stations will work in some areas.

Along the Wapsipinicon River the water table is usually high. These areas may be better suited to permanent pasture or to wildlife than to crops. During spring runoff and after heavy rains, these areas are flooded and crops may be drowned.

If this soil is cultivated, phosphate and potash are needed for all crops. Nitrogen is needed for corn, unless the corn follows a legume.

CAPABILITY UNIT IIIw–2

This unit consists of level to very gently sloping, dark-colored, poorly drained soils of the Blockton and Rolfe series. These soils are on uplands and benches. A few areas are in depressions.

The subsoil is fine textured. Permeability is slow in the Rolfe soils and very slow in the Blockton. The content of organic matter is moderately high in the Rolfe soil and medium in the Blockton. The reaction ranges from slightly acid to strongly acid.

These soils are generally used for cultivated crops. Yields above average can be obtained, but yields may be reduced and occasionally a crop may be lost because of inadequate drainage. Many areas of the Rolfe soil can be fairly well drained with tile, but tile is not recommended for the Blockton soil because of the very slowly permeable subsoil. Some areas may need surface drainage, although most of the Blockton soil has a slight slope. Diversion terraces on slopes above the Blockton soil would reduce wetness in some places.

These soils are suitable for row crops and for hay and pasture. Erosion is a slight hazard on a few areas of the Blockton soil. These areas need the protection of a grass-legume crop 1 year or more in 5, depending on the slope. Alfalfa and red clover may drown out on the Rolfe soil and in the depressional areas of the Blockton soil.

Phosphate and potash are needed for all crops, and nitrogen is needed for corn that does not follow a legume.

CAPABILITY UNIT IIIw–3

This unit consists of level to gently sloping, deep and moderately deep peaty muck. Peaty muck is a dark-colored, very poorly drained organic soil. Some of it is in seepage areas.

Permeability is moderately rapid, but runoff is very slow and the substratum is more slowly permeable than the overlying peaty muck. A perched water table keeps the peaty muck saturated most of the year. The moisture-supplying capacity is very high. The reaction generally is slightly acid or neutral.

This soil is not suited to cultivation unless it is drained. If properly drained, it is suited to intensive row cropping and is moderately or highly productive. It has a somewhat low temperature in the subsoil and warms up slowly in spring. It can be tile drained, but the system may be hard to maintain because of the unstable organic material. If possible, the tile should be placed on or in the substratum, which generally is a mineral soil of finer texture than the organic material. Even though properly installed, tile may not eliminate wetness in some places.

If peaty muck is not drained, it should be left in permanent pasture or as a wildlife habitat. Without drainage it is boggy and is not very good for pasture.

This soil is high in available nitrogen, but all crops grown on it need phosphate and potash.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both

SUBCLASS IVe. SOILS THAT ARE SUBJECT TO VERY SEVERE EROSION IF THEY ARE CULTIVATED AND NOT PROTECTED

CAPABILITY UNIT IVe–1

In this unit is a moderately steep, light-colored, well-drained soil of the Seaton series. This soil is on upland slopes, many of which are irregular.

This is a deep, moderately permeable soil. It usually has good tilth, and it has a high moisture-supplying capacity. Much of the organic matter has been removed by erosion. The reaction generally is strongly acid.

Small grain and alfalfa, red clover, bromegrass, and other hay and pasture plants grow well on this soil. If erosion control practices are applied, a row crop can be grown occasionally.

Erosion is a very severe hazard and, unless conservation practices are applied, this soil should be left in permanent pasture or hay. If the soil is terraced or stripcropped, erosion can be controlled by a rotation of corn 1 year, oats 1 year, and grass-legume meadow 3 years. Terraces can be level. In renovating long-term hay or pasture, corn can be grown for 1 year if planted on the contour.

Phosphate and some potash are needed for all crops. Nitrogen is needed for corn, and it improves grass pasture.

CAPABILITY UNIT IVe–2

In this unit is a moderately sloping and strongly sloping soil of the Lamont series. This soil is light colored and somewhat excessively drained. It is on uplands.

The permeability is moderately rapid, the moisture-supplying capacity is low, and the content of organic matter is very low. Tilth usually is good. Soil reaction ranges from slightly acid to strongly acid.

Yields of some crops are limited by droughtiness and low fertility. This soil is probably better suited to permanent hay or pasture than to row crops or small grain. It is seeded to alfalfa, bromegrass, and orchardgrass for pasture. Corn and oats are grown, but yields are below average. If this soil is contoured, erosion can be controlled by growing a grass-legume meadow crop 3 years in 5. If it is cultivated, wind erosion is a slight hazard, and blowing sand may damage young plants. Crop residue is best left on the surface if possible.

Crops respond well to fertilizer, but because of droughtiness, heavy applications may not be utilized. The response to barnyard manure is good.

CAPABILITY UNIT IVe–3

This unit consists of a moderately sloping and strongly sloping, dark-colored, well-drained soil of the Rockton series. It is on uplands.

This soil is moderately deep to limestone. It is moderately permeable and usually has good tilth. The moisture-supplying capacity is moderate, and the content of organic matter is medium. The reaction is usually slightly acid or medium acid.

Because of the limited root zone and a severe erosion hazard, this soil is probably better suited to permanent

hay and pasture than to row crops. Row crops can be grown if erosion is controlled, but production is relatively low.

Erosion is a severe hazard, and this soil should be left in permanent hay or pasture unless terraced or stripcropped. Erosion can be controlled by terracing and growing a grass-legume meadow crop 3 years in 5. Terraces should be built on a gradient. Cuts and fills ought to be held to a minimum depth so that the bedrock is not exposed in terrace channels. Constructing grassed outlets at least a year before constructing the terraces helps to prevent gullying. In the renovation of long-term hay or pasture stands, corn can be grown for 1 year if planted on the contour.

Phosphate and potash are needed for all crops. Nitrogen is needed for corn.

SUBCLASS IVs. SOILS THAT ARE SEVERELY LIMITED BY LOW MOISTURE-SUPPLYING CAPACITY

CAPABILITY UNIT IVs–1

This unit consists of moderately sloping and strongly sloping, dark colored and moderately dark colored soils of the Sogn series. These soils are excessively drained and are shallow over limestone bedrock. They are on uplands.

The surface layer of these soils generally is loam, but it ranges from loam to sandy loam. The organic-matter content and the reaction also vary. In many areas there are limestone outcrops.

These soils are too droughty and shallow for row crops, and they are subject to severe erosion if cultivated and not protected. They are suitable for permanent hay and pasture, for woodland, or for wildlife habitats. Although some areas are in row crops, yields are below average. Stands of hay and pasture produce better yields if renovated and fertilized. During the renovation, a row crop can be grown if the fields are stripcropped.

CAPABILITY UNIT IVs–2

This unit consists of level to moderately sloping, light-colored and dark-colored soils of the Backbone, Burkhardt, Chelsea, and Hagener series. These soils are excessively drained. They are on uplands and benches.

These soils have moderately rapid to very rapid permeability. Their moisture-supplying capacity is very low. The content of organic matter is low or very low. The reaction varies but, in general, is slightly acid to strongly acid.

These soils are easily tilled. They warm up quickly in spring and can be worked soon after rain. Their suitability for some row crops is limited by droughtiness and low fertility. Alfalfa, bromegrass, and orchardgrass are common crops. Corn and oats are also grown, but yields are below average. Small areas that adjoin soils more suitable for row cropping are managed with those soils. All row crops on the more strongly sloping areas should be contoured or stripcropped. Establishing new seedings may be difficult because of the sandy texture.

If cultivated, these soils are subject to wind erosion. Blowing sand may damage young plants. Leaving crop residue on the surface helps to control wind and water erosion, reduces damage from blowing sand, and conserves moisture.

Crops respond well to light applications of fertilizer. Because of droughtiness, heavy applications are not utilized. Barnyard manure is beneficial.

Class V. Soils that are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover

SUBCLASS Vw. SOILS THAT ARE TOO WET FOR CULTIVATION; NEITHER DRAINAGE NOR PROTECTION IS FEASIBLE

CAPABILITY UNIT Vw–1

This unit consists of level and nearly level, moderately dark colored to light-colored Alluvial land. This land type is excessively drained to poorly drained and is on bottom lands.

Alluvial land varies in texture and has very rapid to moderately slow permeability During extensive floods, large amounts of medium-textured to coarse-textured sediments are deposited and new stream channels are formed. Most Alluvial land is cut up by oxbows and other stream channels.

This land type includes some potentially good soils for crops, and a few small areas are cultivated. Floods may damage fences and deposit sediment on crops or pasture. Unless flooding is controlled, artificial drainage provided, and stream channels straightened, Alluvial land is seldom suitable for cultivation. It is better suited to pasture, wildlife habitats, recreation areas, or woodland. Improving pasture generally is worthwhile.

Class VI. Soils that have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover

SUBCLASS VIe. SOILS THAT ARE SEVERELY LIMITED, CHIEFLY BY RISK OF EROSION, IF PROTECTIVE COVER IS NOT MAINTAINED

CAPABILITY UNIT VIe–1

In this unit is a steep, light-colored, well-drained soil of the Seaton series. It is on uplands.

This soil is deep and moderately permeable. It generally has a high moisture-supplying capacity, but much moisture may be lost through rapid runoff.

Steep slopes and the hazard of severe erosion limit the use of this soil. It is not suitable for row crops but is suitable for pasture, trees, or wildlife habitats. Alfalfa and bromegrass are the best pasture plants. The alfalfa should be a long-lived variety. In most places an alfalfa-bromegrass mixture is most practical for reseeding pastures. Phosphate is needed in most areas. Preparing a seedbed is difficult on the steep slopes, and farm machinery should be operated carefully.

Areas used for producing timber should not be grazed, and undesirable trees ought to be cut out.

SUBCLASS VIs. SOILS THAT ARE GENERALLY UNSUITABLE FOR CULTIVATION AND ARE LIMITED FOR OTHER USES BY LOW MOISTURE-SUPPLYING CAPACITY, BY STONES, OR OTHER FEATURES

CAPABILITY UNIT VIs–1

This unit consists of moderately sloping and strongly sloping, light-colored and dark-colored soils of the Back-

bone, Chelsea, and Hagener series. These soils are excessively drained. They are on uplands.

These soils have a low moisture-supplying capacity, and they are low in content of organic matter.

Strong slopes, droughtiness, and the hazard of erosion limit the use of these soils. They are not suitable for row crops and are better used for pasture, woodland, or wildlife habitats. A mixture of bromegrass and long-lived alfalfa makes a better pasture on these soils than bluegrass. Establishing new seedings may be difficult because of the sandy texture. Leaving crop residue on the surface and adding strawy manure helps to control erosion, protects seedlings from blowing sand, and increases the moisture-supplying capacity. Controlled grazing helps to maintain good stands of pasture.

These soils are low in available nitrogen, phosphorus, and potassium.

Class VII. Soils that have very severe limitations that make them unsuitable for cultivation and restrict their use largely to grazing, woodland, or wildlife

SUBCLASS VIIs. SOILS THAT ARE VERY SEVERELY LIMITED BY LOW MOISTURE-SUPPLYING CAPACITY, STONES, OR OTHER FEATURES

CAPABILITY UNIT VIIs-1

This unit consists of steep, dark colored and moderately dark colored, excessively drained soils of the Sogn series. These soils are shallow over limestone bedrock. They are on uplands.

The surface layer is dominantly loam, but the texture ranges from loam to sandy loam. Slopes are irregular, and in many places there are limestone outcrops.

These soils are too shallow, too steep, and too droughty for row crops or small grain. They are better used for permanent pasture or trees, or as wildlife habitats and recreation areas. Using ordinary farm equipment to renovate pasture is hazardous. Crawler-type tractors can be used on the steeper areas. Grazing ought to be controlled to maintain good growth. Woodland should not be grazed.

SUBCLASS VIIw. SOILS THAT ARE VERY SEVERELY LIMITED BY EXCESS WATER

CAPABILITY UNIT VIIw-1

This unit consists of depressional or flat areas of Marsh, where water is impounded or a water table is at or near the surface. It is in and around ponds and intermittent ponds.

Marsh is unsuited to row crops and small grain and is poorly suited to pasture. The natural vegetation consists of cattails, rushes, sedges, and other water-tolerant plants. Sweet Marsh, the largest acreage of Marsh in Bremer County, is an example of an area that has been developed for wildlife and recreation.

Estimated Yields

Table 2 lists estimated yields of the principal crops grown on each soil in the county. It also lists for each soil the management problems, suitable cropping systems or other uses, and the conservation practices considered necessary for each use.

The estimated yields are based on a high level of management that includes the following practices:

1. Controlling erosion.
2. Planting corn at rates that will produce a final plant population consistent with available moisture.
3. Applying fertilizer and lime in the kinds and amounts indicated by soil tests, so as to reach a level of fertilization equivalent to high rates suggested by the testing laboratory of Iowa State University.
4. Using cropping systems suggested in the subsection "Management of Soils by Capability Units" and in table 2.
5. Draining wet soils by tile or surface drains.
6. Using suitable varieties of crops.
7. Controlling weeds, diseases, and insects.
8. Controlling floods.

In estimating the yields listed in table 2, it was assumed that the practices listed would have been followed for at least 10 years. The estimates are based on research data from experimental farms, on the experience of farmers, and on the opinions of soil scientists and agronomists who know the soils of the county. The research data were compiled before 1964.

In table 2, the most intensive use of row crops consistent with good soil conservation is given in the column headed "Cropping systems and other soil uses." In choosing a cropping system for a farm or field, consideration must be given to the characteristics of the soils, their productivity, and the need for erosion control. Other factors to consider are the kind and size of farm, the amount of capital that can be invested, and the agricultural market.

Woodland

About 5 percent of Bremer County is woodland. Much of the woodland borders the Cedar, Shell Rock, and Wapsipinicon Rivers. In addition, several farms have small woodlots, and most farms have landscape and windbreak plantings of trees and shrubs.

Most of the woodland has been grazed, overcut, or unmanaged and is producing below its potential. In general, the steep woodland has been left untouched. Woodland that adjoins pasture is little more than a source of shade for livestock or a habitat for game animals.

The acreage of woodland in Bremer County has not changed significantly in recent years. Some of it, mostly along stream bottoms and on benches, has been converted to cropland.

Several agencies in Iowa can assist woodland owners in improving their products and in marketing them. The Soil Conservation Service can help woodland owners in determining which soils are suitable for trees. State foresters can assist in developing plans for managing stands of timber.

TABLE 2.—*Management and estimated yields*

[Dashes indicate the crop is not suited to the soil or is not grown on it under the practice specified]

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
Ab	Alluvial land	Vw-1	Flooding.	None	Permanent pasture, woodland, or wildlife habitats.	----	----	----	1. 5	75
ArB	Aredale loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	89	31	67	3. 6	180
				Contouring	R-R-R-O-M	89	31	67	3. 6	180
				Terracing	Intensive row cropping.	89	31	----	----	----
ArC	Aredale loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	84	29	63	3. 3	165
				Contouring	R-R-O-M	84	29	63	3. 3	165
				Terracing	R-R-R-O-M	84	29	63	3. 3	165
AtA	Atkinson loam, 0 to 2 percent slopes.	I-2	None.	None	Intensive row cropping or R-R-R-Ox.	87	30	65	3. 5	175
AtB	Atkinson loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M-M	82	29	61	3. 3	165
				Contouring	R-R-R-O-M	82	29	61	3. 3	165
				Terracing	Intensive row cropping.	82	29	----	----	----
AtC	Atkinson loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	77	27	58	3. 1	155
				Contouring	R-R-O-M-M	77	27	58	3. 1	155
				Terracing	R-R-R-O-M	77	27	58	3. 1	155
BaB	Backbone loamy sand, 2 to 5 percent slopes.	IVs-2	Severe droughtiness.	None	R-O-M	55	19	41	2. 2	110
				Contouring	R-R-O-M	55	19	41	2. 2	110
				Terracing	R-R-Ox	55	19	41	2. 2	110
BaC	Backbone loamy sand, 5 to 9 percent slopes.	IVs-2	Severe droughtiness.	None	Hay or pasture	----	----	----	1. 8	90
				Contouring	R-O-M-M	45	16	34	1. 8	90
				Stripcropping	R-R-O-M-M	45	16	34	1. 8	90
BaD	Backbone loamy sand, 9 to 14 percent slopes.	VIs-1	Severe droughtiness.	None	Hay, pasture, or wildlife habitats.	----	----	----	1. 4	70
BeB	Bassett loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	83	29	62	3. 3	165
				Contouring	R-R-R-O-M	83	29	62	3. 3	165
				Terracing	Intensive row cropping.	83	29	----	----	----
BeC	Bassett loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	78	27	58	3. 1	155
				Contouring	R-R-O-M	78	27	58	3. 1	155
				Terracing	R-R-R-O-M	78	27	58	3. 1	155
BeC2	Bassett loam, 5 to 9 percent slopes, moderately eroded.	IIIe-1	Moderate or severe erosion hazard.	None	R-O-M	73	26	55	2. 9	145
				Contouring	R-R-O-M	73	26	55	2. 9	145
				Terracing	R-R-R-O-M	73	26	55	2. 9	145
Bk	Blockton silty clay loam, dark gray subsoil variant.	IIIw-2	Wetness.	May need surface drainage.	R-R-R-O-M	[5]75	[5]26	[5]56	[5]3. 0	[5]150
BuA	Burkhardt sandy loam, 0 to 2 percent slopes.	IVs-2	Severe droughtiness.	Mulch tillage	Intensive row cropping.	45	16	----	----	----
BuC	Burkhardt sandy loam, 2 to 9 percent slopes.	IVs-2	Severe droughtiness.	None	Hay or pasture	----	----	----	1. 4	70
				Contouring	R-O-M-M	35	12	26	1. 4	70
				Stripcropping	R-R-O-M-M	35	12	26	1. 4	70

See footnotes at end of table.

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TABLE 2.—*Management and estimated yields*—Continued

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
ChB	Chelsea sand, 0 to 5 percent slopes.	IVs-2	Severe droughtiness.	None	R-O-M	45	16	34	1.8	90
				Contouring	R-R-O-M	45	16	34	1.8	90
				Stripcropping	R-R-R-O-M	45	16	34	1.8	90
ChC	Chelsea sand, 5 to 9 percent slopes.	IVs-2	Severe droughtiness.	None	Hay or pasture	-----	-----	-----	1.4	70
				Contouring	R-O-M-M	35	12	26	1.4	70
				Stripcropping	R-R-O-M-M	35	12	16	1.4	70
ChE	Chelsea sand, 9 to 18 percent slopes.	VIs-1	Severe droughtiness.	None	Hay or pasture, woodland, or wildlife habitats.	-----	-----	-----	1.2	60
Ck	Clyde clay loam	IIw-1	Wetness.	Tile drainage	Intensive row cropping or R-R-R-O-M.	78	27	58	3.1	155
CmB	Coggon loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	78	27	58	3.1	155
				Contouring	R-R-R-O-M	78	27	58	3.1	155
				Terracing	Intensive row cropping.	78	27	-----	-----	-----
CmC	Coggon loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	73	26	55	2.9	145
				Contouring	R-R-O-M	73	26	55	2.9	145
				Terracing	R-R-R-O-M	73	26	55	2.9	145
Cn	Colo silty clay loam	IIw-3	Wetness; some flooding.	Drainage and overflow protection.	Intensive row cropping or R-R-R-Ox.	85	30	64	3.4	170
CoB	Colo-Terril complex, 0 to 5 percent slopes.	IIw-3	Wetness; gullying.	Tile drainage	Intensive row cropping or R-R-R-Ox.	86	30	64	3.4	170
CrB	Cresco loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	85	30	64	3.4	170
				Contouring	R-R-R-O-M	85	30	64	3.4	170
				Terracing	Intensive row cropping.	85	30	-----	-----	-----
CrC	Cresco loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	80	28	60	3.2	160
				Contouring	R-R-O-M	80	28	60	3.2	160
				Terracing	R-R-R-O-M	80	28	60	3.2	160
DcB	Dickinson sandy loam, 2 to 5 percent slopes.	IIIs-2	Droughtiness.	None	R-R-O-M	68	24	48	2.7	135
				Contouring	R-R-R-O-M	68	24	48	2.7	135
				Terracing or stripcropping.	Intensive row cropping.	68	24	-----	-----	-----
DcC	Dickinson sandy loam, 5 to 9 percent slopes.	IIIs-2	Droughtiness.	None	R-O-M-M	60	21	45	2.4	120
				Contouring	R-R-O-M	60	21	45	2.4	120
				Terracing or stripcropping.	R-R-R-O-M	60	21	45	2.4	120
DdA	Dickinson sandy loam, benches, 0 to 2 percent slopes.	IIIs-1	Droughtiness.	Mulch tillage	Intensive row cropping or R-R-R-Ox.	70	24	52	2.8	140
DdB	Dickinson sandy loam, benches, 2 to 5 percent slopes.	IIIs-2	Droughtiness.	None	R-R-O-M	65	23	49	2.6	130
				Contouring	R-R-R-O-M	65	23	49	2.6	130
				Terracing or stripcropping.	Intensive row cropping.	65	23	-----	-----	-----
DgA	Dickinson sandy loam, gravelly substratum 0 to 2 percent slopes.	IIIs-1	Droughtiness.	Mulch tillage	Intensive row cropping or R-R-R-Ox.	66	23	50	2.6	130

See footnotes at end of table.

TABLE 2.—*Management and estimated yields*—Continued

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
DgB	Dickinson sandy loam, gravelly substratum, 2 to 5 percent slopes.	IIIs-2	Droughtiness.	None	R-R-O-M	60	21	45	2.4	120
				Contouring	R-R-R-O-M	60	21	45	2.4	120
DoA	Dickinson-Ostrander complex, 0 to 2 percent slopes.	IIs-1	Slight droughtiness.	None	Intensive row cropping or R-R-R-Ox.	85	30	64	3.4	170
DoB	Dickinson-Ostrander complex, 2 to 5 percent slopes.	IIe-2	Slight erosion hazard and droughtiness.	None	R-R-O-M-M	80	28	60	3.2	160
				Contouring	R-R-R-O-M	80	28	60	3.2	160
				Terracing	Intensive row cropping or R-R-R-Ox.	80	28	60	3.2	160
DoC	Dickinson-Ostrander complex, 5 to 9 percent slopes.	IIIe-3	Moderate erosion hazard.	None	R-O-M-M	72	25	54	2.9	145
				Contouring	R-R-O-M-M	72	25	54	2.9	145
				Terracing	R-R-R-O-M	72	25	54	2.9	145
DsB	Dinsdale silty clay loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	94	33	70	3.8	190
				Contouring	R-R-R-O-M	94	33	70	3.8	190
				Terracing	Intensive row cropping.	94	33	-----	-----	-----
DsC	Dinsdale silty clay loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	87	30	65	3.5	175
				Contouring	R-R-O-M	87	30	65	3.5	175
				Terracing	R-R-R-O-M	87	30	65	3.5	175
FaB	Fayette silt loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	92	32	69	3.8	190
				Contouring	R-R-R-O-M	92	32	69	3.8	190
				Terracing	Intensive row cropping.	92	32	-----	-----	-----
FaC2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded.	IIIe-1	Moderate or severe erosion hazard.	None	R-O-M	85	30	64	3.4	170
				Contouring	R-R-O-M	85	30	64	3.4	170
				Terracing	R-R-R-O-M	85	30	64	3.4	170
FoB	Floyd loam, 1 to 4 percent slopes.	IIw-1	Wetness.	Tile drainage; contouring steep slopes.	Intensive row cropping or R-R-R-O-M.	86	30	64	3.4	170
Fr	Franklin silt loam	I-2	Slight wetness.	Possibly tile drainage.	Intensive row cropping or R-R-R-Ox.	96	34	72	3.8	190
HaB	Hagener loamy sand, 2 to 5 percent slopes.	IVs-2	Severe droughtiness.	Mulch tillage	R-O-M	55	19	41	2.2	110
				Contouring	R-R-O-M	55	19	41	2.2	110
				Stripcropping	R-R-R-O-M	55	19	41	2.2	110
HaC	Hagener loamy sand, 5 to 9 percent slopes.	IVs-2	Severe droughtiness.	None	Hay or pasture	-----	-----	-----	1.8	90
				Contouring	R-O-M-M	45	16	34	1.8	90
				Stripcropping	R-R-O-M-M	45	16	34	1.8	90
HaD	Hagener loamy sand, 9 to 14 percent slopes.	VIs-1	Severe droughtiness.	None	Hay or pasture, woodland, or wildlife habitats.	-----	-----	-----	1.4	70
HbA	Hagener loamy sand, benches, 0 to 2 percent slopes.	IVs-2	Severe droughtiness.	Mulch tillage	Intensive row cropping.	58	20	-----	-----	-----
HbB	Hagener loamy sand, benches, 2 to 5 percent slopes.	IVs-2	Severe droughtiness.	Mulch tillage	R-O-M	50	17	38	2.0	100
				Contouring	R-R-O-M	50	17	38	2.0	100
				Stripcropping	R-R-R-Ox	50	17	38	2.0	100

See footnotes at end of table.

TABLE 2.—*Management and estimated yields*—Continued

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
Hc	Harpster silt loam	IIw-1	Wetness.	Tile drainage and special fertilization.	Intensive row cropping or R-R-R-O-M.	85	30	64	3.4	170
Hd	Hayfield loam, deep	I-2	Slight wetness.	Possibly tile drainage.	Intensive row cropping or R-R-R-Ox.	89	31	67	3.6	180
Hm	Hayfield loam, moderately deep.	IIs-1	Limited root zone.	None	Intensive row cropping or R-R-R-Ox.	82	29	61	3.3	165
Hv	Hayfield loam, dark brown variant.	I-2	Slight wetness.	Possibly tile drainage.	Intensive row cropping or R-R-R-Ox.	89	31	67	3.6	180
KeB	Kenyon loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	88	31	66	3.5	175
				Contouring	R-R-R-O-M	88	31	66	3.5	175
				Terracing	Intensive row cropping.	88	31	------	------	------
KeC	Kenyon loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	83	29	62	3.3	165
				Contouring	R-R-O-M	83	29	62	3.3	165
				Terracing	R-R-R-O-M	83	29	62	3.3	165
KeC2	Kenyon loam, 5 to 9 percent slopes, moderately eroded.	IIIe-1	Moderate to severe erosion hazard.	None	R-O-M	78	27	58	3.1	155
				Contouring	R-R-O-M	78	27	58	3.1	155
				Terracing	R-R-R-O-M	78	27	58	3.1	155
Kg	Klinger silty clay loam	I-2	Slight wetness.	Possibly tile drainage; contouring steeper slopes.	Intensive row cropping or R-R-R-Ox.	100	35	75	4.0	200
LaB	Lamont sandy loam, 2 to 5 percent slopes.	IIIs-2	Droughtiness.	None	R-R-O-M	65	23	49	2.6	130
				Contouring	R-R-R-O-M	65	23	49	2.6	130
				Terracing or stripcropping.	Intensive row cropping.	65	23	------	------	------
LaC	Lamont sandy loam, 5 to 9 percent slopes.	IIIs-2	Droughtiness.	None	R-O-M-M	56	20	42	2.2	110
				Contouring	R-R-O-M	56	20	42	2.2	110
				Terracing or stripcropping.	R-R-R-O-M	56	20	42	2.2	110
LaD	Lamont sandy loam, 9 to 14 percent slopes.	IVe-2	Erosion and droughtiness.	None	Hay or pasture	------	------	------	1.8	90
				Contouring	R-O-M-M-M	45	------	------	1.8	90
LbA	Lamont sandy loam, benches, 0 to 2 percent slopes.	IIIs-1	Droughtiness.	Mulch tillage	Intensive row cropping or R-R-R-Ox.	65	23	49	2.6	130
Ld	Lawler loam, deep	I-2	Slight wetness.	Possibly tile drainage.	Intensive row cropping or R-R-R-Ox.	90	32	66	3.6	180
Lm	Lawler loam, moderately deep.	IIs-1	Limited root zone.	None	Intensive row cropping or R-R-R-Ox.	83	29	62	3.3	165
Ma	Marsh	VIIw-1	None.	None	Recreation and wildlife habitats.	------	------	------	.5	25
Mr	Marshan clay loam, deep.	IIw-1	Wetness.	Tile drainage	Intensive row cropping or R-R-R-O-M.	88	31	66	3.5	175

See footnotes at end of table.

TABLE 2.—*Management and estimated yields*—Continued

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
Ms	Marshan clay loam, depressional.	IIIw-1	Wetness.	Tile and surface drainage.	Intensive row cropping.	70	24	-----	-----	-----
Mt	Marshan clay loam, moderately deep.	IIw-1	Wetness.	Tile drainage	Intensive row cropping or R-R-R-O-M.	[5] 80	[5] 28	[5] 60	[5] 3.2	[5] 160
Mx	Maxfield silty clay loam	IIw-1	Wetness.	Tile drainage	Intensive row cropping or R-R-R-O-M.	94	33	70	3.8	190
My	Muscatine silty clay loam.	I-2	Slight wetness.	Possibly tile drainage; contouring steeper slopes.	Intensive row cropping or R-R-R-Ox.	102	36	77	4.1	205
No	Nodaway silt loam.	I-1	Some flooding.	None	Intensive row cropping or R-R-R-Ox.	85	30	64	3.4	170
OrA	Oran loam, 0 to 2 percent slopes.	I-2	Slight wetness.	Possibly tile drainage.	Intensive row cropping or R-R-R-Ox.	90	32	66	3.6	180
OrB	Oran loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	Possibly tile drainage.	R-R-O-M	85	30	64	3.4	170
OsA	Ostrander loam, 0 to 2 percent slopes.	I-2	None.	None	Intensive row cropping or R-R-R-Ox.	95	33	71	3.8	190
OsB	Ostrander loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	90	32	66	3.6	180
				Contouring	R-R-R-O-M	90	32	66	3.6	180
				Terracing	Intensive row cropping.	90	32	-----	-----	-----
OsC	Ostrander loam, 5 to 9 percent slopes.	IIIe-1	Moderate erosion hazard.	None	R-O-M	85	30	64	3.4	170
				Contouring	R-R-O-M	85	30	64	3.4	170
				Terracing	R-R-R-O-M	85	30	64	3.4	170
Pe	Peaty muck, deep	IIIw-3	Wetness.	Tile and surface drainage.	Intensive row cropping or pasture.	[5] 60	[5] 21	[5] 45	[5] 2.4	[5] 120
Pm	Peaty muck, moderately deep.	IIIw-3	Wetness.	Tile and surface drainage.	Intensive row cropping or pasture.	[5] 60	[5] 21	[5] 45	[5] 2.4	[5] 120
PoB	Port Byron silt loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-R-O-M	94	33	70	3.8	190
				Contouring	R-R-R-Ox	94	33	70	3.8	190
				Terracing	Intensive row cropping.	94	33	-----	-----	-----
PoC2	Port Byron silt loam, 5 to 9 percent slopes, moderately eroded.	IIIe-1	Moderate to severe erosion hazard.	None	R-O-M	86	30	64	3.4	170
				Contouring	R-R-O-M	86	30	64	3.4	170
				Terracing	R-R-R-O-M	86	30	64	3.4	170
PoD2	Port Byron silt loam, 9 to 14 percent slopes, moderately eroded.	IIIe-2	Severe erosion hazard.	None	Hay or pasture	-----	-----	-----	3.3	165
				Contouring	R-O-M-M	82	29	61	3.3	165
				Terracing or strip-cropping.	R-R-O-M-M	82	29	61	3.3	165

See footnotes at end of table.

TABLE 2.—*Management and estimated yields*—Continued

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
ReA	Readlyn loam, 0 to 2 percent slopes.	I-2	Slight wetness.	Possibly tile drainage.	Intensive row cropping or R-R-R-Ox.	90	32	66	3.6	180
ReB	Readlyn loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	Possibly tile drainage.	R-R-O-M	85	30	64	3.4	170
				Contouring and possibly tile drainage.	R-R-R-O-M	85	30	64	3.4	170
				Terracing and possibly tile drainage.	Intensive row cropping.	85	30	-----	-----	-----
RfB	Riceville loam, 1 to 3 percent slopes.	IIw-2	Slight wetness.	Possibly tile drainage.	R-R-O-M	80	30	64	3.4	170
				Contouring and drainage.	R-R-R-O-M	80	30	64	3.4	170
RkB	Rockton loam, 2 to 5 percent slopes.	IIe-2	Limited root zone and slight erosion hazard.	None	R-O-M-M	78	27	58	3.1	155
				Contouring	R-R-O-M	78	27	58	3.1	155
				Terracing	R-R-R-O-M	78	27	58	3.1	155
RkC	Rockton loam, 5 to 9 percent slopes.	IIIe-3	Moderate erosion hazard.	None	R-O-M-M-M-M	70	24	52	2.8	140
				Contouring	R-O-M-M	70	24	52	2.8	140
				Terracing or stripcropping.	R-R-O-M-M	70	24	52	2.8	140
RkD	Rockton loam, 9 to 14 percent slopes.	IVe-3	Severe erosion hazard.	None	Hay or pasture	-----	-----	-----	2.4	120
				Terracing or stripcropping.	R-O-M-M-M	60	-----	45	2.4	120
Ro	Rolfe silt loam	IIIw-2	Wetness.	Tile and surface drainage.	R-R-R-O-M	[5] 70	[5] 24	[5] 52	[5] 2.8	[5] 140
Sa	Sable silty clay loam	IIw-1	Wetness.	Tile drainage	Intensive row cropping or R-R-R-O-M.	98	34	73	3.9	195
SbA	Sattre loam, deep, 0 to 2 percent slopes.	I-2	None.	None	Intensive row cropping or R-R-R-Ox.	85	30	64	3.4	170
SbB	Sattre loam, deep, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	80	28	60	3.2	160
				Contouring	R-R-R-O-M	80	28	60	3.2	160
				Terracing	Intensive row cropping.	80	28	-----	-----	-----
SdA	Sattre loam, moderately deep, 0 to 2 percent slopes.	IIs-1	Slight droughtiness.	None	Intensive row cropping or R-R-R-Ox.	78	27	58	3.1	155
SeB	Seaton silt loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-R-O-M	92	32	69	3.7	185
				Contouring	R-R-R-Ox	92	32	-----	-----	-----
				Terracing	Intensive row cropping.	92	32	-----	-----	-----
SeC2	Seaton silt loam, 5 to 9 percent slopes, moderately eroded.	IIIe-1	Moderate to severe erosion hazard.	None	R-O-M	85	30	64	3.4	170
				Contouring	R-R-O-M	85	30	64	3.4	170
				Terracing	R-R-R-O-M	85	30	64	3.4	170
SeD2	Seaton silt loam, 9 to 14 percent slopes, moderately eroded.	IIIe-2	Severe erosion hazard.	None	Hay or pasture	-----	-----	-----	3.2	160
				Contouring	R-O-M-M	80	28	65	3.2	160
				Terracing or stripcropping.	R-R-O-M-M	80	28	65	3.2	160

See footnotes at end of table.

TABLE 2.—*Management and estimated yields*—Continued

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
SeD3	Seaton silt loam, 9 to 14 percent slopes, severely eroded.	IIIe-2	Severe erosion hazard.	None	Hay or pasture	75	28	60	3.0	150
				Contouring	R-O-M-M	75	28	60	3.0	150
				Terracing or stripcropping.	R-R-O-M-M	75	28	60	3.0	150
SeE2	Seaton silt loam, 14 to 18 percent slopes, moderately eroded.	IVe-1	Severe erosion hazard.	None	Hay or pasture	------	------	------	3.0	150
				Terracing or stripcropping.	R-O-M-M-M	75	------	56	3.0	150
SeF2	Seaton silt loam, 18 to 30 percent slopes, moderately eroded.	VIe-1	Severe erosion hazard.	None	Hay and pasture, woodland, wildlife habitats.	------	------	------	2.8	140
SoD	Sogn soils, 5 to 14 percent slopes.	IVs-1	Very shallow root zone.	None	Hay and pasture, woodland, wildlife habitats.	35	------	26	1.4	70
				Stripcropping	R-O-M-M-M-M	35	------	26	1.4	70
SoF	Sogn soils, 14 to 30 percent slopes.	VIIs-1	Very shallow root zone.	None	Pasture, woodland, or wildlife habitats.	------	------	------	1.0	50
Sp	Spillville loam	I-1	Some flooding.	Some overflow protection.	Intensive row cropping or R-R-R-Ox.	87	30	65	3.5	175
Sv	Spillville-Colo complex	IIw-3	Some flooding and wetness.	Drainage and overflow protection.	Intensive row cropping or R-R-R-Ox.	86	30	64	3.4	170
TxA	Terril loam, 0 to 2 percent slopes.	I-1	None.	None	Intensive row cropping or R-R-R-Ox.	90	32	66	3.6	180
TxB	Terril loam, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-R-O-M	87	30	65	3.5	175
				Contouring	R-R-R-Ox	87	30	65	3.5	175
				Terracing	Intensive row cropping.	87	30	------	------	------
Tr	Tripoli clay loam	IIw-1	Wetness.	Tile drainage	Intensive row cropping or R-R-R-O-M.	87	30	65	3.5	175
WaA	Waukegan loam, deep, 0 to 2 percent slopes.	I-2	None.	None	Intensive row cropping or R-R-R-Ox.	87	30	65	3.5	175
WaB	Waukegan loam, deep, 2 to 5 percent slopes.	IIe-1	Slight erosion hazard.	None	R-R-O-M	82	29	61	3.3	165
				Contouring	R-R-R-O-M	82	29	61	3.3	165
				Terracing	Intensive row cropping.	82	29	------	------	------
WgA	Waukegan loam, moderately deep, 0 to 2 percent slopes.	IIs-1	Slight droughtiness.	None	Intensive row cropping.	80	28	60	3.2	160
WgB	Waukegan loam, moderately deep, 2 to 5 percent slopes.	IIe-2	Slight erosion hazard.	None	R-R-O-M-M	80	28	60	3.2	160
				Contouring	R-R-R-O-M	80	28	------	------	------
				Terracing	Intensive row cropping.	80	28	------	------	------
WgC	Waukegan loam, moderately deep, 5 to 9 percent slopes.	IIIe-3	Moderate erosion hazard.	None	R-O-M-M	72	25	54	2.9	145
				Contouring	R-R-O-M-M	72	25	54	2.9	145
				Terracing	R-R-R-O-M	72	25	54	2.9	145

See footnotes at end of table.

TABLE 2.—*Management and estimated yields*—Continued

Map symbol	Soil	Capability unit	Management problems	Management practices	Cropping systems and other soil uses [1]	Expected average yields per acre under a high level of management [2]				
						Corn	Soybeans	Oats	Hay [3]	
						Bu.	*Bu.*	*Bu.*	*Tons*	*AUD* [4]
WkA	Waukegan silt loam, deep, 0 to 2 percent slopes.	I-2	None.	None	Intensive row cropping or R-R-R-Ox.	100	35	75	4.0	200
WnB	Winneshiek loam, 2 to 5 percent slopes.	IIe-2	Limited root zone and slight erosion hazard.	None	R-O-M-M	73	26	55	2.9	145
				Contouring	R-R-O-M	73	26	55	2.9	145
				Terracing or stripcropping.	R-R-R-O-M	73	26	55	2.9	145
WnC	Winneshiek loam, 5 to 9 percent slopes.	IIIe-3	Moderate erosion hazard.	None	R-O-M-M-M-M	65	23	49	2.6	130
				Contouring	R-O-M-M	65	23	49	2.6	130
				Terracing or stripcropping.	R-R-O-M-M	65	23	49	2.6	130

[1] Each cropping system or other soil use is suggested on the assumption that it is accompanied by the conservation practice listed opposite it in the column headed "Management practices." Grain sorghum or soybeans can be substituted for corn; another small grain can be substituted for oats. R=row crop (corn or soybeans), O=oats, M=meadow, x=green-manure catch. Intensive row cropping is row cropping continuously for 4 years or more.

[2] See text for definition of high level of management. Estimates are based on data compiled before 1964.

[3] Except for hay grown on Alluvial land and Marsh, estimated yields of hay are based on three cuttings a year from first-year stands. If the soil is suited to alfalfa, the hay crop is assumed to consist of alfalfa and bromegrass.

[4] AUD—Animal unit days. The number of days during the growing season that 1 acre will provide grazing for an animal unit without injury to the pasture. An animal unit is 1 mature cow, steer, or horse; 5 hogs; or 7 sheep. It is assumed that 40 pounds of dry matter per day are needed for one animal unit.

[5] Yields from these soils are highly variable because adequate drainage is seldom obtained.

Types of Woodland

Two types of native woodland occur in Bremer County. They are the oak—hickory type and the soft maple—elm—cottonwood type.

The oak—hickory type is on rolling to steep uplands, where most of the soils are deep and have an ample supply of moisture. The Bassett, Coggon, Fayette, Franklin, Oran, Riceville, and Seaton soils predominate. There are also the Backbone, Chelsea, and Lamont soils, which are sandy and somewhat droughty, and the Winneshiek and Sogn soils, which are underlain by limestone bedrock. The Sogn soils are very shallow. Besides the predominant oak and hickory, the stands include elm, basswood, hackberry, green ash, and cherry.

The soft maple—elm—cottonwood type of woodland is on nearly level benches and bottom lands, where the soils vary in moisture-supplying capacity. On the bottom lands are Alluvial land and the Nodaway soils, and on the benches are the Hagener, Hayfield, Lamont, Lawler, Marshan, and Sattre soils. The Sattre and Hayfield soils are underlain by coarse material and may be droughty in years of low rainfall. Willow, cottonwood, and swamp white oak commonly grow on the bottom lands. Red elm, American elm, willow, cottonwood, soft maple, swamp white oak, bur oak, shellbark hickory, green ash, and some black walnut grow on the benches.

Landscape and windbreak plantings have been established in the county since the time of settlement. These plantings include white pine, red pine, Austrian pine, Douglas-fir, Scotch pine, and Norway spruce.

Factors Affecting Woodland Management

Tree growth is directly related to the capacity of a soil for supplying moisture. In turn, the moisture-supplying capacity depends on slope, depth, texture, permeability, and internal drainage. The moisture supply is limited in many areas of the sandy, excessively drained Chelsea soils and of the very shallow Sogn soils.

Aspect, or direction of exposure, also directly affects the rate of tree growth. Trees generally grow better on slopes facing north or east than on slopes facing south or west.

Erosion reduces the effective depth, or root zone, of Winneshiek, Rockton, Sattre, Sogn, and other shallow soils. It also interferes with natural reseeding.

Flooding and poor drainage limit tree growth on some areas of Alluvial land and of the Nodaway soils.

In general, hardwoods do better on high-lime soils than conifers, except for eastern redcedar. Pines do better than hardwoods in old, formerly cultivated fields and on eroded or depleted soils.

Woodland Suitability Groups

The soils of Bremer County have been placed in six groups according to their suitability for the growth of trees. Table 3 lists the soil series, the symbols of their component mapping units, and the woodland groups in which the mapping units have been placed. Prairie-derived soils, which occur on uplands, bottom lands, and benches, are included in the woodland groups and are

listed in table 3, but no site indexes and no production data are given for these soils.

The site index is the height in feet that a specified kind of tree, growing on a specified soil, will reach in 50 years. The site indexes and production data given in table 3 are based on measurements of trees and on data in USDA Technical Bulletin No. 560 (*16*).[1]

In the following discussions of the woodland suitability groups, the soil characteristics that affect the growth of trees are stated, and the trees suitable for planting are listed. The lists include species suitable for timber, windbreaks, and Christmas trees, as well as trees and shrubs for wildlife food and cover. Local and State publications tell which trees are most suitable for specific uses. The woodland groups are not numbered consecutively. They are part of a Statewide system, and the soils that make up some of the groups do not occur in Bremer County.

[1] Italic numbers in parentheses refer to Literature Cited, p. 117.

TABLE 3.—*Woodland suitability groups, site indexes, and yields*

[No data given for prairie-derived soils]

Soil series and map symbols	Woodland suitability group	Site index	Annual yield of hardwoods
			Bd. ft./acre
Alluvial land:			
Ab	3	[1] 60	[2] 190
Aredale:			
ArB, ArC	4		
Atkinson:			
AtA, AtB, AtC	4		
Backbone:			
BaB, BaC, BaD	1	[1] 56	155
Bassett:			
BeB, BeC, BeC2	4	[3] 50 (48–56)	130
Blockton, dark gray subsoil variant:			
Bk	4		
Burkhardt:			
BuA, BuC	1		
Chelsea:			
ChB, ChC, ChE	1	[3] 56 (47–63)	155
Clyde:			
Ck	9		
Coggon:			
CmB, CmC	4	[3] 53 (51–54)	140
Colo:			
Cn, CoB	9		
(For Terril part of CoB, see Terril series.)			
Cresco:			
CrB, CrC	4		
Dickinson:			
DcB, DcC, DdA, DdB, DgA, DgB, DoA, DoB, DoC	1		
(For Ostrander part of DoA, DoB, and DoC, see Ostrander series.)			
Dinsdale:			
DsB, DsC	4		
Fayette:			
FaB, FaC2	4	[3] 68 (54–74)	250
Floyd:			
FoB	4		
Franklin:			
Fr	4	[1] 60	190
Hagener:			
HaB, HaC, HaD, HbA, HbB	1		
Harpster:			
Hc	9		
Hayfield:			
Hd, Hm, Hv	4	[1] 58	165
Kenyon:			
KeB, KeC, KeC2	4		
Klinger:			
Kg	4		
Lamont:			
LaB, LaC, LaD, LbA	4	67	230
Lawler:			
Ld, Lm	4		
Marsh:			
Ma	9		
Marshan:			
Mr, Ms, Mt	9		
Maxfield:			
Mx	7		
Muscatine:			
My	4		
Nodaway:			
No	6	58	165
Oran:			
OrA, OrB	4	[1] 55	150
Ostrander:			
OsA, OsB, OsC	4		
Peaty muck:			
Pe, Pm	9		
Port Byron:			
PoB, PoC2, PoD2	4		
Readlyn:			
ReA, ReB	4		
Riceville:			
RfB	7	[1] 50	120
Rockton:			
RkB, RkC, RkD	4		
Rolfe:			
Ro	9		
Sable:			
Sa	7		
Sattre:			
SbA, SbB, SdA	4	[1] 60	190
Seaton:			
SeB, SeC2, SeD2, SeD3, SeE2, SeF2	4	64	210
Sogn:			
SoD, SoF	1		
Spillville:			
Sp, Sv	9		
(For the Colo part of Sv, see the Colo series.)			
Terril:			
TxA, TxB	6		
Tripoli:			
Tr	7		
Waukegan:			
WaA, WaB, WgA, WgB, WgC, WkA	4		
Winneshiek:			
WnB, WnC	4	[3] 59 (57–61)	180

[1] Estimated.

[2] Yields vary; highest yields are obtained from cottonwood, lowest from elm, ash, and soft maple.

[3] Range in site index shown in parentheses.

WOODLAND SUITABILITY GROUP 1

The soils in this group are droughty. Causes of droughtiness include location, extreme sandiness, an excessively drained sandy or gravelly subsoil, and shallowness to bedrock. The seedling mortality rate is high.

The slope range generally is 0 to 14 percent. Some steeper, north- or east-facing slopes are included.

Eastern redcedar, Scotch pine, jack pine, eastern white pine, European larch, and red pine are suitable trees for planting. Honeysuckle, eastern redcedar, Russian-olive, and wild plum are suitable plants for wildlife food and cover.

WOODLAND SUITABILITY GROUP 3

The soils in this group are on bottom lands and are flooded repeatedly. Cottonwood and soft maple are suitable trees for planting. Honeysuckle and eastern redcedar are suitable for wildlife food and cover.

WOODLAND SUITABILITY GROUP 4

This group consists of deep, moderately permeable soils in coves, on second bottoms, and on level to sloping uplands. The slope range generally is 0 to 14 percent, but some steeper, north- or east-facing slopes are included. These soils are the most favorable in the county for trees, though weed competition may be serious.

Trees suitable for planting are eastern redcedar, eastern white pine, European larch, red pine, Scotch pine, black walnut, black cherry, green ash, white ash, basswood, cottonwood, and Norway spruce. Shrubs and trees suitable for wildlife food and cover are dogwood, honeysuckle, ninebark, eastern redcedar, Russian-olive, multiflora rose, and wild plum.

WOODLAND SUITABILITY GROUP 6

The soils in this group are on bottom lands and are flooded repeatedly. Cottonwood, silver maple, and green ash are suitable for planting. Honeysuckle is suitable for wildlife food and cover.

WOODLAND SUITABILITY GROUP 7

This group consists of soils that are tight at a fairly shallow depth. They range from clay loam to clay in texture and are moderately to very slowly permeable. The seedling mortality rate is higher on these soils than on those in groups 4 and 6.

The slope range generally is 0 to 14 percent. Some steeper north- or east-facing slopes are included.

Cottonwood, eastern redcedar, green ash, and hackberry are suitable trees for planting on the very slowly permeable soils. Eastern white pine and Norway spruce can be planted on the moderately permeable soils. Eastern redcedar, honeysuckle, and native dogwood are suitable for wildlife food and cover.

WOODLAND SUITABILITY GROUP 9

The soils in this group are fine textured and are moderately to very slowly permeable. They are similar to those in group 7 except that they are subject to flooding. The seedling mortality rate is therefore higher.

Cottonwood and green ash are suitable trees for planting. Honeysuckle is a suitable plant for wildlife food and cover.

Engineering [2]

Some soil properties are of special importance in engineering because they affect the construction and maintenance of such engineering works as roads, airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Permeability, shear strength, compaction characteristics, soil drainage, shrink-swell characteristics, grain size, plasticity, and reaction (pH) are among the soil properties most important in engineering. Depth to water table, depth to bedrock or sand and gravel, and topography are also important.

This report does not eliminate the need for on-site sampling and testing in preparation for the design and construction of specific engineering works and uses. It should be used only in planning more detailed field surveys to determine the condition of the soil, in place, at the site of the proposed engineering construction.

Information in this report can be used to:

1. Make studies that will aid in selecting and developing industrial, business, residential, and recreational sites.
2. Make preliminary estimates of the engineering properties of soils in the planning of agricultural drainage systems, farm ponds, irrigation systems, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting locations for highways, airports, pipelines, and cables and in planning detailed investigations at the locations.
4. Locate sources of gravel and other construction materials.
5. Correlate performance of engineering structures with soil mapping units to develop information that will be useful in planning the design and maintainence of engineering structures.
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 aerial photographs in preparing maps and reports that can be used readily by engineers.
8. Develop preliminary estimates for construction in a specific area.

In this survey, engineering data are given in tables 4, 5, and 6. Table 4 contains test data on selected soil profiles. Table 5 is a summary of the estimated physical properties of the soils. Table 6 rates the suitability of the soils for engineering uses.

Additional information about the soils can be obtained from other parts of the survey, especially the sections "General Soil Map," "Descriptions of the Soils," "Relief and Drainage," and "Genesis, Classification, and Morphology of Soils."

Some of the terms used in agricultural soil science differ from those used in engineering, and some words—for

[2] This section was prepared in cooperation with the Iowa State Highway Commission and the Division of Physical Research, Bureau of Public Roads.

example, *clay*, *silt*, *sand*, and *granular*—have special meanings in soil science. Such terms are defined in the Glossary at the back of this survey.

Engineering Classification Systems

Most highway engineers classify soil materials in accordance with the system approved by the American Association of State Highway Officials (AASHO) (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils of high bearing capacity, to A–7, which is made up of clay soils having low strength when wet.

Some engineers prefer the Unified system, which was developed by the Corps of Engineers (*20*). In this system soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. In table 5, the soils of Bremer County have been classified according to the AASHO and Unified systems. Basic information about the classification of soils for engineering purposes can be obtained from the PCA Soil Primer (*12*).

Test Data

Engineering test data for 8 soil profiles are given in table 4. The tests were performed by the Iowa State Highway Commission in accordance with standard procedures of the American Association of State Highway Officials. Tests were made for moisture-density, liquid limit, and plastic limit. Mechanical analyses were also made to determine the texture of the soils and the AASHO and Unified classifications.

The moisture-density test is made to determine the compaction qualities of a soil. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains the same, the density of the compacted material will increase until the optimum moisture content is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed maximum dry density. Moisture-density data are important in earthwork, for, as a rule, optimum stability is obtained if the soil is compacted to the maximum dry density when it is at the optimum moisture content.

The liquid limit and plastic limit indicate the effect of water on the consistence of soil material. As the moisture content of a fine-grained soil is increased from the dry state, the material changes from a solid to a semisolid, or plastic, state. As the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a solid to a plastic state. The liquid limit is the moisture content at which the material passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Mechanical analyses were made by a combination of the sieve and hydrometer methods. The percentages of clay obtained by the hydrometer method alone should not be used as a basis for naming soil textural classes.

Estimated Physical Properties of the Soils

The estimates in table 5 are based on the test data in table 4, on information given in other sections of the survey, and on experience with the same kinds of soils in other counties.

Although the detailed soil map, the soil descriptions, and the estimates in table 5 serve as a guide for evaluating most of the soils in the county, a detailed investigation at the site of the proposed construction is needed because as much as 15 percent of an area designated as a specific soil on the map may consist of areas of other soils too small to be shown on the published map. By comparing the soil description with the result of investigations at the site, the presence of an included soil can usually be determined.

The rates of permeability given in table 5 are based on the movement of water through the soil in its undisturbed state. The rates depend largely on the texture and structure of the soil.

Available water capacity refers to the approximate amount of capillary water in the soil at field capacity. When the soil is air dry, this amount of water will wet the soil material to a depth of 1 inch without deeper percolation.

The shrink-swell potential is an indication of the volume change that can be expected with a change in moisture content. In general, soils classified as CH and A–7 have a high shrink-swell potential. Clean sand and gravel (single-grain material) and most other nonplastic or slightly plastic soils have a low shrink-swell potential.

Soil Properties Affecting Road Construction [3]

Many of the soils of Bremer County formed in 2 to 4 feet of loess over glacial till on nearly level to gently sloping uplands. On gently to moderately sloping hillsides, the loess thins out and disappears and the soils are underlain by glacial till.

The Klinger, Sable, and other soils derived from loess on nearly level uplands are fine-textured soils that have an A–7 (MH, ML-CL) classification and a moderately high index number. The material in the surface layer is organic and is difficult to compact, and the subsoil is slightly plastic. The Dinsdale soils and others that formed on stronger slopes in loess over till have a less well developed surface layer and a less plastic A–7 (CL) subsoil, but still have a rather high group index number. Loess soils erode readily. Sod, pavement, or check dams may be needed in gutters and ditches to control erosion.

In the soils derived from thin loess over till, the seasonal high water table is usually perched above the glacial till. In the more nearly level soils and in the depressional soils, a shallow perched water table occurs locally above the somewhat plastic B horizon. In these areas the in-place density of the loess is relatively low, and the soil has a high moisture content. This high moisture content may cause instability in embankments unless it is controlled so as to permit compaction to high density.

[3] This subsection was prepared by ROBERT E. BLATTERT, soils geologist, Iowa State Highway Commission.

TABLE 4.—*Engineering*

[Tests performed by the Iowa State Highway Commission in accordance with standard

Soil name and location	Parent material	Iowa report No. AAD1–	Depth	Horizon	Moisture-density data[1]	
					Maximum dry density	Optimum moisture
			In.		*Lb. per cu. ft.*	*Pct.*
Clyde clay loam: 322 feet N. and 371 feet W. of SE. cor., NE¼ sec. 10, T. 92 N., R. 14 W.	Local alluvium over Iowan till.	7005	5 to 16	A12	95	24
		7006	23 to 28	B2g	122	10
		7007	33 to 45	C1	118	11
		7008	45 to 72	C2	120	11
Colo silty clay loam: 625 feet N. and 160 feet W. of SE. cor., SW¼ sec. 4, T. 91 N., R. 12 W.	Alluvium.	6999	6 to 12	A12	96	18
		7000	24 to 35	A14	101	18
		7001	56 to 62	C3	116	12
Kenyon loam: 553 feet N. and 310 feet E. of SW. cor., sec. 31 T. 93 N., R. 13 W.	Iowan till.	1108	0 to 5	Ap	109	15
		1109	25 to 33	B22	114	14
		1110	54 to 62	C1	118	12
Klinger silty clay loam: 284 feet N. and 387 feet E. of SW. cor., NE¼ SE¼ sec. 26, T. 91 N., R. 12 W.	Wisconsin loess over Iowan till.	1120	0 to 9	A1	93	22
		1121	19 to 26	B21	103	19
		1122	31 to 40	B31 and B32	118	12
Readlyn loam: 878 feet N. and 605 feet W. of SE. cor., sec. 34, T. 93 N., R 11 W.	Iowan till.	1111	0 to 8	Ap	98	20
		1112	30 to 37	B23	118	13
		1113	44 to 50	C1	122	11
Spillville loam: 250 feet N. and 185 feet W. of SE. cor., SW¼ sec. 4, T. 91 N., R. 12 W.	Alluvium.	6997	0 to 12	A11 and A12	87	27
		6998	36 to 47	A15	96	18
Tripoli clay loam: 1,355 feet E. of SW. cor., sec. 35, T. 93 N., R. 13 W.	Iowan till.	6994	0 to 9	Ap	98	20
		6995	29 to 38	B22	117	12
		6996	38 to 66	C	118	12
Waukegan loam, moderately deep: NE. cor., SE¼NW¼ sec. 7, T. 93 N., R. 14 W.	Alluvium.	7002	0 to 9	A1	102	17
		7003	13 to 24	B2	103	17
		7004	28 to 44	IIC2	124	9

[1] Based on AASHO Designation T 99–57, Method A (*1*).

[2] Mechanical analyses according to AASHO Designation T 88 (*1*). Results obtained by this procedure 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 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in

test data

procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [2]										Liquid limit	Plasticity index	Classification	
Percentage passing sieve—						Percentage smaller than—						AASHO	Unified [3]
2 in.	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	84	58	54	29	22	18	50	23	A-7-6 (11)	ML-CL.
------	100	99	99	75	51	38	20	17	15	32	19	A-6(6)	CL.
------	------	------	100	60	10	7	4	4	4	[4] NP	NP	A-3(0)	SP-SM.
100	99	98	97	88	49	38	22	18	15	24	12	A-6(4)	SC.
------	------	------	100	99	85	76	38	31	27	47	24	A-7-6(15)	CL.
------	------	100	99	98	82	75	39	32	27	43	24	A-7-6(14)	CL.
------	------	------	100	99	60	49	21	18	17	26	12	A-6(6)	CL.
------	------	------	100	87	52	45	23	17	12	31	12	A-6(4)	CL.
------	------	[5] 100	99	89	61	54	32	27	23	33	16	A-6(8)	CL.
------	------	[5] 100	98	91	67	58	29	24	19	31	17	A-6(9)	CL.
------	------	------	100	99	93	86	35	27	20	44	17	A-7-6(12)	ML-CL.
------	------	------	100	99	95	85	37	32	30	43	23	A-7-6(14)	CL.
------	[6] 100	99	98	87	56	51	31	27	24	32	17	A-6(7)	CL.
------	------	------	100	92	65	57	27	21	15	39	15	A-6(8)	ML-CL.
------	100	99	98	85	57	52	32	28	24	35	20	A-6(8)	CL.
100	99	99	97	87	58	55	28	24	22	29	15	A-6(7)	CL.
------	------	------	100	95	72	63	24	16	11	54	20	A-7-5(14)	MH.
------	------	100	99	94	68	57	28	23	20	38	18	A-6(10)	CL.
------	------	------	100	91	64	56	29	28	17	39	18	A-6(9)	CL.
------	------	100	99	89	61	56	34	28	25	35	20	A-6(9)	CL.
100	99	96	94	86	62	54	31	25	18	32	17	A-6(8)	CL.
------	------	100	98	85	66	60	26	18	12	40	17	A-6(9)	CL.
------	100	98	94	83	65	61	29	22	17	37	15	A-6(8)	CL.
100	98	84	72	23	4	3	2	2	2	NP	NP	A-1-b(0)	SW.

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 of soil.

[3] 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, such as ML-CL.

[4] Nonplastic.

[5] Profile description states that 3 to 7 percent of the glacial till below the B1 horizon contains stones ¾ inch to 4 inches in diameter.

[6] Profile description states that numerous rounded stones, ½ inch to 2½ inches in diameter, are concentrated in the upper 3 inches.

TABLE 5.—*Estimated physical*

Soil name	Water table	Depth from surface	Classification: USDA texture
		Inches	
Alluvial land (Ab) All properties variable; no classification possible.	Variable, but generally high.		
Aredale (ArB, ArC)	Below 5 feet.	0 to 14	Loam
		14 to 50	Loam
		50 to 80	Loam
Atkinson (AtA, AtB, AtC)	Below 5 feet.	0 to 20	Loam
		20 to 35	Clay loam
		35 to 40	Clay
Backbone (BaB, BaC, BaD)	Below 5 feet.	0 to 20	Loamy sand
		20 to 28	Sandy loam to sandy clay loam
Bassett (BeB, BeC, BeC2)	Perched at 24 inches during extended wet periods.	0 to 17	Loam
		17 to 55	Heavy loam
		55 to 80	Heavy loam
Blockton (Bk)	Perched at 24 inches during extended wet periods.	0 to 15	Light silty clay loam
		15 to 45	Silty clay
		45 to 80	Sandy loam to gravelly sand
Burkhardt (BuA, BuC)	Below 5 feet.	0 to 13	Sandy loam to loam
		13 to 80	Gravelly sand
Chelsea (ChB, ChC, ChE)	Below 5 feet.	0 to 80	Fine and medium sand
Clyde (Ck)	Seasonally high at 12 inches.	0 to 20	Clay loam to loam
		20 to 50	Loam to loamy sand
		50 to 80	Heavy loam
Coggon (CmB, CmC)	Perched at 24 inches during extended wet periods.	0 to 17	Loam
		17 to 55	Heavy loam
		55 to 80	Heavy loam
Colo (Cn)	Seasonally high at 24 inches.	0 to 40	Silty clay loam
		40 to 60	Silty clay loam to loam
Colo-Terril complex (CoB). See individual soils.			
Cresco (CrB, CrC)	Perched at 24 inches during extended wet periods.	0 to 17	Loam
		17 to 50	Heavy loam
		50 to 80	Heavy loam
Dickinson (DcB, DcC)	Below 5 feet.	0 to 27	Sandy loam
		27 to 80	Sand
Dickinson, benches (DdA, DdB)	Below 5 feet.	0 to 27	Sandy loam
		27 to 40	Sand
		40 to 80	Sand or gravelly sand
Dickinson, gravelly substratum (DgA, DgB)	Below 5 feet.	0 to 30	Sandy loam
		30 to 80	Gravelly sand
Dickinson-Ostrander complex (DoA, DoB, DoC). See individual soils.			
Dinsdale (DsB, DsC)	Below 5 feet.	0 to 12	Silty clay loam
		12 to 30	Silty clay loam
		30 to 80	Heavy loam
Fayette (FaB, FaC2)	Below 5 feet.	0 to 13	Silt loam
		13 to 35	Silty clay loam
		35 to 80	Silt loam

See footnote at end of table.

and chemical properties of the soils

Classification—Continued		Percentage passing sieve [1]			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
CL	A-6	100	100	65 to 80	0.8 to 2.5	0.15 to 0.19	5.6 to 6.5	Moderate.
CL	A-6	100	100	65 to 80	0.8 to 2.5	.14 to .18	5.6 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 2.5	.14 to .18	6.6 to 7.8	Moderate.
CL	A-6	100	100	60 to 75	0.8 to 2.5	.15 to .19	6.1 to 7.3	Moderate.
CL	A-6	99	96 to 99	60 to 70	0.2 to 2.5	.16 to .18	6.1 to 6.5	Moderate.
CH	A-7-6	95 to 100	90 to 100	65 to 95	.05 to 0.2	.14 to .18	6.4 to 7.0	High.
SM	A-2-4	100	100	15 to 30	2.5 to 5.0	.04 to .06	6.1 to 6.5	Low.
SC or CL	A-4 to A-6	100	100	36 to 55	0.8 to 2.5	.10 to .18	5.1 to 6.0	Low to moderate.
CL	A-6	100	100	55 to 75	0.8 to 2.5	.15 to .19	5.1 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	4.8 to 5.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.0 to 7.5	Moderate.
ML-CL or CL	A-7-6	100	100	94 to 98	0.8 to 2.5	.20 to .22	5.1 to 6.5	Moderate to high.
CH	A-7-5	100	100	99	>0.05	.15 to .18	5.1 to 6.5	Very high.
SC or SW	A-4 to A-1-b	84 to 100	72 to 100	3 to 50	2.5 to 10+	.02 to .14	6.1 to 7.3	Low to none.
SM or CL	A-4	98	94	36 to 65	2.5 to 5.0	.11 to .16	5.6 to 6.5	Low.
SW	A-1-b	84	72	3 to 6	10+	.02	5.6 to 6.5	None.
SP-SM	A-3	100	100	4 to 15	5.0 to 10	.02 to .04	5.1 to 7.0	None.
CL, MH, or OH	A-7-6	100	100	55 to 75	0.8 to 2.5	.16 to .20	6.1 to 7.3	High.
CL or SP	A-6, A-3	99	99	10 to 65	0.8 to 2.5	.06 to .18	6.6 to 7.3	Moderately low.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.6 to 7.3	Moderate.
CL	A-6	100	100	55 to 75	0.8 to 2.5	.14 to .18	5.1 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	4.5 to 5.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.1 to 7.8	Moderate.
CL, ML, or OH	A-7-6	100	100	80 to 90	0.2 to 0.8	.20 to .22	6.1 to 7.3	High.
CL	A-6	100	100	60 to 85	0.2 to 0.8	.14 to .21	6.1 to 7.3	Moderate.
CL	A-6	100	100	55 to 75	0.8 to 2.5	.16 to .20	5.1 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	5.1 to 6.0	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.1 to 7.8	Moderate.
SM or SC	A-4	100	100	36 to 50	2.5 to 5.0	.11 to .15	5.1 to 7.3	Low.
SM or SP	A-3	100	100	4 to 15	5.0 to 10	.02 to .04	5.1 to 6.5	None.
SM or SC	A-4	100	100	36 to 50	2.5 to 5.0	.11 to .15	5.1 to 7.3	Low.
SM or SP	A-3	100	100	4 to 15	5.0 to 10	.02 to .04	5.1 to 6.5	None.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .04	5.1 to 6.5	None.
SM or SC	A-4	99	97	36 to 50	2.5 to 5.0	.10 to .14	5.1 to 7.3	Low.
SW	A-1-b	84	72	3 to 6	10+	.02	5.1 to 6.5	None.
CL or ML-CL	A-6	100	100	90 to 95	0.8 to 2.5	.20 to .22	5.6 to 6.5	Moderate to high.
CL	A-7-6	100	100	90 to 95	0.8 to 2.5	.19 to .21	5.6 to 6.5	Moderate to high.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.0 to 7.8	Moderate.
ML or CL	A-4 to A-6	100	100	94 to 98	0.8 to 2.5	.18 to .20	5.6 to 6.5	Moderate.
CL	A-7-6	100	100	94 to 98	0.8 to 2.5	.19 to .20	4.7 to 5.5	Moderate to high.
CL	A-6	100	100	90 to 96	0.8 to 2.5	.17 to .19	5.6 to 7.8	Moderate.

TABLE 5.—*Estimated physical*

Soil name	Water table	Depth from surface	Classification: USDA texture
		Inches	
Floyd (FoB)	Seasonally high at 24 inches.	0 to 20	Loam
		20 to 50	Loam to loamy sand
		50 to 80	Heavy loam
Franklin (Fr)	Seasonally high at 36 inches.	0 to 12	Silt loam
		12 to 30	Silty clay loam
		30 to 80	Heavy loam
Hagener (HaB, HaC, HaD)	Below 5 feet.	0 to 15	Loamy sand
		15 to 80	Sand
Hagener, benches (HbA, HbB)	Below 5 feet.	0 to 15	Loamy sand
		15 to 30	Sand
		30 to 80	Sand to gravelly sand
Harpster (Hc)	Seasonally high at 18 inches.	0 to 20	Silt loam to silty clay loam
		20 to 35	Silt loam to silty clay loam
		35 to 80	Silt loam
Hayfield, deep (Hd)	Seasonally high at 36 inches.	0 to 42	Loam
		42 to 80	Loamy sand to gravelly sand
Hayfield, moderately deep (Hm)	Seasonally high at 36 inches.	0 to 30	Loam
		30 to 80	Loamy sand to gravelly sand
Hayfield, dark brown variant (Hv)	Seasonally high at 36 inches.	0 to 38	Loam
		38 to 80	Loamy sand to gravelly sand
Kenyon (KeB, KeC, KeC2)	Perched at 24 inches during extended wet periods.	0 to 17	Loam
		17 to 50	Heavy loam
		50 to 80	Heavy loam
Klinger (Kg)	Seasonally high at 36 inches.	0 to 15	Silty clay loam
		15 to 30	Silty clay loam
		30 to 80	Heavy loam
Lamont (LaB, LaC, LaD)	Below 5 feet.	0 to 16	Sandy loam
		16 to 30	Sandy loam to light sandy clay loam.
		30 to 80	Sand
Lamont, benches (LbA)	Below 5 feet.	0 to 16	Sandy loam
		16 to 30	Sandy loam to light sandy clay loam.
		30 to 40	Sand
		40 to 80	Sand or gravelly sand
Lawler, deep (Ld)	Seasonally high at 36 inches.	0 to 18	Loam
		18 to 42	Loam
		42 to 80	Loamy sand to gravelly sand
Lawler, moderately deep (Lm)	Seasonally high at 36 inches.	0 to 18	Loam
		18 to 30	Loam
		30 to 80	Loamy sand to gravelly sand
Marsh (Ma) All properties variable; no classification possible.	At surface.		
Marshan (Mr, Ms)	Seasonally high at 18 inches; at 0 to 10 inches in depressions.	0 to 18	Clay loam
		18 to 42	Clay loam
		42 to 80	Loamy sand to gravelly sand
Marshan, moderately deep (Mt)	Seasonally high at 18 inches.	0 to 18	Clay loam
		18 to 30	Clay loam
		30 to 80	Loamy sand to gravelly sand

See footnote at end of table.

and chemical properties of the soils—Continued

Classification—Continued		Percentage passing sieve [1]			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
CL or ML	A-6	100	100	55 to 75	0. 8 to 2. 5	0. 18 to 0. 22	6. 1 to 7. 3	Moderate.
CL or SM	A-6, A-3	99	99	10 to 65	0. 8 to 2. 5	. 06 to . 18	6. 1 to 7. 3	Moderate to low.
CL	A-6	99	96 to 99	55 to 65	0. 2 to 0. 8	. 14 to . 18	7. 0 to 7. 8	Moderate.
ML or CL	A-6	100	100	90 to 95	0. 8 to 2. 5	. 18 to . 20	5. 6 to 6. 5	Moderate.
CL	A-7-6	100	100	90 to 95	0. 8 to 2. 5	. 18 to . 21	5. 1 to 6. 0	Moderate to high.
CL	A-6	99	96 to 99	55 to 65	0. 2 to 0. 8	. 14 to . 18	6. 1 to 7. 8	Moderate.
SM	A-2-4	100	100	15 to 25	5. 0 to 10	. 04 to . 06	5. 1 to 7. 3	Low.
SM or SP	A-3	100	100	4 to 15	5. 0 to 10	. 02 to . 04	5. 1 to 7. 3	None.
SM	A-2-4	100	100	15 to 25	5. 0 to 10	. 04 to . 06	5. 1 to 7. 3	Low.
SM	A-3	100	100	5 to 15	5. 0 to 10	. 02 to . 04	5. 1 to 7. 3	None.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5. 0 to 10+	. 02 to . 04	5. 1 to 7. 3	None.
ML or OH or CL	A-7-6	100	100	92 to 97	0. 8 to 2. 5	. 20 to . 22	7. 6 to 8. 4	Moderate to high.
CL	A-7-6	100	100	92 to 97	0. 2 to 0. 8	. 18 to . 20	7. 6 to 8. 4	Moderate to high.
CL	A-6	100	100	92 to 97	0. 8 to 2. 5	. 17 to . 19	7. 6 to 8. 4	Moderate.
CL	A-6	100	96 to 99	55 to 80	0. 8 to 2. 5	. 14 to . 19	4. 5 to 6. 5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5. 0 to 10+	. 02 to . 04	4. 5 to 6. 0	None.
CL	A-6	99	94 to 98	55 to 75	0. 8 to 2. 5	. 14 to . 19	4. 5 to 6. 5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5. 0 to 10+	. 02 to . 04	4. 5 to 6. 0	None.
CL	A-6	100	94 to 99	55 to 75	0. 8 to 2. 5	. 14 to . 19	4. 5 to 6. 5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5. 0 to 10+	. 02 to . 04	4. 5 to 6. 0	None.
Cl	A-6	100	100	55 to 75	0.8 to 2.5	.16 to .20	5.1 to 6.5	Moderate.
Cl	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	5.1 to 6.0	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.1 to 7.8	Moderate.
ML-CL	A-7-6	100	100	90 to 95	.08 to 2.5	.20 to .22	5.6 to 6.5	Moderate to high.
CL	A-7-6	100	100	90 to 95	.08 to 2.5	.19 to .21	5.1 to 6.2	Moderate to high.
CL	A-6	99	96 to 99	55 to 65	.02 to .08	.14 to .18	6.1 to 7.8	Moderate.
SM or SC	A-4	100	100	36 to 50	2.5 to 5.0	.10 to .14	5.6 to 7.3	Low.
SC	A-4 to A-6	100	100	36 to 50	2.5 to 5.0	.12 to .16	5.1 to 6.5	Low to moderate.
SM or SP	A-3	100	100	4 to 15	5.0 to 10	.02 to .04	5.1 to 6.5	None.
SM or SC	A-4	100	100	36 to 50	2.5 to 5.0	.10 to .14	5.6 to 7.3	Low.
SC	A-4 to A-6	100	100	36 to 50	2.5 to 5.0	.12 to .16	5.1 to 6.5	Low to moderate.
SM or SP	A-3	100	100	4 to 15	5.0 to 10	.02 to .04	5.1 to 6.5	None.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .04	5.1 to 6.5	None.
ML or CL	A-6	100	99	55 to 75	0.8 to 2.5	.15 to .19	5.1 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 75	0.8 to 2.5	.14 to .18	5.1 to 6.5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .06	5.1 to 6.5	None.
ML or CL	A-6	100	98	55 to 75	0.8 to 2.5	.18 to .20	5.1 to 6.5	Moderate.
CL	A-6	99	94 to 98	55 to 75	0.8 to 2.5	.14 to .18	5.1 to 6.5	Moderate.
SM to SP or SW	A-3 to A-1	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .06	5.1 to 6.5	None.
CL or OH	A-7	100	99	55 to 80	0.2 to 0.8	.18 to .20	6.5 to 7.3	Moderate to high.
CL	A-6	99	96 to 99	55 to 80	0.2 to 0.8	.16 to .18	6.5 to 7.3	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .06	6.5 to 7.3	None.
CL or OH	A-7	100	99	55 to 75	0.2 to 0.8	.18 to .20	6.5 to 7.3	Moderate to high.
CL	A-6	99	94 to 98	55 to 75	0.2 to 0.8	.16 to .18	6.5 to 7.3	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .06	6.5 to 7.3	None.

TABLE 5.—*Estimated physical*

Soil name	Water table	Depth from surface	Classification: USDA texture
		Inches	
Maxfield (Mx)	Seasonally high at 18 inches.	0 to 18	Silty clay loam
		18 to 30	Silty clay loam
		30 to 80	Heavy loam
Muscatine (My)	Seasonally high at 36 inches.	0 to 15	Silty clay loam
		15 to 35	Silty clay loam
		35 to 80	Silt loam
Nodaway (No)	Below 5 feet.	0 to 40	Silt loam
		40 to 80	Silt loam to silty clay loam
Oran (OrA, OrB)	Seasonally high at 30 inches.	0 to 19	Loam
		19 to 50	Heavy loam
		50 to 80	Heavy loam
Ostrander (OsA, OsB, OsC)	Below 5 feet.	0 to 19	Loam
		19 to 45	Loam
		45 to 80	Loam
Peaty muck, deep (Pe)	Seasonally at surface.	0 to 50	Peaty muck
		50 to 80	Loam to loamy sand
Peaty muck, moderately deep (Pm)	Seasonally at surface.	0 to 30	Peaty muck
		30 to 80	Loam to loamy sand
Port Byron (PoB, PoC2, PoD2)	Below 5 feet.	0 to 80	Silt loam
Readlyn (ReA, ReB)	Seasonally high at 30 inches.	0 to 19	Loam
		19 to 47	Heavy loam
		47 to 80	Heavy loam
Riceville (RfB)	Seasonally high at 30 inches.	0 to 19	Loam
		19 to 50	Heavy loam to light clay loam
		50 to 80	Heavy loam to light clay loam
Rockton (RkB, RkC, RkD)	Below 5 feet.	0 to 20	Loam
		20 to 26	Clay loam
		26 to 28	Clay
Rolfe (Ro)	Normally below 48 inches; perched at 20 inches during wet periods.	0 to 18	Silt loam
		18 to 36	Silty clay loam to clay loam
		36 to 80	Loam to loamy sand
Sable (Sa)	Seasonally high at 18 inches.	0 to 18	Silty clay loam
		18 to 35	Silty clay loam
		35 to 80	Silt loam
Sattre, deep (SbA, SbB)	Below 5 feet.	0 to 42	Loam
		42 to 80	Loamy sand to gravelly sand
Sattre, moderately deep (SdA)	Below 5 feet.	0 to 30	Loam
		30 to 80	Loamy sand to gravelly sand
Seaton (SeB, SeC2, SeD2, SeD3, SeE2, SeF2)	Below 5 feet.	0 to 80	Silt loam
Sogn (SoD, SoF)	Below 5 feet.	0 to 11	Loam
Spillville (Sp)	Below 5 feet.	0 to 40	Loam
		40 to 60	Loam
Spillville-Colo complex (Sv). See individual soils.			
Terril (TxA, TxB)	Below 5 feet.	0 to 30	Loam
		30 to 50	Loam
		50 to 80	Loam to gravelly sand

See footnote at end of table.

and chemical properties of the soils—Continued

Classification—Continued		Percentage passing sieve [1]			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
MH, CL, or OH	A-7-6	100	100	92 to 97	0.2 to 0.8	0.20 to 0.22	6.6 to 7.3	High.
CL	A-7-6	100	100	90 to 95	0.2 to 0.8	.19 to .21	6.6 to 7.3	Moderate to high.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.15 to .18	6.6 to 7.3	Moderate.
ML or CL	A-7-6	100	100	92 to 97	0.8 to 2.5	.20 to .22	5.6 to 6.5	Moderate to high.
CL	A-7-6	100	100	92 to 97	0.8 to 2.5	.19 to .21	6.1 to 6.5	Moderate to high.
CL	A-6	100	100	92 to 97	0.8 to 2.5	.18 to .23	6.6 to 7.8	Moderate.
CL	A-6	100	100	90 to 97	0.8 to 2.5	.18 to .20	6.6 to 7.3	Moderate.
CL	A-6 or A-7-6	100	100	90 to 97	0.8 to 2.5	.18 to .21	6.6 to 7.3	Moderate to high.
CL	A-6	100	100	55 to 75	0.8 to 2.5	.15 to .19	5.6 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	4.5 to 5.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.1 to 7.8	Moderate.
CL	A-6	100	100	55 to 75	0.8 to 2.5	.16 to .20	5.1 to 6.5	Moderate.
CL	A-4 to A-6	98	94 to 98	50 to 65	0.8 to 2.5	.14 to .18	5.1 to 6.0	Moderate.
CL	A-4 to A-6	98	94 to 98	50 to 65	0.8 to 2.5	.14 to .18	6.1 to 7.8	Moderate.
Pt	A-8				2.5 to 5.0	.25	6.1 to 7.3	Moderate.
CL, SC, or SP	A-6 to A-3	99	98	10 to 65	0.8 to 5.0	.06 to .18	6.6 to 7.8	Low to moderate.
Pt	A-8				2.5 to 5.0	.25	6.1 to 7.3	Moderate.
CL, SC, or SP	A-6 to A-3	99	98	10 to 65	0.8 to 5.0	.06 to .18	6.6 to 7.8	Low to moderate.
CL-ML	A-6	100	100	90 to 95	0.8 to 2.5	.18 to .20	5.6 to 7.8	Moderate.
CL	A-6	100	100	55 to 75	0.8 to 2.5	.16 to .20	5.6 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	9.2 to 0.8	.14 to .18	5.1 to 6.0	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.2 to 0.8	.14 to .18	6.1 to 7.8	Moderate.
CL	A-6	100	100	55 to 75	0.8 to 2.5	.15 to .19	5.6 to 6.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.1 to 0.2	.14 to .18	4.5 to 5.5	Moderate.
CL	A-6	99	96 to 99	55 to 65	0.1 to 0.2	.14 to .18	6.1 to 7.8	Moderate.
CL	A-6	100	100	60 to 75	0.8 to 2.5	.15 to .19	6.1 to 7.3	Moderate.
CL	A-6	99	96 to 99	60 to 70	0.8 to 2.5	.16 to .18	6.1 to 6.5	Moderate.
CH	A-7-6	95 to 100	90 to 100	65 to 95	0.5 to 0.2	.14 to .18	6.1 to 7.3	High.
ML-CL	A-7-6	100	100	55 to 75	0.8 to 2.5	.18 to .22	5.6 to 6.5	Moderate to high.
CL or CH	A-7-6	100	100	65 to 95	.05 to .02	.17 to .21	5.1 to 6.5	High.
CL or SP	A-6 to A-3	99	98	10 to 65	0.8 to 5.0	.04 to .18	6.6 to 7.3	Moderate to low.
MH, CH, or OH	A-7-6	100	100	92 to 97	0.2 to 0.8	.20 to .22	6.6 to 7.3	High.
CL	A-7-6	100	100	92 to 97	0.2 to 0.8	.19 to .21	6.6 to 7.3	Moderate to high.
CL	A-6	100	100	92 to 97	0.8 to 2.5	.17 to .19	6.6 to 7.8	Moderate.
CL	A-6	100	96 to 99	55 to 80	0.8 to 2.5	.14 to .19	5.1 to 6.5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .04	5.1 to 6.0	None.
CL	A-6	99	94 to 98	55 to 75	0.8 to 2.5	.14 to .19	5.1 to 6.5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5.0 to 10+	.02 to .04	5.1 to 6.0	None.
CL-ML	A-6	100	100	90 to 95	0.8 to 2.5	.18 to .23	4.5 to 7.8	Moderate.
CL	A-6	100	96 to 99	60 to 75	0.8 to 2.5	.14 to .18	6.6 to 7.8	Moderate.
MH, ML, or CL	A-6 to A-7-5	100	100	65 to 80	0.8 to 2.5	.15 to .20	6.6 to 7.3	Moderate to high.
CL	A-6	100	99	60 to 75	0.8 to 2.5	.14 to .18	6.6 to 7.3	Moderate.
CL	A-6	100	100	65 to 80	0.8 to 2.5	.15 to .19	5.6 to 6.5	Moderate.
CL	A-6	100	100	65 to 80	0.8 to 2.5	.14 to .18	5.6 to 6.5	Moderate.
CL or SW	A-6 to A-1-b	84 to 100	72 to 100	3 to 70	0.8 to 10+	.02 to .18	6.1 to 7.3	Moderate to none.

TABLE 5.—*Estimated physical*

Soil name	Water table	Depth from surface	Classification: USDA texture
		Inches	
Tripoli (Tr)	Seasonally high at 18 inches.	0 to 16	Clay loam
		16 to 24	Clay loam
		24 to 80	Heavy clay loam
Waukegan, deep (WaA, WaB)	Below 5 feet.	0 to 42	Loam
		42 to 80	Loamy sand to gravelly sand
Waukegan, moderately deep (WgA, WgB, WgC)	Below 5 feet.	0 to 30	Loam
		30 to 80	Loamy sand to gravelly sand
Waukegan, deep (WkA)	Below 5 feet.	0 to 42	Silt loam
		42 to 80	Loamy sand to gravelly sand
Winneshiek (WnB, WnC)	Below 5 feet.	0 to 20	Loam
		20 to 26	Clay loam
		26 to 29	Clay

[1] Exclusive of the pebble band that normally is between the solum and the glacial till.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Alluvial land (Ab)	Variable	Variable	Unsuitable	Good to very poor; high water table.	Variable	High water table; frequent flooding.
Aredale (ArB, ArC)	Good to a depth of 14 inches.	Unsuitable	Unsuitable	Good or fair; easily compacted; fair or good bearing capacity.	Good	Seepage in some cuts.
Atkinson (AtA, AtB, AtC).	Good to a depth of about 12 inches.	Unsuitable	Suitable; generally at a depth of 36 to 50 inches, but less than 36 inches in a few places.	Fair or good in upper part; poor in clayey material above limestone.	Good	Limestone generally at a depth of 36 to 50 inches, but at less than 36 inches in a few places.
Backbone (BaB, BaC, BaD).	Very poor	Good; poorly sorted sandy material to a depth of about 20 inches.	Suitable; at a depth of 20 to 40 inches.	Fair or good; limestone at a depth of 20 to 40 inches; low shrink-swell potential.	Unsuitable	Highly erodible; limestone at a depth of 20 to 40 inches.

See footnotes at end of table.

and chemical properties of the soils—Continued

Classification—Continued		Percentage passing sieve [1]			Permeability	Available water capacity	Reaction	Shrink-swell potential
Unified	AASHO	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
					Inches per hour	*Inches per inch of soil*	*pH*	
CL or MH	A-7-6	100	100	60 to 75	0. 2 to 2. 5	0. 18 to 0. 21	6. 6 to 7. 8	Moderate to high.
CL	A-6	100	99	55 to 70	0. 2 to 2. 5	. 16 to . 19	6. 6 to 7. 8	Moderate.
CL	A-6	99	96 to 99	55 to 65	0. 2 to 2. 5	. 14 to . 18	6. 6 to 7. 8	Moderate.
CL	A-6	99	94 to 98	55 to 75	0. 8 to 2. 5	. 14 to . 19	5. 1 to 6. 5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5. 0 to 10+	. 02 to . 04	5. 6 to 6. 5	None.
CL	A-6	99	94 to 98	55 to 75	0. 8 to 2. 5	. 14 to . 19	5. 1 to 6. 5	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5. 0 to 10+	. 02 to . 04	5. 6 to 6. 5	None.
CL-ML	A-6	100	100	70 to 90	0. 8 to 2. 5	. 18 to . 20	5. 6 to 7. 3	Moderate.
SM to SP or SW	A-3 to A-1-b	84 to 100	72 to 100	3 to 15	5. 0 to 10+	. 02 to . 04	5. 6 to 6. 5	None.
CL	A-6	100	100	60 to 75	0. 8 to 2. 5	. 15 to . 19	5. 6 to 6. 5	Moderate.
CL	A-6	99	96 to 99	60 to 70	0. 8 to 2. 5	. 16 to . 18	5. 6 to 6. 5	Moderate.
CH	A-7-6	95 to 100	90 to 100	65 to 95	0. 5 to 0. 2	. 14 to . 18	6. 1 to 7. 3	High.

interpretations

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Frequent flooding; too porous in many areas to hold water; high water table.	Variable; fair stability; piping.	Low agricultural potential.	Not needed	Not needed	Severe: frequent flooding; high water table.	Severe: frequent flooding; high water table.
Moderate permeability; excessive seepage where sand lenses occur.	Adequate strength and stability; fair or good compaction; slow permeability when compacted.	Not needed	May have a sandy lens in the subsoil; no severe limitations.	No limitations	Moderate: fair or good bearing capacity; low compressibility.	Slight or moderate: moderate permeability.
Limestone generally at a depth of 36 to 50 inches, but at less than 36 inches in a few places; excessive seepage.	Adequate strength and stability above limestone; slow permeability above rock when compacted.	Not needed	Limestone generally at a depth of 36 to 50 inches, but at less than 36 inches in a few places.	Limestone generally at a depth of 36 to 50 inches, but at less than 36 inches in a few places.	Moderate: fair or good bearing capacity; limestone generally at a depth of 36 to 50 inches, but at less than 36 inches in places.	Severe: limestone generally at a depth of 36 to 50 inches, but at less than 36 inches in a few places.
Too porous; sandy soil 20 to 40 inches thick over limestone.	Fair stability; fairly rapid seepage; difficult to vegetate.	Not needed	Limestone at a depth of 20 to 40 inches; difficult to vegetate; severe limitations.	Highly erodible; very low fertility; difficult to vegetate.	Slight: limestone at a depth of 20 to 40 inches.	Severe: limestone at a depth of 20 to 40 inches.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Bassett (BeB, BeC, BeC2).	Good to a depth of about 7 inches.	Unsuitable	Unsuitable	Good; low compressibility; fair or good bearing capacity; easily compacted.	Good	Seepage in some cuts; susceptibility to frost heave where sand pockets occur.
Blockton (Bk)	Fair to a depth of about 10 inches.	Unsuitable	Unsuitable	Unsuitable; high shrink-swell potential; poor bearing capacity.	Good, but workability very poor on account of high clay content.	Very poor workability; high shrink-swell potential; difficult to compact.
Burkhardt (BuA, BuC)	Fair to a depth of about 7 inches.	Good; generally well-graded gravelly sand; a few poorly graded lenses.[3]	Unsuitable	Good or excellent; good bearing capacity; very low shrink-swell potential.	Unsuitable	Good stability; highly erodible on steep slopes.
Chelsea (ChB, ChC, ChE).	Very poor	Good; poorly graded, fine and medium sand.	Unsuitable	Good; slight compressibility; highly erodible.	Unsuitable	Reasonable stability; highly erodible on steep slopes; loose sand may hinder hauling.
Clyde (Ck)	Fair or good to a depth of about 20 inches; high water table.	Unsuitable	Unsuitable	Very poor; wetness; high water table; high content of organic mater.	Good, but difficult to obtain because of wetness, high water table, and some boulders.	Wetness; poor drainage; high water table; high content of organic matter; fair or poor bearing capacity; high susceptibility to frost action.
Coggon (CmB, CmC)	Fair to a depth of about 17 inches.	Unsuitable	Unsuitable	Good; low compressibility; fair or good bearing capacity; easily compacted.	Good	Seepage in some cuts; susceptibility to frost action in sand pockets.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Excessive seepage where sand pockets occur.	Adequate strength and stability; fair or good compaction; slow permeability when compacted.	Some hillside seepage; tile may be beneficial.	Some wetness may occur after terraces are constructed; cuts should be minimum; low subsoil fertility; slight limitations.	Low fertility in till; tile may be needed; few limitations.	Slight: good bearing capacity and shear strength; low compressibility.	Severe or moderate: moderately slow permeability.
Very slow permeability; very slow seepage; nearly level topography.	Very poor workability; high shrink-swell potential; difficult to compact.	Very slow permeability; surface drainage needed; subsurface drainage questionable.	Not needed; diversions above this soil may be beneficial.	May be difficult to vegetate.	Severe: poor bearing capacity and shear strength; uniform consolidation.	Severe: very slow permeability.
Too porous	Good stability; pervious; slope protection required; difficult to vegetate.	Not needed	Seldom needed; shallow to gravelly material; difficult to vegetate.	Not needed	No limitation: very low compressibility.	Slight: rapid permeability; unfiltered sewage may travel long distances.
Too porous	Reasonable stability; pervious; fair or poor resistance to piping; slope protection required; difficult to vegetate.	Not needed	Difficult to construct and maintain; sandy; very low fertility; difficult to vegetate; severe limitations.	Sandy; highly erodible; difficult to vegetate.	No limitations: fair or good shear strength; low compressibility.	Slight: rapid permeability; unfiltered sewage may travel long distances.
Nearly level topography; moderately slow permeability; high water table; some sand lenses require sealing.	Top 24 inches unsuitable; adequate strength and stability in material below; fair or good compaction; slow permeability when compacted; poor drainage.	Moderately slow permeability; subsurface drainage satisfactory where outlets are adequate; boulders may interfere with installation.	Generally not needed, but a diversion may protect it from overflow; poor drainage.	Tile needed; some boulders may interferee with installation; low fertility in subsoil.	Severe: fair or poor bearing capacity; high water table; uneven consolidation.	Severe: high water table.
Excessive seepage where sand pockets occur.	Adequate strength and stability; fair or good compaction; slow permeability when compacted.	Moderately slow permeability; some hillside seeps can be drained by tile.	Low subsoil fertility; some areas may be wet after terraces are constructed; cuts should be minimum; slight limitations.	Low fertility in subsoil; tile may be needed; few limitations.	Slight: good bearing capacity and shear strength; low compressibility.	Severe or moderate: moderately slow permeability.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Colo (Cn, CoB) (For Terril part of CoB, see Terril series.)	Fair or good to a depth of about 40 inches; high water table.	Unsuitable	Unsuitable	Very poor; wetness; high water table; high content of organic matter.	Fair or good; high content of organic matter in top 40 inches; high water table.	Wetness; poor drainage; occasional flooding; poor bearing capacity.
Cresco (CrB, CrC)	Good to a depth of about 11 inches.	Unsuitable	Unsuitable	Good; low compressibility; fair or good bearing capacity; easily compacted.	Good	Seepage in some cuts; frost heave where sand pockets occur.
Dickinson (DcB, DcC, DoA, DoB, DoC). (For Ostrander part of the DoA, DoB, and DoC units, see Ostrander series.)	Fair to a depth of about 10 inches.	Good; poorly graded fine and medium sand at a depth of 20 to 40 inches.[3]	Unsuitable	Good or excellent; good workability; very low shrink-swell potential; slopes erodible.	Unsuitable	Fair stability; seepage in some deep cuts; steep slopes highly erodible; sand may flow; loose sand may hinder hauling.
Dickinson (DdA, DdB)	Fair to a depth of about 10 inches.	Good; poorly graded fine and medium sand; may grade to sandy gravel.[3]	Unsuitable	Good or excellent; good workability; very low shrink-swell potential; slopes erodible.	Unsuitable	Fair stability; steep slopes highly erodible; loose sand may hinder hauling.
Dickinson (DgA, DgB)	Fair to a depth of about 10 inches.	Good; generally well-graded gravelly sand at a depth of 20 to 40 inches; a few poorly graded lenses.[3]	Unsuitable	Good or excellent; good bearing capacity; very low shrink-swell potential.	Unsuitable	Very good stability; steep slopes highly erodible.
Dinsdale (DsB, DsC)	Good to a depth of about 11 inches.	Unsuitable	Unsuitable	Fair in loess; good in till; fair or good bearing capacity; easily compacted in till.	Good	Seepage in some cuts; frost action where sand lenses occur.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Moderately slow permeability; occasional flooding; level topography.	Poor stability; high content of organic matter; high or moderate shrink-swell potential.	Moderately slow permeability; subsurface drainage satisfactory where outlets are available; protection from occasional overflow is beneficial.	Not needed	Not needed	Severe: poor bearing capacity; high water table; high compressibility.	Severe: occasional flooding; high water table.
Excessive seepage where sand pockets occur.	Adquate strength and stability; fair or good compaction; slow permeability when compacted.	A few hillside seeps; tile may be beneficial.	Low fertility in subsoil; some areas may be wet after construction of terraces; cuts should be minimum; slight limitations.	Low fertility in till; tile may be needed; few limitations.	Slight: good bearing capacity and shear strength; low compressibility.	Severe or moderate: moderately slow permeability.
Moderately rapid permeability; seepage rate may be high.	Reasonable stability; pervious; fair or poor resistance to piping; slope protection required; difficult to vegetate.	Not needed	Sandy subsoil has low fertility; difficult to vegetate; cuts should be minimum; some limitations.	Subsoil highly erodible; difficult to vegetate.	No limitations: very low compressibility.	Slight: rapid permeability.
Moderately rapid permeability; substratum too porous.	Reasonable stability; pervious; fair or poor resistance to piping; slope protection required; difficult to vegetate.	Not needed	Sandy subsoil has very low fertility; difficult to vegetate; generally short slopes; cuts should be minimum.	Not needed	No limitations: low compressibility; fair or good shear strength.	Slight: rapid permeability.
Too porous	Very good stability; pervious; slope protection required; difficult to vegetate.	Not needed	Seldom needed; subsoil sandy and gravelly below a depth of about 30 inches; very low fertility; difficult to vegetate; cuts should be minimum.	Not needed	No limitations: very low compressibility.	Slight: rapid permeability; unfiltered sewage may travel long distances; slight limitations.
Excessive seepage in some sand pockets.	Adequate strength and stability; fair or good compaction; slow permeability when compacted.	Not needed	Glacial till at depth of 20 to 40 inches; cuts should be kept above till.	Slight erodibility; tile may be needed; few limitations.	Moderate: fair or good bearing capacity; medium or high compressibility in loess; low compressibility in till.	Severe or moderate: moderate to slow permeability in till.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Fayette (FaB, FaC2)	Fair to a depth of about 9 inches.	Unsuitable	Unsuitable	Fair; fair bearing capacity; medium compressibility; fair workability.	Fair	Rolling topography; highly erodible; easy to vegetate.
Floyd (FoB)	Good to a depth of about 15 inches.	Unsuitable	Unsuitable	Poor; seasonal high water table; high content of organic matter to a depth of about 20 inches.	Good; seasonal high water table.	Seasonal high water table; frost action.
Franklin (Fr)	Good to a depth of about 7 inches.	Unsuitable	Unsuitable	Fair in loess; fair or good in till; fair or good bearing capacity; till easily compacted; seasonal high water table.	Good; seasonal high water table.	Seasonal high water table; susceptible to frost action in sand lenses.
Hagener (HaB, HaC, HaD).	Poor	Good; poorly graded fine and medium sand.	Unsuitable	Good; low compressibility; highly erodible.	Unsuitable	Reasonable stability; steep slopes highly erodible; loose sand may hinder hauling.
Hagener (HbA, HbB)	Poor	Good; poorly graded fine and medium sand; may grade to gravel below a depth of 30 inches.	Unsuitable	Good to a depth of 30 inches; good to excellent below this depth; low compressibility; highly erodible.	Unsuitable	Reasonable stability; seepage in some cuts; loose sand may hinder hauling; sand may flow; steep slopes highly erodible.
Harpster (Hc)	Good or fair to a depth of about 18 inches.	Unsuitable	Unsuitable	Very poor; wetness; high content of organic matter; high water table.	Fair or good; may be difficult to obtain because of wetness.	Poor drainage; high water table; poor bearing capacity.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Seepage rate may be excessive; reservoir should be scarified and compacted.	Fair stability; fair compaction; medium compressibility; moderate or high shrink-swell potential.	Not needed	Somewhat erodible.	Somewhat erodible.	Moderate: fair or poor bearing capacity; moderate or high compressibility; uniform consolidation.	Slight or moderate: moderate permeability.
Moderate permeability; excessive seepage where a few sand lenses occur.	Fair stability; fair compaction; medium compressibility; moderate shrink-swell potential; fair resistance to piping.	Moderate or moderately slow permeability; tile generally improves drainage.	Somewhat poor drainage; subsoil has low fertility; some limitations.	Subsoil has low fertility; tile needed; few limitations.	Moderate: fair or good bearing capacity; seasonal high water table; uneven consolidation.	Severe: moderate or moderately slow permeability; seasonal high water table.
Excessive seepage where sand pockets and lenses occur.	Adequate stability; fair or good compaction; slow permeability when compacted.	Moderate or moderately slow permeability; tile may improve drainage.	Somewhat poor drainage; glacial till at a depth of 20 to 40 inches; some limitations.	Nearly level topography; tile needed; few limitations.	Moderate: fair or good bearing capacity; compressibility medium to high in loess; low in till.	Severe: moderate or moderately slow permeability; seasonal high water table.
Too porous	Reasonable stability; pervious; fair or poor resistance to piping; slope protection required; difficult to vegetate.	Not needed	Difficult to construct and maintain; sandy soil; very low fertility; difficult to vegetate; severe limitations.	Sandy soil; highly erodible; difficult to vegetate.	No limitations: fair or good shear strength; low compressibility.	Slight: rapid permeability.
Too porous	Reasonable stability; pervious; fair resistance to piping; slope protection required; difficult to vegetate.	Not needed	Not needed	Not needed	No limitations: fair or good shear strength; low compressibility.	Slight: rapid permeability.
Moderately slow permeability; high water table; nearly level topography.	Poor stability; moderate or high shrink-swell potential.	Moderately slow permeability; subsurface drainage is satisfactory if outlets are available.	Not needed	Not needed	Severe: poor bearing capacity; high water table; high compressibility.	Severe: high water table.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Hayfield (Hd)	Good to a depth of about 7 inches.	Fair or poor below a depth of about 42 inches; water table may be at this level.[3]	Unsuitable	Fair to a depth of about 42 inches; fair to excellent below this depth; very high seasonal water table.	Fair or good to a depth of about 42 inches; unsuitable below this depth; very high seasonal water table.	Coarse substratum below a depth of 42 inches; nearly level topography; very high seasonal water table.
Hayfield (Hm)	Good to a depth of about 7 inches.	Fair below a depth of about 30 inches; water table may be at this level.[3]	Unsuitable	Fair to a depth of about 30 inches; fair to excellent below this depth; very high seasonal water table.	Fair or good to a depth of about 30 inches; unsuitable below this depth; very high seasonal water table.	Coarse substratum below a depth of 30 inches; nearly level topography; very high seasonal water table.
Hayfield (Hv)	Good to a depth of about 7 inches.	Fair or poor below a depth of about 38 inches.[3]	Unsuitable	Fair to a depth of about 38 inches; fair to excellent below this depth; very high seasonal water table.	Fair or good to a depth of about 38 inches; unsuitable below this depth; very high seasonal water table.	Coarse substratum below a depth of 38 inches; nearly level topography; very high seasonal water table.
Kenyon (KeB, KeC, KeC2).	Good to a depth of about 11 inches.	Unsuitable	Unsuitable	Good; low compressibility; fair or good bearing capacity; easily compacted.	Good	Seepage in some cuts; susceptibility to frost heave in sand pockets.
Klinger (Kg)	Fair or good to a depth of about 12 inches.	Unsuitable	Unsuitable	Fair in loess; good in till; fair or good bearing capacity; till easily compacted; seasonal high water table.	Good; seasonal high water	Seasonal high water table; susceptibility to frost action in sand lenses.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Moderate permeability; porous substratum at a depth of about 42 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of about 42 inches; moderate or low shrink-swell potential; fair or poor resistance to piping.	Permeability moderate in subsoil, rapid in substratum; because of very high seasonal water table, tile may improve drainage.	Not needed	Not needed	Slight: stable substratum at a depth of about 42 inches; very high seasonal water table.	Moderate: rapid permeability in substratum, but very high seasonal water table.
Moderate permeability; porous substratum at a depth of about 30 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of about 30 inches; moderate or low shrink-swell potential; poor resistance to piping.	Permeability moderate in subsoil, rapid in substratum; because of very high seasonal water table, tile may improve drainage.	Not needed	Not needed	Slight: very high seasonal water table; stable substratum below a depth of 30 inches.	Moderate: rapid permeability in substratum, but very high seasonal water table.
Moderate permeability; porous substratum at a depth of about 38 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of about 38 inches; moderate or low shrink-swell potential; fair or poor resistance to piping.	Permeability moderate in subsoil, rapid in substratum; because of very high seasonal water table, tile may improve drainage.	Not needed	Not needed	Slight: stable substratum at a depth of about 38 inches; very high seasonal water table.	Moderate: rapid permeability in substratum, but very high seasonal water table.
Excessive seepage in some sand pockets.	Adequate strength and stability; fair or good compaction; slow permeability when compacted.	Some hillside seeps; tile may be beneficial; moderately slow permeability.	Low fertility in subsoil; some areas may be wet after construction of terraces; cuts should be minimum; slight limitations.	Low fertility in till; tile may be needed; few limitations.	Slight: good bearing capacity and shear strength; low compressibility.	Severe or moderate: moderately slow permeability.
Excessive seepage in some sand pockets and lenses.	Adequate stability; fair or good compaction; slow permeability when compacted.	Moderate or moderately slow permeability; tile may improve drainage.	Somewhat poor drainage; glacial till at a depth of 20 to 40 inches; some limitations.	Tile needed; few limitations.	Moderate: fair or good bearing capacity; compressibility medium or high in loess, low in till.	Severe: moderate or moderately slow permeability; seasonal high water table.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Lamont (LaB, LaC, LaD).	Poor	Good; poorly graded fine and medium sand at a depth of 20 to 40 inches.	Unsuitable	Good or excellent; good workability; very low shrink-swell potential; slopes erodible.	Unsuitable	Fair stability; seepage in some cuts; steep slopes highly erodible; slope protection required; loose sand may hinder hauling; sand may flow.
Lamont (LbA)	Poor	Fair; poorly graded fine and medium sand at a depth of 20 to 40 inches; may grade to gravelly sand below a depth of 40 inches.	Unsuitable	Good or excellent; good workability; low shrink-swell potential; slopes erodible.	Unsuitable	Fair stability; steep slopes highly erodible; slope protection required; loose sand may hinder hauling.
Lawler (Ld)	Good to a depth of about 14 inches.	Fair or poor below a depth of about 42 inches; water table may be at this depth.[3]	Unsuitable	Poor to a depth of 42 inches; fair to excellent below this depth; seasonal high water table; high content of organic matter.	Fair or good to a depth of about 42 inches; unsuitable below this depth; seasonal high water table.	Seasonal high water table; coarse substratum below a depth of 42 inches; nearly level topography.
Lawler (Lm)	Good to a depth of about 14 inches.	Fair below a depth of about 30 inches; water table may be at this depth.[3]	Unsuitable	Poor to a depth of about 30 inches, excellent below this depth; seasonal high water table; high content of organic matter.	Fair or good to a depth of about 30 inches; unsuitable below this depth; seasonal high water table.	Seasonal high water table; coarse substratum below a depth of 30 inches; nearly level topography.
Marsh (Ma)	Poor	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Intermittent ponds; very high water table.
Marshan (Mr, Ms)	Fair or good to a depth of about 18 inches; high water table.	Poor; sand below a depth of about 42 inches; high water table.[3]	Unsuitable	Very poor; high water table; high content of organic matter.	Fair or good to a depth of 40 inches; high water table.	Poor drainage; high water table; high content of organic matter; occasional short periods of flooding; high susceptibility to frost action.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Moderately rapid permeability; seepage rate may be high.	Reasonable stability; pervious; fair or poor resistance to piping; slope protection required; difficult to vegetate.	Not needed	Sandy subsoil has low fertility; difficult to vegetate; some limitations.	Subsoil highly erodible; difficult to vegetate.	No limitations: low compressibility; fair or good shear strength.	Slight: rapid permeability.
Moderately rapid permeability; seepage rate may be high; nearly level topography.	Reasonable stability; pervious; fair or poor resistance to piping; slope protection required; difficult to vegetate.	Not needed	Not needed	Not needed	No limitations: low compressibility; fair or good shear strength.	Slight: rapid permeability.
Moderate permeability; porous substratum at a depth of 42 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of 42 inches; moderate or low shrink-swell potential; fair or poor resistance to piping.	Permeability moderate in subsoil, rapid in substratum; tile may improve drainage.	Not needed	Not needed	Slight: seasonal high water table; good stability below a depth of 42 inches.	Moderate: rapid permeability in substratum; seasonal high water table.
Moderate permeability; porous substratum at a depth of about 30 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of 30 inches; moderate or low shrink-swell potential; poor resistance to piping.	Permeability moderate in subsoil, rapid in substratum; tile may improve drainage.	Not needed	Not needed	Slight: seasonal high water table; good stability below a depth of 30 inches.	Moderate: rapid permeability in substratum; seasonal high water table.
Intermittent ponds; very high water table.	Variable	Not practical	Not needed	Not needed	Very severe: intermittent ponds; very high water table.	Variable.
Moderately slow permeability; high water table; nearly level topography; rapid permeability in substratum.	Poor stability and high compressibility above a depth of 20 inches; high shrink-swell potential in upper 42 inches; fair or poor resistance to piping.	Rapid permeability in substratum; subsurface drainage satisfactory if outlets are available.	Not needed	Not needed	Severe: high water table; fair or poor bearing capacity; occasional flooding.	Severe: high water table.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Marshan (Mt)	Fair or good to a depth of about 16 inches; high water table.	Fair below a depth of about 30 inches; high water table.[3]	Unsuitable	Very poor; high water table; high content of organic matter.	Fair or good to a depth of 30 inches; unsuitable below this depth; high water table.	Poor drainage; high water table; high content of organic matter; occasional short periods of flooding; high susceptibility to frost action.
Maxfield (Mx)	Fair or good to a depth of about 16 inches; high water table.	Unsuitable	Unsuitable	Very poor; high water table; high content of organic matter.	Fair or good; high water table.	Poor drainage; high water table; poor bearing capacity; high content of organic matter.
Muscatine (My)	Fair or good to a depth of about 16 inches.	Unsuitable	Unsuitable	Fair; fair bearing capacity; medium compressibility; fair workability.	Good; very high seasonal water table.	Fair or poor bearing capacity; very high seasonal water table.
Nodaway (No)	Good	Unsuitable	Unsuitable	Fair; high compressibility; high content of organic matter below a depth of 45 inches; fair compaction.	Fair	Occasional flooding; fair bearing capacity.
Oran (OrA, OrB)	Good to a depth of about 7 inches.	Unsuitable	Unsuitable	Fair or good; very high seasonal water table; low compressibility; fair- or good bearing capacity; easily compacted.	Good; very high seasonal water table.	Frost action in sand pockets; very high seasonal water table.
Ostrander (OsA, OsB, OsC).	Good to a depth of about 11 inches.	Unsuitable	Unsuitable	Good; low compressibility; fair or good bearing capacity; easily compacted.	Good	Seepage in some cuts; frost action in sand pockets.
Peaty muck (Pe)	Poor alone; good to a depth of about 50 inches if mixed with mineral soil; high water table.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Very poor stability and bearing capacity; muck to a depth of 40 to 60 inches; high water table.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Moderately slow permeability; porous substratum at a depth of 30 inches; high water table; nearly level topography.	Poor stability and high compressibility above a depth of about 20 inches; high shrink-swell potential in upper 30 inches; poor resistance to piping.	Rapid permeability in substratum; subsurface drainage satisfactory if outlets are available.	Not needed	Not needed	Severe: high water table; fair or poor bearing capacity; occasional flooding.	Severe: high water table.
Moderately slow permeability; high water table; nearly level topography.	Stability poor in loess, adequate in till; compressibility high in loess, low in till.	Moderately slow permeability; subsurface drainage satisfactory if outlets are available.	Not needed	Not needed	Severe: high water table; fair or poor bearing capacity; compressibility high in loess, low in till.	Severe: high water table.
Excessive seepage in some areas; nearly level topography.	Fair stability; fair compaction; medium compressibility; moderate or high shrink-swell potential.	Moderate permeability; tile may improve drainage.	Not needed in level areas; somewhat poor drainage; some limitations.	Tile needed; slight limitations.	Moderate or severe: fair or poor bearing capacity; very high seasonal water table; uniform consolidation.	Moderate or severe: moderate permeability; very high seasonal water table.
Moderate permeability; local flooding.	High compressibility; fair compaction; moderate or high shrink-swell potential; fair resistance to piping.	Protection from local flooding may be beneficial; subsurface drainage not needed.	Somewhat erodible.	Somewhat erodible.	Moderate or severe: poor bearing capacity; local flooding.	Severe: local flooding; moderate permeability.
Excessive seepage where sand pockets occur.	Adequate shear strength and stability; fair or good compaction; slow permeability when compacted.	Moderately slow permeability; tile may improve drainage.	Somewhat poor drainage; low fertility in subsoil; some limitations.	Tile needed; low fertility in till; few limitations.	Moderate: good bearing capacity and shear strength; very high seasonal water table; low compressibility.	Severe: moderately slow permeability; very high seasonal water table
Bottom should be scarified and compacted; some sand pockets.	Adequate strength and stability; fair or good compaction; slow permeability when compacted.	Not needed	Low fertility in till; cuts should be minimum; slight limitations.	Low fertility in till; few limitations.	Slight: good bearing capacity and shear strength; low compressibility.	Moderate: moderate permeability.
Muck to a depth of 40 to 60 inches; high water table; substratum generally stratified.	Unsuitable	Tile required for crops; good outlets necessary; interceptor tile may be needed.	Not needed	Not needed	Very severe: muck to a depth of 40 to 60 inches; muck should be removed from foundations; high water table.	Severe: high water table.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Peaty muck (Pm)	Poor alone; good to a depth of about 30 inches if mixed with mineral soil; high water table.	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Very poor stability and bearing capacity; 20 to 40 inches of muck; high water table.
Port Byron (PoB, PoC2, PoD2).	Good to a depth of about 11 inches.	Unsuitable	Unsuitable	Fair; fair or poor bearing capacity and shear strength; fair workability.	Fair	Highly erodible; some rolling topography; easy to vegetate.
Readlyn (ReA, ReB)	Good to a depth of about 11 inches.	Unsuitable	Unsuitable	Fair or good; very high seasonal water table; low compressibility; fair or good bearing capacity; easily compacted.	Good; very high seasonal water table.	Frost action in sand pockets; very high seasonal water table.
Riceville (RfB)	Good to a depth of about 7 inches.	Unsuitable	Unsuitable	Fair or good; very high seasonal water table; low compressibility; fair or good bearing capacity; easily compacted.	Good; very high seasonal water table.	Frost heave in sand pockets; very high seasonal water table.
Rockton (RkB, RkC, RkD).	Good to a depth of about 10 inches.	Unsuitable	Suitable at a depth of 20 to 32 inches.	Poor; limestone at a depth of 20 to 32 inches.	Fair or good; limestone at a depth of 20 to 32 inches.	Limestone at a depth of 20 to 32 inches.
Rolfe (Ro)	Good to depth of about 10 inches.	Unsuitable	Unsuitable	Poor or very poor; high water table; high content of organic matter.	Fair or good; high water table.	Poor drainage; poor bearing capacity; high water table.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Muck to a depth of 20 to 40 inches; high water table; substratum generally stratified.	Unsuitable	Tile required for crops; good outlets necessary; interceptor tile may be needed.	Not needed	Not needed	Very severe: 20 to 40 inches of muck that should be removed from foundations; high water table.	Severe: high water table.
Excessive seepage in some areas.	Fair stability; fair compaction, but poor if above optimum moisture content; moderate shrink-swell potential.	Not needed	Somewhat erodible.	Somewhat erodible.	Moderate: fair or poor bearing capacity; moderate or high compressibility; uniform consolidation.	Slight or moderate: moderate permeability; some very steep slopes.
Excessive seepage where sand pockets occur.	Adequate shear strength and stability; fair or good compaction; slow permeability when compacted.	Moderately slow permeability; tile may improve drainage.	Somewhat poor drainage; low fertility in subsoil; some limitations.	Low fertility in till; tile needed; few limitations.	Moderate: good bearing capacity and shear strength; very high seasonal water table; low compressibility.	Severe: moderately slow permeability; very high seasonal water table.
Excessive seepage where sand pockets occur.	Adequate shear strength and stability; fair or good compaction; slow permeability when compacted.	Slow permeability; tile may improve drainage.	Somewhat poor drainage; low fertility in subsoil; some limitations.	Low fertility in till; tile needed; few limitations.	Moderate: good bearing capacity and shear strength; very high seasonal water table; low compressibility.	Severe: slow permeability; very high seasonal water table.
Limestone at a depth of 20 to 32 inches; excessive seepage.	Limestone at a depth of 20 to 32 inches; adequate strength and stability above limestone; slow permeability above rock when compacted.	Not needed	Limestone at a depth of 20 to 32 inches; severe limitations.	Limestone at a depth of 20 to 32 inches; few limitations.	Slight: limestone at a depth of 20 to 32 inches.	Very severe: limestone at a depth of 20 to 32 inches.
Slow permeability; nearly level topography; high water table.	Fair or poor stability; moderate or high shrink-swell potential; poor workability.	Slow permeability; tile normally improves drainage if outlets are adequate; surface inlets or drains may be needed.	Not needed	Not needed	Severe: poor drainage; fair or poor bearing capacity; uneven consolidation.	Very severe: slow permeability; high water table.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Sable (Sa)	Fair to a depth of about 18 inches.	Unsuitable	Unsuitable	Very poor; wetness; high water table; high content of organic matter.	Fair or good; may be difficult to obtain because of wetness and high water table.	Poor drainage; high water table; poor bearing capacity; high content of organic matter.
Sattre (SbA, SbB)	Good to a depth of about 7 inches.	Fair or good below a depth of 42 inches; well-graded to poorly graded sand or gravel. [3]	Unsuitable	Fair to a depth of 42 inches; good or excellent below this depth.	Fair or good to a depth of 42 inches; unsuitable below this depth.	Coarse substratum at a depth of 42 inches.
Sattre (SdA)	Good to a depth of about 7 inches.	Good below a depth of 30 inches; well-graded to poorly graded sand or gravel.[3]	Unsuitable	Fair to a depth of 30 inches; good or excellent below this depth.	Fair or good to a depth of 30 inches; unsuitable below this depth.	Coarse substratum at a depth of 30 inches; nearly level topography.
Seaton (SeB, SeC2, SeD2, SeD3, SeE2, SeF2).	Fair	Unsuitable	Unsuitable	Fair; fair or poor bearing capacity and shear strength; fair workability.	Fair	Highly erodible; rolling topography; easy to vegetate.
Sogn (SoD, SoF)	Poor; limestone at a depth of 4 to 15 inches.	Unsuitable	Suitable at a depth of 4 to 15 inches.	Very poor; limestone at a depth of 4 to 15 inches.	Poor; limestone at a depth of 4 to 15 inches.	Limestone at a depth of 4 to 15 inches; rolling topography.
Spillville (Sp, Sv) (For Colo part of the Sv unit, see the Colo series.)	Good	Unsuitable	Unsuitable	Fair or poor; high content of organic matter to a depth of 40 inches; easily compacted.	Fair or good; high content of organic matter to a depth of 40 inches.	Seepage in some cuts; occasional flooding.
Terril (TxA, TxB)	Good to a depth of about 30 inches.	Unsuitable	Unsuitable	Fair or poor; high content of organic matter to a depth of 20 to 40 inches; easily compacted.	Fair or good	Seepage in some cuts; occasional flooding.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Moderately slow permeability; high water table; nearly level topography.	Poor stability; high or moderate shrink-swell potential; high compressibility.	Moderately slow permeability; subsurface drainage is satisfactory if outlets are available.	Not needed	If needed, poor drainage may interfere with construction; tile needed; nearly level topography.	Severe: poor bearing capacity; high water table; high compressibility.	Severe: high water table.
Moderate permeability; porous substratum at a depth of 42 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of 42 inches; moderate or low shrink-swell potential; poor resistance to piping.	Not needed	Not needed in level areas; no limitations in sloping areas.	If needed, no limitations.	Slight: fairly stable substratum at a depth of 42 inches.	Slight: rapid permeability in substratum.
Moderate permeability; porous substratum at a depth of 30 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of 30 inches; moderate or low shrink-swell potential; poor resistance to piping.	Not needed	Not needed	Not needed	No limitations	Slight: rapid permeability in substratum.
Excessive seepage in some areas.	Fair stability; fair compaction, but poor if above optimum moisture content; moderate shrink-swell potential.	Not needed	Somewhat erodible.	Somewhat erodible.	Moderate: fair or poor bearing capacity; medium or high compressibility; uniform consolidation.	Slight or moderate: moderate permeability; some very steep slopes.
Limestone at a depth of 4 to 15 inches; unsuitable.	Limestone at a depth of 4 to 15 inches; unsuitable.	Not needed	Limestone at a depth of 4 to 15 inches; severe limitations.	Limestone at a depth of 4 to 15 inches.	No limitations	Very severe: limestone at a depth of 4 to 15 inches.
Moderate permeability; occasional flooding.	Adequate strength and stability; high content of organic matter; fair or poor resistance to piping; easy to vegetate.	Tile may improve drainage if outlets are available; protection from overflow is beneficial.	Not needed	Not needed	Moderate or severe: fair or poor bearing capacity; occasional flooding; medium compressibility.	Very severe: occasional flooding.
Some sand lenses below a depth of 40 inches; excessive seepage where sand lenses occur.	Adequate strength and stability; fair or poor resistance to piping; easy to vegetate.	Not needed	No limitations	No limitations	Moderate: fair bearing capacity; medium compressibility.	Severe where the soil is in drainageways; slight or moderate in other areas because of moderate permeability.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as a source of—					Soil features affecting—
	Topsoil	Sand	Limestone	Road fill [1]	Impermeable material	Highway [1] location
Tripoli (Tr)	Fair to a depth of about 16 inches.	Unsuitable	Unsuitable	Poor or very poor; high water table; high content of organic matter.	Good; high water table.	Poor drainage; high water table; fair or poor bearing capacity.
Waukegan (WaA, WaB).	Good to a depth of about 11 inches.	Fair or good below a depth of 42 inches; well-graded to poorly graded sand or gravel.[3]	Unsuitable	Fair to a depth of 42 inches; good to excellent below this depth.	Fair to a depth of 42 inches; unsuitable below this depth.	Coarse-textured substratum at a depth of 42 inches; good workability.
Waukegan (WgA, WgB, WgC).	Good to a depth of about 14 inches.	Good below a depth of 30 inches; well-graded to poorly graded sand or gravel.[3]	Unsuitable	Fair to a depth of 30 inches; good or excellent below this depth; good bearing capacity and shear strength below a depth of 30 inches.	Fair to a depth of 30 inches; unsuitable below this depth.	Coarse-textured substratum at a depth of 30 inches; good workability.
Waukegan (WkA)	Good to a depth of about 12 inches.	Fair or good below a depth of 42 inches; well-graded to poorly graded sand or gravel.[3]	Unsuitable	Fair to a depth of 42 inches; good or excellent below this depth.	Fair to a depth of 42 inches; unsuitable below this depth.	Coarse-textured substratum below a depth of 42 inches; good workability.
Winneshiek (WnB, WnC).	Good to a depth of about 7 inches.	Unsuitable	Suitable at a depth of 20 to 32 inches.	Poor; limestone at a depth of 20 to 32 inches.	Fair or good; limestone at a depth of 20 to 32 inches.	Limestone at a depth of 20 to 32 inches.

[1] Engineers and others should not apply specific values to the estimates given for bearing capacity of soils.

[2] On-site tests should be made before any sewage disposal system is installed. Slopes of less than 10 percent generally do not create serious problems if the soils are otherwise suitable. All the soils along the Wapsipinicon River and Plum Creek have a high water table and are unsuitable for use as filter fields regardless of their rate of permeability.

interpretations—Continued

Soil features affecting—Continued					Degree of limitations affecting—	
Farm ponds		Agricultural drainage	Terraces and diversions	Waterways	Foundations for low buildings [1]	Sewage disposal fields [2]
Reservoir area	Embankment					
Moderately slow permeability; high water table; nearly level topography.	Top 20 inches unsuitable; material below has adequate strength and stability; fair or good compaction; slow permeability when compacted; poor drainage.	Moderately slow permeability; subsurface drainage satisfactory if outlets are available.	Not needed	Where waterways are needed, poor drainage may interfere with construction; tile needed; nearly level topography.	Severe: poor drainage; high water table; fair bearing capacity.	Very severe; high water table.
Moderate permeability; porous substratum at a depth of 42 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of 42 inches; moderately low shrink-swell potential; fair or poor resistance to piping.	Not needed	Coarse-textured substratum at a a depth of 42 inches; no limitations.	No limitations	Slight: stable substratum at a depth of 42 inches.	Slight: rapid permeability in substratum.
Moderate permeability; porous substratum at a depth of 30 inches.	Fair stability; fair compaction; medium compressibility to a depth of 30 inches;moderate or low shrink-swell potential; poor resistance to piping.	Not needed	Coarse-textured substratum at a depth of about 30 inches; low fertility; difficult to vegetate; some limitations.	Coarse textured substratum at a depth of 30 inches; few limitations.	No limitations	Slight: rapid permeability in substratum.
Moderate permeability; porous substratum at a depth of 42 inches; nearly level topography.	Fair stability; fair compaction; medium compressibility to a depth of 42 inches; moderate or low shrink-swell potential; fair or poor resistance to piping.	Not needed	Not needed	Not needed	Slight or moderate: fair or poor bearing capacity to a depth of 42 inches; stable substratum.	Slight: rapid permeability in substratum.
Limestone at a depth of 20 to 32 inches; excessive seepage rate.	Limestone at a depth of 20 to 32 inches; adequate strength and stability above limestone; slow permeability above rock when compacted.	Not needed	Limestone at a depth of 20 to 32 inches; severe limitations.	Limestone at a depth of 20 to 32 inches; few limitations.	Slight: limestone at a depth of 20 to 32 inches.	Severe: limestone at a depth of 20 to 32 inches.

[3] Only a few soils in Bremer County are possible sources of gravel. In many areas of these soils there are limitations because the gravel is interbedded with sand lenses or because there is a high water table, especially along the Wapsipinicon River and Plum Creek. Soils that are sources of gravel are the Burkhardt and Dickinson (fair or good), Sattre, Waukegan, Hayfield, and Lawler (fair or poor), and Marshan (poor).

Because of their high in-place density, the glacial till soils generally do not have an excessively high moisture content and are more easily compacted than soils derived from loess.

Fayette, Seaton, and Port Byron soils formed in local deposits of loess that occur as elongated ridges southeast of Waverly, east of and parallel to the Cedar River. These soils have an A–6 (ML-CL) classification. The deposits of loess are at least 15 feet thick, and fresh cuts made for roadway grades will cause the loess to erode rapidly unless erosion control measures are applied almost immediately.

The Kenyon, Bassett, Ostrander, and other soils derived from loam till, are loams and sandy loams of A–6 and A–4 (CL) classification. If found in or adjacent to grading projects, these soils are normally placed in the upper subgrade of unstable areas. Pockets and lenses of sand, many of which are water bearing, are commonly interspersed throughout the till. Where the road grade is only a few feet above such a deposit and silty till overlies it, frost heaves are likely to develop unless the deposit is drained or the soil above it is replaced with granular backfill or clayey glacial till.

The bottom-land soils formed in recent alluvium that washed from the hills and uplands. The Colo soil has a thick, organic surface layer that may consolidate erratically under an embankment load. This soil is classified A–7 (CL, ML or OH). It has low in-place density and high moisture content. The Nodaway soil, which occurs on bottom lands, is a silty clay and is classified A–7 (CL). It has a sandy silt overwash, classified A–6 (CL), that also has low in-place density and high moisture content. If these soils are used as foundations of embankments more than 15 feet high, they should be carefully analyzed to make sure there is sufficient strength to support such embankments. Roadways through bottom lands should be constructed on continuous embankments that extend above the level of frequent flooding. The Nodaway and similar soils may have an overwash of fine sand, and, if an embankment is constructed only a few feet above the water table, frost heaving may result unless proper drainage is established or materials not susceptible to frost action are used in the subgrade.

The bedrock under the glacial till is limestone. In areas where the bedrock is not deeply buried, sinkholes have formed, leaving the typical drained potholes or depressions. Because these sinkholes do not provide foundation support for roadway embankments or structures, their location and extent should be carefully determined during preliminary investigations. The soils of the Atkinson and Winneshiek series, which are classified A–6 (CL) over A–7–6 (CH), occur where bedrock is close to the surface. The subsoil is undesirable as upper subgrade because of its high clay content and nonuniform residual characteristics.

All of the soils underlain by limestone are suitable for winter grading.

Soil Properties Affecting Conservation Engineering

In this section soil properties are discussed in relation to the construction of drainage systems, terraces, diversions, waterways, and farm ponds. Table 6 shows the suitability of the soils for these purposes. Technical assistance in designing drainage systems and other conservation structures can be obtained through the Bremer County Soil Conservation District.

Irrigation, which is also a part of conservation engineering, is not discussed in this survey, because it is not practiced extensively in Bremer County. Corn and meadow crops are irrigated by the sprinkler method on some of the flat sandy soils near Plainfield.

Drainage systems.—Artificial drainage of fields to reduce time lost after rains has become increasingly important. Tile drainage is the most common method. Open ditch drainage is second.

A tile drainage system is installed to remove excess subsurface water and, in some cases, to remove surface water through surface intakes. The factors to consider before installing tile are (1) the need for drainage, (2) the suitability of tile drainage, (3) the availability of a suitable outlet, and (4) an adequate design to provide a complete and economical system.

The permeability of the soil determines whether or not tile drainage will work well. Tile drains are not satisfactory in very slowly permeable soils, such as Blockton silty clay loam, dark gray subsoil variant. Surface water can be removed from such soils through open intakes. Shallow surface drains can also be graded away from these areas to remove excess surface water. Tile drains work well in soils that have moderate to moderately slow permeability (fig. 13). In Riceville loam and other slowly permeable soils, the tile lines need to be closer together than in soils that have moderate permeability, and even then they may work only moderately well. Tile is hard to install and maintain in Marshan clay loam, moderately deep, and in other soils that have a sand substratum.

Open ditches are used to remove excess surface water or to remove water collected by tile. Shallow open ditches are effective in removing water from depressional areas.

Information concerning drainage for soils of the county can be obtained from the "Iowa Drainage Guide," published by Iowa State University (*4*).

Terraces.—A terrace is a ridge built across a slope to intercept runoff and seepage and to control erosion. Terraces control erosion by reducing the length of slope so that fields on long slopes can be cropped more intensively without excess loss of soil. In addition, terraces conserve moisture in dry years, improve surface drainage, improve row patterns, and act as guidelines for contour planting and for field divisions.

The factors to consider before building a terrace are the purpose, the slope of the soil, and the soil material of which the terrace will be built.

Most of the terraces built in Bremer County are graded terraces, which are designed to discharge runoff water at a nonscouring rate. Level terraces are satisfactory on some of the Port Byron and Seaton soils, but graded terraces are generally more satisfactory, especially during seasons of more than normal rainfall.

Cut and fill terraces are best for most deep soils that have slopes of as much as 12 percent. By the use of cut and fill methods, terraces can be constructed so that they are parallel, and point rows can be eliminated between

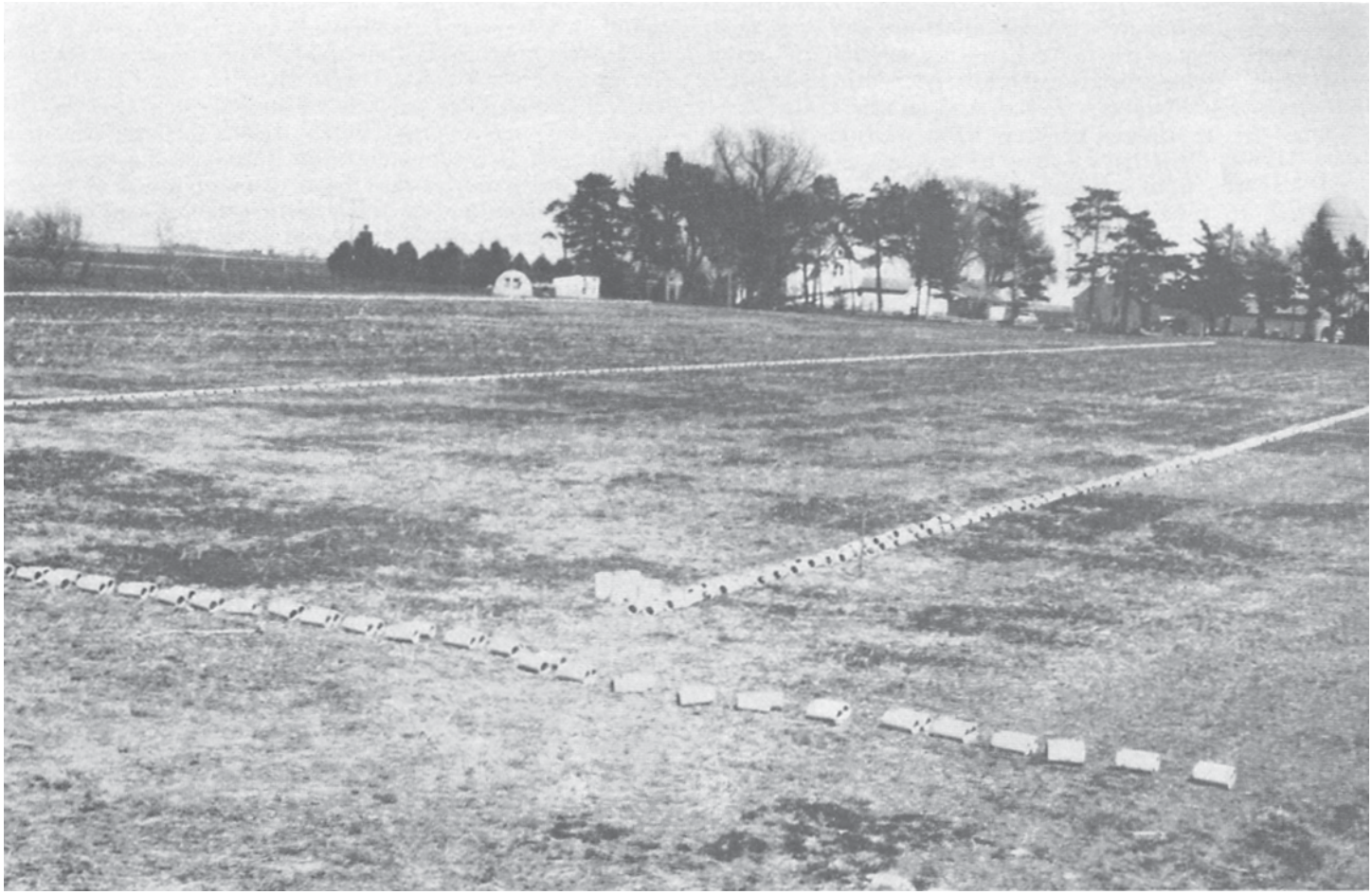

Figure 13.—**A field of Tripoli clay loam to be drained by tile.**

terraces. On slopes that are steeper than 12 percent, consideration should be given to the use of bench terraces with seeded back slopes.

Port Byron, Seaton, Fayette, and other loess-derived soils that have suitable slopes can be terraced. Kenyon, Ostrander, Coggon, Bassett, and other till-derived soils are less well suited because their subsoil is less fertile and most of them have a stone or pebble layer, which is detrimental if exposed in terrace channels. In Bassett, Kenyon, and a few other soils, terracing may increase wetness. Tile drains are needed in these soils. Terracing extremely sandy soils is generally not recommended. Sands slump and blow into the terrace channels, making maintenance very difficult. Rockton, Winneshiek, and similar soils underlain by limestone bedrock can be terraced, but deep cuts should be avoided. Deep cuts also should be avoided in soils that are firm below the pebble layer.

Diversions.—A diversion is a channel constructed across the slope to intercept surface water from the soils upslope and thus protect the soils on lower slopes or bottom lands. Terril, Spillville, and Clyde soils are examples of those that can benefit from diversions placed upslope. In addition to intercepting runoff, diversions prevent gullying and catch silt that might cover young plants.

Grassed waterways.—A grassed waterway is a vegetated channel that conducts runoff water at a nonerosive velocity to a safe or stable outlet. All drainageways are subject to gullying unless they are protected by a good vegetative cover. If gullies have formed in waterways, large amounts of earth have to be moved before the channels can be shaped properly. Many waterways that have a steep grade need grade stabilization structures to flatten the grade and reduce the velocity of water. Grassed waterways are also needed as outlets for terraces and diversions.

Most soils in Bremer County can produce enough vegetation to prevent erosion if the channels are shaped and a suitable grade is established. Many waterways are in the Colo and Terril soils, which are very fertile. Where infertile soil material has been exposed by earthmoving, a topdressing of surface material, manure, and mulch may be needed before enough vegetation can be produced to protect the waterway.

In many places waterways should be drained by tile so that suitable grass can be established and the waterways will be dry enough to be crossed by farm machinery.

The till-derived soils commonly have a pebble band between the till and the overlying soil. Pebbles in the bottom of a waterway can set up turbulence and cause cutting.

Erosion control structures in waterways.—Reinforced concrete drop spillways or drop inlets are the most commonly used structures for controlling erosion in waterways. Such structures are generally needed in waterways that drain the Nodaway, Terril, and similar soils.

Generally, reinforced concrete drop spillways are used for waterways that have a drop of as much as 6 to 8 feet. Grades in the waterway below a drop spillway must be stabilized to prevent gullying on the downstream side from undermining the structure. The grade below a drop spillway can be steep if the structure can be placed on a rock base.

Farm ponds.—Farm ponds provide water for livestock in areas where there is no natural supply or an insufficient one. Thus, they also help in controlling erosion by making additional acreage available for rotation grazing. Ponds also provide fishing and other forms of recreation (fig. 14).

In general, the soils derived from glacial till are better fill for farm pond embankments than those derived from loess, but not many suitable sites are available in those sections of the county where the glacial soils are predominant. If a pond is to be constructed in soil that is shallow to limestone bedrock, the site should be carefully selected.

Drop inlets are used for controlling the velocity of runoff in waterways that have a drop in excess of 8 feet. They are constructed of metal or concrete and are set into the upstream side of an earth dam to stabilize the upstream grade. The inlet is connected to a spillway of metal or concrete pipe, which passes through the dam and empties at a lower elevation into a stable waterway. Suitable fill material may have to be obtained at a considerable distance from the structure site. Good compaction usually can be obtained with regular equipment, if care is used in selecting and placing fill material. Glacial soil material is generally better for fill material than loessal material. If side abutments are seepy, toe drains should be provided under the structure. Structures placed in areas of Clyde soils commonly need toe drains.

Genesis, Classification, and Morphology of Soils

In this section the genesis, or formation, of soils is discussed, the two systems of soil classification now in use are explained and the soil series are classified, the morphology of each series is described, and physical and chemical data are given for selected soil profiles.

***Figure 14.*—Farm pond that provides recreation, helps to control gullying, and serves as a source of water.**

Factors of Soil Genesis

Soil is created by soil-forming processes that change materials deposited or accumulated by natural forces. 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 has existed since accumulation; (3) the plant and animal life on and in the soil; (4) the topography, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors of soil genesis. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by topography. Parent material also affects the kind of profile that can be formed and, in some cases, determines it almost entirely. Finally, time is essential for the changing of parent material into a soil profile. Generally a long time is required for the development of distinct horizons.

The interrelations of the factors of soil genesis are so complex that few generalizations can be made about one factor unless conditions are specified for the other four.

Parent material

The accumulation of parent material is the first step in the development of a soil. Some soils in Bremer County, such as those of the Sogn and Rockton series, formed partly from material weathered in place from bedrock. Most of the soils in the county, however, formed from material that was transported from the site of the parent rock by ice, wind, or water.

Thus, the main kinds of parent material in Bremer County are glacial material, which is transported by ice; loess, transported by wind; and alluvium, transported by water. Other kinds of parent material in the county are eolian sand, which is transported by wind; residuum, weathered in place from bedrock; organic material, accumulated from decaying plants; and colluvium, transported by gravity.

Glacial material.—Most of the soils in Bremer County formed in material of glacial origin. The Readlyn, Tripoli, Kenyon, Clyde, Floyd, Bassett, and Oran soils, which are predominant in soil associations 1, 2, and 3, formed in glacial material.

During the Pleistocene epoch, or Ice Age, snow and ice accumulated to a great depth. As pressure increased with the increasing depth of ice and snow, the ice sheet flowed as a plastic mass. Like a giant bulldozer it moved across the landscape. Rocks were ground into smaller particles. Hills were leveled, and valleys were filled. Rocks embedded in the bottom of the ice provided scouring action as the glacier moved.

The first of the glacial advances over Bremer County, the Nebraskan glaciation, occurred approximately 750,000 years ago. It was followed by the Aftonian interglacial period, which was followed by the Kansan glacial period. The Kansan glaciation is thought to have started about 500,000 years ago. It also covered all of Bremer County. The third and most recent glaciation to advance over Bremer County is currently recognized in Iowa as the Iowan substage of the Wisconsin glaciation (*8*). The Wisconsin glacial period is believed to have begun about 35,000 years ago.

Recent studies of the presence and identification of Iowan glacial till indicate that the conclusions formed from studies made before 1960 are questionable. Intensive, detailed, geomorphic and stratigraphic work shows that the landscape is a multilevel sequence of erosion surfaces, and that many of the levels are cut into Kansan and Nebraskan till (*22*).

Most of the glacial parent material in Bremer County is loamy in texture and is nearly free of pebbles, rocks, and boulders to a depth of 1½ to 2½ feet. At this depth there generally is a pebble band (*5*, *15*) that separates the overlying loamy material from firm glacial till. This band consists of a 2- to 4-inch concentration of pebbles 1 to 3 inches in diameter (fig. 15). The depth to the pebble band is 1½ to 2 feet in Dinsdale, Ostrander, and other soils on uplands and a little more than 2 feet in Floyd, Clyde, and other soils in drainageways (fig. 16).

Boulders 3 to 15 feet in diameter are on the surface of some areas mantled by glacial drift. Boulders and stones 6 to 30 inches in diameter are concentrated in some draws and drainageways.

Loess.—The deposits of loess in Bremer County originated 14,000 to 16,000 years ago, during the Wisconsin Age (*13*, *14*). Thick deposits are found in the steep, rolling hills west of the town of Denver. This area, which

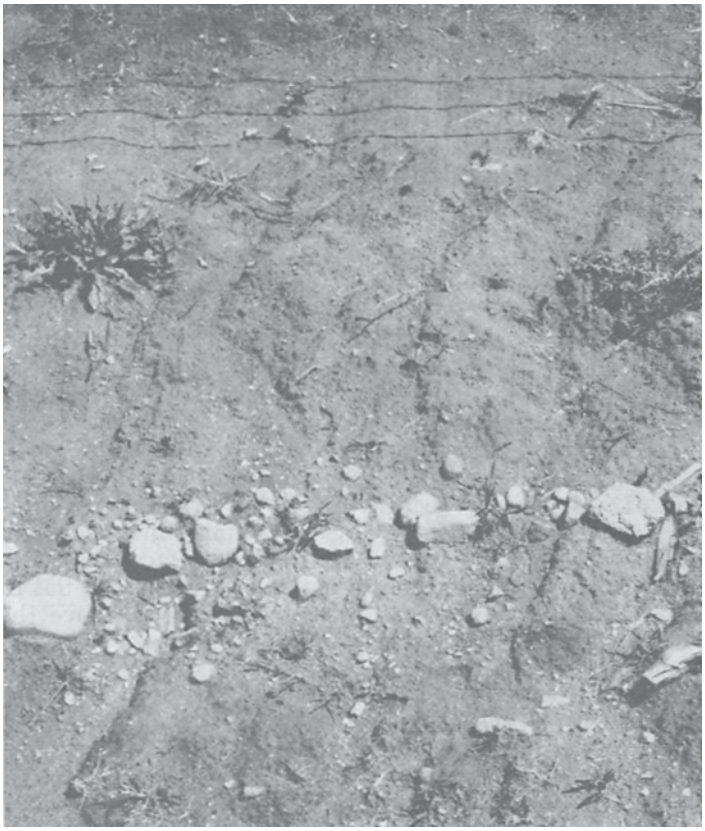

***Figure 15.*—A pebble band in a Floyd soil. The band is typical of those that can be seen in many road cuts throughout Bremer County.**

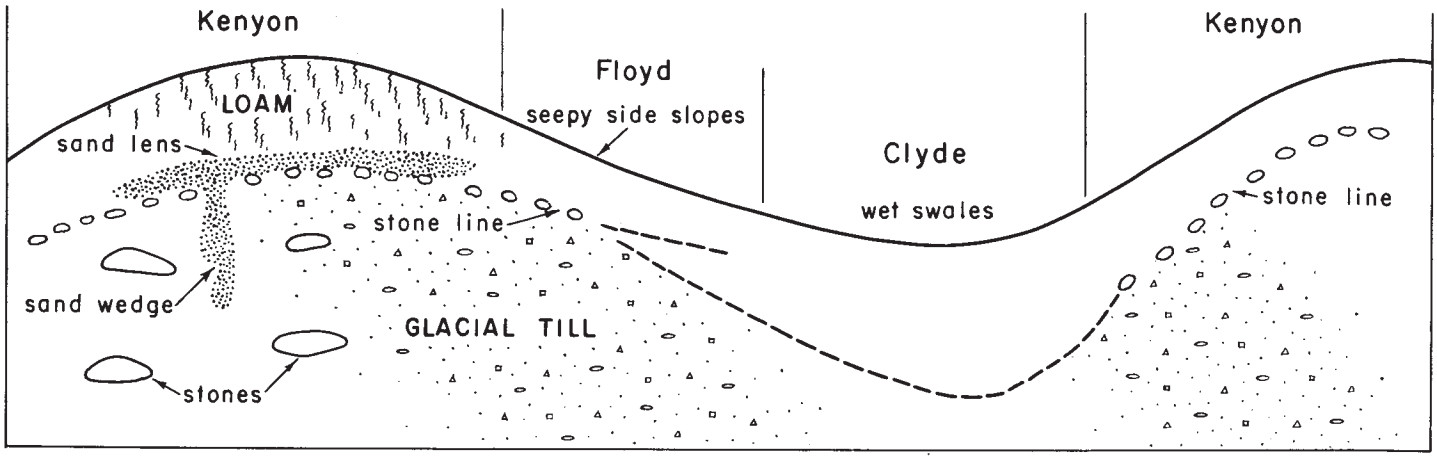

Figure 16.—**Parent material of the Kenyon, Floyd, and Clyde soils.**

is in soil association 5, is about 1½ miles wide and 3 miles long and extends in a northwest-southeast direction. Seaton and Fayette soils predominate. In an area about 3 miles wide and 6 miles long east and southeast of Denver, the glacial till is covered by 20 to 110 inches of loess. The loess is generally thickest near Denver. This area coincides with soil association 4 in which Klinger, Maxfield, and Port Byron soils are predominant.

Alluvium.—Two major areas of alluvium are along the Cedar and Wapsipinicon Rivers, and many smaller areas are along tributary streams. Alluvial soils are commonly stratified with layers of sand, silt, or gravel. Colo and Spillville soils are the major soils that developed from alluvium in Bremer County.

Colluvium.—Sediments that accumulate at the base of upland slopes as a result of gravity, soil creep, or local wash are referred to as local alluvium or colluvium. The Terril soils formed in such sediments.

Eolian sand.—Eolian sand is inextensive in Bremer County. Most areas of the soils that formed in eolian sand are in soil association 6. These soils are on uplands and benches and may occur as mounds or dunes. Eolian sand consists largely of quartz, which is very resistant to weathering. It has not been altered appreciably since being deposited. Hagener and Chelsea soils developed mainly in eolian sand. Dickinson and Lamont soils developed in somewhat loamier eolian material.

Residuum.—Residuum is the residue from the weathering of sedimentary rock in place. It is a minor parent material in Bremer County. Sogn, Winneshiek, Rockton, and Atkinson soils are underlain by limestone bedrock. None of these soils developed entirely in residuum, but in some places a thin layer of clay residuum is above the bedrock. In most of the county, the bedrock is buried beneath glacial till, loess, eolian sandy material, or alluvium.

Most of the bedrock in the county is Cedar Valley limestone, of the Devonian system (*18*). The Maquoketa formation of the Ordovician system underlies a slightly irregular north-south strip about 4 miles wide in the center of the county. It extends from the northern boundary of the county south to the Chicago Great Western Railway. This formation contains thick, cherty dolomite and blue-green shale. Surrounding the Maquoketa formation is a strip 2 to 4 miles wide underlain by the Hopkinton formation of the Silurian system. This formation also underlies an area about 6 miles long and 1 or 2 miles wide southeast of Waverly. The Hopkinton formation is dolomite but contains some cherty zones.

Organic material.—Organic deposits are the parent material of the small areas of peaty muck in Bremer County. Wetness and poor drainage have retarded the decay of organic matter. This accumulated organic matter, with small amounts of mineral matter, serves as a soil material. The thickness of it ranges from 20 to 80 inches in Bremer County.

Climate

According to available evidence, the soils in Bremer 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 forest vegetation (*13*). The morphology of most of the soils indicates that they developed in a climate similar to that of the present. The present climate is marked by wide, seasonal extremes of temperature, but it is fairly uniform over the county. No major differences among soils in the county were caused by differences in the recent climate; however, local conditions can modify the influence of the general climate. Dry, sandy, south-facing slopes, for example, have a local climate, or microclimate, that is warmer and less humid than the average climate of the area. Low, poorly drained bottom lands are wetter and colder than surrounding areas. These contrasts account for some of the differences among soils in the same general climatic region.

Plant and animal life

As plants grow and die, their remains add organic matter to the upper layers of soil material. Deep-rooted plants bring plant nutrients up from the lower layers. Micro-organisms also are important in soil development. They are a source of organic matter, they aid in decomposing organic matter, they combine free nitrogen into forms that can be used by plants, and they aid in the release of nitrogen and other nutrients for use by plants.

Most of the soils in Bremer County developed under prairie grasses or a mixture of prairie grasses and water-tolerant plants. Kenyon and Floyd soils, for example, developed under this sort of vegetation. The native grasses have myriads of fibrous roots in the uppermost 20 inches of the soil; thus, there is a large amount of organic matter in the surface layer of soils that developed under grass.

A few soils in the county developed under deciduous trees, the roots of which commonly extend deep into the subsoil and do not provide the organic matter in the surface layer that grass roots provide. The surface layer of such soils is thin and contains little organic matter, because it receives only what is released from fallen leaves and dead trees, and much of this remains on the surface or is lost through decomposition. The Coggon and Seaton soils are examples of soils that formed under deciduous trees.

A number of the soils were first under prairie grass and then under forest vegetation, and their properties are intermediate between those of soils that formed entirely under grass or entirely under forest. The Franklin and Oran soils are examples.

The Kenyon, Bassett, and Coggon soils are members of a group of soils that formed from the same parent material and under comparable environment except for the native vegetation. Differences in native vegetation account for the main differences in morphology among soils of this group.

Man's influence on soil.—By his use of soil, man reduces or increases the thickness of soil layers, changes the drainage and topography, alters the chemical and physical composition, changes the living matter in the soil and on it. Thus, man influences soil genesis. The effects of man's influence on soil, however, may or may not be evident.

Topography

Topography influences soil development mainly through its effect on drainage, runoff, and erosion. Gradient, pattern, and length of slope affect the amount of water that enters a soil.

The steeper the slope, the more water runs off the surface and the less penetrates the soil. Nearly level and moderate, convex slopes predominate in Bremer County, but some areas are very steep.

Aspect, as well as gradient, has significant influence. South-facing slopes generally are warmer and drier than north-facing slopes and consequently support a different kind and amount of vegetation.

The influence of a porous, rapidly permeable parent material may override the influence of topography. Dickinson soils, for example, are somewhat excessively drained, even though they are no more than moderately sloping, because they are very rapidly permeable.

The Tripoli, Readlyn, and Kenyon soils are examples of soils that formed in the same kind of parent material and under similar vegetation but differ because of differences in topographic position. The Tripoli soils are on broad, level or nearly level, high, upland flats. Readlyn soils are on nearly level ridges and long, gentle convex side slopes. Kenyon soils are on long, convex ridges, or highs, and gentle or moderate, convex side slopes. Topography influences the drainage of these soils.

Depressions in the landscape collect and impound water for a period of time and thus accelerate the development of soils that are poorly drained and have a distinct, light-colored subsurface layer and a gray subsoil. The Blockton and Rolfe soils formed in depressions.

Alluvial land and soils of the Colo, Spillville, and Nodaway series are on bottom land. Although they are nearly level, their microrelief affects runoff, depth to water table, and the rate at which they receive new sediments. Colo soils are on low elevations, generally some distance from stream channels. They have a high water table and impound water for short periods of time. Alluvial land and Nodaway soils lie next to stream channels. They receive sediments during periods of flooding. Nodaway soils are on slightly higher elevations than Alluvial land and thus have a lower water table and do not impound water. Spillville soils are intermediate in relief between Colo and Nodaway soils. They are better drained and less clayey than Colo.

The Terril soils are on foot slopes and have properties related to the soils upslope from which they receive sediments.

The Sogn soils are on steep slopes and have weak soil development. Most of the water that falls on their surface layer runs off.

Time

Time is necessary for the processes of soil formation to take place. The amount of time varies from a few days, during which fresh alluvial deposits can accumulate, to thousands of years. Generally, if weathering continues over a long period of time, more and more soluble material is leached out and the texture of the subsoil becomes finer. Other factors, however, may modify the effect of time. Soils that formed in material resistant to weathering, such as quartz sand, do not change much with time. Very steep soils weather slowly because much of the water runs off and little infiltrates.

The age of the deposits from which many of the soils in Bremer County formed is given under the heading "Parent material."

Classification of Soils

Two systems of classifying soils are now in use in the United States. One is the 1938 system (*3*), later revised and supplemented. The other is the system that was adopted by the Soil Conservation Service in 1965. The current system is explained in "Soil Classification, A Comprehensive System—7th Approximation," issued in tentative form in 1960 by the Soil Conservation Service and most recently revised by a supplement issued in March 1967. Table 7 shows the soil series classified into higher categories according to the current and the 1938 system. The placement of some soil series in the current system, especially in families, may change as more precise information becomes available. For this reason the family category is not shown in table 7.

TABLE 7.—*Soil series classified according to the current and the 1938 systems of classification*

Series	Current classification		1938 classification	
	Subgroup	Order	Great soil group	Order
Aredale	Typic Hapludoll	Mollisol	Brunizem	Zonal.
Atkinson	Typic Argiudoll	Mollisol	Brunizem	Zonal.
Backbone	Mollic Hapludalf	Alfisol	Gray-Brown Podzolic [1]	Zonal.
Bassett	Mollic Hapludalf	Alfisol	Gray-Brown Podzolic [1]	Zonal.
Blockton, dark gray subsoil variant.	Typic Argialboll	Mollisol	Planosol	Intrazonal.
Burkhardt	Entic Hapludoll	Mollisol	Brunizem [2]	Zonal.
Chelsea	Alfic Udipsamment	Entisol	Gray-Brown Podzolic [2]	Zonal.
Clyde	Typic Haplaquoll	Mollisol	Humic Gley	Intrazonal.
Coggon	Typic Hapludalf	Alfisol	Gray-Brown Podzolic	Zonal.
Colo	Cumulic Haplaquoll	Mollisol	Humic Gley [3]	Intrazonal.
Cresco	Typic Argiudoll	Mollisol	Brunizem	Zonal.
Dickinson	Typic Hapludoll	Mollisol	Brunizem	Zonal.
Dinsdale	Typic Argiudoll	Mollisol	Brunizem	Zonal.
Fayette	Typic Hapludalf	Alfisol	Gray-Brown Podzolic	Zonal.
Floyd	Aquic Hapludoll	Mollisol	Brunizem	Zonal.
Franklin	Aeric Mollic Ochraqualf	Alfisol	Gray-Brown Podzolic [1]	Zonal.
Hagener	Entic Hapludoll	Mollisol	Brunizem [2]	Zonal.
Harpster	Typic Calciaquoll	Mollisol	Humic Gley	Intrazonal.
Hayfield	Aeric Mollic Ochraqualf	Alfisol	Gray-Brown Podzolic [1]	Zonal.
Kenyon	Typic Hapludoll	Mollisol	Brunizem	Zonal.
Klinger	Aquic Argiudoll	Mollisol	Brunizem	Zonal.
Lamont	Typic Hapludalf	Alfisol	Gray-Brown Podzolic	Zonal.
Lawler	Aquic Hapludoll	Mollisol	Brunizem	Zonal.
Marshan	Typic Haplaquoll	Mollisol	Humic Gley	Intrazonal.
Maxfield	Typic Haplaquoll	Mollisol	Humic Gley	Intrazonal.
Muscatine	Aquic Argiudoll	Mollisol	Brunizem	Zonal.
Nodaway	Typic Udifluvent	Entisol	Alluvial	Azonal.
Oran	Aeric Mollic Ochraqualf	Alfisol	Gray-Brown Podzolic [1]	Zonal.
Ostrander	Typic Hapludoll	Mollisol	Brunizem	Zonal.
Peaty muck		Histosol	Bog	Intrazonal.
Port Byron	Typic Hapludoll	Mollisol	Brunizem	Zonal.
Readlyn	Aquic Hapludoll	Mollisol	Brunizem	Zonal.
Riceville	Aeric Mollic Ochraqualf	Alfisol	Gray-Brown Podzolic [1]	Zonal.
Rockton	Typic Argiudoll	Mollisol	Brunizem	Zonal.
Rolfe	Typic Argialboll	Mollisol	Planosol	Intrazonal.
Sable	Typic Haplaquoll	Mollisol	Humic Gley	Intrazonal.
Sattre	Mollic Hapludalf	Alfisol	Gray-Brown Podzolic [1]	Zonal.
Seaton	Typic Hapludalf	Alfisol	Gray-Brown Podzolic	Zonal.
Sogn	Lithic Hapludoll	Mollisol	Lithosol	Azonal.
Spillville	Cumulic Hapludoll	Mollisol	Brunizem [3]	Zonal.
Terril	Cumulic Hapludoll	Mollisol	Brunizem	Zonal.
Tripoli	Typic Haplaquoll	Mollisol	Humic Gley	Intrazonal.
Waukegan	Typic Hapludoll	Mollisol	Brunizem	Zonal.
Winneshiek	Mollic Hapludalf	Alfisol	Gray-Brown Podzolic [1]	Zonal.

[1] Intergrade to Brunizem.
[2] Intergrade to Regosol.
[3] Intergrade to Alluvial.

In the 1938 classification system the soils are placed in six categories. Beginning with the most inclusive, the categories are the order, the suborder, the great soil group, the family, the series, and the type. The highest category consists of only three orders, whereas the lowest category consists of thousands of soil types. The suborder and family categories have never been fully developed in the 1938 system and thus have been little used. Attention has been given largely to the classification of soils into types and series within counties or comparable areas and to the subsequent grouping of series into great soil groups and orders.

The classification of soils into types and series is discussed in the section "How This Survey Was Made." In the following paragraphs the classification of soils into great soil groups and orders is explained.

A great soil group consists of soil series that have similar major characteristics. The soils of all the series in a great soil group have the same kinds of principal horizons, though the degree of development may vary. Within each group, the soils may differ greatly in parent material, color, texture, age, and position on the landscape. Some soil series have properties intermediate between two great soil groups. These are called intergrades or transitional soils.

The highest category of the 1938 system consists of the zonal order, the intrazonal order, and the azonal order (*19*).

Zonal order

The zonal order is made up of soils having evident, genetically related horizons that reflect in their formation

the dominant influence of climate and living organisms. In Bremer County the zonal order is represented by the Brunizem and Gray-Brown Podzolic great soil groups.

BRUNIZEMS

Brunizems, formerly called Prairie soils, develop under prairie grass in a temperate, relatively humid climate (*17*). The Brunizems in Bremer County generally are nearly level to rolling.

Typical Brunizems have a black or very dark brown A horizon 10 to 16 inches thick, a brown or mottled gray and brown B horizon 15 to 30 inches thick, and a yellowish-brown mottled C horizon. The C horizon may or may not be leached of carbonates.

Most Brunizems in this county are medium textured in the A horizon and medium textured or moderately fine textured in the B horizon. The A horizon has a granular structure; the B horizon has a slightly rounded, subangular blocky structure; and the C horizon generally lacks a distinct structure. The horizon boundaries are generally gradual.

The Brunizems are represented in Bremer County by the Aredale, Atkinson, Cresco, Dickinson, Dinsdale, Floyd, Kenyon, Klinger, Lawler, Muscatine, Ostrander, Port Byron, Readlyn, Rockton, Terril, and Waukegan soils. Soils of the Burkhardt and Hagener series are Brunizems intergrading to Regosols. The Spillville soils are Brunizems intergrading to Alluvial soils.

GRAY-BROWN PODZOLIC SOILS

Gray-Brown Podzolic soils form under forest vegetation. Typically, they 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, and a yellowish-brown or mottled gray and yellowish-brown B horizon 20 to 40 inches thick or more. The C horizon is yellowish brown and is leached.

In this county the texture of the A1 and A2 horizons is silt loam or loam; that of the B horizon is silty clay loam or loam to clay loam. Generally, the A1 horizon has weak granular structure and the A2 horizon has thin platy structure. The structure of the B horizon is generally subangular blocky or is prismatic and breaks to subangular. In some places the structure is angular blocky. The C horizon does not have a well-developed structure. The horizon boundaries are more distinct than those of Brunizems.

The Gray-Brown Podzolic soils are represented in Bremer County by the Coggon, Fayette, Lamont, and Seaton series.

The Backbone, Bassett, Franklin, Hayfield, Oran, Sattre, and Winneshiek soils are Gray-Brown Podzolic soils intergrading to Brunizems. Laboratory data indicate that, genetically, these soils are more closely related to Gray-Brown Podzolic soils than to Brunizems (*21*). They developed under grass and hardwoods, whereas the typical Gray-Brown Podzolic soils developed under hardwoods. The encroachment of deciduous trees on the prairie has been related to changes in climate (*9*). In general, the intergrades to Brunizems have a thicker, darker colored A1 horizon and a less distinct A2 horizon than the typical Gray-Brown Podzolic soils.

The Chelsea soils are Gray-Brown Podzolic soils intergrading to Regosols.

Intrazonal order

The intrazonal order is made up of soils having evident, genetically related horizons that reflect the dominant influence of a local factor, such as topography or parent material. The Humic Gley, Bog, and Planosol great soil groups represent the intrazonal order in Bremer County.

HUMIC GLEY SOILS

Humic Gley soils form under prairie or sedge vegetation in wet, poorly drained sites. A typical Humic Gley soil in Bremer County 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 of the A and B horizons ranges from loam to silty clay loam. The maximum content of clay may be in the A horizon. The structure is typically granular in the A horizon and subangular blocky in the B horizon. It is weakly developed or lacking in the C horizon.

The Humic Gley soils developed in areas that have a high water table as a result of poor natural drainage. The excess water kept oxygen from entering the soil pores and thus brought about reduction, segregation, and removal of the iron compounds and resulted in an olive-gray subsoil.

The Humic Gley group is represented in Bremer County by the Clyde, Harpster, Marshan, Maxfield, Sable, and Tripoli soils. The Colo soils are Humic Gley soils intergrading to Alluvial soils.

BOG SOILS

Bog soils consist of peat and muck. These soils occupy very poorly drained depressions or seepage areas. The excess water limits the supply of oxygen and retards the decay of accumulated organic matter. Bog, or organic, soils are more than 30 percent organic matter in the surface layer, which in Bremer County is more than 12 inches thick. Peat consists of partly decomposed plant residue in which plant parts can be recognized. It is brown in color. Muck is black, is thoroughly decomposed, and contains a higher percentage of mineral matter than peat.

Peaty muck is the only Bog soil in Bremer County.

PLANOSOLS

Planosols generally are nearly level or depressional. Most of the Planosols in Bremer County are in depressions on stream benches or uplands. A high water table and ponded surface water have influenced their development.

Typical Planosols have a very dark gray or black A1 horizon 4 to 10 inches thick, a gray or light-gray, platy A2 horizon 3 to 16 inches thick, and a very dark gray to dark olive-brown B horizon 10 to 20 inches thick. The C horizon is mottled brown and gray or light gray.

The texture of the A1 and the A2 horizon is medium; that of the B horizon is fine or moderately fine; and that of the C horizon is moderately fine. Some Planosols, such as the Blockton soils, have sand and gravel at a varying depth. The clay in the B horizon limits the penetration of water and roots.

The structure of the A1 horizon is granular, and that of the A2 horizon is generally platy. The B horizon has weak prismatic structure that breaks to strong fine blocks. The C horizon has weak structure or none.

The Rolfe and the Blockton soils are the only Planosols in Bremer County.

Azonal order

The azonal order is made up of soils that lack distinct, genetically related horizons, commonly because of youth, resistant parent material, or steep topography. This order is represented in Bremer County by the Alluvial soils and the Lithosols.

ALLUVIAL SOILS

Alluvial soils occur on bottom lands and low benches. They form in sediments deposited by floodwater. They do not have well-differentiated horizons formed by the processes of soil development, but some Alluvial soils have distinct layers that are the successive deposits of sediments. Layers of sand and silt are common. All soil properties vary because of the variations in the nature of the sediments.

The Alluvial great soil group is represented in Bremer County by the Nodaway soils. The largest areas of these soils are along Quarter Section Run, west of the town of Denver.

LITHOSOLS

Lithosols are rocky, stony, or shallow soils that consist of about 12 inches or less of soil material over consolidated bedrock. Most Lithosols are strongly sloping or steep. The Sogn soils are the only ones in Bremer County classified as Lithosols. These soils occur mainly along the Cedar and the Shell Rock Rivers.

Morphology of Soils

This subsection contains a description of the morphology, or physical composition, of the soils of each series. In each series description a representative profile is described and the range of characteristics is given.

Aredale Series

The Aredale series consists of well-drained soils that developed from loamy, medium-textured eolian material 36 to 70 inches thick over glacial till. In many places a pebble band occurs between the loamy overburden and the glacial till.

These soils are on uplands. The slope range is 2 to 9 percent. The native vegetation consisted of prairie grasses.

Aredale soils contain more sand than Port Byron and Dinsdale soils. They are deeper to glacial till than Ostrander soils. They contain less sand than Dickinson soils.

Representative profile of Aredale loam, 580 feet west and 162 feet north of the corner post in the southeast corner of the SW¼ sec. 6, T. 91 N., R. 14 W., in a cultivated field—

Ap—0 to 7 inches, black (10YR 2/1) loam or silt loam; weak, fine, granular structure; friable; roots are plentiful; slightly acid; clear, smooth boundary.

A12—7 to 11 inches, black (10YR 2/1) loam or silt loam; moderate, fine, granular structure; friable; roots are plentiful; slightly acid; gradual, smooth boundary.

A3—11 to 15 inches, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) loam or silt loam; some mixing of brown to dark brown (10 YR 4/3); weak, fine, granular structure; friable; few black (10YR 2/1) worm casts; few roots; slightly acid; gradual, smooth boundary.

B1—15 to 22 inches, dark-brown (10YR 3/3) loam or silt loam; some mixing of dark yellowish brown (10YR 3/4); weak, fine, subangular blocky structure; friable; few very dark brown (10YR 2/2) worm casts; few roots; few fine pores; medium acid; gradual, smooth boundary.

B21—22 to 38 inches, loam or silt loam; nearly continuous dark yellowish-brown (10YR 3/4) ped faces; ped interiors are dark yellowish-brown (10YR 4/4); weak, fine, subangular blocky structure; friable; few roots; common fine pores; medium acid; lower 3 inches is somewhat yellower and slightly sandier; abrupt, smooth boundary.

IIB22—38 to 46 inches, light sandy clay loam; ped faces are yellowish brown (10YR 5/4) with some streaks of brown (10YR 5/3); ped interiors are yellowish brown (10YR 5/6); moderate, fine and medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; prism faces are yellowish brown (10YR 5/4) and have a concentration of fine sand on the larger areas; slightly firm; a few, very fine, black (10YR 2/1) oxide concretions; pebble band (pebbles ½ inch to 2 inches in diameter) at the surface of this horizon; few roots; few fine pores; slightly acid; gradual, smooth boundary.

IIIB3—46 to 58 inches, light clay loam; few, fine, distinct, light brownish-gray (2.5Y 6/2) and strong-brown (7.5YR 5/8) mottles; prism faces are yellowish brown (10YR 5/4) with a few streaks of light brownish gray (2.5Y 6/2); ped interiors are yellowish brown (10YR 5/6); moderate, medium, prismatic structure that breaks to moderate, coarse, subangular blocky structure; there is a slight concentration of fine sand on prism faces; slightly firm; few, very fine, black (10YR 2/1) oxide concretions; few roots; few fine pores; slightly acid; gradual, smooth boundary.

IIIC1—58 to 66 inches, yellowish-brown (10YR 5/6) light clay loam; few, fine, distinct, light brownish-gray (2.5Y 6/2) and strong-brown (7.5YR 5/8) mottles; massive; slightly firm; neutral; clear, wavy boundary.

IIIC2—66 to 70 inches, same as IIIC1 horizon, but calcareous.

The A1 horizon is 7 to 12 inches thick, if not more than slightly eroded, and is black (10YR 2/1) or very dark brown (10YR 2/2). The A3 horizon is very dark brown (10YR 2/2) or dark brown (10YR 3/3). If the B1 and B2 horizons are in the eolian material, they commonly have the same colors as those of the profile described. If the B3 and C horizons are in the eolian material, they are dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/6). In glacial till, the B and C horizons differ from those described, principally in the number and distinctness of the grayish-brown mottles and in the color of the ped and prism faces.

The eolian parent material is medium loam or silt loam. The sand content generally ranges from 25 to 45 percent and the clay content from 16 to 20 percent. The glacial till ranges from medium loam to sandy clay loam or light clay loam and is generally slightly firm. In most places there are a few fine manganese concretions in the lower IIIB horizon. The A3 and B horizons range from slightly acid to medium acid. Where the glacial till is deep, there are scattered pockets or discontinuous lenses of sandy material 8 to 16 inches thick between the till and the overburden. All of the eolian parent material is

leached. The depth to calcareous till ranges from 60 to 90 inches.

Atkinson Series

The Atkinson series consists of well-drained soils that developed from loamy glacial sediments 36 to 50 inches thick. These soils are underlain by limestone bedrock or a thin layer of residuum and bedrock. A pebble band occurs at a depth of 18 to 24 inches in most places. The top 4 to 16 inches of limestone is generally shattered.

These soils are on uplands and on a few nearly level to gently sloping benches. They have a slope range of 0 to 9 percent, but most slopes are between 3 and 8 percent. The native vegetation consisted of prairie grasses.

Atkinson soils are deeper to limestone than Rockton soils. They have a limestone substratum, whereas Kenyon, Ostrander, and Aredale soils are underlain by glacial till.

Representative profile of Atkinson loam, 550 feet north and 60 feet east of the corner post in the southwest corner of the NW¼SW¼ sec. 27, T. 91 N., R. 13 W., in a cultivated field—

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

A3—7 to 15 inches, very dark grayish-brown (10YR 3/2) light loam; common fine mixings of very dark brown (10YR 2/2), brown, and dark brown (10YR 4/3); weak, medium, subangular blocky structure that breaks to weak, very fine, subangular blocky; friable; few roots; neutral; clear, smooth boundary.

B1—15 to 23 inches, brown and dark-brown (10YR 4/3) medium loam; few, fine, dark yellowish-brown (10YR 4/4) peds; weak, medium, subangular blocky structure; friable; few roots; few fine pores; few, flat to angular, 3- to 10-inch stones in the lower part; slightly acid; clear, smooth boundary.

IIB21t—23 to 30 inches, brown and dark-brown (10YR 4/3) light clay loam; some mixing of very dark gray (10YR 3/1) and dark gray (10YR 4/1); moderate, fine, subangular blocky structure; friable; few, very dark brown (10YR 2/2) clay films on ped faces and in some root channels; few roots; few fine pores; slightly acid; gradual, smooth boundary.

IIB22t—30 to 35 inches, medium clay loam with common, fine, distinct, yellowish-brown (10YR 5/4 and 10YR 5/6) mottles; ped faces have nearly continuous, brown to dark-brown (10YR 4/3) clay films and a few, somewhat thicker, dark-brown (10YR 3/3) streaks; ped interiors are brown to dark brown (10YR 4/3); weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; slightly firm; neutral; clear, smooth boundary.

II&IIIB23t—35 to 46 inches, heavy clay loam to light clay; few, fine, distinct, light brownish-gray (2.5Y 6/2) and strong-brown (7.5YR 5/8) mottles; prism and ped faces are dark brown and brown (10YR 4/3 and 5/3); common, fine, distinct, light grayish-brown (2.5Y 6/2) mottles and a few, fine, distinct, yellowish-red (5YR 4/8) clay films; ped interiors are yellowish brown (10YR 5/4); black (10YR 2/1) clay films in root channels, some channels filled; slightly acid; abrupt, smooth boundary.

IIIR—46 inches, hard limestone that is somewhat shattered.

The Al horizon is black (10YR 2/1) to very dark brown (10YR 2/2) loam 7 to 11 inches thick. The A3 horizon ranges from very dark brown (10YR 2/2) to dark yellowish brown (10YR 3/4) and generally has some mixing of darker or lighter colors.

The IIB2 horizon is dominantly clay loam, but it ranges from heavy loam to clay loam. The color ranges from brown or dark brown (10YR 4/3) to yellowish brown (10YR 5/4).

A fine-textured layer 2 to 8 inches thick occurs above the limestone in some places. This layer generally is residuum. It is yellowish brown to strong brown and contains some light brownish-gray or yellowish-red mottles. Clay films in the fine-textured layer are also yellowish red or reddish brown.

The solum is generally slightly acid but ranges to medium acid in the A and B1 horizons and to neutral in the lower B2 horizon.

The depth to bedrock ranges from 36 to 50 inches, but the depth is between 40 and 50 inches in most places. The shattered upper part of the bedrock is 4 to 16 inches thick, and from 2 to 10 percent of this part is medium-textured or fine-textured material. Plant roots penetrate this shattered rock.

Backbone Series

The Backbone series consists of somewhat excessively drained soils that developed from sandy loam and loamy sand over a moderately fine textured layer underlain by limestone bedrock at a depth of 20 to 40 inches. The top 4 to 16 inches of limestone is commonly shattered.

These soils are on uplands. They have a slope range of 2 to 14 percent. The native vegetation consisted of hardwoods.

Backbone soils are coarser textured than Winneshiek soils and finer textured than Chelsea soils. They are underlain by limestone, whereas Lamont soils are not. They have a thicker solum than Sogn soils.

Representative profile of Backbone loamy sand, 900 feet south and 212 feet east of the northwest corner of sec. 28, T. 91 N., R. 13 W.; in bluegrass, but formerly cultivated—

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loamy sand; very weak, very fine, granular structure; very friable; plentiful roots; slightly acid; abrupt, smooth boundary.

A2—8 to 12 inches, brown (10YR 5/3) loamy sand; common, dark-brown (10YR 3/3) mixings; single grain; few roots; slightly acid; clear, irregular boundary.

B1—12 to 17 inches, sandy loam; ped faces are brown to dark brown (10YR 4/3) and dark yellowish brown (10YR 4/4); ped interiors are dark yellowish brown (10YR 4/4); weak, medium, subangular blocky structure; friable; few roots; medium acid; clear, smooth boundary.

IIB21t—17 to 27 inches, medium clay loam to heavy sandy clay loam; prism and ped faces are brown (10YR 5/3) and dark yellowish brown (10YR 4/4); ped interiors are dark yellowish brown (10YR 4/4); weak, coarse, prismatic structure that breaks to moderate, fine and medium, subangular blocky structure; firm; few, dark-brown (7.5YR 3/2) clay films; common, fine pores; strongly acid; clear, wavy boundary.

IIB22t—27 to 32 inches, heavy clay loam; ped faces have discontinuous, very dark gray (10YR 3/1) clay films; ped interiors are brown to dark brown (10YR 4/3); moderate, fine, subangular blocky structure; firm; strongly acid; abrupt, wavy boundary.

IIIR—32 inches, yellow (10YR 7/6) and light yellowish-brown (2.5Y 6/4) silt loam (estimated 6 percent sand); some mixing of dark brown (7.5YR 4/4); friable; a few vertical, dark-brown (10YR 3/3) clay streaks; 20 percent of this horizon consists of angular chunks of limestone ½ inch to 6 inches long; abrupt, wavy boundary; shattered, hard limestone at a depth of 36 inches.

The A1 horizon is very dark gray (10YR 3/1) loamy sand to sandy loam 6 to 8 inches thick. The Ap horizon is very dark grayish brown (10YR 3/2) or dark grayish brown (10YR 4/2). The A2 horizon is dark grayish-brown (10YR 4/2) to brown (10YR 5/3) loamy sand. This horizon is generally 2 to 6 inches thick, but in some places it extends into the B horizon in narrow, irregular columns, and it may extend down to the limestone.

The B1 horizon is light sandy loam, but medium sandy loam is not excluded. The IIB2 horizon, which is 4 to 15 inches thick, is light to heavy clay loam and may grade to clay or silty clay just above the bedrock. The colors of the B horizon vary little in value and chroma but may range in hue to 7.5YR.

The friable, mealy IIIR horizon is incidental to the series and is not always present. The solum always extends to shattered, hard bedrock. It ranges from slightly acid to strongly acid, depending on whether the soil is cultivated and limed.

The depth to limestone ranges from 20 to 40 inches but generally is between 24 and 34 inches. The upper 4 to 16 inches of limestone is generally shattered. From 2 to 10 percent of the shattered limestone is medium-textured to fine-textured material that can be penetrated by plant roots.

Bassett Series

The Bassett series consists of moderately well drained soils that developed from loamy material 14 to 21 inches thick over loam glacial till. A pebble band separates the glacial till from the overlying material in most places.

These soils are on uplands. They have a slope range of 2 to 9 percent. The native vegetation consisted of trees and grasses.

The Bassett series is a member of the hydrosequence that includes the somewhat poorly drained Oran series. Bassett soils have a lighter colored Ap horizon and a thinner A1 horizon than Kenyon soils, and they have an A2 horizon, which Kenyon soils lack. They have a darker Ap horizon than Coggon soils and a thicker, darker A1 horizon. In many places their horizons are less distinct than those of Coggon soils.

Representative profile of Bassett loam, 320 feet east and 80 feet south of the northwest corner of the SE¼ SE¼ sec. 22, T. 93 N., R. 12 W., in a cultivated field—

Ap—0 to 6 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; few roots; slightly acid; abrupt, smooth boundary.

A2—6 to 14 inches, brown or dark-brown (10YR 4/3) loam; some mixing of very dark brown (10YR 2/2) from the Ap horizon; weak, thin, platy structure; friable; strongly acid; clear, wavy boundary.

IIB1—14 to 20 inches, heavy loam; prism and ped faces are brown (10YR 5/3) and dark yellowish brown (10YR 4/4); ped interiors are dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6); weak, medium, prismatic structure that breaks to weak, fine, subangular blocky structure; few roots; common, fine and medium pores; friable; pebble band (½-inch to 3-inch pebbles) at a depth of 14 to 17 inches; strongly acid; gradual, smooth boundary.

IIB21—20 to 29 inches, heavy loam; prism faces are thinly coated with pale-brown (10YR 6/3) fine sand; ped faces are brown (10YR 5/3) and have a few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; ped interiors are strong brown (7.5YR 5/6) and brown (10YR 5/3); moderate, medium, prismatic structure that breaks to weak, fine, subangular blocky structure; friable; few roots; common, fine and medium pores; very strongly acid; gradual, smooth boundary.

IIB22t—29 to 34 inches, loam; prism faces are thinly coated with light brownish gray (2.5Y 6/2) very fine sand that has a few, large, distinct, brown to dark-brown (10YR 4/3) mottles; ped interiors are strong brown (7.5YR 5/6), yellowish brown (10YR 5/6), and grayish brown (2.5Y 5/2); moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; slightly firm; few dark-gray (10YR 4/1 and N 4/0) clay films on prism and ped faces and in a few of the root channels; few roots; few fine and medium pores; very strongly acid; gradual, smooth boundary.

IIB3t—34 to 45 inches, loam; few, fine, faint, brown to dark-brown (10YR 4/3) mottles; prism faces are thinly coated with grayish-brown (2.5Y 5/2) very fine sand that has a few, medium, faint, brown (10YR 5/3) mottles; ped interiors are yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2); weak, medium, prismatic structure; slightly firm; few dark-brown to brown (7.5YR 4/2) clay films on prism faces and in root channels; many, fine, black (N 2/0) oxide concretions and grainy coats; very strongly acid; gradual, smooth boundary.

IIC1—45 to 62 inches, dark yellowish-brown (10YR 4/4), yellowish-brown (10YR 5/6), and light brownish-gray (2.5Y 6/2) loam; few, fine, faint, strong-brown (7.5YR 5/8) mottles to a depth of 56 inches; massive; slightly firm; few, fine, black (N 2/0) oxide concretions and grainy coatings; strongly acid in upper part, medium acid in lower part; gradual, smooth boundary.

IIC2—62 to 76 inches, yellowish-brown (10YR 5/6), dark yellowish-brown (10YR 4/4), and light brownish-gray (2.5Y 6/2) heavy loam; massive; slightly firm; slightly acid; clear, wavy boundary.

IIC3—76 to 80 inches, same as IIC2 but calcareous.

The Ap horizon is generally very dark brown (10YR 2/2) to dark brown (10YR 3/3). In undisturbed areas the A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) and is 4 to 7 inches thick. The A2 horizon ranges from very dark grayish brown (10YR 3/2) to dark brown or brown (10YR 4/3) and from distinct to barely discernible. The texture of the A1 and A2 horizons is dominantly loam but may be gritty silt loam.

The texture of the B and C horizons is generally heavy loam but ranges from medium loam to sandy clay loam and light clay loam. In the zone of the pebble band the texture is heavy sandy loam in most places. The profile is generally friable to a depth of about 30 inches and slightly firm below. The loamy material overlying the pebble band has a higher content of silt and a lower content of sand than the underlying till.

The colors of the B and C horizons differ from those described, principally in the amount and distinctness of grayish-brown mottling. Mottles occur at a depth of 24 to 34 inches. A few distinct clay films and streaks are on prism and ped faces in the lower B2 horizon and the B3 horizon, and a few clay films or accumulations are in the root channels of the B3 and C horizons. Oxide concretions are not always present.

The B horizon is strongly to very strongly acid. The depth to calcareous till ranges from 50 to 90 inches but is generally between 60 and 80 inches.

Blockton Series, Dark Gray Subsoil Variant

The Blockton series, dark gray subsoil variant, consists of poorly drained soils, that developed from fine textured and moderately fine textured, silty alluvial sediments. These sediments are presumed to have been deposited by slack water from the Shell Rock and Cedar Rivers.

These soils are on stream benches. The slope range is 0 to 2 percent. A few areas are in slight depressions. The native vegetation consisted of prairie grasses and sedges tolerant of excessive wetness.

These soils have a finer textured B horizon than Rolfe soils.

Representative profile of Blockton silty clay loam, dark gray subsoil variant, 900 feet north and 250 feet west of the southeast corner of the SW¼ sec. 30, T. 91 N., R. 14 W., in a cultivated field—

A1—0 to 10 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; plentiful roots; medium acid; clear, smooth boundary.

A2—10 to 16 inches, dark-gray (10YR 4/1) heavy silt loam; weak, thin, platy structure; friable; few roots; strongly acid; abrupt, smooth boundary.

B21tg—16 to 27 inches, dark-gray (10YR 4/1) heavy silty clay; few, fine, distinct, olive-brown (2.5Y 4/4) mottles; weak, fine, prismatic structure that breaks to strong, fine and very fine, subangular blocky structure; firm; smooth, shiny ped faces; few roots; few fine pores; strongly acid; clear, smooth boundary.

B22tg—27 to 42 inches, grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) heavy silty clay; moderate, fine and very fine, angular blocky structure; firm; smooth, shiny ped faces; slightly acid; clear, smooth boundary.

B3t—42 to 46 inches, light olive-brown (2.5Y 5/4) and pale-olive (5Y 6/3) medium silty clay; few, fine, prominent, yellowish-red (5YR 4/6) and few, fine, faint, grayish-brown (2.5Y 5/2) mottles; weak, medium, angular blocky structure; firm; matrix is leached, but there are a few soft lime concretions; neutral; clear, smooth boundary.

IIC—46 to 70 inches, brown or dark-brown (10YR 4/3) gravelly loamy sand, some mixing of strong brown (7.5YR 5/6); single grain; loose; few small lime concretions below a depth of 64 inches; neutral.

The A1 horizon is dominantly black (10YR 2/1) light silty clay loam to heavy silt loam 6 to 10 inches thick. The A2 horizon is dark-gray (10YR 4/1) to very dark grayish-brown (10YR 3/2) silt loam 6 to 12 inches thick. The B1 horizon is generally lacking.

The B2 horizon is very dark gray (10YR 3/1) to olive-gray (5Y 5/2) medium to heavy silty clay. It commonly has a few brown and olive-brown mottles. The upper B2 horizon is a little darker colored than the lower B2 horizon in most places. The B3 horizon has a higher chroma and more distinct mottling than the B2 horizon. It ranges from medium silty clay loam to medium silty clay.

The C horizon is about the same color as the B3 horizon but ranges from silty clay to loamy sand in texture and generally is calcareous. The reaction of the A and B1 horizons and the upper B2 horizon is medium to strongly acid. The lower B2 horizon is slightly acid to medium acid and the B3 horizon is slightly acid to neutral. The sand content of the solum ranges from 1 to 10 percent. The depth to the IIC horizon ranges from 40 to 60 inches but is commonly between 40 and 50 inches.

Burkhardt Series

The Burkhardt series consists of excessively drained soils derived from a shallow layer of sandy loam to light loam over gravelly material.

These soils generally are on stream benches and bench escarpments, but a few small areas are on uplands. The slope range is 0 to 2 percent on the benches and 2 to 9 percent on the escarpments and uplands. The native vegetation consisted of mixed prairie grasses.

Burkhardt soils are shallower to gravelly material than Waukegan soils and Dickinson, gravelly substratum soils, and they have less clay in the B horizon. They have a finer textured A horizon than Hagener soils but are coarser textured below the A horizon.

Representative profile of Burkhardt sandy loam, 1,160 feet east of the southwest corner of the SE¼ sec. 32, T. 93 N., R. 14 W., and 15 feet north of road fence, in a cultivated field—

Ap—0 to 7 inches, very dark brown (10YR 2/2) sandy loam; weak, fine and very fine, granular structure; friable; neutral; clear, smooth boundary.

A3—7 to 13 inches, very dark brown (7.5YR 2/2) sandy loam that has some dark brown (7.5YR 3/2) and a few, fine, very dark brown (10YR 2/2) krotovinas; very weak, fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

IIB2—13 to 16 inches, dark-brown (10YR 3/3) loamy gravel; single grain; loose; strongly acid; clear, smooth boundary (estimated 40 percent ½-inch to 1½-inch pebbles, 40 percent 2-millimeter to ½-inch pebbles, 20 percent medium to very coarse sand).

IIB3—16 to 23 inches, dark-brown (10YR 3/3) gravelly loamy sand; single grain; loose; strongly acid; clear, smooth boundary.

IIC1—23 to 48 inches, dark yellowish-brown (10YR 4/4), yellowish-brown (10YR 5/6), and light yellowish-brown (10YR 6/4) gravelly coarse sand; single grain; loose; medium acid.

The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2) loam to sandy loam. The weakly developed B horizon is dark brown (7.5YR 3/2 to 10YR 3/3). The depth to the gravelly material is 8 to 20 inches but is dominantly between 10 and 16 inches. This material ranges from gravelly sand to loamy gravel and gravel. Gravel lenses may occur as discontinuous bands in the lower substratum. The reaction ranges from slightly acid to strongly acid in the A and B horizons, depending on the liming program.

Chelsea Series

The Chelsea series consists of excessively drained soils that developed from deep sands and loamy sands.

These soils are on uplands, stream benches, and outwash areas. They are commonly on upland slopes that face east, south, or southeast. On benches and outwashes they occur as mounds or dunes. The slope range is 0 to 18 percent. The native vegetation consisted of hardwoods.

Chelsea soils are lighter colored than Hagener soils and are coarser textured than Lamont soils. They are also coarser textured than Backbone soils and are not underlain by limestone at a depth of 20 to 40 inches.

Representative profile of Chelsea sand, 460 feet south and 30 feet west of the northeast corner, SW¼ sec. 28, T. 91 N., R. 14 W., in a cultivated field—

Ap—0 to 4 inches, very dark brown (10YR 2/2) fine sand; very weak, fine, granular structure that breaks to single grain; loose; plentiful roots; slightly acid; clear, smooth boundary.

B—4 to 16 inches, dark yellowish-brown (10YR 3/4) medium sand; single grain; loose; few roots; strongly acid; diffuse, smooth boundary.

C1—16 to 52 inches, dark yellowish-brown (10YR 4/4) medium sand; single grain; strongly acid; abrupt, smooth boundary.

B21—52 to 53½ inches, dark-brown and brown (7.5YR 4/4) loamy sand; single grain; loose; strongly acid; abrupt, irregular boundary.

C2—53½ to 60 inches, dark yellowish-brown (10YR 4/4) medium sand; single grain; strongly acid; abrupt, smooth boundary.

B22—60 to 62 inches, brown and dark-brown (7.5YR 4/4) loamy sand; single grain; loose; strongly acid; abrupt, irregular boundary.

C3—62 to 70 inches, yellowish-brown (10YR 5/6) medium sand; single grain; loose; strongly acid.

The A1 horizon ranges from very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and from medium sand to loamy fine sand. It is 1 to 3 inches thick. The Ap horizon ranges from very dark grayish brown (10YR 3/2) to brown or dark brown (10YR 4/3). It is generally medium sand, but the range includes loamy sand. A dark grayish-brown (10YR 4/2) to brown (10YR 5/3) A2 horizon, 3 to 6 inches thick, is present in some places.

The B2 horizon consists of bands of brown and dark-brown (7.5YR 4/4) light to heavy loamy sand 1/16 inch to 2 inches thick. Most of these bands are below a depth of 40 inches but, in a few places, they are within 8 inches of the surface. In some profiles these very thin bands occur at intervals of 4 to 6 inches below a depth of 40 inches. The B2 horizon has a redder hue than the C horizon and is slightly finer textured.

The C horizon is dominantly medium sand in texture and brown or dark brown (10YR 4/3) to yellowish brown (10YR 5/6) in color. The color ranges from brown or dark brown (7.5YR 4/4) to brownish yellow (10YR 6/6), and the texture on uplands can be medium or coarse sand. On stream benches the texture below a depth of 30 inches may range to sandy gravel.

The reaction of the profile ranges from neutral to strongly acid, depending on whether the soil has been limed.

Clyde Series

The Clyde series consists of poorly drained soils that developed in 20 to 40 inches of moderately fine textured or medium-textured material over medium-textured, friable glacial till or valley fill. In many places the till is stratified with sand to sandy loam material. A pebble band may occur between the overlying material and the till or valley fill.

These soils are in drainageways and lower concave positions on uplands. The slope range is 0 to 3 percent. The native vegetation consisted of grasses and water-tolerant plants.

Clyde soils are considered a member of the hydrosequence that includes the somewhat poorly drained Floyd soils. They are more variable in texture in the B and C horizons than Tripoli soils and are deeper to calcareous material. They differ from Marshan soils in that the latter have a thick substratum of sand or gravel. Clyde soils have a thinner A1 horizon than Colo soils. They contain more sand and less silt than Maxfield and Sable soils.

Representative profile of Clyde clay loam, 322 feet north and 371 feet west of the corner post in the southeast corner of the NE¼ sec. 10, T. 92 N., R. 14 W., in a bluegrass pasture—

A1—0 to 16 inches, black (N 2/0) light clay loam; weak to moderate, fine and very fine, granular structure; friable; plentiful roots; neutral; gradual, smooth boundary.

A3—16 to 23 inches, very dark gray (10YR 3/1) light clay loam; few, fine, distinct, dark grayish-brown (2.5Y 4/2) mottles and very few black (10YR 2/1) mixings; very weak, fine, subangular blocky structure that breaks to weak, fine, granular structure; friable; few roots; few fine pores; neutral; clear, smooth boundary.

IIB21g—23 to 28 inches, very dark gray (5Y 3/1) heavy loam; very few mixings of very dark gray (N 3/0) and few, fine, distinct, olive brown (2.5Y 4/4) mottles; weak, fine, subangular blocky structure; friable; few roots; few fine pores; an indistinct pebble band (pebbles ½ to 1 inch in diameter) at 24 inches; neutral; clear, smooth boundary.

IIB22—28 to 33 inches, olive-brown (2.5Y 4/4) and grayish-brown (2.5Y 5/2) sandy clay loam; common, fine, distinct, very dark gray (5Y 3/1) and common, fine, prominent, strong-brown (7.5YR 5/8) mottles; very weak, fine, subangular blocky structure; friable; few roots; few fine pores; mildly alkaline; clear, smooth boundary.

IIIB3—33 to 45 inches, yellowish-brown (10YR 5/6), strong-brown (7.5YR 5/8), and grayish-brown (2.5Y 5/2) loamy sand; few, fine, distinct, gray (N 5/0) mottles; kneaded, light yellowish brown (2.5Y 6/4); weak, coarse, subangular blocky structure; very friable; neutral; abrupt, wavy boundary.

IVC1—45 to 72 inches, yellowish-brown (10YR 5/6) and gray (10YR 5/1 and 5Y 6/1) heavy loam; few, fine, faint, strong-brown (7.5YR 5/8) and few, fine, prominent, red (2.5YR 4/8) mottles; massive; friable; neutral.

The A1 horizon is 12 to 20 inches thick and is generally light clay loam to heavy loam, but the texture ranges from silt loam to medium silty clay loam. An A3 horizon is not always present, but colors normally found in this horizon extend to a depth of 24 inches or more in places. The gleying varies considerably in thickness, intensity, and depth from the surface.

The matrix of the B horizon and upper C horizon is dominantly heavy loam to sandy clay loam, and it is stratified with discontinuous lenses and pockets of material ranging from sand to sandy loam.

The A horizon is slightly acid to neutral, and the B horizon is neutral to mildly alkaline. The depth to calcareous material is 50 to 80 inches.

Coggon Series

The Coggon series consists of moderately well drained soils that developed in 14 to 21 inches of loamy material over glacial till of loam texture. In many places a pebble band separates the glacial till from the overlying material.

These soils are on uplands. They have a slope range of 2 to 9 percent. The native vegetation consisted of hardwoods.

Coggon soils have a thinner A1 horizon and a lighter colored Ap horizon than Bassett soils. They also have a more distinct A2 horizon and a more strongly developed B horizon than Bassett soils.

Representative profile of Coggon loam, 930 feet west and 725 feet south of the northeast corner of sec. 22, T. 93 N., R. 12 W., in pastured open woods—

A1—0 to 3 inches, very dark gray (10YR 3/1) loam; moderate, fine and very fine, granular structure; friable; prominent roots; slightly acid; clear, wavy boundary.

A2—3 to 11 inches, dark grayish-brown (10YR 4/2) light loam; some mixing of very dark gray (10YR 3/1) from the A1 horizon; moderate, thin, platy structure; friable; plentiful roots; medium acid; clear, wavy boundary.

B1—11 to 17 inches, brown (10YR 5/3) loam; few fine mixings of yellowish brown (10YR 5/6) from the B21 horizon; moderate, fine, subangular blocky structure; friable; pebble band in lower part; few roots; strongly acid; clear, smooth boundary.

IIB21t—17 to 24 inches, heavy loam; ped faces are brown (10YR 5/3); ped interiors are yellowish brown (10YR 5/6); moderate, fine, subangular blocky structure; friable; few roots; few fine pores; strongly acid; gradual, smooth boundary.

IIB22t—24 to 31 inches, heavy loam; nearly continuous, grayish-brown (2.5Y 5/2), grainy ped faces; ped interiors are yellowish brown (10YR 5/6); few, fine, distinct, yellowish-red (5YR 5/8) and common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; moderate, fine, subangular blocky structure; friable; few dark-gray (10YR 4/1) clay films on ped faces and in a few root channels; few roots; few fine and medium pores; strongly acid; gradual, smooth boundary.

IIB23—31 to 44 inches, loam; discontinuous, light brownish-gray (2.5Y 6/2) grainy prism and ped faces; ped interiors are yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8); common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; moderate, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; slightly firm; common, fine, black (10YR 2/1) concretions of oxide; strongly acid; gradual, smooth boundary.

IIB3—44 to 62 inches, heavy loam; discontinuous, grayish-brown (10YR 5/2), grainy ped faces; ped interiors are yellowish brown (10YR 5/6); common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, medium, subangular blocky structure; slightly firm; strongly acid; gradual, smooth boundary.

IIC1—62 to 82 inches, yellowish-brown (10YR 5/6) and light brownish-gray (2.5Y 6/2) heavy loam; massive; neutral; clear, wavy boundary.

IIC2—82 to 94 inches, same as IIC1 but calcareous.

The thickness of the A1 horizon ranges from 1 to 4 inches and generally is very dark gray (10YR 3/1). The Ap horizon is dark grayish brown (10YR 4/2) to brown or dark brown (10YR 4/3). The A1 and A2 horizons are generally loam, but may be gritty silt loam.

The texture of the B and C horizons is dominantly heavy loam, but it ranges from medium loam to sandy clay loam or light clay loam. In the zone of the pebble band, the texture may be heavy sandy loam. The profile is generally friable to a depth of 30 inches and is slightly firm below this depth.

The loamy material overlying the pebble band is higher in content of silt and lower in content of sand than the underlying till. The colors of the B and C horizons differ from those of the profile described principally in the amount and distinctness of grayish-brown mottling. Mottles occur at a depth of 24 to 34 inches. A few distinct clay films are on the prism and ped faces in the B2 horizon. A few clay films or accumulations of clay may be in the root channels in the B3 and C horizons.

The B horizon is strongly to very strongly acid. The depth to calcareous material ranges from 50 to 100 inches but is generally between 60 and 85 inches.

Colo Series

The Colo series consists of poorly drained soils that developed from moderately fine textured alluvial deposits.

These soils are on flood plains of rivers and narrow, intermittent streams. They are level or have a slope not greater than 1 percent. The native vegetation consisted of grasses and water-tolerant plants.

Colo soils contain more clay and generally less sand than Spillville soils, and their hues are grayer and lighter below a depth of 40 inches. They have a thicker A1 horizon and a less distinct B horizon than Marshan and Clyde soils and contain less sand above a depth of 40 inches.

Representative profile of Colo silty clay loam, 625 feet north and 160 feet west of the southeast corner of the SW¼ sec. 4, T. 91 N., R. 12 W., in bluegrass pasture (measurement taken from center of Highway No. 3)—

A11—0 to 20 inches, black (N 2/0) light silty clay loam; moderate, fine, subangular blocky structure that breaks to moderate, fine, granular structure; friable; plentiful roots; slightly acid; clear, smooth boundary.

A12—20 to 29 inches, black (N 2/0) silty clay loam; few faint mixings of very dark brown (10YR 2/2); moderate, fine and very fine, subangular blocky structure; friable; few roots; few fine pores; neutral; clear, smooth boundary.

A13—29 to 39 inches, black (N 2/0) light silty clay loam; common, fine, prominent, yellowish-red (5YR 4/6) and dark-brown or brown (7.5YR 4/4) mottles; moderate, medium, prismatic structure; slightly firm; slightly acid; gradual, smooth boundary.

IIB—39 to 51 inches, black (10YR 2/1) and dark-gray (5Y 4/1) light clay loam; common, fine, distinct, dark-brown or brown (7.5YR 4/4) mottles; weak, medium, prismatic structure with rather irregular, shiny prism faces; slightly firm; few roots; slightly acid; clear, smooth boundary.

IIC1g—51 to 62 inches, gray (5Y 5/1) sandy clay loam; massive; slightly firm; few roots; neutral; clear, smooth boundary.

IIIC2g—62 to 76 inches, dark-gray (5Y 4/1) and olive-gray (5Y 5/2) stratified sand and sandy loam; massive to single grain; loose.

These soils have a color value of 3 or less to a depth of at least 40 inches, and the chroma is never greater than 1 above a depth of 50 inches. The texture is silty clay loam in the upper 30 to 40 inches, and the content of sand is generally 12 to 18 percent. Below this depth the texture ranges from loam to light clay loam and sandy clay loam. Moderately coarse or coarse substrata are below a depth of 45 inches in places.

Cresco Series

The Cresco series consists of moderately well drained soils that developed in 14 to 21 inches of loamy material over firm glacial till. A pebble band occurs between the glacial till and the overlying material in most places.

These soils are on uplands. The slope range is 2 to 9 percent. The native vegetation consisted of prairie grasses.

Cresco soils have more clay in the glacial till than the well-drained Ostrander soils, and they are firm and are mottled at a shallower depth. They have a thicker and darker colored A1 horizon than Bassett soils, and they lack an A2 horizon, which Bassett soils have. Cresco soils are firmer in the B horizon and upper C horizon than Kenyon soils and are grayer in the B horizon. They contain more sand and less silt than the Dinsdale soils, which developed from moderately thick loess over glacial till. They differ from Atkinson soils in not having a limestone substratum.

Representative profile of Cresco loam, 660 feet west of the northeast corner of sec. 22, T. 91 N., R. 14 W., and 68 feet south of the road fence, in a cultivated field—

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

A3—7 to 14 inches, very dark grayish-brown (10YR 3/2) loam; few mixings of dark yellowish brown (10YR 4/4) and very dark brown (10YR 2/2); weak, fine, subangular blocky structure; friable; few very dark brown (10YR 2/2) worm casts; few roots; few fine pores; slightly acid; clear, smooth boundary.

B1—14 to 21 inches, dark yellowish-brown (10YR 4/4) loam; common mixings of brown to dark brown (10YR 4/3) and a few mixings of yellowish brown (10YR 5/6); weak to moderate, fine subangular blocky structure; friable; few roots; few fine pores; pebble band in upper part of horizon; pebbles are ½ inch to 2 inches in diameter and are both angular and subrounded; strongly acid; gradual, smooth boundary.

IIB21t—21 to 32 inches, heavy loam; prism and ped faces are nearly continuous grayish brown (2.5Y 5/2) to light olive brown (2.5Y 5/4); ped interiors are dark yellowish brown (10YR 4/4); few, fine, distinct grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) mottles and common, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure that breaks to moderate, fine and medium, subangular blocky structure; firm; few roots; few fine pores; very few, fine, black (10YR 2/1) oxide concretions; strongly acid; gradual, smooth boundary.

IIB22t—32 to 45 inches, light clay loam; prism and ped faces are grayish brown (2.5Y 5/2) with few, fine, distinct, dark yellowish brown (10YR 4/4) and few, fine, faint, gray (5Y 6/1) mottles in the lower part; ped interiors are dark yellowish brown (10YR 4/4); many, fine, distinct, grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) mottles; weak, coarse, prismatic structure that breaks to weak, medium, subangular blocky structure; firm; few roots; few fine pores; very few, fine, black (10YR 2/1) oxide concretions; strongly acid; gradual, smooth boundary.

IIC1—45 to 66 inches, dark yellowish-brown (10YR 4/4), olive-brown (2.5Y 4/4), and grayish-brown (2.5Y 5/2) light clay loam; common, fine, distinct, strong-brown (7.5YR 5/6) and gray (5Y 6/1) mottles; massive, with some vertical cleavage but no prism faces; firm; few roots to a depth of 60 inches; few fine pores; common, fine, black (10YR 2/1) oxide concretions; slightly acid; gradual boundary.

IIC2—66 to 88 inches, same as IIC1 but more yellowish and less grayish; slightly acid.

The A1 horizon is 7 to 11 inches thick, if not more than slightly eroded, and is black (10YR 2/1) or very dark brown (10YR 2/2). The color of the A3 horizon varies between dark brown (10YR 3/3), very dark brown (10YR 2/2), and very dark grayish brown (10YR 3/2).

The texture of the B and C horizons is dominantly heavy loam to light clay loam or sandy clay loam. In the zone of the pebble band, the texture may be heavy sandy loam. The loamy material overlying the pebble band contains more silt and less sand than the underlying till.

The colors of the B and C horizons differ from those of the profile described principally in the amount and distinctness of grayish-brown mottling. Mottling starts at a depth of 20 to 28 inches. The prism and ped faces, when dry, have a gray to grayish-brown, grainy appearance. In places a few faint to distinct clay films or streaks are on the prism or ped faces of the lower B2 horizon and the B3 horizon. In some places a few of the root channels of the B3 and C horizons are lined with clay films or streaks

The A3, B1, and B2 horizons are medium acid to strongly acid. The depth to calcareous material ranges from 45 to 100 inches.

Dickinson Series

The Dickinson series consists of somewhat excessively drained soils that developed from sandy loam material 20 to 40 inches thick over sand or over gravelly material.

These soils are on uplands, on stream benches, and in outwash areas. In some places they occur as mounds or dunes. The soils that have a gravelly substratum generally are on benches and in outwash areas. The slope range is 0 to 9 percent, and the slopes face east, south, or southeast.

Dickinson soils are not so coarse textured as Hagener soils. They are darker colored than Lamont soils and lack an A2 horizon, which those soils have. Dickinson soils are coarser textured than Aredale and Waukegan soils.

Representative profile of Dickinson sandy loam, 840 feet west and 200 feet north of the southeast corner of sec. 29, T. 92 N., R. 11 W., in a cultivated field—

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

A12—8 to 12 inches, very dark brown (10YR 2/2) medium sandy loam; some mixing of dark brown (10YR 3/3) in the lower part; few roots; strongly acid; gradual, smooth boundary.

B1—12 to 17 inches, dark-brown (10YR 3/3) heavy sandy loam; weak, fine, subangular blocky structure; very friable; few roots; strongly acid; gradual, smooth boundary.

B2—17 to 21 inches, dark yellowish-brown (10YR 4/4) medium sandy loam; very weak, fine, subangular blocky structure; very friable; few roots; strongly acid; clear, wavy boundary.

B3—21 to 27 inches, dark yellowish-brown (10YR 4/4) sandy loam to loamy sand; very weak, fine, subangular blocky structure; very friable; strongly acid; gradual, smooth boundary.

C1—27 to 48 inches, dark yellowish-brown (10YR 4/4) medium sand; single grain; loose; strongly acid; gradual, smooth boundary.

C2—48 to 60 inches, yellowish-brown (10YR 5/6) and light yellowish-brown (10YR 6/4) medium sand; some mixing of strong brown (7.5YR 5/8); single grain; loose; strongly acid.

The A horizon generally is very dark brown (10YR 2/2) sandy loam 8 to 12 inches thick, but it may be as much as 16 inches thick and the color may be very dark grayish brown (10YR 3/2).

The B horizon varies between dark brown (10YR 3/3), brown or dark brown (10YR 4/3), and dark yel-

lowish brown (10YR 4/4). The texture is light to heavy sandy loam.

The solum generally extends to a depth of 23 to 32 inches, but it may extend to 40 inches. The C horizon is generally medium sand but the range of texture includes loamy fine sand in upland areas. Glacial till is below a depth of 50 inches in some upland areas.

On benches and outwash areas the texture of the C horizon is dominantly medium sand but it ranges to gravel below a depth of 40 inches.

The reaction of the B and C horizons is slightly acid to strongly acid. The reaction of the A horizon depends on whether the soil has been limed.

Representative profile of Dickinson sandy loam, gravelly substratum, in a cultivated field—

A1—0 to 16 inches, very dark brown (10YR 2/2) sandy loam; weak, fine and very fine, granular structure; friable; neutral; few roots; gradual, smooth boundary.

B2—16 to 23 inches, very dark brown (10YR 2/2) sandy loam; some mixing of brown or dark brown (10YR 4/3) and very dark grayish brown (10YR 3/2); weak, medium, subangular blocky structure; very friable; few roots; slightly acid; clear, smooth boundary.

B3—23 to 29 inches, dark-brown (10YR 3/3) and brown or dark-brown (10YR 4/3) loamy sand; very weak, medium, subangular blocky structure; very friable; few roots; medium acid; abrupt, smooth boundary.

IIC1—29 to 44 inches, yellowish-brown (10YR 5/6) fine gravelly sand; single grain; loose; medium acid; gradual boundary (estimated 35 percent consists of ⅛-inch to ¾-inch pebbles).

IIC2—44 to 61 inches, light yellowish-brown (10YR 6/4) coarse sand; single grain; loose; contains a few small pebbles; medium acid; gradual boundary.

IIC—61 to 66 inches, same as C1 horizon.

The A horizon ranges from 10 to 18 inches in thickness but is generally between 12 and 16 inches thick. It generally is very dark brown (10YR 2/2).

The B horizon is dark brown (10YR 3/3) and brown or dark brown (10YR 4/3) and generally is medium sandy loam, although it ranges from light to heavy sandy loam. The thickness of the sandy loam horizons generally is 20 to 30 inches.

The solum generally extends to a depth of 22 to 34 inches and grades from sandy loam in the upper part to gravelly loamy sand in the lower 2 to 8 inches. A few pebbles occur throughout the solum in some places.

Dinsdale Series

The Dinsdale series consists of well-drained soils that developed in 20 to 40 inches of moderately fine textured loess over glacial till. In places a pebble band occurs between the loess and the till.

These soils are on uplands. The slope range is 2 to 9 percent. The native vegetation consisted of prairie grasses.

The Dinsdale series is a member of the hydrosequence that contains the somewhat poorly drained Klinger and the poorly drained Maxfield soils. Dinsdale soils contain less sand than Aredale, Ostrander, and Dickinson soils. They developed in a thinner layer of loess than Port Byron soils.

Representative profile of Dinsdale silty clay loam, 500 feet north and 400 feet west of the corner post in the southeast corner of the NE¼ sec. 29, T. 91 N., R. 12 W., in a cultivated field—

Ap—0 to 9 inches, black (10YR 2/1) light silty clay loam; weak, fine, granular structure; friable; plentiful roots; slightly acid; clear, smooth boundary.

A3—9 to 15 inches, light silty clay loam; ped faces are very dark brown (10YR 2/2) and very dark gray (10YR 3/1); ped interiors are very dark grayish brown (10YR 3/2); weak, fine, subangular blocky structure that breaks to moderate, fine, granular structure; friable; few roots; medium acid; clear, smooth boundary.

B21t—15 to 20 inches, dark-brown (10YR 3/3) light silty clay loam; some mixing of brown or dark brown (10YR 4/3) and very dark brown (10YR 2/2); moderate, fine, subangular blocky structure; friable; few roots; few fine pores; medium acid; clear, smooth boundary.

B22t—20 to 30 inches, light silty clay loam; prism faces are mixed brown or dark brown (10YR 4/3) and dark brown (10YR 3/3); ped interiors are brown or dark brown (10YR 4/3); very weak, medium, prismatic structure that breaks to weak, fine, subangular blocky structure; friable; few roots; common fine pores; few very dark brown (10YR 2/2) worm casts; lower part of horizon has some mixing of yellowish brown (10YR 5/4) from the underlying horizon; medium acid; clear, smooth boundary.

IIB23—30 to 39 inches, medium loam; prism and ped faces are nearly continuous yellowish brown (10YR 5/4); ped interiors are yellowish brown (10YR 5/6); few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, medium, prismatic structure that breaks to moderate, medium, subangular blocky structure; slightly firm; few roots; many fine pores; few black (10YR 2/1) concretions of an oxide; well-defined pebble band in upper part; pebbles range from ¼ inch to 4 inches in diameter; slightly acid; gradual, smooth boundary.

IIB3—39 to 56 inches, yellowish-brown (10YR 5/6) medium loam; common, medium, prominent, light brownish-gray (2.5Y 6/2) streaks and few, fine, distinct, yellowish-red (5YR 5/8) mottles; weak, medium, prismatic structure; prism faces are nearly continuous light olive brown (2.5Y 5/4); slightly firm; few roots to a depth of 44 inches; many fine pores; slightly acid; gradual, smooth boundary.

IIC1—56 to 62 inches, strong-brown (7.5YR 5/8) and yellowish-brown (10YR 5/6) medium loam; common, fine, prominent, light brownish-gray (2.5Y 6/2) streaks that are horizontal or nearly so; massive; slightly firm; few fine pores; few black (10YR 2/1) concretions of an oxide; neutral; clear, wavy boundary.

IIC2—62 to 70 inches, same as IIC1 but calcareous.

The A1 horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). If not more than slightly eroded, it is 7 to 11 inches thick. The texture of the A horizon ranges from light silty clay loam to heavy silt loam.

The part of the B horizon that developed from loess is light or medium silty clay loam. It ranges from dark brown (10YR 3/3) to dark yellowish brown (10YR 4/4) in color. The ped faces are generally a little darker than the interiors. The C horizon and the part of the B horizon that developed from glacial till differ from those described, principally in the amount and distinctness of the grayish-brown colors. The prism and ped faces, when dry, have a gray to grayish-brown, grainy appearance. The texture of the till is typically medium or heavy loam but ranges to sandy clay loam and, in some places, to light clay loam. A few clay films are on the ped faces in the B2, IIB2, and IIB3 horizons, and there are a few clay films in some of the root channels. A few iron or manganese concretions are in the B2, B3, and C horizons. In places there are discontinuous lenses of sand to sandy loam 1 to 8 inches thick between the loess and the till.

The A3 horizon and the B horizon in the loess are slightly acid or medium acid. The till part of the B horizon is slightly acid to neutral. The depth to calcareous material ranges from 40 to 70 inches but is generally between 50 and 65 inches.

Fayette Series

This series consists of well-drained soils that developed from very thick loess of low sand content.

These soils are on upland ridgetops and side slopes. The slope range is 2 to 9 percent. The native vegetation consisted of hardwoods.

Fayette soils generally contain a little less sand throughout than Seaton soils, and a little more clay in the B2 horizon.

Representative profile of Fayette silt loam, 0.09 mile west of the southeast corner of sec. 22, T. 91 N., R. 13 W., and 60 feet north of roadbank, in timber—

AO—½ inch to 0, partly decomposed leaves from hardwood trees.

A1—0 to 3 inches, black (10YR 2/1) light silt loam; weak, very fine, granular structure; very friable; roots abundant; neutral; clear, smooth boundary.

A21—3 to 8 inches, dark grayish-brown (10YR 4/2) light silt loam; some mixing of brown or dark brown (10YR 4/3) and very dark gray (10YR 3/1); moderate, thin, platy structure; very friable; plentiful roots; slightly acid; gradual, smooth boundary.

A22—8 to 13 inches, brown (10YR 5/3) light silt loam; some mixing of very dark gray (10YR 3/1) and dark yellowish brown (10YR 4/4); moderate, thin, platy structure; plentiful roots, slightly acid; clear, wavy boundary.

B1t—13 to 18 inches, heavy silt loam; ped faces are dark yellowish brown (10YR 4/4); ped interiors are yellowish brown (10YR 5/6); moderate, fine, subangular blocky structure; slightly firm; few, patchy, brown or dark-brown (7.5YR 4/4) clay films; few roots; many fine pores; very strongly acid; gradual, smooth boundary.

B21t—18 to 25 inches, light silty clay loam; ped faces are dark yellowish brown (10YR 4/4); ped interiors are yellowish brown (10YR 5/6); weak, medium, prismatic structure that breaks to moderate or strong, fine, subangular blocky structure; slightly firm; few, patchy, brown or dark-brown (7.5YR 4/4) clay films; slightly firm; few roots; many fine pores; strongly acid; gradual, smooth boundary.

B22t—25 to 38 inches, light silty clay loam; ped faces are brown to dark brown (7.5YR 4/4) and dark yellowish brown (10YR 4/4); ped interiors are yellowish brown (10YR 5/6); weak, medium, prismatic structure that breaks to moderate, fine and medium, subangular blocky structure; slightly firm; dark-brown (7.5YR 3/2) clay films, few and patchy in upper part, but nearly continuous at a depth between 35 and 38 inches; root channels lined with very dark gray (10YR 3/1) clay films; few roots; many fine pores; strongly acid; clear, smooth boundary.

B31t—38 to 51 inches, heavy silt loam; ped faces are dark yellowish brown (10YR 4/4); ped interiors are yellowish brown (10YR 5/6); weak, medium, prismatic structure that breaks to weak, medium, subangular blocky structure; friable; thin, patchy, brown or dark-brown (7.5YR 4/4) clay films; few roots; many fine pores; few, fine, black (10YR 2/1) concretions of an oxide; strongly acid; gradual, smooth boundary.

B32—51 to 59 inches, heavy silt loam; ped faces are brown or dark brown (10YR 4/3) mottled with yellowish brown (10YR 5/6); ped interiors are yellowish brown (10YR 5/6); few, fine, faint, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure that breaks to weak, coarse, subangular blocky; friable; few roots; many fine pores; strongly acid; gradual, smooth boundary.

C—59 to 74 inches, yellowish-brown (10YR 5/6) and brown (10YR 5/3) heavy silt loam; few, fine, faint, strong-brown (7.5YR 5/8) mottles; massive; friable; few roots; many fine pores; medium acid.

The A1 horizon is 1 to 4 inches thick and is black (10YR 2/1) or very dark gray (10YR 3/1). The Ap horizon, if slightly eroded, is dark grayish brown (10YR 4/2) or very dark grayish brown (10YR 3/2). The A2 horizon is 6 to 11 inches thick and ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3).

The B horizon commonly has dark yellowish-brown (10YR 4/4) or yellowish-brown (10YR 5/6) ped interiors and somewhat darker ped faces. Clay films range from a few to nearly continuous on the ped faces and some of the prism faces. The clay content of the B2 horizon ranges from 27 to 30 percent.

The reaction is strongly acid or very strongly acid in the B1 and B2 horizons and medium acid or strongly acid in the B3 horizon. The depth to calcareous loess is more than 70 inches.

Floyd Series

The Floyd series consists of somewhat poorly drained soils that developed in 18 to 36 inches of loamy material over medium-textured, friable, glacial till. The till is commonly stratified. A pebble band separates the loamy material from the till in most places.

These soils are on uplands. They occur on convex and concave lower slopes and in coves. The slope range is 1 to 4 percent. The native vegetation consisted of prairie grasses.

Floyd soils occur with moderately well drained Kenyon, well drained Ostrander, and poorly drained Clyde soils. They are less acid than Readlyn soils and are more friable and stratified in the B and C horizons. They have a thicker A1 horizon than Oran soils and lack an A2 horizon. Floyd soils do not have a thick lower substratum of sand or gravel, which Lawler soils have.

Representative profile of Floyd loam, 200 feet west and 40 feet north of the southeast corner of sec. 14, T. 92 N., R. 13 W., in bluegrass sod—

A1—0 to 16 inches, black (10YR 2/1) loam; weak to moderate, fine, granular structure; friable; plentiful roots; neutral; gradual, smooth boundary.

A3—16 to 24 inches, very dark grayish-brown (2.5Y 3/2) and very dark gray (10YR 3/1) heavy loam; weak, fine, subangular blocky structure; friable; few roots; few fine pores; neutral; gradual, smooth boundary.

B1—24 to 33 inches, olive-brown (2.5Y 4/4) sandy clay loam; common, fine, faint, dark grayish-brown (2.5Y 4/2) mottles throughout and few, fine, distinct, yellowish-brown (10YR 5/8) mottles in lower part; weak, fine, subangular blocky structure; friable; few roots; few fine pores; pebble band (½-inch to 1½-inch pebbles) at a depth of 31 inches; neutral; clear, smooth boundary.

IIB21—33 to 41 inches, yellowish-brown (10YR 5/8) light sandy loam; weak, medium, subangular blocky structure; very friable; neutral; clear, smooth boundary.

IIB22—41 to 50 inches, yellowish-brown (10YR 5/8) heavy loam; many, fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak, medium, subangular blocky structure; friable; few grayish-brown (2.5Y 5/2) ped faces; neutral; clear, wavy boundary.

IIC—50 to 60 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; friable; calcareous.

The A1 horizon is 9 to 18 inches thick. Not all profiles have a recognizable A3 horizon.

Mottles in the upper B horizon are generally few to common and are dark grayish brown (2.5Y 4/2) and yellowish brown (10YR 5/8). The B1 and B2 horizons range from very dark grayish brown (10YR 3/2) to olive brown (2.5Y 4/4). The texture of the till, other than in the stratified parts, ranges from light loam to sandy clay loam. The loamy material overlying the till contains more silt and less sand than the till.

The B3 horizon, if present, and the C horizon are commonly yellowish brown (10YR 5/8) mottled with grayish brown (2.5Y 5/2) and light olive gray (2.5Y 5/4). At a depth between 30 and 60 inches the material is stratified, and the texture ranges from sand to sandy clay loam in places. Slightly firm glacial till is below a depth of 45 to 60 inches in some places.

The A and B horizons are slightly acid to neutral. The depth to calcareous material ranges from 45 to 60 inches.

Franklin Series

This series consists of somewhat poorly drained soils that developed from medium-textured loess 20 to 40 inches thick over glacial till. A pebble band separates the loess from the till in most places.

These soils are on uplands. The slope range is 1 to 3 percent. The native vegetation consisted of grasses and trees.

Franklin soils have a thinner A1 horizon than Klinger soils, and they have an A2 horizon. They have less sand in the upper part of the solum than Oran soils.

Representative profile of Franklin silt loam, 350 feet east and 600 feet north of the southwest corner of the SE¼SE¼ sec. 36, T. 91 N., R. 12 W., in a bluegrass pasture—

A1—0 to 7 inches, black (10YR 2/1) medium silt loam; moderate, fine, granular structure; friable; plentiful roots; neutral; clear, wavy boundary.

A2—7 to 15 inches, gray (10YR 5/1) and grayish-brown (10YR 5/2) light silt loam; many very dark grayish-brown (10YR 3/2) organic stains and mixings; dark grayish brown (10YR 4/2) or very dark grayish brown (10YR 3/2) when kneaded; weak to moderate, thin, platy structure; friable; plentiful roots; very strongly acid; clear, wavy boundary.

B1—15 to 24 inches, light silty clay loam; ped faces are grayish brown (2.5Y 5/2); ped interiors are light olive brown (2.5Y 5/4); weak, medium, prismatic structure that breaks to moderate, fine and very fine, subangular blocky structure; friable; few roots; many fine pores; very strongly acid; gradual, smooth boundary.

B2t—24 to 32 inches, dark grayish-brown (2.5Y 4/2) and grayish-brown (2.5Y 5/2) light silty clay loam; few, fine, faint, light olive-brown (2.5Y 5/4) and few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; friable; few, fine, faint, dark yellowish-brown (10YR 3/4) clay films on ped faces; few roots; many fine pores; strongly acid; abrupt, smooth boundary.

IIB3—32 to 46 inches, yellowish-brown (10YR 5/6) heavy loam; many, medium, distinct, grayish-brown (2.5Y 5/2) mottles and few, fine, faint, olive-brown (2.5Y 5/4) mottles; very weak, prismatic structure; friable; very thin clay film or shade of dark brown (7.5YR 3/2) on prism faces, streaked with fine lines of dark-brown (7.5YR 3/2) clay; many root channels partly filled with dark-brown (7.5YR 3/2) and black (10YR 2/1) clay films; few small globs of black (10YR 2/1) clay; common fine pores; upper part of horizon contains a band of 1-inch to 3-inch pebbles and a discontinuous lens of sand 1 inch to 4 inches thick; strongly acid; clear, smooth boundary.

IIB32—46 to 61 inches, strong-brown (7.5YR 5/8) and yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) and light yellowish-brown (2.5Y 6/4) mottles; very weak, medium, prismatic structure; slightly firm; few black (10YR 2/1) and dark-brown (7.5YR 3/2) streaks and some globs of clay; grades from medium acid to slightly acid with depth; clear, wavy boundary.

IIC—61 to 81 inches, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) medium loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; slightly firm; calcareous.

The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) and is 4 to 8 inches thick. The Ap horizon is commonly very dark brown (10YR 2/2). The A2 horizon ranges from gray (10YR 5/1) mixed with some very dark grayish brown to dark grayish brown (10YR 4/2) mixed with some brown or dark brown (10YR 4/3). Some organic stains or mixings occur in the A2 horizon.

The B horizon that developed in loess ranges from dark grayish brown (10YR 4/2) mottled with brown or dark brown (10YR 4/3) and yellowish brown (10YR 5/6) to grayish brown (2.5Y 5/2) mottled with olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6). The texture of these horizons is light or medium silty clay loam.

The IIB horizon in the glacial till and the IIC horizon differ from those of the profile described, principally in the amount and distinctness of the grayish-brown mottling. The prism and ped faces, when dry, have a gray or grayish-brown, grainy appearance. The texture of the till is typically heavy or medium loam but ranges to sandy loam and, in a few places, to light clay loam.

The clay films and streaks described in the B and IIB horizons are common to these soils. In many areas the B horizon that developed in loess contains a few iron and manganese concretions. The loess and the till are separated by discontinuous lenses of sand to sandy loam 1 inch to 10 inches thick or by a thin pebble band.

The B1, B2, and upper B3 horizons are strongly acid or very strongly acid. The depth to calcareous material ranges from 45 to 70 inches.

Hagener Series

The Hagener series consists of excessively drained soils that developed from loamy fine sand, fine sand, and medium sand.

These soils are on uplands and on stream benches and outwash areas. The slope range is 2 to 14 percent. On uplands these soils have an east, south, or southeast exposure. In some places they occur on mounds or dunes. The native vegetation consisted of prairie grasses.

Hagener soils are coarser textured than Dickinson soils. They have a darker colored and thicker A horizon than Chelsea soils. Hagener soils are free of gravel in the subsoil, in contrast with the Burkhardt soils.

Representative profile of Hagener loamy sand, 780 feet west of the northeast corner of the NW¼ sec. 32, T.

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92 N., R. 14 W., and 27 feet south of road fence, in a cultivated field—

Ap—0 to 7 inches, very dark brown (10YR 2/2) loamy sand; very weak, very fine, granular structure; very friable; few roots; neutral; clear, smooth boundary.

A12—7 to 15 inches, very dark brown (10YR 2/2) loamy sand; some mixing of very dark grayish brown (10YR 3/2); very weak, very fine, granular structure; very friable; few roots; neutral; gradual, wavy boundary.

B—15 to 29 inches, brown to dark-brown (10YR 4/3) fine sand; some mixing of very dark grayish brown (10YR 3/2); single grain; loose; neutral; gradual, wavy boundary.

C1—29 to 38 inches, light yellowish-brown (10YR 6/4) and yellowish-brown (10YR 5/6) fine sand; single grain; loose; slightly acid; gradual, smooth boundary.

C2—38 to 62 inches, light yellowish-brown (10YR 6/4) and yellowish-brown (10YR 5/6) fine sand; some mixing of strong brown (7.5YR 5/8) and brownish yellow (10YR 6/6); single grain; loose; neutral; diffuse boundary.

C3—62 to 73 inches, yellowish-brown (10YR 5/6) and light yellowish-brown (10YR 6/4) loamy sand; some mixing of strong brown (7.5YR 5/8); single grain; loose; gradual boundary.

C4—73 to 85 inches, stratified loamy sand and light loam.

The A1 horizon is generally very dark brown (10YR 2/2) but may be dark brown (10YR 3/3). It is 8 to 16 inches thick unless eroded.

The chroma and value of the B and C horizons are 3 or more. The profile on uplands ranges from loamy fine sand to medium sand. Glacial till is below a depth of 50 inches in a few places. On benches and outwash areas, the texture is the same as on uplands, except that below a depth of 30 inches, it may range to sandy gravel.

A3 and B horizons are not present in all profiles. The reaction of the B and C horizons is neutral to strongly acid.

Harpster Series

The Harpster series consists of highly calcareous soils that developed from a thick deposit of loess or local alluvium.

These soils are mainly on broad, level or nearly level upland ridgetops. In places they are in upland depressions. They are slightly lower on the landscape than the associated Sable soils. The native vegetation consisted of prairie grasses and water-tolerant plants.

Harpster soils are more alkaline in the solum than Sable soils.

Representative profile of Harpster silt loam, 86 feet east and 92 feet north of the corner post in the southwest corner of sec. 29, T. 91 N., R. 12 W., in bluegrass sod—

A11—0 to 9 inches, black (10YR 2/1) heavy silt loam; moderate to strong, fine, granular structure; friable; abundant roots; few, fine, broken fragments of snail shells; calcareous; moderately alkaline; clear, smooth boundary.

A12—9 to 19 inches, black (10YR 2/1) light silty clay loam; moderate, very fine, granular structure; friable; plentiful roots; few, fine, broken fragments of snail shells; horizon tends to be weakly stratified; calcareous; moderately alkaline; gradual, smooth boundary.

A3—19 to 25 inches, very dark gray (10YR 3/1) light silty clay loam; moderate, fine and very fine, granular structure; friable; plentiful roots; few fine pores; few fine snail shells 1 to 3 millimeters long, and 4 to 8 per cubic inch; calcareous; moderately alkaline; gradual, smooth boundary

Bg—25 to 34 inches, very dark gray (N 3/0) heavy silt loam; common, fine, distinct, olive-gray (5Y 5/2) mixings; moderate, fine, subangular blocky structure; friable; few roots; few fine pores; few fine snail shells 1 to 3 millimeters long, and 4 to 8 per cubic inch; calcareous; moderately alkaline; gradual, smooth boundary.

C1g—34 to 54 inches, olive-gray (5Y 5/2) medium silt loam; common, fine, prominent, strong-brown (7.5YR 5/8) mottles; few gray (5Y 5/1) mixings; massive; friable; few roots to a depth of 40 inches; common fine and few medium pores; few dark reddish-brown (5YR 2/2) iron concretions; several krotovinas filled with very dark gray (10YR 3/1) heavy silt loam that has weak, medium, subangular blocky structure and contains a few fine snail shells; calcareous; mildly alkaline; diffuse, smooth boundary.

C2g—54 to 78 inches, same as C1g, but krotovinas are smaller and contain very dark gray (10YR 3/1), olive-brown (2.5Y 4/4), and grayish-brown (2.5Y 5/2) medium silt loam; 2-inch discontinuous lens of strong-brown (7.5YR 5/8), olive-brown (2.5Y 4/4), and grayish-brown (2.5Y 5/2) sandy loam at a depth of 66 inches; calcareous; mildly alkaline.

The A11 horizon is black (10YR 2/1) and ranges from heavy silt loam to light silty clay loam. The A12 and A3 horizons are light or medium silty clay loam. The A1 horizon is typically 14 to 20 inches thick, but the black color extends to a depth of 26 inches in places.

The color of the B horizon ranges from very dark gray (N 3/0) to light olive gray (5Y 6/2), and in many places there are a few mottles. The texture ranges from heavy silt loam to light silty clay loam.

The C horizon generally is at a depth between 30 and 40 inches. The texture of the C horizon is dominantly medium or heavy silt loam, but heavy loam to light clay loam are included in the series. The mottles in this horizon range from brown to olive in color and vary in number and distinctness. Krotovinas are generally present.

In some of the depressional areas, the solum contains fewer snail shells than that of the profile described. In a few places, there are very slight ridges or rims that contain more snail shells, especially in the A11 horizon, than are described in the representative profile. The solum is mildly or moderately alkaline. The C horizon is generally mildly alkaline.

Hayfield Series

The Hayfield series consists of somewhat poorly drained soils that developed from loamy, medium-textured alluvial deposits 24 to 60 inches thick over coarse-textured material.

These soils are mainly on stream benches, but they are also on areas of outwash in uplands. The slope range is 0 to 2 percent. The native vegetation consisted of grasses and trees.

The Hayfield series is a member of the hydrosequence that includes the well-drained Sattre soils. Some of the Hayfield soils have a lighter colored, thinner A1 horizon than the Lawler soils. Hayfield soils also have an A2 horizon, which Lawler soils lack.

Representative profile of Hayfield loam, deep, 253 feet west and 45 feet south of the corner post in the northeast corner of sec. 31, T. 92 N., R. 13 W., in open timber—

A1—0 to 6 inches, black (10YR 2/1) medium loam; moderate, fine, granular structure; friable; plentiful roots; medium acid; clear, wavy boundary.

A21—6 to 10 inches, dark grayish-brown (10YR 4/2) medium loam; few dark-brown (10YR 3/3) organic stains; weak, medium, platy structure that breaks to weak, fine, granular structure; friable; plentiful roots; medium acid; clear, wavy boundary.

A22—10 to 14 inches, dark grayish-brown (10YR 4/2) light loam; common, dark-brown (10YR 3/3) organic stains and a few very dark brown (10YR 2/2) mixings; weak, thin, platy structure that breaks to weak, fine, granular structure; friable; few roots; strongly acid; gradual, wavy boundary.

B1—14 to 18 inches, dark grayish-brown (10YR 4/2) and very dark grayish-brown (10YR 3/2) medium loam; weak, fine, subangular blocky structure; friable; few grainy coats on ped faces; few roots; few fine and medium pores; strongly acid; gradual boundary.

B21t—18 to 27 inches, dark grayish-brown (10YR 4/2) and brown to dark-brown (10YR 4/3) medium loam; few, fine, distinct, strong-brown (7.5YR 5/6) and grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; few roots; few fine and medium pores; strongly acid; clear, smooth boundary.

B22t—27 to 32 inches, grayish-brown (2.5Y 5/2) and brown to dark-brown (10YR 4/3) medium loam; few, fine, faint, brown to dark-brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; friable; few roots; few fine pores; strongly acid; clear, smooth boundary.

B23—32 to 40 inches, strong-brown (7.5YR 5/8), grayish-brown (2.5Y 5/2), and yellowish-brown (10YR 5/6) heavy sandy loam; few, fine, distinct, dark yellowish-brown (10YR 3/4) and dark-red (2.5YR 3/6) mottles; weak, medium, subangular blocky structure; very friable; few fine pores; medium acid; clear, smooth boundary.

IIC1—40 to 46 inches, pale-brown (10YR 6/3), strong-brown (7.5YR 5/8), and yellowish-brown (10YR 5/6) gravel; about 50 percent is ½ inch to 3 inches in diameter; single grain; loose; medium acid; clear, smooth boundary.

IIC2— 46 to 60 inches, same colors as IIC1; gravelly sand, about 20 percent is ½ inch to 3 inches in diameter; single grain; loose; strongly acid.

The A1 horizon varies between black (10YR 2/1) and very dark brown (10YR 2/2) and is 4 to 7 inches thick. The Ap horizon is generally very dark brown (10YR 2/2) or very dark grayish-brown (10YR 3/2). The A2 horizon is distinct to barely discernible. It varies between grayish brown (2.5Y 5/2), dark grayish brown (10YR 4/2), and very dark grayish brown (10YR 3/2) and is mottled with a few organic stains or brown to yellowish-brown colors. The B horizon is grayish brown (2.5Y 5/2), dark grayish brown (10YR 4/2), and brown or dark brown (10YR 4/3) to strong brown (7.5YR 5/8) and is mottled with redder or yellower colors.

The texture of the solum is generally medium loam but ranges from heavy to light loam, and the lower B horizon may be heavy sandy loam.

Loamy sand to gravel is the texture of the substratum, which begins at a depth of 24 to 36 inches in the moderately deep Hayfield soil and at 36 to 45 inches in the deep soil.

The reaction ranges from medium acid in the upper part of the profile to very strongly acid in the B and IIC horizons.

A group of the Hayfield soils has a dark-brown surface layer and differs enough from the rest of the series to be considered a variant. A separate profile is described for this group.

Representative profile of Hayfield loam, dark brown variant, about 400 feet north of the west end of the bridge over the Wapsipinicon River in the SW¼SW¼ sec. 18, T. 92 N., R.11 W., in bluegrass pasture—

A1—0 to 6 inches, very dark brown (10YR 2/2) loam; moderate, fine, granular structure; friable; plentiful roots; medium acid; clear, wavy boundary.

A2—6 to 14 inches, brown to dark brown (7.5YR 4/4) and dark brown (7.5YR 3/2) loam; common, fine, faint, dark reddish-brown (5YR 3/2) mottles; weak, fine, subangular blocky structure; friable; plentiful roots; very strongly acid; gradual, smooth boundary.

B1—14 to 26 inches, dark-brown (7.5YR 3/2) loam; common, fine, distinct, very dark gray (10YR 3/1) and dark reddish-brown (5YR 3/4) mottles; weak, fine, subangular blocky structure; friable; few roots; many quartz grains on ped faces; very strongly acid; gradual, smooth boundary.

B21t—26 to 35 inches, gray (10YR 5/1) heavy loam; common, fine, distinct, dark yellowish-brown (10YR 3/4) mottles; weak, fine, subangular blocky structure; friable; few roots; many quartz grains on ped faces; very strongly acid; clear, smooth boundary.

B22—35 to 45 inches, dark-gray (10YR 4/1) and gray (10YR 5/1) sandy loam; many, fine, distinct, dark yellowish-brown (10YR 3/4) and dark-brown (7.5YR 3/2) mottles and few, fine, distinct, dark-gray (N 4/0) mottles; weak, medium, subangular blocky structure; very friable; many, fine, hard, dark reddish-brown (5YR 3/2) oxide concretions and a few black (10YR 2/1) oxide concretions; very strongly acid; clear, smooth boundary.

IIC1—45 to 54 inches, light-gray (10YR 7/1) sand; common, fine, prominent, yellowish-brown (10YR 5/4) mottles; a few black (10YR 2/1) oxide concretions; single grain; loose; strongly acid; gradual, smooth boundary.

IIC2— 54 to 70 inches, light-gray (10YR 7/2) coarse sand; single grain; loose; strongly acid.

The A1 horizon is generally very dark brown (10YR 2/2) loam or silt loam 4 to 7 inches thick. The Ap horizon is very dark brown (10YR 2/2) to dark brown (7.5YR 3/2). The A2 and B horizons vary little from the profile described except that the 10YR and 5YR hues may be a little more prominent. The grayish B horizon ranges from gray (10YR 6/1) to dark grayish brown (10YR 4/2) and has common to many mottles that range from dark reddish brown (5YR 3/2) to strong brown (7.5YR 5/8) and, in a few places, to yellowish brown (10YR 5/6). The grayer colors begin at a depth between 24 and 30 inches and extend into the C horizon.

Black oxide concretions are common in the B horizon, and they increase with depth. The dark reddish-brown (5YR 3/2 and 3/4) oxide concretions do not occur in all profiles.

The A horizon is generally medium loam or gritty silt loam. The B horizon is dominantly medium loam but ranges from heavy loam to light loam and, below a depth of 33 inches, is sandy loam in some places.

The coarse-textured substratum ranges from loamy sand to gravel and is generally at a depth of 33 to 45 inches. The A2, B, and IIC horizons are strongly acid or very strongly acid.

Kenyon Series

The Kenyon series consists of moderately well drained soils that developed in 14 to 21 inches of loamy material over friable to firm glacial till of loam texture. A peb-

ble band occurs between the glacial till and the overlying material in most places.

These soils are on uplands. The slope range is 2 to 9 percent. The native vegetation consisted of prairie grasses.

The Kenyon series is a member of the hydrosequence that includes the well-drained Ostrander, the somewhat poorly drained Readlyn, and the poorly drained Tripoli soils. Kenyon soils are shallower to mottling and have a stronger structure than Ostrander soils. They have a thicker and darker colored A1 horizon than Bassett soils and lack an A2 horizon. Kenyon soils are less firm and less gray in the B horizon than Cresco soils. They contain more sand and less silt than Dinsdale soils, which developed from moderately thick loess over glacial till. Kenyon soils differ from Atkinson soils in not having a limestone substratum.

Representative profile of Kenyon loam, 553 feet north and 310 feet east of the southwest corner of sec. 31, T. 93 N., R. 13 W., in a cultivated field—

Ap—0 to 5 inches, black (10YR 2/1) loam; cloddy peds that break to weak, fine, granular structure; friable; plentiful roots; slightly acid; clear, smooth boundary.

A12—5 to 10 inches, very dark brown (10YR 2/2) heavy loam; weak, fine, subangular blocky structure that breaks to weak, fine, granular structure; friable; common roots; medium acid; clear, smooth boundary.

A3—10 to 14 inches, very dark grayish-brown (10YR 3/2) heavy loam; moderate, fine and very fine, subangular blocky structure; friable; common, fine, distinct, very dark gray (10YR 3/1) and common, fine, faint, brown to dark-brown (10YR 4/3) worm casts and mixings from the A12 and B1 horizons; few roots; strongly acid; clear, smooth boundary.

I&IIB1—14 to 19 inches, heavy loam; ped faces are very dark grayish brown (10YR 3/2) and brown to dark brown (10YR 4/3); ped interiors are brown to dark brown (10YR 4/3); moderate, fine, subangular blocky structure; friable; few very dark gray (10YR 3/1) worm casts; few roots; common fine pores; a discontinuous band of pebbles and stones 1 to 6 inches in diameter are in this horizon and occupy 5 to 10 percent of the total volume; few roots; strongly acid; clear, smooth boundary.

IIB21—19 to 25 inches, heavy loam; ped faces are brown to dark brown (10YR 4/3); ped interiors are dark yellowish brown (10YR 4/4); weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; friable; few very dark grayish-brown (10YR 3/2) worm casts; few roots; common fine and few medium pores; few, fine, faint, soft, reddish-brown concretions of ferro-manganese oxide; strongly acid; gradual, smooth boundary.

IIB22—25 to 33 inches, heavy loam; ped faces are yellowish brown (10YR 5/4) and have a few, fine, faint, brown to dark-brown (10YR 4/3) streaks; ped interiors are yellowish brown (10YR 5/6); weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; friable; few roots; common fine pores in peds; few, fine, faint, black and reddish-brown, soft concretions of ferro-manganese oxide; strongly acid; gradual, smooth boundary.

IIB23—33 to 40 inches, heavy loam; ped faces are brown (10YR 5/3) and have common, fine, faint, brown to dark-brown (10YR 4/3) mottles; ped interiors are yellowish brown (10YR 5/6); common, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, prismatic structure that breaks to moderate, fine and medium, subangular blocky structure; slightly firm to friable; few roots; common fine pores; few, soft, distinct, ferro-manganese oxide concretions; medium acid; gradual, smooth boundary.

IIB3t—40 to 54 inches, heavy loam; ped faces are grayish brown (10YR 5/2) and have common, fine, distinct, brown to dark-brown (7.5YR 4/4) mottles; ped interiors are yellowish brown (10YR 5/6 and 5/8); common, fine, distinct, brown to dark-brown (10YR 4/3) mottles; weak, medium, prismatic structure that breaks to moderate, medium, angular blocky structure; firm; few roots; common fine pores; few, soft, black (10YR 2/1) oxide concretions; very few thin clay films in pores; slightly acid; clear, wavy boundary.

IIC1—54 to 62 inches, yellowish-brown (10YR 5/6) and dark yellowish-brown (10YR 4/4) heavy loam; common, fine, distinct, brown to dark-brown (7.5YR 4/4) mottles; massive, with some distinct vertical cleavage; firm; calcareous; common, fine, light-gray (10YR 7/1) and yellow (10YR 7/8) lime concretions; gradual, wavy boundary.

IIC2—62 to 76 inches, brown to dark-brown (10YR 4/3) and gray (5Y 5/1) heavy loam; few, fine, faint, yellowish-brown (10YR 5/6) mottles; massive, with some vertical cleavage; firm; few, soft, black (10YR 2/1) oxide concretions; calcareous; some lime concretions but fewer than in the C1 horizon.

The A1 horizon is 8 to 12 inches thick, if not more than slightly eroded, and is black (10YR 2/1) or very dark brown (10YR 2/2). The color of the A3 horizon varies between dark brown (10YR 3/3), very dark brown (10YR 2/2), and very dark grayish brown (10YR 3/2).

The texture of the B and C horizons is dominantly heavy loam but ranges from medium loam to light clay loam or sandy clay loam. The loamy material overlying the pebble band contains more silt and less sand than the underlying till. In the zone of the pebble band, the texture is heavy sandy loam in some places.

The profile is generally friable to a depth of about 30 inches and friable to firm below this depth.

The color of the B and C horizons differs from that of the profile described, principally in the amount and distinctness of grayish-brown mottling. Mottling generally starts at a depth of 30 to 36 inches, but the oxidic mottles of high value and chroma are at a depth of 20 to 30 inches in places. The prism and ped faces of the B horizon have a gray to grayish brown, grainy appearance when dry. A few faint to distinct clay films or streaks may occur on the prism or ped faces of the lower B2 and the B3 horizons. A few of the root channels in the B3 and C horizons may be lined with clay films or streaks.

The A3, B1, and B2 horizons are medium or strongly acid. The depth to calcareous material ranges from 45 to 85 inches but is generally 55 to 65 inches.

Klinger Series

The Klinger series consists of somewhat poorly drained soils that developed in 20 to 40 inches of loess over glacial till. A pebble band separates the loess from the till in most places.

These soils are on uplands and have a slope range of 1 to 3 percent. The native vegetation consisted of prairie grasses.

The Klinger series is a member of the hydrosequence that includes the well-drained Dinsdale and the poorly drained Maxfield soils. Klinger soils are shallower to glacial till than Muscatine soils. They have a thicker A1 horizon than Franklin soils and lack an A2 horizon. They contain less sand than Readlyn and Floyd soils.

Representative profile of Klinger silty clay loam, 284 feet north and 387 feet east of the southwest corner of

the NE¼SE¼ sec. 26, T. 91 N., R. 12 W., in a cultivated field—

Ap—0 to 9 inches, black (10YR 2/1) light silty clay loam; weak, fine, subangular blocky structure; plentiful roots; friable; medium acid; gradual, smooth boundary.

A3—9 to 13 inches, black (10YR 2/1) and very dark gray (10YR 3/1) light silty clay loam; moderate, fine, granular structure; friable; plentiful roots; few fine pores; many earthworm casts; strongly acid; gradual, smooth boundary.

B1—13 to 19 inches, light silty clay loam; ped faces are coated with very dark gray (10YR 3/1) that decreases with depth; ped interiors are very dark grayish brown (2.5Y 3/2); few, fine, faint, olive-brown (2.5Y 4/4) mottles; moderate, fine and very fine, subangular blocky structure; friable; few roots; many fine and medium pores; common, small, moderately hard, dark-colored oxide concretions; strongly acid; gradual, smooth boundary.

B21t—19 to 26 inches, medium silty clay loam; ped faces are dark grayish-brown (2.5Y 4/2) with common, fine, faint, olive-brown (2.5Y 4/4) mottles; ped interiors are dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4); weak to moderate, fine, subangular blocky structure; slightly firm; few discontinuous clay films on some of the concave ped surfaces; few roots; many fine and medium pores; common, small, moderately hard, dark-colored oxide concretions; strongly acid; gradual, smooth boundary.

B22t—26 to 31 inches, dark grayish-brown (2.5Y 4/2) medium silty clay loam; common, fine, faint, olive-brown (2.5Y 4/4), light olive-brown (2.5Y 5/6), and grayish-brown (2.5Y 5/2) mottles; very weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; slightly firm; few very dark gray (10YR 3/1) clay films on some concave ped faces and in root channels; few roots; many fine pores and common medium pores; common, small, moderately hard, dark-colored oxide concretions; slight increase in content of sand with depth; medium acid; abrupt, smooth boundary.

IIB3t—31 to 46 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; moderate, coarse, prismatic structure that breaks to weak, medium, subangular blocky structure, which becomes weaker with depth; ped faces are grayish brown (2.5Y 5/2) and have few, fine, distinct, yellowish-brown (10YR 5/4) mottles; slightly firm; few gray clay films on some ped faces in upper two-thirds of horizon; few roots to a depth of 38 inches; common fine pores; upper 3 inches contains a band of pebbles 1/2 inch to 2½ inches in diameter; slightly acid in upper part, grading to neutral in lower part; clear, irregular boundary.

IIC—46 to 64 inches, yellowish-brown (10YR 5/6) and light brownish-gray (2.5Y 6/2) heavy loam; massive, with distinct vertical cleavage to a depth of about 52 inches; slightly firm; very few very dark gray clay films along root channels; few, small, white, carbonate concretions; calcareous.

The A1 horizon is 8 to 13 inches thick and is generally black (10YR 2/1). Cultivated areas have an Ap horizon that also is black (10YR 2/1). The A3 horizon is dominantly very dark gray (10YR 3/1) with some mixing of black and very dark grayish brown. The A horizon is generally light silty clay loam but ranges to heavy silt loam.

The B1 horizon is dominantly very dark grayish brown light or medium silty clay loam that has a few mottles. The B2 horizon in the loess is light or medium silty clay loam. It ranges from dark grayish brown (10YR 4/2) to light olive brown (2.5Y 5/4) in color and has a few mottles. The IIB horizon that developed in glacial till and the C horizon differ from those of the profile described principally in the amount and distinctness of the grayish-brown mottling. The prism and ped faces in the till, when dry, have a gray to grayish-brown, grainy appearance. The texture of the till is normally heavy or medium loam but ranges to sandy clay loam and, in a few places, to light clay loam.

A few clay films on ped faces and in root channels are common to most profiles. A few iron and manganese concretions occur in most of these soils. Discontinuous lenses of sand to sandy loam 1 to 10 inches thick occur between the loess and the till in many places.

The A3 and B1 horizons are strongly acid to medium acid. The B2 horizon is slightly acid to strongly acid. The depth to calcareous material ranges from 40 to 60 inches.

Lamont Series

The Lamont series consists of somewhat excessively drained soils that developed in 20 to 40 inches of sandy loam materials over sand.

These soils are on uplands and benches and may occur as mounds or dunes. The slope range is 2 to 14 percent. The upland slopes generally face east, south, or southeast. The native vegetation consisted of hardwoods.

Lamont soils are not so coarse textured as Chelsea soils and are deeper than Backbone soils, which are underlain by limestone bedrock. They are lighter colored than Dickinson soils.

Representative profile of Lamont sandy loam, about 800 feet north and 30 feet east of the southwest corner of the NW¼ sec. 15, T. 92 N., R. 14 W., in closed woods—

A1—0 to 4 inches, black (10YR 2/1) heavy sandy loam; weak, fine, granular structure; friable; abundant roots; neutral; clear, smooth boundary.

A21—4 to 7 inches, very dark gray (10YR 3/1) medium sandy loam; few, fine, dark grayish-brown (10YR 4/2) mixings; weak, fine, granular structure; friable; plentiful roots; slightly acid; gradual, smooth boundary.

A22—7 to 17 inches, dark grayish-brown (10YR 4/2) light sandy loam; common, fine, very dark grayish-brown (10YR 3/2) mixings; very weak, fine, subangular blocky structure; very friable; plentiful roots; medium acid; clear, wavy boundary.

B21t—17 to 23 inches, brown to dark-brown (10YR 4/3) light sandy clay loam; few, fine, dark-brown (10YR 3/3) mixings; weak, coarse, prismatic structure that breaks to weak, fine, subangular blocky; friable; few roots; many fine pores; medium acid; gradual, smooth boundary.

B22t—23 to 29 inches, brown to dark-brown (10YR 4/3) heavy sandy loam; weak, coarse, prismatic structure that breaks to weak, fine, subangular blocky; friable; few roots; many fine pores; few, 1/8-inch to 1/2-inch, discontinuous, horizontal bands of dark-brown (7.5YR 3/2) light sandy clay loam in which a few discontinuous clay films coat some of the ped surfaces; strongly acid; gradual, smooth boundary.

C1—29 to 38 inches, brown to dark-brown (7.5YR 4/4) sand; single grain; loose; few roots; few, 1/8-inch to 1/2-inch, discontinuous, horizontal bands of dark-brown (7.5YR 3/2) loamy sand that are massive and very friable; strongly acid; clear, smooth boundary.

C2—38 to 43 inches, dark yellowish-brown (10YR 4/4) sand; single grain; loose; strongly acid; clear, smooth boundary.

B23—43 to 46 inches, brown to dark-brown (7.5YR 4/4) light sandy loam; massive; very friable; strongly acid; clear, wavy boundary.

C3—46 to 52 inches, yellowish-brown (10YR 5/4) fine and medium sand; single grain; loose; strongly acid; abrupt, smooth boundary.

B24—52 to 53 inches, brown to dark-brown (7.5YR 4/4) loamy sand; massive; loose; strongly acid; abrupt, irregular boundary.

C4—53 to 55 inches, same as C3.

B25—55 to 56 inches, same as B24.

C5—56 to 64 inches, same as C3.

The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1) sandy loam 2 to 5 inches thick. The Ap horizon is dark grayish-brown (10YR 4/2) or very dark grayish-brown (10YR 3/2) sandy loam. The A2 horizon is dark grayish-brown (10YR 4/2) to brown (10YR 5/3) sandy loam to loamy sand 6 to 14 inches thick. This horizon is generally a little coarser on benches than on uplands.

Above the C horizon there is a typical B2 horizon of sandy loam to light sandy clay loam 6 to 16 inches thick. It is brown or dark brown (7.5YR 4/4 or 10YR 4/3). Below a depth of 40 inches and within the C horizon, there are also B2 horizons, which have a texture of sandy loam to loamy sand. These horizons are 1/8 inch to 2 inches thick, and are dark brown (7.5YR 3/2 and 4/4). They are 2 to 20 inches apart.

The C horizon is dominantly brown or dark-brown (7.5YR 4/4) to brownish-yellow (10YR 6/6) medium sand but ranges from loamy fine sand to coarse sand. On benches the texture ranges to gravel below a depth of 40 inches.

The B and C horizons range from slightly acid to strongly acid.

Lawler Series

The Lawler series consists of somewhat poorly drained soils that developed in loamy, medium-textured alluvial deposits 24 to 45 inches deep over coarse-textured material.

These soils commonly occur on level or nearly level benches, but in a few places they are in small outwash areas on uplands. The slope range is 0 to 2 percent. The native vegetation consisted of prairie grasses.

The Lawler series is a member of the hydrosequence that includes the well-drained Waukegan and the poorly drained Marshan soils. Lawler soils have a thicker, darker colored A1 horizon than Hayfield soils, and they lack an A2 horizon. They have a much coarser textured substratum than Floyd soils. They have a thinner A1 horizon than Spillville soils and are underlain by coarse materials at a depth of 24 to 45 inches.

Representative profile of Lawler loam, deep, 1,640 feet south and 109 feet east of the corner post in the northwest corner of sec. 4, T. 91 N., R. 13 W., in a pasture—

Ap—0 to 8 inches, black (10YR 2/1) medium loam; weak, medium, subangular blocky structure that breaks to weak, fine, granular structure; friable; plentiful roots; medium acid; clear, smooth boundary.

A12—8 to 15 inches, black (10YR 2/1) medium loam; moderate, fine, granular structure; friable; plentiful roots; medium acid; gradual, smooth boundary.

A3—15 to 21 inches, very dark grayish-brown (10YR 3/2) heavy loam; few, fine, faint, dark grayish-brown (10YR 4/2) mottles and few very dark gray (10YR 3/1) mixings; weak, fine, subangular blocky structure; friable; few fine pores; few roots; medium acid; gradual, smooth boundary.

B1—21 to 27 inches, dark grayish-brown (2.5Y 4/2) to very dark grayish-brown (2.5Y 3/2) heavy loam; common, fine, distinct, yellowish-brown (10YR 5/6) and olive-brown (2.5Y 4/4) and few, fine, distinct, yellowish-red (5YR 4/6) mottles; when kneaded, color is dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4); weak, medium, subangular blocky structure; friable; many fine pores and few medium pores; few roots; slightly acid; gradual, smooth boundary.

B21—27 to 36 inches, mixed dark grayish-brown (2.5Y 4/2), grayish-brown (2.5Y 5/2), and yellowish-brown (10YR 5/6) heavy loam; few, fine, faint, light olive-brown (2.5Y 5/6) and few, fine, distinct, dark-brown or brown (7.5YR 4/4) mottles; color when kneaded is olive brown (2.5Y 4/4); weak, medium, subangular blocky structure; friable; many fine and medium pores; few roots; slightly acid; clear, wavy boundary.

B22—36 to 40 inches, yellowish-brown (10YR 5/6), light olive-brown (2.5Y 5/6), and grayish-brown (2.5Y 5/2) light sandy clay loam; very weak, coarse, subangular blocky structure; friable; few fine and medium pores; few fine roots; slightly acid; clear, smooth boundary.

IIC1—40 to 50 inches, stratified dark grayish-brown (10YR 4/2) loamy coarse gravel and dark-gray (10YR 4/1) sandy loam; pebbles are dominantly ½ inch to 2 inches long, are subrounded, and occupy about 40 percent of the stratum; sandy loam is massive and very friable; loamy coarse gravel is single grain and loose; slightly acid; clear boundary.

IIC2—50 to 60 inches, brown to dark-brown (10YR 4/3) loamy coarse gravel; pebbles are subrounded, are ½ to 1 inch long, and occupy about 40 percent of the horizon; slightly acid; single grain; loose.

The A1 horizon is 9 to 16 inches thick. The A1 or Ap horizon is black (10YR 2/1). The B1 and B2 horizons range from very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) to olive brown (2.5Y 4/4) and have few to common mottles.

The texture of the solum is dominantly medium or heavy loam. The lower B2 horizon commonly grades to sandy loam just above the C horizon.

The coarse-textured substratum ranges from loamy sand to gravel. This begins at a depth of 24 to 36 inches in the moderately deep phase and at 36 to 45 inches in the deep phase.

The reaction throughout the profile is generally medium acid but ranges from slightly acid to strongly acid.

Marshan Series

The Marshan series consists of poorly drained soils that developed in moderately fine textured alluvial deposits 24 to 45 inches thick over coarse-textured material.

These soils are on level or nearly level benches that are slightly depressional in places. The slope range is 0 to 2 percent. The native vegetation consisted of grasses and water-tolerant plants.

The Marshan series is a member of the hydrosequence that includes the somewhat poorly drained Lawler and the well-drained Waukegan soils. They have a thinner A1 horizon than the Colo soils, which are dark colored to a depth of 40 inches or more. Marshan soils are underlain by coarse materials, whereas Clyde soils are underlain by a finer textured substratum of stratified glacial till.

Representative profile of Marshan clay loam, deep, 90 feet north and 40 feet west of the corner post in the southeast corner of the NE¼NE¼ sec. 18, T. 92 N., R. 11 W., in a cultivated field—

Ap—0 to 7 inches, black (N 2/0) light clay loam; weak, fine, subangular blocky structure that breaks to weak, fine, granular; friable; plentiful roots; neutral; abrupt, smooth boundary.

A12—7 to 16 inches, black (N 2/0) light clay loam; weak, fine, subangular blocky structure that breaks to weak, fine, granular; friable; plentiful roots; neutral; clear, smooth boundary.

A3—16 to 23 inches, black (10YR 2/1) light clay loam; few, fine, faint, very dark gray (10YR 3/1) mottles; weak, fine, subangular blocky structure that breaks to weak, fine, granular; friable; few roots; neutral; clear, smooth boundary.

B21g—23 to 29 inches, gray (10YR 5/1) clay loam; common, fine, faint, very dark grayish-brown (2.5Y 3/2) and few, fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak, fine, subangular blocky structure; friable; few roots; pebble band in lower part of horizon consists of pebbles ½ inch to 3 inches across; few roots; neutral; clear, smooth boundary.

B22—29 to 38 inches, light olive-brown (2.5Y 5/4) heavy sandy loam; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; few roots to a depth of 32 inches; neutral; clear, smooth boundary.

IIC1—38 to 48 inches, grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/6) loamy sand; single grain; loose; neutral; clear, smooth boundary.

IIC2—48 to 52 inches, yellowish-brown (10YR 5/6), grayish-brown (10YR 5/2), and very dark gray (10YR 3/1) fine gravelly sand; single grain; loose; neutral; abrupt, clear boundary.

IIC3—52 to 56 inches, gray (5Y 6/1) and yellowish-brown (10YR 5/6) heavy sandy loam; massive; friable; neutral; abrupt, smooth boundary.

IIC4—56 to 62 inches, yellowish-brown (10YR 5/6) and grayish-brown (10YR 5/2) sand containing a few 2-inch to 3-inch pebbles; neutral.

The A1 horizon is 12 to 20 inches thick and is generally light clay to loam but ranges to heavy loam. The B horizon is dominantly light clay loam but ranges to heavy loam and sandy clay loam. The upper part of the B horizon has a hue of 2.5Y or 5Y, a value of 3 to 5, a chroma of 1, and a few mottles. The lower part has a higher chroma and more mottles.

The coarse-textured substratum ranges in texture from loamy sand to gravel. It begins at a depth of 24 to 36 inches in the moderately deep soil and at 36 to 45 inches in the deep soil.

The reaction generally is neutral throughout the profile, but it is slightly acid in a few places.

Maxfield Series

This series consists of poorly drained soils that developed in 20 to 40 inches of loess over glacial till. A pebble band occurs between the loess and the till in most places.

These soils are on uplands, and in a few places they are in drainageways. The slope range is 0 to 2 percent. The native vegetation consisted of prairie grasses and water-tolerant plants.

The Maxfield series is a member of the hydrosequence that includes the somewhat poorly drained Klinger and the well-drained Dinsdale soils. Maxfield soils are shallower to glacial till than Sable soils. They have less sand above a depth of 20 to 40 inches than Tripoli, Clyde, and Marshan soils. They are not underlain by coarse materials as are the Marshan soils.

Representative profile of Maxfield silty clay loam, 90 feet east and 35 feet north of the corner post in the southwest corner of sec. 24, T. 91 N., R. 12 W., in a cultivated field—

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

A12—7 to 12 inches, black (N 2/0) light silty clay loam; some mixing of grayish brown (2.5Y 5/2); moderate, fine, granular structure; friable; few roots; neutral; clear, smooth boundary.

A3—12 to 17 inches, black (10YR 2/1) medium silty clay loam; common, fine, distinct, dark grayish-brown (2.5Y 4/2) mottles; moderate, fine, granular structure; friable; few roots; neutral; gradual, smooth boundary.

B21—17 to 23 inches, dark grayish-brown (2.5Y 4/2) medium silty clay loam; few, fine, distinct, reddish-brown (5YR 4/4) mottles; weak, fine, subangular blocky structure; friable; few roots; many fine pores; neutral; gradual, smooth boundary.

B3g—23 to 32 inches, olive-gray (5Y 5/2) to olive (5Y 5/3) heavy silt loam; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, fine, subangular blocky structure; friable; few roots; many fine pores; neutral; abrupt, smooth boundary.

IIB3—32 to 45 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, light brownish-gray (2.5Y 6/2) mottles; weak, medium, prismatic structure that breaks to weak, coarse, subangular blocky structure; prism faces are pale olive (5Y 6/3); slightly firm; in the upper part of the horizon is a band of pebbles ¼ inch to 2 inches, and a few as much as 4 inches, in diameter; a 1-inch lens of yellowish-brown (10YR 5/8) loamy sand with common, fine, distinct, light brownish-gray (2.5Y 6/2) mottles occurs at the top of this horizon; few roots to a depth of 40 inches; slightly acid; gradual, smooth boundary.

IIC1—45 to 56 inches, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/8) heavy loam; many, medium, distinct, light brownish-gray (2.5Y 6/2) mottles; massive; slightly firm; slightly acid; clear, wavy boundary.

IIC2—56 to 66 inches, same as IIC1, but calcareous.

The A1 horizon ranges from 10 to 16 inches in thickness, is black (N 2/0 to 10YR 2/1), and generally is light silty clay loam but may be medium silty clay loam. The A3 horizon is dominantly medium silty clay loam. The color has a value of 3 to a depth of 24 inches.

The B21 horizon ranges from very dark grey (10YR 3/1) with a few olive (5Y 5/3) mottles to dark grayish brown (2.5Y 4/2) with a few reddish-brown (5YR 4/4) mottles. The texture generally is medium silty clay loam. The B2 horizon ranges from olive gray (5Y 4/2) to dark grayish brown (2.5Y 4/2) and has a few reddish-brown to olive mottles. The texture is heavy silt loam to light silty clay loam. If a B3 horizon occurs within the loess parent material, it is about the same color as the B2 and is normally heavy silt loam.

The B3 horizon that developed in glacial till and the C horizon differ from those of the profile described, principally in the amount and distinctness of the brownish-gray mottling. The prism and ped faces in the till, when dry, have a gray to grayish-brown, grainy appearance. The texture of the till is normally heavy or medium loam but ranges to sandy clay loam and, in a few places, to light clay loam.

In places there are a few clay films in root channels of the B3 horizon, but this is not typical of the Maxfield series. Discontinuous lenses of sand to sandy loam 1 to 12 inches thick occur between the loess and the till in many areas, especially in drainageways.

The reaction is generally neutral in the loess material and slightly acid to neutral in the till. The depth to calcareous material ranges from 40 to 60 inches.

Muscatine Series

The Muscatine series consists of somewhat poorly drained soils that developed from thick deposits of loess.

These soils are on uplands. The slope range is 1 to 3 percent. The native vegetation consisted of prairie grasses.

The Muscatine series is a member of the hydrosequence that includes the poorly drained Sable soils. Muscatine soils are deeper to glacial till than Klinger soils. They are not so well drained as Port Byron soils and have slightly more clay in the A and the upper B horizons.

Representative profile of Muscatine silty clay loam, 420 feet north and 326 feet west of the corner post in the southeast corner of sec. 30, T. 91 N., R. 12 W., in a cultivated field—

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

A12—7 to 15 inches, black (10YR 2/1) light silty clay loam; moderate, very fine, subangular blocky structure; friable; few roots; medium acid; gradual, smooth boundary.

A3—15 to 21 inches, very dark gray (10YR 3/1) and black (10YR 2/1) light silty clay loam; moderate, fine, subangular blocky structure; friable; few roots; slightly acid; gradual, smooth boundary.

B1t—21 to 28 inches, very dark gray (10YR 3/1) and dark grayish-brown (2.5Y 4/2) light silty clay loam; few, fine, distinct, light olive-brown (2.5Y 5/4) mottles; moderate, fine, subangular blocky structure; friable; few roots; slightly acid; gradual, smooth boundary.

B2—28 to 36 inches, olive-brown (2.5Y 4/4) heavy silt loam; common, fine, faint, dark grayish-brown (2.5Y 4/2) and few, fine, distinct, strong-brown (7.5YR 5/6) mottles; very weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; friable; few roots; common fine pores; neutral; gradual, smooth boundary.

B31—36 to 44 inches, light olive-brown (2.5Y 5/4) medium silt loam; common, fine, distinct, yellowish-brown (10YR 5/6 and 5/8) mottles; very weak, medium, prismatic structure that breaks to weak, medium, subangular blocky structure; friable; few roots; many fine pores; many, fine, very dark gray (10YR 3/1) oxide concretions and few black (10YR 2/1) worm mixings; neutral; gradual, smooth boundary.

B32—44 to 49 inches, grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) medium silt loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; very weak, prismatic structure that breaks to weak, coarse, subangular blocky structure; friable; many, fine, black (10YR 2/1) oxide concretions and few black (10YR 2/1) worm mixings; neutral; diffuse, smooth boundary.

C1—49 to 67 inches, grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) medium silt loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; massive; friable; few, fine, soft, black (10YR 2/1) oxide concretions; neutral; clear, wavy boundary.

C2—67 to 90 inches, same as C1 but calcareous.

The A1 horizon is 10 to 16 inches thick. The A3 horizon is dominantly very dark gray (10YR 3/1) with some mixing of black and dark grayish brown. The A horizon is generally light silty clay loam but ranges to heavy silt loam.

The B1 horizon differs from that of the profile described principally in texture, which may be light or medium silty clay loam. The B2 horizon has a color of dark grayish brown (10YR 4/2) to light olive brown (2.5Y 5/4) and is slightly mottled. It has a texture of heavy silt loam to light silty clay loam. A few clay films may occur on the ped faces in the B1 and B2 horizons and in the root channels in the B3 horizon.

The A3 and B1 horizons are slightly acid to medium acid. The B2 horizon is slightly acid to neutral. The depth to calcareous material ranges from 50 to 70 inches.

Nodaway Series

The Nodaway series consists of moderately well drained, moderately dark colored to light-colored soils derived from recently deposited, medium-textured, stratified alluvium.

These soils are on bottom lands and alluvial fans in association with steep, medium-textured eolian soils. The slope range is 0 to 2 percent. The native vegetation consisted of trees and grasses.

Nodaway soils are lighter colored and much more stratified than Terril and Spillville soils, and they are silty rather than loamy.

Representative profile of Nodaway silt loam, 106 feet west and 128 feet south of the northeast corner of the NW¼NE¼ sec. 28, T. 91 N., R. 13 W., in a cultivated field—

Ap—0 to 8 inches, very dark grayish-brown (2.5Y 3/2) silt loam; few, fine, faint, very dark brown (10YR 2/2) and dark brown to brown (10YR 4/3) mixings; pale-brown (10YR 6/3) when dry; weak, fine, granular structure; friable; few roots; neutral; abrupt, smooth boundary.

C1—8 to 41 inches, dark grayish-brown (2.5Y 4/2) (70 percent) and very dark grayish-brown (10YR 3/2) (30 percent) silt loam; common, fine, distinct, brown (10YR 5/3) mottles; very thinly stratified (0.05 to 1.0 millimeter); very friable; few roots to a depth of 32 inches; few strata of yellowish-brown (10YR 5/4) fine sand in upper part of horizon and few strata of grayish-brown (2.5Y 5/2) fine sand in lower part; neutral; abrupt, smooth boundary.

C2—41 to 57 inches, very dark grayish-brown (10YR 3/2) silt loam consisting of distinct, dark grayish-brown (2.5Y 4/2) and very dark brown (10YR 2/2) strata 0.5 millimeter to 1.5 millimeters thick; very friable; neutral; clear, smooth boundary.

IIAb—57 to 86 inches, very dark brown (10YR 2/2) silt loam; common, fine, faint, very dark grayish-brown (10YR 3/2) mottles; massive; friable; this horizon contains less sand than the C2; neutral.

The stratified lenses in the C1 and C2 horizons range from very dark grayish brown (10YR 3/2 to 2.5Y 3/2) to brown (10YR 5/3) and dark grayish brown (2.5Y 4/2).

The depth to the dark-colored IIAb horizon is 34 to 80 inches. The dark-colored substratum ranges from very dark brown (10YR 2/2) silt loam to silty clay loam.

The reaction throughout the profile is generally neutral.

Oran Series

The Oran series consists of somewhat poorly drained soils that developed in 14 to 24 inches of loamy material over glacial till of loam texture. A pebble band occurs between the glacial till and the overlying material in most places. These soils are on uplands. The slope range is 0 to 5 percent. Most of the slopes are convex, but a few of the lower ones are concave. Some areas of these soils are in upland coves. The native vegetation consisted of grasses and trees.

The Oran series is a member of the hydrosequence that includes the moderately well drained Bassett soils. Oran soils have a lighter colored Ap horizon and a thinner A1 horizon than Readlyn soils, and they have an A2 horizon, which Readlyn soils lack. Oran soils have a little less clay in the B and C horizons than Riceville soils and are less gray in these horizons. They contain more sand and less silt than Franklin soils, which developed from moderately thick loess over glacial till.

Representative profile of Oran loam, 1,200 feet east and 77 feet south of the corner post in the northwest corner of sec. 4, T. 93 N., R. 12 W., in a cultivated field—

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

A2—7 to 13 inches, dark grayish-brown (10YR 4/2) and brown to dark-brown (10YR 4/3) loam; weak, thin, platy structure; friable; few very dark brown (10YR 2/2) worm casts; few roots; very strongly acid; clear, wavy boundary.

B1—13 to 17 inches, dark yellowish-brown (10YR 4/4), yellowish-brown (10YR 5/6), and dark grayish-brown (10YR 4/2) heavy loam; few, fine, faint, brown to dark-brown (7.5YR 4/4) mottles; weak, fine, subangular blocky structure; friable; few roots; few fine pores; very strongly acid; clear, smooth boundary.

IIB21—17 to 23 inches, heavy loam that has few, fine, distinct, dark grayish-brown (10YR 4/2) mottles; ped faces are grayish brown (2.5Y 5/2) and have common, fine, distinct, yellowish-brown (10YR 5/6) mottles; ped interiors are yellowish brown (10YR 5/6); weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky; prism faces are grayish brown (10YR 5/2 and 2.5Y 5/2); friable; few roots; few fine and medium pores; a few pebbles are scattered throughout, and those in the lower part are 2 to 4 inches long; very strongly acid; gradual, smooth boundary.

IIB22t—23 to 30 inches, heavy loam that has common, fine, distinct, grayish-brown (10YR 5/2) mottles; ped interiors are brown (10YR 5/3); moderate, medium, prismatic structure that breaks to moderate, fine, subangular blocky; prism faces are light brownish gray (2.5Y 6/2) and have common, fine, distinct, yellowish-brown (10YR 5/6) mottles; few dark-gray (10YR 4/1) clay films on prism and ped faces; slightly firm; few roots; common fine pores and few medium pores; strongly acid; gradual, smooth boundary.

IIB3t—30 to 43 inches, loam; ped interiors are yellowish brown (10YR 5/8); weak, medium, prismatic structure that breaks to very weak, coarse, subangular blocky structure; slightly firm; very thin, discontinuous, dark-gray (10YR 4/1) clay films on prism faces; films are mottled with a few very dark gray (10YR 3/1), and somewhat thicker, vertical clay streaks; many of the vertical and a few of the horizontal root channels are lined with very dark gray (10YR 3/1) clay films, and there are a few small globs of clay in these channels; few roots; common fine pores; slightly acid; clear, wavy boundary.

IIC—43 to 60 inches, yellowish-brown (10YR 5/6) and light brownish-gray (10YR 6/2) loam; massive; slightly firm; a few root channels are lined with dark-gray (10YR 4/1) clay films; few, small, rounded, hard lime concretions at a depth of 43 to 49 inches; calcareous.

The Ap horizon is generally very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). In undisturbed areas the A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and is 4 to 7 inches thick. The A2 horizon is dark brown or brown (7.5YR 4/2) to very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2). It grades from distinct to barely discernible. The A1 and A2 horizons are dominantly loam but may be gritty silt loam.

The texture of the B and C horizons is dominantly heavy loam but ranges from medium loam to light clay loam or sandy clay loam. The texture around the pebble band may be heavy sandy loam. The soil is generally friable to a depth of about 24 inches and is slightly firm below this depth. The loamy material overlying the pebble band contains more silt and less sand than the underlying till.

The color of the B and C horizons varies principally in the amount and distinctness of the grayish mottling. Prism and ped faces in the B2 and B3 horizons, when dry, have a gray to grayish-brown, grainy appearance. In the lower B2 horizon and the B3 horizon, the prism and ped faces generally have a few distinct clay films and streaks. The root channels of the B3 and C horizons are generally lined with clay films.

The B1 and B2 horizons are strongly acid or very strongly acid, and the B3 horizon is slightly acid to strongly acid. The depth to calcareous material ranges from 40 to 70 inches but is generally between 40 and 50 inches.

Ostrander Series

The Ostrander series consists of well-drained soils that developed in 14 to 24 inches of loamy material over friable glacial till loam. A pebble band separates the glacial till from the overlying material in most places.

These soils are on uplands. The slope range is 1 to 9 percent. The native vegetation consisted of prairie grasses.

Ostrander soils have less mottling, are deeper to mottling, and have a weaker structure than Kenyon soils. They are shallower to glacial till than Aredale soils, which developed in very deep, medium-textured eolian material. They contain more sand and less silt than Dinsdale soils, which developed in moderately thick loess over glacial till. Ostrander soils are not underlain by limestone bedrock at a depth of 36 to 50 inches as are Atkinson soils.

Representative profile of Ostrander loam, 1,808 feet west and 789 feet south of the corner post in the northeast corner of sec. 5, T. 91 N., R. 14 W., in a cultivated field—

Ap—0 to 6 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; few roots; slightly acid; clear, smooth boundary.

A12—6 to 10 inches, black (10YR 2/1) loam; weak, fine and very fine, granular structure; friable; few roots; slightly acid; gradual, smooth boundary.

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A3—10 to 17 inches, dark-brown (10YR 3/3) and very dark brown (10YR 2/2) loam; weak, fine and very fine, subangular blocky structure; friable; many black (10YR 2/1) worm casts; few roots; few fine pores; strongly acid; gradual, wavy boundary.

B1—17 to 22 inches, loam; nearly continuous dark-brown (10YR 3/3) ped coats; ped interiors are dark yellowish brown (10YR 4/4); weak, very fine, subangular blocky structure; friable; many very dark brown (10YR 2/2) and few yellowish-brown (10YR 5/6) worm casts; few roots; few fine pores; strongly acid; clear, smooth boundary.

IIB2—22 to 32 inches, loam; discontinuous brown to dark-brown (10YR 4/3) ped coats; yellowish-brown (10YR 5/6) ped interiors; weak, fine, subangular blocky structure; friable; few roots; common fine pores; few very dark grayish-brown (10YR 3/2) worm casts; band of pebbles ½ inch to 3 inches in diameter in upper part of horizon; medium acid; gradual, smooth boundary.

IIB3—32 to 46 inches, loam; discontinuous yellowish-brown (10YR 5/4) ped coats; yellowish-brown (10YR 5/6) ped interiors; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky structure; friable; common fine pores; few, fine, black (10YR 2/1) oxide concretions; few ½-inch to 1-inch pebbles; slightly acid; gradual, smooth boundary.

IIC1—46 to 54 inches, yellowish-brown (10YR 5/4 and 5/6) light loam; about 20 percent of the matrix consists of light brownish-gray (2.5Y 6/2), discontinuous, horizontal lenses; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; massive, with some thick horizontal cleavage; friable; few very pale brown (10YR 7/3) lime concretions; calcareous; gradual, smooth boundary.

IIC2—54 to 60 inches, yellowish-brown (10YR 5/4 and 5/6) and 20 percent light brownish-gray (2.5Y 6/2) loam; massive; friable; few very pale brown (10YR 7/3) lime concretions; calcareous.

The A1 horizon is 7 to 11 inches thick, if not more than slightly eroded, and is black (10YR 2/1) or very dark brown (10YR 2/2). The A3 horizon is very dark brown (10YR 2/2) to dark yellowish brown (10YR 3/4).

The texture of the B and C horizons is dominantly medium loam but ranges from light loam to sandy clay loam. Around the pebble band, the texture is heavy sandy loam in some places. The profile is generally friable throughout, but it is slightly firm in some places below a depth of 40 inches. The loamy material overlying the pebble band contains more silt and less sand than the underlying glacial till. Pockets, or discontinuous lenses, of sandy material occur in much of the glacial till.

The B horizon has a chroma greater than 3 and is more than 36 inches deep to mottling. In a few places, oxide concretions occur throughout the B and C horizons.

The A3, B1, and B2 horizons are medium acid or strongly acid. The depth to calcareous material ranges from 40 to 70 inches but is generally between 45 and 60 inches.

Peaty Muck

Peaty muck consists of very poorly drained, organic soil over stratified glacial till or alluvial sediments. Most of it is in hillside seepage areas adjoining outwashes or stream benches, but some of it is in upland drainageways. Except in cultivated areas, the surface is hummocky. The slope range is 1 to 4 percent. The native vegetation consisted of grasses and other water-tolerant plants.

Representative profile of Peaty muck, moderately deep, 100 feet north and 40 feet east of the corner post in the southwest corner of sec. 4, T. 93 N., R. 11 W., in an area formerly cultivated but now in pasture—

O11—0 to 14 inches, black (N 2/0) peaty muck; few fine roots; neutral; abrupt, clear boundary.

O12—14 to 21 inches, black (10YR 2/1) and very dark brown (10YR 2/2) peaty muck, containing a few undecomposed plant fibers that disintegrate when rubbed; few roots; neutral; clear, smooth boundary.

O13—21 to 31 inches, black (N 2/0) muck that has a few uncoated quartz grains; neutral; abrupt, smooth boundary.

IIC1—31 to 36 inches, gray (N 5/0) heavy silt loam; common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; few undecomposed plant fibers that disintegrate when rubbed; massive; friable; few ¼-inch to 2½-inch pebbles; moderately alkaline; clear, wavy boundary.

IIC2—36 to 50 inches, gray (N 5/0) coarse sandy loam; massive; very friable; few roots; few undecomposed plant fibers that disintegrate when rubbed; few ¼-inch to 1½-inch pebbles; moderately alkaline; clear, smooth boundary.

IIC3—50 to 74 inches, stratified gray (N 5/0) silt loam and loamy sand; massive; friable; few small particles of undecomposed organic matter that disintegrate when rubbed; moderately alkaline.

The thickness of the organic material ranges from 20 to 80 inches. The upper 20 to 30 inches of organic material consists mostly of peaty muck, but some of it is muck. In a very few areas the upper part is mucky peat. The material in the II horizon is medium textured or moderately coarse textured and is stratified.

The reaction is generally slightly acid or neutral, but it ranges from moderately alkaline to strongly acid.

Port Byron Series

The Port Byron series consists of well-drained soils that developed from very thick, medium-textured loess of local origin.

These soils are on rolling uplands. The slope range is 2 to 14 percent. The native vegetation consisted of prairie grasses.

Port Byron soils have a thicker, somewhat darker colored A1 horizon than Seaton soils, and they lack an A2 horizon. They contain less sand than Aredale soils and are much deeper to glacial till than Dinsdale soils. Port Byron soils are better drained than Muscatine soils and have slightly less clay in the A horizon and the upper B horizon.

Representative profile of Port Byron silt loam, 60 feet north and 80 feet west of the southeast corner of the NE¼SW¼ sec. 26, T. 92 N., R. 14 W., on a north-facing, convex slope of 6 percent—

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

A3—8 to 17 inches, very dark grayish-brown (10YR 3/2) heavy silt loam; few brown to dark-brown (10YR 4/3) mixings; weak, very fine, subangular blocky structure; friable; nearly continuous, very dark brown (10YR 2/2) organic coatings; few roots; medium acid; gradual, smooth boundary.

B2t—17 to 30 inches, brown to dark-brown (10YR 4/3) heavy silt loam; very weak, coarse, prismatic structure that breaks to weak, fine and medium, subangular blocky structure; friable; discontinuous dark-brown (10YR 3/3) ped faces; few roots; few very fine pores; very thin, discontinuous clay films in the lower part of this horizon; medium acid; gradual, smooth boundary.

B3—30 to 46 inches, dark yellowish-brown (10YR 4/4) heavy silt loam; very weak, coarse, prismatic structure that breaks to weak, fine and medium, subangular blocky structure; friable; few roots; many very fine pores; medium acid; diffuse, smooth boundary.

C—46 to 66 inches, yellowish-brown (10YR 5/4) medium silt loam; few, fine, faint, yellowish-brown (10YR 5/6) mottles; massive; friable; few small pockets or lenses of light yellowish-brown (10YR 6/4) loamy very fine sand; very fine pores and scattered roots; medium acid.

The A1 horizon is 7 to 11 inches thick, if not more than slightly eroded, and is black (10YR 2/1) or very dark brown (10YR 2/2). If the A3 horizon is not part of the Ap, it is very dark grayish-brown (10YR 3/2) or dark-brown (10YR 3/3) silt loam.

The sand content of the entire profile generally ranges from 6 to 16 percent. In areas adjoining sandy soils, the content of sand may be as much as 25 percent, and most of the sand is very fine.

The clay content of the A and B horizons ranges from 18 to 27 percent. The C horizon is light or medium silt loam. In many places the C horizon is brown or yellowish brown.

Port Byron soils are slightly acid to medium acid throughout the solum. The depth to calcareous material is generally 60 to 80 inches.

Readlyn Series

The Readlyn series consists of somewhat poorly drained soils that developed in 14 to 24 inches of loamy material over friable to firm glacial till of loam texture. A pebble band occurs between the glacial till and the overlying material in most places.

These soils are on uplands. The slope range is 0 to 5 percent. The native vegetation consisted of prairie grasses.

The Readlyn series is a member of the hydrosequence that includes the moderately well drained Kenyon and the poorly drained Tripoli soils. Readlyn soils have a thinner A1 horizon and are firmer in the B and C horizons than Floyd soils, and they are not underlain by stratified material. They have a thicker A1 horizon than Oran soils and lack an A2 horizon. Readlyn soils contain more sand and less silt than Klinger soils, which developed from moderately deep loess over till.

Representative profile of Readlyn loam, 870 feet south and 860 feet east of the northwest corner of the NE¼ sec. 23, T. 92 N., R. 13 W., in a cultivated field—

Ap—0 to 7 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; plentiful roots; medium acid; clear, smooth boundary.

A3—7 to 12 inches, very dark brown (10YR 2/2) loam; some mixing of brown to dark brown (10YR 4/3); weak, fine, subangular blocky structure; friable; few roots; strongly acid; gradual, smooth boundary.

B1—12 to 17 inches, very dark grayish-brown (10YR 3/2) loam; few fine mixings of brown to dark brown (10YR 4/3) and very dark gray (10YR 3/1) in the upper part and few, fine, faint, dark grayish-brown (2.5Y 4/2) mottles in the lower part of horizon; weak, fine, subangular blocky structure; friable; few roots; strongly acid; gradual, smooth boundary.

IIB21—17 to 24 inches, dark grayish-brown (2.5Y 4/2) to olive-brown (2.5Y 4/4) heavy loam; few, fine, faint, dark grayish-brown (10YR 4/2) and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure that breaks to weak, fine, subangular blocky structure; friable; many 1-inch to 3-inch pebbles occur at a depth of 17 to 20 inches; few roots; few fine pores; strongly acid; gradual, smooth boundary.

IIB22—24 to 31 inches, heavy loam that has common, fine, faint, yellowish-brown (10YR 5/6) and common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; ped faces are grayish brown (2.5Y 5/2) and have common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; ped interiors are dark yellowish brown (10YR 4/4); weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky structure; slightly firm; few roots; common fine pores; medium acid; gradual, smooth boundary.

IIB23—31 to 43 inches, heavy loam that has common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; ped faces are grayish brown (2.5Y 5/2); ped interiors are yellowish brown (10YR 5/6); moderate, medium, prismatic structure that breaks to moderate, fine, subangular blocky; slightly firm; few very dark gray (10YR 3/1) clay films on ped faces; few, soft, black (10YR 2/1) oxide concretions; few roots; common fine pores; slightly acid; gradual, smooth boundary.

IIB3—43 to 52 inches, heavy loam that has many, fine, distinct, grayish-brown (2.5Y 5/2) mottles; ped faces are grayish brown (2.5Y 5/2) and have many, medium, distinct, yellowish-brown (10YR 5/8) mottles; ped interiors are yellowish brown (10YR 5/6); weak, medium, prismatic structure; slightly firm; few roots; few fine pores; neutral; clear, wavy boundary.

IIC—52 to 60 inches, yellowish-brown (10YR 5/6) heavy loam that has many, fine, distinct, grayish-brown (2.5Y 5/2) mottles; common, fine, soft, white (N 8/0) lime accumulations and concretions; slightly firm; calcareous.

The A1 horizon ranges from 7 to 11 inches in thickness and is generally black (10YR 2/1). If cultivated, it is commonly very dark brown (10YR 2/2). The color of the A3 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) and may be slightly mottled.

The texture of the B and C horizons is dominantly heavy loam but ranges from medium loam to light clay loam or sandy clay loam. In the zone of the pebble band, the texture is heavy sandy loam in a few places.

The soil is generally friable to a depth of about 24 inches and is slightly firm below this depth. The loamy material over the pebble band contains more silt and less sand than the underlying till.

The color of the B and C horizons differs from that of the profile described, principally in the amount and distinctness of the grayish mottling. Prism and ped faces in the B2 and B3 horizons, when dry, have a gray to grayish-brown, grainy appearance. In the lower B2 and the B3 horizons there are a few distinct clay films or streaks on the prism and ped faces. In some places clay films or streaks are in the root channels of the B3 and C horizons. Reddish and black oxide concretions, if present, are in the B and C horizons.

The A3, B1, B21, and B22 horizons are medium or strongly acid. The depth to calcareous material ranges from 40 to 70 inches but is generally between 40 and 60 inches.

Riceville Series

The Riceville series consists of somewhat poorly drained soils that developed in 14 to 24 inches of loamy material over firm glacial till of light clay loam texture.

In most places a pebble band separates the glacial till and the overlying material.

These soils are on uplands. The slope range is 1 to 3 percent. The native vegetation consisted of grasses and trees.

Riceville soils are firmer in the B and C horizons than Oran soils, and they have slightly more clay and grayer coloring in those horizons.

Representative profile of Riceville loam, 288 feet east and 210 feet south of the corner post in the northwest corner of the SW¼ sec. 8, T. 93 N., R. 12 W., in a cultivated field—

Ap—0 to 6 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; few roots; slightly acid; abrupt, smooth boundary.

A2—6 to 12 inches, dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) loam to silt loam; common, fine, faint, brown or dark-brown (10YR 4/3) mottles and a few very dark gray (10YR 3/1) mixings; moderate, thin, platy structure; friable; few, fine, hard, dark-colored oxide concretions; few roots; strongly acid; clear, smooth boundary.

B1—12 to 17 inches, dark grayish-brown (10YR 4/2) and brown (10YR 5/3) heavy loam; common, fine, faint, brown or dark-brown (10YR 4/3) mottles; weak, fine, subangular blocky structure; friable; few, fine, hard, dark-colored oxide concretions; few roots; few fine pores; pebble band in lower part of horizon; very strongly acid; clear, smooth boundary.

IIB21t—17 to 25 inches, sandy clay loam; ped faces are grayish brown (10YR 5/2) and have common, fine, distinct, yellowish-brown (10YR 5/6) mottles; ped interiors are grayish brown (2.5Y 5/2) (40 percent) and strong brown (7.5YR 5/6); weak or moderate, fine, prismatic structure that breaks to weak, fine, subangular blocky structure; slightly firm; some fine sand on prism faces; few black (10YR 2/1) clay films in root channels; few roots; few fine and medium pores; very strongly acid; gradual, smooth boundary.

IIB22t—25 to 38 inches, light clay loam; prism and ped faces are grayish brown (2.5Y 5/2) and have common, fine, distinct, yellowish-brown (10YR 5/6) mottles; ped interiors are grayish brown (2.5Y 5/2) (60 percent) and yellowish brown (10YR 5/8); weak, medium, prismatic structure that breaks to weak, fine, subangular blocky structure; firm; few, distinct, very dark gray (10YR 3/1) clay films; some prism faces have a thick coating of fine and very fine sand; nearly continuous black (10YR 2/1) clay films in root channels; few roots; common fine pores; strongly acid; gradual, smooth boundary.

IIB3t—38 to 48 inches, grayish-brown (2.5Y 5/2) (60 percent) and yellowish-brown (10YR 5/8) light clay loam to heavy loam; very weak, medium, prismatic structure; prism faces are grayish brown (2.5Y 5/2) and have common, fine, distinct, yellowish-brown (10YR 5/6) mottles; firm; few, distinct, very dark gray (10YR 3/1) clay films and streaks; root channels are lined with black (10YR 2/1) clay films; few pencil-size globs of clay in root channels; some prism faces coated with fine sand; few roots to a depth of 44 inches; few fine pores; strongly acid; gradual, smooth boundary.

IIC—48 to 65 inches, yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam that has few, fine, distinct, strong-brown mottles; massive; slightly firm; black (10YR 2/1) and very dark gray (10YR 3/1) clay films in root channels; slightly acid.

The Ap horizon is generally very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). In undisturbed areas the A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and is 4 to 7 inches thick. The A2 horizon is distinct to barely discernible. In color it varies between dark brown or brown (7.5YR 4/2), dark grayish brown (10YR 4/2), very dark grayish brown (10YR 3/2), and grayish brown (10YR 5/2). The A1 and A2 horizons are dominantly loam but may be gritty silt loam.

The texture of the B2, B3, and C horizons is dominantly light clay loam but ranges to heavy loam or sandy clay loam. In the zone of the pebble band the texture is heavy sandy loam in some places.

The profile is generally friable in the first 24 inches and is firm below this to a depth of about 50 inches. The loamy material overlying the pebble band contains more silt and less sand than the underlying till.

The color of the B and C horizons varies principally in the amount and distinctness of the grayish color. Prism and ped faces in the B2 and B3 horizons, when dry, have a gray to grayish brown, grainy appearance. Commonly a few vertical cracks occur along the prism faces, and these are filled with fine and very fine gray sand. Clay films and streaks occur on prism and ped faces and in root channels of the B2 and B3 horizons. In many places there are no oxide concretions.

The B1 and B2 horizons are strongly or very strongly acid. The B3 horizon is slightly acid to strongly acid. The depth to calcareous material ranges from 40 to 70 inches.

Rockton Series

The Rockton series consists of well-drained soils that developed in 18 to 24 inches of loamy glacial material overlying 2 to 12 inches of material that is mostly moderately fine textured. In many places a pebble band occurs at the base of the overlying loamy material. Limestone bedrock is at a depth of 20 to 30 inches. The top 4 to 16 inches of the bedrock is generally shattered.

Most areas of these soils are on uplands; a few are on nearly level benches. The slope range is 1 to 14 percent. The native vegetation consisted of prairie grasses.

Rockton soils are shallower than Atkinson soils. They have a thicker, darker colored A1 horizon than Winneshiek soils, and they lack an A2 horizon. Rockton soils are deeper to limestone than Sogn soils.

Representative profile of Rockton loam, 112 feet south of the northwest corner of sec. 6, T. 93 N., R. 14 W., and 85 feet east of road fence, in a cultivated field—

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

A3—8 to 14 inches, very dark grayish-brown (10YR 3/2) and dark yellowish-brown (10YR 3/4) heavy loam; some mixing of black (10YR 2/1) from horizon above; weak, fine, subangular blocky structure; friable; few roots; many fine and medium pores; slightly acid; gradual, smooth boundary.

B21—14 to 21 inches, brown or dark-brown (10YR 4/3) and dark yellowish-brown (10YR 4/4) sandy clay loam; weak, medium, subangular blocky structure; friable; few very dark gray (10YR 3/1) worm casts in upper part of horizon; few roots; many fine and very fine pores; slightly acid; gradual, smooth boundary.

IIB22t—21 to 28 inches, dark yellowish-brown (10YR 4/4) clay loam; few, fine, yellowish-brown (10YR 5/8) mixings; moderate, fine, subangular blocky structure; few brown or dark-brown (10YR 4/3) ped coatings that appear to be very thin clay films or pressure faces; friable; few roots; many fine and

very fine pores; noticeable increase in clay in lower part of this horizon; pebble band at a depth of 22 inches; neutral; abrupt, wavy boundary.

R—28 inches, hard limestone bedrock that is somewhat shattered.

The A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) loam. It is 7 to 11 inches thick if not more than slightly eroded. The A3 horizon is loam. It is very dark brown (10YR 2/2) to dark yellowish brown (10YR 3/4), generally with some mixing of darker colors.

The B21 horizon is dominantly dark brown (10YR 3/3) to yellowish-brown (10YR 5/4) medium loam, but the texture ranges from light loam to sandy clay loam. The matrix of the IIB2 horizon is brown or dark-brown (10YR 4/3) to yellowish-brown (10YR 5/8) light to heavy clay loam. A thin clay or silty clay B2 horizon may occur just above the limestone.

The depth to limestone is generally 24 to 30 inches. The shattered part of the limestone is 4 to 16 inches thick, and 2 to 10 percent of it is medium-textured to fine-textured material. Plant roots penetrate this shattered rock.

The solum is generally slightly acid, but the A1 and B1 horizons may be medium acid and the B2 horizon may be neutral.

Rolfe Series

The Rolfe series consists of poorly drained soils that developed from medium-textured and moderately fine textured, stratified glacial till or from local alluvium.

These soils are in and along upland drainageways and in flat or slightly depressional areas on stream benches. They have a slope range of 0 to 3 percent. The native vegetation consisted of prairie grasses and water-tolerant plants.

Rolfe soils are not so fine textured as Blockton soils, dark gray subsoil variant. They have a thinner A1 horizon than Clyde and Marshan soils, and they have an A2 horizon, which those soils lack. They also have more clay and a more strongly developed B horizon than Clyde and Marshan soils. Compared with Hayfield and Franklin soils, Rolfe soils are finer textured and distinctly gleyed in the B horizon, and they have an A2 horizon.

Representative profile of Rolfe silt loam, 83 feet east and 383 feet north of the corrugated steel culvert in the SW¼NE¼ sec. 3, T. 93 N., R. 11 W., in permanent pasture—

A11—0 to 3 inches, black (10YR 2/1) silt loam; moderate, fine, granular structure; very friable; abundant roots; strongly acid; clear, smooth boundary.

A12—3 to 10 inches, black (10YR 2/1) silt loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; moderate, fine, granular structure that tends to be platy; very friable; strongly acid; gradual, smooth boundary.

A2—10 to 19 inches, dark-gray (10YR 4/1) to very dark gray (10YR 3/1) silt loam; common, fine, distinct, olive-brown (2.5Y 4/4) mottles; grayish brown (10YR 5/2) to light brownish gray (10YR 6/2) when dry; very dark gray (10YR 3/1) when crushed; moderate, thin, platy structure; very friable; strongly acid; gradual, smooth boundary.

B21t—19 to 23 inches, very dark gray (10YR 3/1) clay loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; very dark grayish brown (10YR 3/2) when crushed; dark gray (10YR 4/1) when dry; weak, medium, subangular blocky structure; slightly firm; medium acid; gradual, smooth boundary.

IIB22tg—23 to 29 inches, clay loam; very dark gray (10YR 3/1) ped faces, very dark gray (10YR 3/1) and strong brown (7.5YR 5/6) ped interiors; very dark grayish brown (10YR 3/2) when crushed; moderate, medium, subangular blocky structure; slightly firm; pebble band in this horizon; medium acid; gradual, smooth boundary.

IIB23g—29 to 35 inches, dark-gray (10YR 4/1) and strong-brown (7.5YR 5/8) heavy sandy clay loam; very dark gray in root channels; dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4) when crushed; weak, medium, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

IIB24g—35 to 42 inches, light clay loam; dark-gray (10YR 4/1) ped faces; gray (10YR 5/1) and strong-brown (7.5YR 5/8) ped interiors; weak, medium, subangular blocky structure; slightly firm; very dark gray in root channels; slightly acid; gradual, smooth boundary.

IICg—42 to 64 inches, gray (10YR 5/1) and strong-brown (7.5YR 5/8) light clay loam; dark gray (10YR 4/1) in root channels; massive; slightly firm; slightly acid; gradual, smooth boundary.

The A1 horizon is dominantly black (10YR 2/1) silt loam 6 to 12 inches thick, but the color varies between black (10YR 2/1) and very dark brown (10YR 2/2), and the texture varies between loam and silt loam. The A2 horizon is 8 to 12 inches thick and consists of silt loam that is dark gray (10YR 4/1), dark grayish brown (10YR 4/2), and very dark gray (10YR 3/1). It is commonly mottled with brown or dark brown (10YR 4/3) to olive brown (2.5Y 4/4).

The B2 horizon ranges from dark-gray (10YR 4/1) medium clay loam to black (10YR 2/1) heavy silty clay loam. The amount and distinctness of mottling generally increase with depth. The upper part of the B2 horizon is darker colored than the lower part. The B3 horizon, if present, generally has a greater proportion of strong-brown (7.5YR 5/8) to olive-brown (2.5Y 4/4) color than the B2 horizon. In texture it ranges from light clay loam to heavy silt loam.

The C horizon commonly is loam in texture and is similar to the B3 horizon in color. The content of sand ranges from 15 to 30 percent in the A horizon and upper B horizon and generally is between 30 and 40 percent below these horizons. In most places on benches, a coarse-textured IIC horizon occurs below a depth of 40 to 50 inches.

The reaction of the A1 horizon, the A2 horizon, and the upper B2 horizon is medium acid or strongly acid. That of the lower B2 horizon is slightly acid or medium acid, and that of the B3 horizon is slightly acid or neutral. The C horizon is commonly neutral.

Sable Series

In the Sable series are soils that developed from thick loess that is low in content of sand.

Most areas of these soils are on broad upland divides. A few areas are in drainageways. The slope range is 0 to 2 percent. The native vegetation consisted of prairie grasses and water-tolerant plants.

The Sable series is a member of a hydrosequence that includes the somewhat poorly drained Muscatine soils. Sable soils are deeper to glacial till than Maxfield soils. They are more acid in the solum than Harpster soils.

Representative profile of Sable silty clay loam, 225 feet east and 50 feet south of the corner post in the northwest corner of sec. 32, T. 91 N., R. 12 W., in a cultivated field—

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

A12—7 to 15 inches, black (N 2/0) medium silty clay loam; weak, very fine, granular structure; friable; few roots; neutral; clear, smooth boundary.

A3—15 to 19 inches, black (10YR 2/1) medium silty clay loam; weak to moderate, very fine, granular structure; friable; few roots; neutral; clear, smooth boundary.

B1g—19 to 24 inches, very dark gray (10YR 3/1 to 5Y 3/1) medium silty clay loam that has common, fine, distinct, olive-gray (5Y 5/2) mottles; weak, fine, subangular blocky structure that breaks to moderate, very fine, granular structure; friable; few roots; neutral; gradual, smooth boundary.

B2g—24 to 33 inches, olive-gray (5Y 5/2) light silty clay loam that has common, fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak, fine, subangular blocky structure; friable; few roots; common fine and medium pores; neutral; gradual, smooth boundary.

B3g—33 to 50 inches, olive-gray (5Y 5/2) heavy silt loam that has few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; numerous fine root channels in peds; most channels lack color contrast with the matrix, but a few have dark-brown streaks; a very few of the fine root channels have very dark gray (10YR 3/1) clay films at a depth of 33 to 40 inches; few fine ferromanganese concretions; neutral; gradual, smooth boundary.

C1g—50 to 80 inches, light olive-gray (5Y 6/2) and yellowish-brown (10YR 5/6) silt loam; massive; friable; numerous fine root channels that lack color contrast with the matrix; many, distinct, hard ferromanganese concretions; neutral; clear, smooth boundary.

C2g—80 to 90 inches, light olive-gray (5Y 6/2) and yellowish-brown (10YR 5/6) silt loam; massive; friable; calcareous.

The A horizon ranges from 16 to 20 inches in thickness. The A1 horizon is dominantly light clay loam but may be medium silty clay loam. The A3 horizon is generally medium silty clay loam.

The B1 horizon is medium or light silty clay loam. It ranges from very dark gray (10YR 3/1 and 5Y 3/1) to dark grayish brown (2.5Y 4/2) and is slightly mottled. The B2 horizon generally has a texture of light silty clay loam. The color of the B2 and the B3 horizons ranges from gray (5Y 5/1) to light olive gray (5Y 6/2), and there are a few mottles.

The solum generally is neutral in reaction. The depth to calcareous loess ranges from 50 to 85 inches

Sattre Series

The Sattre series consists of well-drained soils that developed from medium-textured loamy material 24 to 45 inches thick over coarse-textured material.

These soils are on stream benches and on a few small outwashes in uplands. The slope range is 0 to 5 percent. The native vegetation consisted of grasses and trees.

This series is the well-drained member of a hydrosequence that includes the somewhat poorly drained Hayfield soils. Sattre soils have a thinner, lighter colored A1 horizon than Waukegan soils, and they have an A2 horizon, which Waukegan soils lack. They are not so coarse textured as Dickinson and Lamont soils. They are deeper to coarse-textured material than Burkhardt soils.

Representative profile of Sattre loam, moderately deep, 440 feet south and 380 feet west of the northeast corner of the SE¼NE¼ sec. 23, T. 93 N., R. 12 W., in a cultivated field—

Ap—0 to 7 inches, very dark brown (10YR 2/2) light loam; weak, fine, granular structure; friable; plentiful roots; slightly acid; abrupt, smooth boundary.

A2—7 to 13 inches, brown or dark-brown (10YR 4/3) light loam; very weak, medium, platy structure that breaks to weak, fine, subangular blocky structure; friable; numerous very dark brown (10YR 2/2) worm casts and mixings; plentiful roots; few fine pores; slightly acid; clear, wavy boundary.

B1—13 to 19 inches, dark-brown (10YR 3/3) and brown or dark-brown (7.5YR 4/4) medium loam; moderate, fine, subangular blocky structure; friable; few very dark brown (10YR 2/2) worm casts; few roots; few fine pores; strongly acid; clear, smooth boundary.

B21t—19 to 29 inches, brown or dark-brown (7.5YR 4/4) medium sandy clay loam; about 20 percent consists of fragments greater than 2 millimeters in diameter, and one-half consists of fragments 1 inch to 3 inches in diameter; moderate, fine, subangular blocky structure; ped faces are slightly darker than interiors; clay films are on a few of the faces; friable; few roots; few fine and medium pores; strongly acid; clear, smooth boundary.

B22—29 to 32 inches, brown or dark-brown (7.5YR 4/4) cobbly heavy sandy loam that has few, fine, faint, dark reddish-brown (5YR 3/4) mottles; about 12 percent consists of cobblestones 1 inch to 3 inches in diameter; weak, fine, subangular blocky structure; friable; few roots; strongly acid; abrupt, smooth boundary.

IIC1—32 to 37 inches, brown or dark-brown (7.5YR 4/4) cobbly medium and coarse sand; about 30 percent of this consists of cobblestones 1 inch to 3 inches in diameter; single grain; loose; few roots; strongly acid; abrupt, smooth boundary.

IIC2—37 to 43 inches, yellowish-brown (10YR 5/4) medium sand; single grain and loose when moist, massive and slightly hard when dry; strongly acid; clear, smooth boundary.

IIC3—43 to 50 inches, yellowish-brown (10YR 5/6) medium sand that has common, fine, faint, strong-brown (7.5YR 5/8) and few, fine, distinct, yellowish-red (5YR 4/8) mottles; single grain; loose; strongly acid; clear, smooth boundary.

IIC4—50 to 75 inches, yellowish-brown (10YR 5/6) and light-gray (5Y 7/2) fine and medium sand that grades into grayish-brown (2.5Y 5/2) medium sand with common, fine, distinct, brown or dark-brown (10YR 4/3) mottles; single grain; loose; strongly acid.

The Ap horizon generally is very dark brown (10YR 2/2) to dark brown (10YR 3/3). In undisturbed areas the A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2) and is 4 to 7 inches thick. The A2 horizon is distinct to barely discernible. It varies between brown or dark brown (10YR 4/3) and dark grayish brown (10YR 4/2) and has mixings of darker colors.

The structure of the B horizon ranges from moderate, fine, subangular blocky to weak, medium, subangular blocky. The color varies little from that of the profile described. Patchy clay films are on the ped faces in most places. When dry, some of the ped faces have a gray, grainy appearance.

The texture of the solum is dominantly medium loam but ranges from light to heavy loam. The lower B

horizon may be heavy sandy loam. In some areas the B2 horizon contains fewer pebbles or cobblestones than the B2 horizon in the profile described.

The coarse-textured substratum ranges from loamy sand to gravel. This begins at a depth of 24 to 36 inches in the moderately deep phase and at 36 to 45 inches in the deep phase.

The B and C horizons are medium acid or very strongly acid.

Seaton Series

The Seaton series consists of well-drained soils that developed from very thick, medium-textured loess of local origin.

These soils are on convex, rolling uplands. The slope range is 2 to 30 percent. The native vegetation consisted of hardwoods.

Seaton soils commonly have a slightly higher content of fine or very fine sand throughout their profile than Fayette soils and a slightly lower content of clay in the B2 horizon. They have a thinner and generally lighter colored A1 horizon than Port Byron soils, and they have an A2 horizon. Seaton soils contain considerably less sand than Lamont soils.

Representative profile of Seaton silt loam, 550 feet west of the corner post in the southeast corner of sec. 16, T. 91 N., R. 13 W., and 10 feet north of a pasture fence, in open timber and bluegrass pasture high above a road cut—

A1—0 to 3 inches, very dark brown (10YR 2/2) light silt loam; moderate, fine and very fine, granular structure; very friable; abundant roots; neutral; clear, smooth boundary.

A2—3 to 10 inches, dark grayish-brown (10YR 4/2) and brown or dark-brown (10YR 4/3) light silt loam; moderate, thin, platy structure; very friable; few very dark gray (10YR 3/1) worm casts; abundant roots; medium acid; clear, wavy boundary.

B21t—10 to 17 inches, dark yellowish-brown (10YR 4/4) heavy silt loam; moderate, fine, granular and subangular blocky structure; friable; nearly continuous, dark yellowish-brown (10YR 4/4) ped faces that are dominantly very fine sand; few, patchy, dark-brown (7.5YR 3/2) clay films on ped surfaces; plentiful roots; many fine pores; strongly acid; clear, wavy boundary.

B22t—17 to 32 inches, dark yellowish-brown (10YR 4/4) heavy silt loam; weak, medium, prismatic structure that breaks to weak, medium, subangular blocky structure; friable; thin, nearly continuous, brown or dark-brown (10YR 4/3) prism and ped coatings that are dominantly very fine sand; ped coats are pale brown (10YR 6/3) and very pale brown (10YR 7/3) when dry; about 15 percent of both the vertical and horizontal ped faces have dark-brown (7.5YR 3/2) and brown or dark-brown (7.5YR 4/4) clay films; across the prism faces these clay films appear to be somewhat banded but are not continuous; a very few root channels have brown or dark-brown (7.5YR 4/4) clay films; few roots; many fine pores; very strongly acid; gradual, smooth boundary.

B31t—32 to 51 inches, medium silt loam; nearly continuous brown or dark-brown (10YR 4/3) prism and ped coatings that are dominantly very fine sand; ped coats are pale brown (10YR 6/3) and very pale brown (10YR 7/3) when dry; ped interiors are dark yellowish brown (10YR 4/4); weak, medium, prismatic structure that breaks to weak, coarse, subangular blocky structure; friable; a few, patchy, dark-brown (7.5YR 3/2) and brown or dark-brown (7.5YR 4/4) clay films on prism faces, and discontinuous, dark-brown (7.5YR 3/2) clay films in a few root channels; few roots; many fine pores and a few medium pores; strongly acid; gradual, smooth boundary.

B32t—51 to 63 inches, dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/8) medium silt loam; few, fine, distinct, reddish-yellow (7.5YR 7/8) mottles; weak, medium, prismatic structure; friable; prism faces are brown or dark brown (10YR 4/3) and have few, fine, distinct, yellowish-brown (10YR 5/6) mottles; coatings on ped faces are dominantly very fine sand; discontinuous, brown or dark-brown (7.5YR 4/4) clay films in some of the root channels; few, fine, dark concretions; few roots; many fine pores and few medium pores; strongly acid; diffuse boundary.

C—63 to 84 inches, yellowish-brown (10YR 5/6) medium silt loam; few, fine, distinct, yellow (10YR 7/8) mottles and few, fine, distinct, grayish-brown (2.5Y 5/2) mottles, the number increasing to common below a depth of 70 inches; massive; friable; a few fine pores; slightly acid to a depth of 75 inches, neutral at a depth of 75 to 80 inches.

The A1 horizon is 1 inch to 4 inches thick and varies between black (10YR 2/1), very dark brown (10YR 2/2), and very dark gray (10YR 3/1). The Ap horizon, if slightly eroded, is dark grayish brown (10YR 4/2) or very dark grayish brown (10YR 3/2). The A2 horizon is 6 to 8 inches thick and ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3).

Most of the peds in the B horizon have dark yellowish-brown interiors and somewhat darker faces. A few patchy clay films are on the ped faces and on some of the prism faces. The clay content of the B2 horizon ranges from 20 to 26 percent.

The structure and texture of the profile described is dominant for the Seaton series. The sand content of the entire profile generally ranges from 6 to 16 percent and is very fine or fine in size. The content of sand is higher where these soils adjoin sandy soils.

The B1 horizon, if present, and the B2 horizon are strongly acid or very strongly acid, and the B3 horizon is strongly acid to medium acid. The depth to calcareous material ranges from 60 to 100 inches but is generally below 70 inches.

Sogn Series

The Sogn series consists of somewhat excessively drained soils derived from 4 to 15 inches of moderately coarse textured to moderately fine textured material over limestone bedrock. The top 4 to 16 inches of the limestone generally is shattered.

These soils are on uplands and bench escarpments. The slope range is 5 to 30 percent. The native vegetation consisted of prairie grasses or grasses and trees.

Sogn soils are shallower to limestone bedrock than Rockton, Winneshiek, and Backbone soils.

Representative profile of Sogn soils, northeast corner of the SW¼ sec. 29, T. 91 N., R. 13 W., in open timber—

A1—0 to 10 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; plentiful roots; neutral; clear, wavy boundary.

A3—10 to 14 inches, very dark grayish-brown (10YR 3/2) clay loam; moderate, fine, subangular blocky structure; friable; neutral; plentiful roots; abrupt, wavy boundary.

IIR—14 inches, 95 percent hard shattered limestone and 5 percent very dark grayish-brown (10YR 3/2) and

brown or dark-brown (10YR 4/3) heavy clay loam; moderate, fine, subangular blocky structure; neutral; fragments of rock are 6 to 15 inches long and ½ inch to 2 inches thick; few roots.

The A1 horizon generally is black (10YR 2/1) or very dark brown (10YR 2/2) medium loam, but it is very dark grayish-brown (10YR 3/2) sandy loam in places. It is 4 to 12 inches thick and, in a few places, is directly on bedrock. The A3 horizon ranges from 0 to 7 inches in thickness and from sandy loam to clay loam in texture.

A layer of clay or silty clay, 2 to 4 inches thick and dark reddish brown (5YR 3/2) to very dark grayish brown (10YR 3/2), may separate the A horizon from the bedrock.

The first 4 to 16 inches of the limestone generally is shattered, and from 2 to 10 percent of the shattered material is medium textured to fine textured. Roots penetrate this shattered rock. In steep areas there may be rock outcrops.

The A horizon is generally neutral in reaction but may be slightly calcareous in plowed or eroded areas.

Spillville Series

This series consists of somewhat poorly drained soils that developed from medium-textured, loamy, alluvial sediments.

These soils are on the flood plains of rivers and narrow intermittent streams. They are level or have a slope of as much as 1 percent. The native vegetation consisted of mixed prairie grasses.

Spillville soils have a thicker surface horizon than Terril soils. They contain less clay and generally more sand than Colo soils, and they have a somewhat higher chroma below a depth of 40 inches. Spillville soils are darker colored and less stratified than Nodaway soils. Their A and B horizons are considerably thicker than those of Lawler soils.

Representative profile of Spillville loam, 250 feet north and 185 feet west of the southeast corner of the SW¼ sec. 4, T. 91 N., R. 12 W., in bluegrass pasture; measurement taken from the center of Highway No. 3—

A11—0 to 12 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; abundant roots; slightly acid; clear, smooth boundary.

A12—12 to 36 inches black (10YR 2/1) loam; weak, medium and fine, subangular blocky structure that breaks to weak, fine, granular structure; friable; plentiful roots to a depth of 19 inches; few roots below this depth; few fine pores; few ½-inch to 1½-inch pebbles at a depth of 33 inches; slightly acid; clear, smooth boundary.

A13—36 to 47 inches, very dark gray (10YR 3/1) heavy loam; common, fine, faint, dark reddish-brown (5YR 2/2) and common, fine, distinct, reddish-brown (5YR 4/4) mottles; weak, coarse, prismatic structure that breaks to weak, fine, subangular blocky and weak, fine, granular; friable; few roots; common fine pores; slightly acid; gradual, smooth boundary.

B—47 to 55 inches, very dark gray (N 3/0) heavy loam; few, fine, faint, olive-brown (2.5Y 4/4) and dark reddish-brown (5YR 3/4) mottles; weak, medium, prismatic structure that breaks to weak, fine and medium, subangular blocky structure; slightly firm; few black (N 2/0) coats in root channels; slightly acid; clear, smooth boundary.

C—55 to 60 inches, very dark grayish-brown (10YR 3/2) loam; many soft concretions and smears of yellowish red (5YR 4/8) and few, medium, distinct, gray (N 5/0) mottles; massive; friable; slightly acid.

The A1 horizon varies between black (10YR 2/1), very dark brown (10YR 2/2), and very dark gray (10YR 3/1). The depth is 40 inches to values of 4 or chromas of 2 or greater. The texture of the solum is dominantly loam, but it ranges to gritty silt loam in the A1 horizon and to heavy sandy loam and sandy clay loam below this horizon. Moderately coarse or coarse textured substrata are below a depth of 45 inches in some places. The profile is generally slightly acid.

Terril Series

The Terril series consists of well drained or moderately well drained soils in loamy, medium-textured, alluvial material.

These soils are along some upland waterways and on stream benches and alluvial fans adjoining uplands. They are also on some of the flood plains of bottom lands. The slope range is 0 to 5 percent. The native vegetation consisted of prairie grasses.

Terril soils have a thinner surface horizon than Spillville soils. Their A1 horizon is considerably thicker than that of Waukegan soils. Terril soils are darker colored and less stratified than Nodaway soils, and they are loam in texture whereas Nodaway soils are silt loam.

Representative profile of Terril loam, 726 feet west of the northeast corner of sec. 21, T. 91 N., R. 14 W., and 244 feet south of the road fence, in bluegrass pasture—

A11—0 to 19 inches, black (10YR 2/1) loam; moderate, fine and very fine, granular structure; friable; abundant roots; medium acid; gradual, smooth boundary.

A12—19 to 28 inches, black (10YR 2/1) loam; some mixing of very dark brown (10YR 2/2); weak, medium, subangular blocky structure that breaks to weak, fine, granular; friable; plentiful roots; many fine pores and few medium pores; ped interiors are not quite so dark-colored as ped faces; medium acid; gradual, smooth boundary.

B2—28 to 32 inches, very dark brown (10YR 2/2) and dark brown (10YR 3/3) loam; weak, fine, subangular blocky structure; friable; few black (10YR 2/1) worm casts; plentiful roots; many fine pores and few medium pores; medium acid; gradual, smooth boundary.

B3—32 to 39 inches, dark-brown (10YR 3/3) loam; many, fine, faint, dark yellowish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; friable; few roots; many fine pores and few medium pores; medium acid; gradual, smooth boundary.

C1—39 to 48 inches, dark yellowish-brown (10YR 3/4 and 4/4) loam; massive; friable; few roots; common fine pores and few medium pores; slightly acid; gradual, smooth boundary.

IIC2—48 to 53 inches, dark yellowish-brown (10YR 4/4) sandy loam; massive; very friable; few roots; few fine and medium pores; slightly acid; clear, smooth boundary.

IIIC3—53 to 65 inches, yellowish-brown (10YR 5/6) loamy sand; common, fine, distinct, dark yellowish-brown (10YR 3/4) mottles; massive; very friable; few fine pores; band of pebbles 1 inch to 3 inches in diameter in upper 4 inches; slightly acid; gradual, smooth boundary.

IIIC4—65 to 74 inches, yellowish-brown (10YR 5/6) gravelly loamy sand; common, fine, distinct, dark yellowish-brown (10YR 3/4) mottles; single grain; loose; some of the pebbles are rounded, and some are angular and have sharply broken corners; slightly acid.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2). A color value of 3 or higher and

a chroma of 3 are at a depth of 20 to 40 inches, but a value of 4 is usually present to a depth of 40 inches in most places.

The weakly developed B horizon ranges from very dark brown (10YR 2/2) to dark yellowish brown (10YR 4/4) in color and is loam in texture.

The texture of the parent material may be loam or gritty silt loam, but the texture in the profile described is typical. The depth to the coarse-textured substratum is generally more than 48 inches but in some places is not more than 40 inches.

The reaction of the solum ranges from slightly acid to medium acid, and that of the C horizon from slightly acid to neutral.

Tripoli Series

The Tripoli series consists of poorly drained soils that developed in 20 to 30 inches of moderately fine textured, loamy material over friable to firm glacial till of loam to light clay loam texture. A distinct to indefinite pebble band occurs between the glacial till and the loamy material.

Most of these soils are on broad, slightly convex to slightly concave uplands. A few of them are in concave drainageways. The slope range is 0 to 2 percent. The native vegetation consisted of prairie grasses and water-tolerant plants.

The Tripoli series is a member of a hydrosequence that includes the somewhat poorly drained Readlyn soils and the moderately well drained Kenyon soils. They are not stratified in the substratum as are Clyde and Floyd soils and are shallower to calcareous material. Tripoli soils have more sand and less silt in the A horizon and upper B horizon than Maxfield soils. They also contain more sand and less silt than Sable soils.

Representative profile of Tripoli clay loam, 1,355 feet east of the center of the crossroads at the southwest corner of sec. 35, T. 93 N., R. 13 W., and 34 feet north of the road ditch, in a cultivated field—

Ap—0 to 9 inches, black (N 2/0) light clay loam; moderate, fine, granular structure; friable; few roots; neutral; abrupt, smooth boundary.

A12—9 to 14 inches, black (10YR 2/1) medium clay loam; few black (N 2/0) and very dark grayish-brown (10YR 3/2) peds; moderate, fine, granular structure; friable; few roots; neutral; gradual, smooth boundary.

A3—14 to 20 inches, very dark gray (10YR 3/1) medium clay loam; common, fine, distinct, very dark grayish-brown (2.5Y 3/2) mottles; weak, medium, subangular blocky structure that breaks to weak, fine, granular; friable; few roots; many fine pores; neutral; gradual, smooth boundary.

B1g—20 to 24 inches, very dark grayish-brown (2.5Y 3/2) light clay loam that grades to dark grayish brown (2.5Y 4/2) with depth; few, fine, faint, dark-gray (10YR 4/1) and common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; common fine and medium pores; mildly alkaline; gradual, smooth boundary.

IIB21—24 to 29 inches, olive-brown (2.5Y 4/4) and light olive-brown (2.5Y 5/4) heavy loam; few, fine, faint, dark grayish-brown (2.5Y 4/2) and common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few roots; common fine and medium pores; indistinct band of pebbles that are dominantly ¼ to ½ inch in diameter; mildly alkaline; gradual, smooth boundary.

IIB22—29 to 38 inches, heavy loam; grayish-brown (2.5Y 5/2) prism and ped faces that have many, medium, prominent, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/8) mottles; yellowish-brown (10YR 5/6) ped interiors; many, medium, prominent, grayish-brown (2.5Y 5/2) and few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure that breaks to moderate, fine, subangular blocky; friable; few roots; common fine and medium pores; mildly alkaline; gradual, wavy boundary.

IIC—38 to 66 inches, yellowish-brown (10YR 5/6), strong-brown (7.5YR 5/8), and grayish-brown (2.5Y 5/2) heavy loam; massive with some vertical cleavage; cleavage faces are grayish brown (2.5Y 5/2) and have many, medium, distinct, yellowish-brown and strong-brown mottles; slightly firm; few roots to a depth of 47 inches; common fine and medium pores; few small lime concretions ⅛ to ¼ inch in diameter; calcareous.

The A1 horizon ranges from 12 to 17 inches in thickness and is dominantly light clay loam but ranges from heavy loam to light clay loam.

The texture of the B2 and C horizons is generally heavy loam but ranges to light clay loam. The loamy material above the pebble band contains more silt and less sand than the underlying till. Some fine gravel or cobble-size igneous rocks are in the IIB and IIC horizons. The color of the B1 horizon ranges from olive gray (5Y 5/2) to dark grayish brown (2.5Y 4/2) and is generally mottled. The color of the B2 and C horizons differs from that of the profile described principally in the amount and distinctness of the grayish-brown mottling. When dry, the ped and prism faces of the B horizon have a gray, grainy appearance.

The profile is generally friable to a depth of about 24 to 40 inches and is slightly firm below this depth.

The B horizon is neutral or mildly alkaline. The depth to calcareous till ranges from 34 to 44 inches.

Waukegan Series

The Waukegan series consists of well-drained soils that developed in medium-textured alluvial deposits 24 to 48 inches thick over coarse-textured material.

Most of these soils are on stream benches and bench escarpments, but a few of them are on small upland outwashes. The slope range is 0 to 9 percent, but most slopes are between 0 and 5 percent. The native vegetation consisted of prairie grasses.

The Waukegan series is a member of the hydrosequence that includes the somewhat poorly drained Lawler and the poorly drained Marshan soils. Waukegan soils are darker colored than Sattre soils and have no A2 horizon. They are not so coarse textured in the A and B horizons as the Dickinson soils. Waukegan soils are deeper to coarse textured materials than Burkhardt soils. They have a thinner A1 horizon than Terril soils.

Representative profile of Waukegan loam, moderately deep, 377 feet south of the center of a farmer's driveway along railroad tracks and 64 feet eastward, perpendicular to the tracks, in the SE¼NW¼ sec. 7, T. 93 N., R. 14 W., in a bluegrass pasture—

A1—0 to 9 inches, black (10YR 2/1) heavy loam; moderate, fine, granular structure; friable; roots are plentiful; strong acid; gradual, smooth boundary.

A3—9 to 13 inches, very dark brown (10YR 2/2) heavy loam; moderate, fine and very fine, subangular blocky

structure; ped faces are slightly darker colored than interiors; plentiful roots; strongly acid; gradual, smooth boundary.

B2—13 to 24 inches, dark-brown (10YR 3/3) and very dark grayish-brown (10YR 3/2) heavy loam; some mixing of very dark brown (10YR 2/2) in the upper part of the horizon and of brown or dark brown (10YR 4/3) in the lower part; very weak, medium, prismatic structure that breaks to weak, fine, subangular blocky; friable; plentiful roots; few fine pores; strongly acid; clear, smooth boundary.

IIC1—24 to 28 inches, brown or dark-brown (10YR 4/3) loamy fine gravel; about 25 percent is more than 2 millimeters in diameter; single grain; loose; few roots; strongly acid; gradual, smooth boundary.

IIC2—28 to 44 inches, dark yellowish-brown (10YR 4/4), stratified fine gravelly sand and medium sand; about 25 percent is more than 2 millimeters in diameter; single grain; loose; strongly acid; gradual, smooth boundary.

IIC3—44 to 52 inches, yellowish-brown (10YR 5/6) medium and coarse sand; single grain; loose; strongly acid.

IIC4—52 to 63 inches, light-gray (10YR 7/2) medium sand; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; single grain; loose; medium acid.

Representative profile of Waukegan silt loam, deep, 210 feet east of railroad track where it crosses the road, and 190 feet south of road fence in the NE¼NE¼ sec. 27, T. 91 N., R. 14 W., in a cultivated field—

Ap—0 to 6 inches, black (10YR 2/1) silt loam; cloddy peds break to weak or moderate, fine, granular and subangular blocky structure; friable; plentiful roots; neutral; clear, smooth boundary.

A12—6 to 10 inches, black (10YR 2/1) silt loam; weak or moderate, fine, granular structure; friable; plentiful roots; slightly acid; gradual, smooth boundary.

A3—10 to 15 inches, very dark brown (10YR 2/2) silt loam; some mixing of black (10YR 2/1) from layer above and few uncoated quartz grains on ped faces; weak or moderate, fine, granular structure with tendency toward subangular blocky; friable; few roots; few fine pores; slightly acid; gradual, smooth boundary.

B1—15 to 20 inches, dark-brown (10YR 3/3) silt loam; very dark gray (10YR 3/1) organic stains that decrease with depth; few uncoated sand grains; weak, fine, subangular blocky structure; friable; few roots; common fine pores; slightly acid; gradual, smooth boundary.

B2—20 to 31 inches, brown or dark-brown (10YR 4/3) silt loam; few very dark grayish-brown (10YR 3/2) organic stains; weak, fine, subangular blocky structure; very friable; common fine and medium pores; slightly acid; gradual, smooth boundary.

B31—31 to 39 inches, brown or dark-brown (7.5YR 4/4) silt loam; very weak, fine, subangular blocky structure; very friable; abundant fine pores and few medium pores; slightly acid; clear, smooth boundary.

IIB32—39 to 42 inches, strong-brown (7.5YR 5/6) sandy loam; very weak, fine, subangular blocky structure; very friable; slightly acid; clear, smooth boundary.

IIC—42 to 60 inches, yellowish-brown (10YR 5/6) to light yellowish-brown (10YR 6/4) sand; single grain; loose; slightly acid.

The A1 horizon of Waukegan loam is black (10YR 2/1) or very dark brown (10YR 2/2) in color. It ranges from 7 to 14 inches in thickness but is generally between 8 and 11 inches thick.

The A horizon of Waukegan silt loam is similar to that of the loam in color but is 8 to 16 inches thick.

The texture of the solum is dominantly medium loam but ranges from heavy loam to silt loam.

The depth to the underlying coarse material ranges from 24 to 48 inches.

The loam is medium acid or strongly acid throughout the profile. The silt loam is slightly acid or medium acid.

Winneshiek Series

The Winneshiek series consists of well-drained soils that developed in 18 to 24 inches of loamy material over 2 to 12 inches of moderately fine textured material. Commonly a pebble band occurs at the base of the loamy material. These soils are underlain by hard limestone bedrock at a depth of 20 to 30 inches. The top 4 to 16 inches of limestone is generally shattered.

These soils are on uplands. The slope range is 2 to 9 percent. The native vegetation consisted of grasses and trees.

Winneshiek soils have a thinner, somewhat lighter colored A1 horizon than Rockton soils, and they have an A2 horizon. They are deeper to limestone bedrock than Sogn soils. They are not so coarse textured as Backbone soils.

Representative profile of Winneshiek loam, 127 feet south and 40 feet east of the northwest corner of the SW¼NE¼ sec. 7, T. 93 N., R. 12 W., in a cultivated field—

Ap—0 to 6 inches, very dark brown (10YR 2/2) light loam; weak, fine, granular structure; friable; few roots; medium acid; clear, smooth boundary.

A2—6 to 10 inches, brown or dark-brown (10YR 4/3) light loam; weak, medium, platy structure; friable; few very dark brown (10YR 2/2) worm casts and mixings; few roots; medium acid; clear, wavy boundary.

B1—10 to 15 inches, brown or dark-brown (7.5YR 4/4) sandy clay loam; weak, medium, subangular blocky structure that breaks to weak, fine, subangular blocky; friable; few roots; medium acid; clear, smooth boundary.

B21—15 to 20 inches, brown or dark-brown (7.5YR 4/4) sandy clay loam; moderate, medium, subangular blocky structure; friable; few roots; few fine pores; pebble band in lower part; slightly acid; clear, smooth boundary.

IIB22t—20 to 26 inches, brown or dark-brown (7.5 YR 4/4) heavy clay loam; moderate, medium, subangular blocky structure; few, fine, dark-brown (7.5YR 3/2) clay films on ped faces; friable; few roots; few fine pores; slightly acid; clear, smooth boundary.

IIIB23t—26 to 29 inches, dark-brown (7.5YR 3/2) clay; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; firm or very firm; neutral; abrupt, wavy boundary.

IIIR—29 inches, hard limestone bedrock that is somewhat shattered.

The Ap horizon is medium or light loam. It is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A2 horizon is light loam or gritty silt loam and is distinct to barely discernible. It varies between dark grayish brown (10YR 4/2) and brown or dark brown (10YR 4/3).

The B1 and B2 horizons are medium loam to sandy clay loam and are brown or dark brown (7.5YR 4/4) to dark yellowish brown (10YR 3/4). The IIB2 horizon is light to heavy clay loam that ranges from brown or dark brown (7.5YR 4/4) to strong brown (7.5YR 5/8) and yellowish brown (10YR 5/6). The clay or silty clay IIIB layer does not occur in all profiles.

The depth to shattered bedrock is 24 to 30 inches. The shattered part of the bedrock is 4 to 16 inches thick, and from 2 to 10 percent of it is medium to fine textured. Plant roots penetrate this material.

The reaction is medium acid in the A and B1 horizons, slightly acid or medium acid in the B2 horizon, and slightly acid or neutral in the IIB2 horizon.

Physical and Chemical Properties of Selected Soils

The data obtained by physical and chemical analysis of selected soils in Bremer County are given in table 8. Profiles of some of the selected soils are described in the preceding section.

The data in table 8 can be used by soil scientists in classifying soils and in developing concepts of soil genesis. They are also helpful in estimating water-holding capacity, wind erosion, fertility, tilth, and other properties that affect soil management.

Field and laboratory methods

This subsection contains laboratory analyses of the Kenyon, Klinger, and Readlyn soils. All samples were collected from carefully selected pits.

Unless otherwise noted, all laboratory analyses recorded in table 8 were made on material that passed the 2-millimeter sieve, and the data are reported on an oven-dry basis. Bulk density is reported for the soil fabric formed of material less than 2 millimeters in diameter.

An estimate of the fraction of each sample larger than three-fourths of an inch was made during the sampling. If necessary, samples were sieved after being dried, and rock fragments larger than three-fourths of an inch in diameter were discarded. The material less than three-fourths of an inch in diameter was rolled, crushed, and then sieved by hand to remove rock fragments more than 2 millimeters in diameter. The fraction that consists of particles between 2 millimeters and three-fourths of an inch in diameter is recorded in table 8 as "Coarse fragments." This value is calculated from the total weight of the particles less than three-fourths of an inch in diameter.

The proportions of particles more than three-fourths of an inch and of those between 2 millimeters and three-fourths of an inch in diameter are somewhat arbitrary. The accuracy of the data depends on the extent of the preparation, which varies with the objectives of the study. Nevertheless, both fractions contain unaltered rock fragments more than 2 millimeters in diameter, and they do not contain slakable clods of earthy material.

The particle size analysis was made according to the procedure detailed by Kilmer and others (*7*, *6*, *10*). Organic carbon was determined by a modification of the Walkley-Black wet combustion method (*11*). The calcium carbonate equivalent was determined by measuring the volume of carbon dioxide emitted from soil samples treated with concentrated hydrochloric acid. The cation exchange capacity was determined by direct distillation of adsorbed ammonia. Calcium, sodium, and potassium were obtained from a neutral normal ammonium acetate extract. Extractable calcium and magnesium were determined as calcium oxalate and as magnesium ammonium phosphate (*11*). Sodium and potassium were determined by a flame spectrophotometer. Reaction was determined with a glass electrode at a 1 : 1 soil-water ratio. Nitrogen was determined by a modified AOAC procedure (*2*).

General Nature of the County

The territory that is now Bremer County was originally a part of the Winnebago Reservation and later part of the "Neutral Land." In 1851, several counties in Iowa were created, among them Bremer. Janesville, the first town to be laid out in the county, was platted in 1853 and recorded in 1854.

Transportation, Industries, and Markets

U.S. Routes 218 and 63 serve north-south traffic along the western edge and through the center of the county. These routes are connected with all parts of the county by State Routes 3, 93, and 188 and by county roads. All farms have access to surfaced roads. Four main railroad lines connect Bremer County with Chicago, Minneapolis, and Omaha. Scheduled airline transportation is available at Waterloo in adjoining Blackhawk County, and several small municipal or private airports provide some passenger service. Bus transportation is available on the main highways. Motor freight lines serve every trading center in the county.

The county is primarily agricultural, but it has some industries, most of which are in Waverly. Among the products manufactured are truck crane excavators, poultry and livestock feeding and watering equipment, corncribs, and corn-drying equipment. There are also several creameries, a large powdered-milk plant, a cheese factory, and a turkey-processing plant. Hog-buying stations and grain elevators are in most of the towns.

Recreation

Four city parks provide for community recreation in Waverly. In the rural areas hunting, fishing, canoeing, and other forms of outdoor recreation are provided by the winding channels of the Cedar, Shell Rock, and Wapsipinicon Rivers and by the 1,600 acres of water and woods in the Sweet Marsh area.

Bremer County supports many kinds of wildlife that contribute to its recreation and economy. Some furbearing animals are trapped during the winter months. Pheasants are hunted throughout the uplands. Migratory waterfowl, foxes, squirrels, cottontail rabbits, and other game are hunted in stream valleys and in rolling wooded areas bordering rivers. Some white-tailed deer are found in woods along the major rivers.

TABLE 8.—*Physical and chemical*

[Analysis made at Soil Survey Laboratory, Soil Conservation Service, Lincoln, Nebraska.

Soil	Horizon	Depth	Particle size distribution— Very coarse sand (2–1 mm.)	Coarse sand (1–0.5 mm.)	Medium sand (0.5–0.25 mm.)	Fine sand (0.25–0.10 mm.)	Very fine sand (0.10–0.05 mm.)	Silt (0.05–0.002 mm.)	Clay (less than 0.002 mm.)	Coarse fragments (greater than 2.0 mm.)
		In.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Kenyon loam: 553 feet N. and 310 feet E. of SW. cor., sec. 31, T. 93 N., R. 13 W.	Ap	0 to 5	1.9	11.8	12.8	19.4	7.4	28.5	18.2	(1)
	A12	5 to 10	1.8	10.2	10.3	16.4	7.3	31.5	22.5	(1)
	A3	10 to 14	3.2	9.4	9.7	15.8	7.7	30.2	24.0	4
	I–IIB1	14 to 19	3.2	7.4	8.3	15.5	9.1	31.0	25.5	3
	IIB21	19 to 25	2.7	6.3	8.7	17.9	10.8	28.3	25.3	3
	IIB22	25 to 33	3.5	6.8	8.3	17.6	11.1	29.3	23.4	3
	IIB23	33 to 40	3.5	6.4	8.3	18.0	11.0	30.6	22.2	3
	IIB31t	40 to 47	2.2	5.6	7.6	16.3	10.1	33.5	24.7	(1)
	IIB32t	47 to 54	2.9	6.4	7.8	15.2	9.2	33.2	25.3	2
	IIC1	54 to 62	3.4	5.8	7.1	16.4	10.2	36.0	21.1	3
	IIC2	62 to 76	3.1	5.9	6.8	15.3	10.0	37.0	21.9	3
Klinger silty clay loam: 284 feet N. and 387 feet E. of SW. cor., of NE¼SE¼ sec. 26, T. 91 N., R. 12 W.	Ap	0 to 9	.3	1.3	1.5	2.4	3.1	62.5	28.9	(1)
	A3	9 to 13	.4	1.6	1.8	2.9	3.3	61.9	28.1	(1)
	B1	13 to 19	.2	1.1	1.1	1.8	3.6	61.1	31.1	(1)
	B21t	19 to 26	.2	.9	1.2	1.9	5.8	59.4	30.6	(1)
	B22t	26 to 31	.3	1.9	2.4	3.9	7.1	57.6	26.8	(1)
	IIB31t	31 to 36	3.0	10.9	12.7	18.6	8.3	25.6	20.9	1
	IIB32t	36 to 40	3.4	9.1	9.7	15.5	8.8	27.9	25.6	(1)
	IIB33t	40 to 46	2.9	7.0	6.8	13.6	9.7	31.9	28.1	2
	IIC1	46 to 52	2.9	6.6	7.4	14.4	10.0	30.8	27.9	(1)
	IIC2	52 to 64	3.6	6.7	7.2	13.8	9.7	32.1	26.9	1
Readlyn loam: 878 feet N. and 605 feet W. of SE. cor., sec. 34, T. 93 N., R. 11 W.	Ap	0 to 8	1.4	7.6	9.6	12.9	4.6	41.1	22.8	(1)
	A3	8 to 12	2.1	8.0	9.3	12.8	4.4	39.8	23.6	(1)
	B1	12 to 17	3.6	8.2	8.9	13.7	5.1	34.2	26.3	3
	IIB21	17 to 24	4.8	9.1	9.7	16.2	8.1	23.8	28.3	4
	IIB22	24 to 30	2.8	6.9	8.2	16.2	10.3	27.7	27.9	6
	IIB23	30 to 37	4.2	7.6	7.8	15.3	9.8	28.2	27.1	5
	IIB3	37 to 44	4.0	7.3	7.8	15.5	10.4	29.1	25.9	6
	IIC1	44 to 50	4.5	7.6	7.8	15.6	10.5	32.8	21.2	10
	IIC2	50 to 60	5.8	9.2	10.1	18.8	10.3	31.1	14.7	9

[1] Trace.

Agriculture

According to the 1964 Iowa farm census, about 96 percent of Bremer County, or 271,207 acres, was in farms. Most of the farmland was used for crops, but 50, 254 acres was used for pasture and 21,748 acres consisted of lots, roads, farmsteads, or wasteland. About 64 percent of the farmland was owned by the operator, and 36 percent was rented by the operator.

The acreage in farms varied only slightly during the period from 1940 to 1964. In 1940 the total area of farmland was 270,908 acres; in 1964 it was 271,207 acres. The number of farms decreased gradually from 2,040 in 1940 to 1,760 in 1964, and the average size of farms increased from 133 acres to 154 acres.

Table 9 shows the acreage of principal crops and table 10 the livestock on farms in the county in stated years. All data in this section are from the Iowa Annual Farm Census, as compiled by the Iowa Department of Agriculture in cooperation with the U.S. Department of Agriculture.

Climate [4]

Bremer County has a continental climate. Changes in weather are frequent and often pronounced, primarily because the county is near two major storm tracks—one from the southwest and the other from the northwest.

Summers are warm and winters are cold, but prolonged periods of intense cold or heat are rare. Considerable sunshine and southerly winds prevail in summer, but winters are somewhat cloudy and winds are from the west or northwest. The minimum temperature varies somewhat throughout the county, particularly on calm, clear nights when farm lowlands may have a temperature several degrees below that of the uplands or urban localities. Otherwise, climatic variations are slight, and the Waverly-Tripoli record, summarized in table 11, is representative of Bremer County.

[4] This section was prepared by PAUL J. WAITE, State Climatologist, U.S. Weather Bureau.

properties of selected soils

Absence of figures indicates values are not significant or were not determined]

Texture class	Reaction (1:1)	Organic carbon	Nitrogen	C/N ratio	Bulk density (oven dry)	Cation exchange capacity (NH_4OAC)	Extractable cations (meq. per 100 grams of soil)					Base saturation on NH_4OAC	Base saturation on sum bases plus H	Carbonate as $CaCO_3$	
							Ca	Mg	H	Na	K			Less than 2 mm.	Clay
	pH	*Pct.*	*Pct.*		*Gm/cc*	*Meq./100 gm.*						*Pct.*	*Pct.*	*Pct.*	*Pct.*
Loam	6.3	1.99	0.170	12	1.52	15.1	10.4	3.6	5.9	0.1	0.2	95	71	------	------
Loam	5.8	1.77	.132	13	1.58	15.5	9.9	3.0	8.3	.1	.2	85	61	------	------
Loam	5.4	1.01	.089	11	------	14.5	9.5	2.7	8.1	.1	.2	86	61	------	------
Loam	5.2	.66	.066	10	------	13.7	8.4	2.6	7.1	.1	.2	82	61	------	------
Loam	5.2	.40	.040	10	1.66	12.2	8.3	2.5	5.9	.1	.2	91	65	------	------
Loam	5.2	.28	------	------	1.69	11.7	8.1	2.3	4.2	.1	.2	91	72	------	------
Loam	5.7	.23	------	------	------	11.9	8.8	2.4	3.5	.1	.2	97	77	------	------
Loam	6.0	.20	------	------	1.76	12.9	10.2	2.7	2.8	.1	.2	102	82	------	------
Loam	7.0	.18	------	------	1.70	13.6	------	------	------	.1	.2	------	------	(1)	------
Loam	7.8	.13	------	------	1.84	10.8	------	------	------	.1	.2	------	------	10	(1)
Loam	7.9	.13	------	------	1.81	10.6	------	------	------	.1	.2	------	------	11	(1)
Silty clay loam	5.6	3.03	.260	12	1.39	24.8	15.5	5.0	12.7	.2	.2	84	62	------	------
Silty clay loam	5.4	1.24	.124	10	------	20.2	12.8	3.6	10.0	.1	.3	83	63	------	------
Silty clay loam	5.5	.68	.081	8	1.44	20.9	14.7	4.4	7.9	.1	.4	94	71	------	------
Silty clay loam	6.2	.38	.052	7	1.50	21.5	17.4	5.2	4.5	.1	.4	107	84	------	------
Silt loam	6.4	.27	------	------	1.52	19.9	16.3	4.8	3.6	.1	.4	108	86	------	------
Loam	6.6	.12	------	------	------	11.4	9.5	2.8	1.6	.1	.2	110	89	------	------
Loam	6.9	.08	------	------	1.84	13.1	11.1	3.1	1.6	.1	.2	111	90	(1)	------
Clay loam	7.1	.08	------	------	1.86	13.9	12.0	3.3	1.6	.1	.2	112	91	(1)	------
Clay loam	7.4	.06	------	------	1.84	13.4	11.4	3.2	1.2	.1	.2	111	92	(1)	------
Loam	7.7	.04	------	------	1.83	12.6	------	------	------	.1	.2	------	------	2	------
Loam	5.5	2.51	.228	11	1.53	19.0	11.0	5.3	11.2	.1	.2	87	60	------	------
Loam	5.2	1.27	.124	10	------	15.8	8.9	2.5	10.0	.1	.2	74	54	------	------
Loam	5.1	.65	.074	9	1.48	16.0	9.6	2.9	7.6	.1	.2	80	63	------	------
Clay loam	5.3	.35	.040	9	1.58	16.1	11.5	3.5	5.2	.1	.2	95	75	------	------
Clay loam	5.8	.24	------	------	1.73	16.0	11.9	3.7	3.8	.1	.2	99	81	------	------
Clay loam	6.7	.13	------	------	1.78	14.2	11.4	3.5	3.3	.1	.2	107	82	------	------
Loam	7.2	.12	------	------	------	13.3	10.7	3.4	1.2	.1	.2	108	92	------	------
Loam	7.9	.08	------	------	1.84	9.9	------	------	------	.1	.2	------	------	13	1
Sandy loam	8.0	.05	------	------	1.94	8.5	------	------	------	(1)	.2	------	------	7	(1)

TABLE 9.—*Acreage of principal crops in stated years*

Crop	1940	1950	1960	1964
	Acres	*Acres*	*Acres*	*Acres*
Corn for all purposes	64,628	76,025	101,376	86,056
Oats harvested for grain	51,318	57,444	34,235	28,401
Other small grains harvested for grain [1]	917	297	148	107
All hay	36,188	34,876	35,918	35,633
Alfalfa and alfalfa mixtures	4,119	11,208	25,845	27,184
Soybeans harvested for beans	3,437	8,463	17,210	24,725
Sorghum for all purposes	1,283	28	52	19

[1] Includes mostly wheat and some rye and barley; no barley was grown in 1964.

TABLE 10.—*Livestock on farms in stated years*

Livestock	1940	1950	1960	1964
Milk cows [1]	24,556	21,383	20,249	21,286
Beef cows	(2)	(2)	1,605	2,446
Calves born	19,661	19,135	19,475	20,684
Lambs born	3,134	1,816	2,343	2,256
Hens and pullets on hand	376,941	432,524	388,591	313,166
Turkeys raised	(2)	53,562	77,531	83,826
Grain-fed cattle marketed	(2)	2,251	7,732	5,854
Grain-fed sheep and lambs marketed	(2)	(2)	931	2,473
Sows farrowed	[3] 16,279	[3] 19,288	[4] 24,264	[4] 18,400

[1] All cows and heifers 2 years old and older kept for milk.
[2] Figures not available.
[3] Includes only sows farrowed or bred to farrow between December 1 of the stated year and June of the following year.
[4] Includes sows farrowed or bred to farrow between June 1 of the stated year and June 1 of the following year.

TABLE 11.—*Summary of temperature and*

[Based on a 30-year record,

Month	Temperature in °F.							Mean degree days[1]
	Means			Extremes				
				High		Low		
	Daily maximum	Daily minimum	Monthly	Degrees	Year	Degrees	Year	
January	27.6	8.9	18.3	59	1944	−31	1936	1,448
February	31.2	12.1	21.7	59	1959[2]	−27	1933	1,223
March	41.4	22.8	32.1	81	1939[2]	−13	1960	1,017
April	58.3	35.9	47.1	91	1952	9	1936	534
May	71.6	48.3	60.0	106	1934	24	1945	223
June	80.5	58.3	69.4	106	1934	35	1945	63
July	85.8	62.1	74.0	109	1936	44	1945	12
August	83.5	60.5	72.0	105	1936	36	1935	18
September	75.3	50.1	62.7	101	1939	21	1942	153
October	64.1	40.3	52.2	91	1953	14	1952[2]	422
November	45.0	25.7	35.4	81	1933	−11	1959	858
December	31.9	14.6	23.3	64	1946	−27	1950	1,293
Year	58.0	36.6	47.4	109	1936	−31	1936	7,264

[1] Degree-days based on 65° F. The heating degree days for a day are determined by subtracting the average temperature for each day from 65. These daily values are totaled to obtain the number of degree-days in a month. To determine the mean degree days for a month in a given period, total the degree-days for that month in each year of the period and divide by the number of years.

About 70 percent of the annual precipitation falls from April through September. Rainfall is most abundant in June, which has an average of 4.46 inches. Measurable precipitation occurs on about 95 days in a year, and 0.1 of an inch or more occurs on about 76 days in a year. Because growing corn requires about an inch of water per week, except during the early stages, dry spells in midsummer occasionally cause concern. Sustained drought is rare, however, and soil moisture reserves are usually adequate to supply crops with water during dry spells. The probability of receiving an inch or more of rainfall per week during the critical growing period varies from nearly 50 percent early in June to about 25 percent late in August.

The heaviest rainfall recorded for 1 day during the past 30 years was 5.50 inches at Tripoli in April 1951. A rainfall of 3.1 inches in 1 day can be expected about once in 2 years, and 5.5 inches can be expected about once in 40 years. Occasionally there are floods, most often in June from heavy rainfall or in March and April from snowmelt and rainfall.

The average winter snowfall is 31.6 inches, but the amount varies greatly. The most severe snowstorm in the past 20 years occured in January 1949, when 14 inches of snow fell within 24 hours. A snowfall of 12 inches in 1 day was measured in March 1959. The snowiest winter in recent years was the winter of 1961–1962, when there was 62 inches of snowfall.

In the characteristic manner of an interior continental climate, the range of temperature is marked throughout the year. The average temperature during the year ranges from 18.3° F. in January to 74° in July. The average maximum range is from —27° in winter to 96° in summer. A temperature of above 90°, which is too hot for the best growth of most plants, occurs an average of 22 days a year. A temperature of zero or lower occurs an average of 21 days a year. The coldest temperature of record was —34° in January 1912, and the hottest was 109° in July 1936. The average growing season is 149 days, between the freeze dates of May 7 and October 3.

About 40 thunderstorms occur during a year, mostly in the summer, and they may be accompanied by high winds, heavy rainfall, or hail. Tornadoes occur on an average of only once in 5 years.

Relief and Drainage

Most of the landscape in Bremer County is nearly level to moderately sloping. The slopes are generally long, and a system of drainageways and small streams is fairly well established. The steep and strongly sloping areas along the east side of the Cedar River and the Shell Rock River and west of Denver are in strong contrast to the rest of the landscape. More detailed information about the relief in specific parts of the county is given in the section "General Soil Map."

Three major streams, the Cedar River, the Shell Rock River, and the Wapsipinicon River, flow south-southeast across Bremer County. The Shell Rock River cuts a winding course about 6 miles long across the southwestern corner of the county and joins the west fork of the Cedar River a half mile or so south of the Bremer County line. The Cedar River enters the county in the northwestern corner. The Wapsipinicon River enters the north-central part.

precipitation at the Waverly-Tripoli station

from 1931 through 1960]

Precipitation in inches								Mean number of days with—				
Monthly mean	Greatest daily		Snow and sleet					Precipitation 1/10 inch or more	Maximum temperature of—		Minimum temperature of—	
	Inches	Year	Monthly mean	Greatest monthly		Greatest daily			90° and above	32° and below	32° and below	0° and below
				Inches	Year	Inches	Year					
1. 14	1. 02	1947	7. 1	17. 6	1932	14. 0	1949	3	0	17	31	11
. 93	1. 46	1948	6. 4	17. 9	1939	6. 0	1959 [2]	3	0	7	27	1
2. 21	1. 80	1933	7. 9	32. 5	1951	12. 0	1959	7	0	2	27	0
2. 85	5. 50	1951	. 8	4. 7	1936	4. 0	1949	10	(3)	1	18	0
3. 98	3. 00	1960	(4)	3. 0	1947	2. 0	1935	6	1	0	2	0
4. 46	4. 35	1951	0	0	--------	--------	--------	6	5	0	0	0
3. 70	3. 00	1942	0	0	--------	--------	--------	11	8	0	0	0
3. 86	3. 18	1931	0	0	--------	--------	--------	6	6	0	0	0
3. 53	5. 27	1941	(4)	1. 0	1942	1. 0	1942	9	2	0	1	0
2. 30	3. 32	1954	(4)	. 8	1932	. 8	1932	5	(3)	0	3	0
1. 76	3. 28	1938	2. 9	13. 0	1934	12. 0	1934	5	0	1	20	0
1. 13	1. 30	1932	6. 5	14. 9	1937	8. 0	1940 [2]	5	0	21	28	9
31. 85	5. 50	1951	31. 6	32. 5	1951	14. 0	1949	76	22	49	157	21

[2] Most recent occurrence.
[3] Less than half a day.
[4] Less than half an inch.

The tributaries of these three rivers maintain courses nearly parallel with their master streams and are generally not more than 3 or 4 miles from them. The areas between streams are so narrow and so mature that no significant lateral streams have developed.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Bench. A shelflike landform. A structural bench is formed by the underlyinging strata of rock. A stream bench is formed by deposition and erosion.

Biosequence. A sequence of soils whose properties are functionally related to differences in organisms.

Bottom land. The normal flood plain of a stream and the old alluvial plain that is seldom flooded. First bottoms are areas that border a stream channel and are subject to flooding; the flood plain. Second bottoms are old alluvial plains that border first bottoms and are seldom flooded.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Concretions. Hard grains, pellets, or nodules of various sizes, shapes, and colors, consisting of concentrations of compounds that cement the soil grains together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle to moderate pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to thumb and forefinger, and tends to stretch somewhat and pull apart, rather than to pull free from either finger.

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 at right angles to the slope.

Glacial drift. Rock material transported by glacial ice and then deposited; includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash. Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice. Referred to in this report as "outwash areas" or "outwashes."

Glacial till. Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Green-manure catch. A crop grown between two crops in ordinary sequence, or between the rows of a main crop, and then turned under. It may be grown as a substitute for a crop that has failed.

Hydrosequence. A sequence of soils whose properties are functionally related to differences in drainage and moisture content.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

Leaching, soil. The removal of materials in solution by the passage of water through soil.

Loess. An eolian deposit consisting mostly of silt-sized particles.

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 soil 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.*

Profile. A vertical section of the soil through all its horizons and extending into the parent material. See Horizon, soil.

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 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz, but sand 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.

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 mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (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 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.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. (See also clay, sand, and silt.) The basic textural classes, in order of increasing proportions of fine particles are as follows: *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Toposequence. A sequence of soils whose properties are functionally related to topography.

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