SOIL SURVEY OF

Worth County, Iowa

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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1967–70. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station. It is part of the technical assistance furnished to the Worth County Soil Conservation District.

HOW TO USE THIS SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and the information in the test. 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 section "Management for Crops and Pasture."

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

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

Community planners and others can read about soil properties that affect the choice of homesites, industrial sites, schools, and parks in the section "Urban Uses of Soils."

Engineers and builders will find under "Use of the Soils in Engineering" tables that contain estimates of soil properties and information about soil features that affect highways and other engineering works.

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

Newcomers in Worth 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."

Contents

Issued January 1976

SOIL SURVEY OF WORTH COUNTY, IOWA

BY RUSSELL L. BUCKNER AND JOHN D. HIGHLAND, SOIL CONSERVATION SERVICE

FIELDWORK BY RUSSELL L. BUCKNER, THOMAS A. DEWITT, WILLIAM L. FOUTS, HARVEY A. HARMAN, LARRY K. JOHNSON, AND NORMAN L. JOHNSON, SOIL CONSERVATION SERVICE

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

WORTH COUNTY is in the north-central part of Iowa (fig. 1). It has an area of about 256,064 acres. Northwood, the county seat, is in the north-central part of the county about 145 miles north and a little east of Des Moines, the State capital.

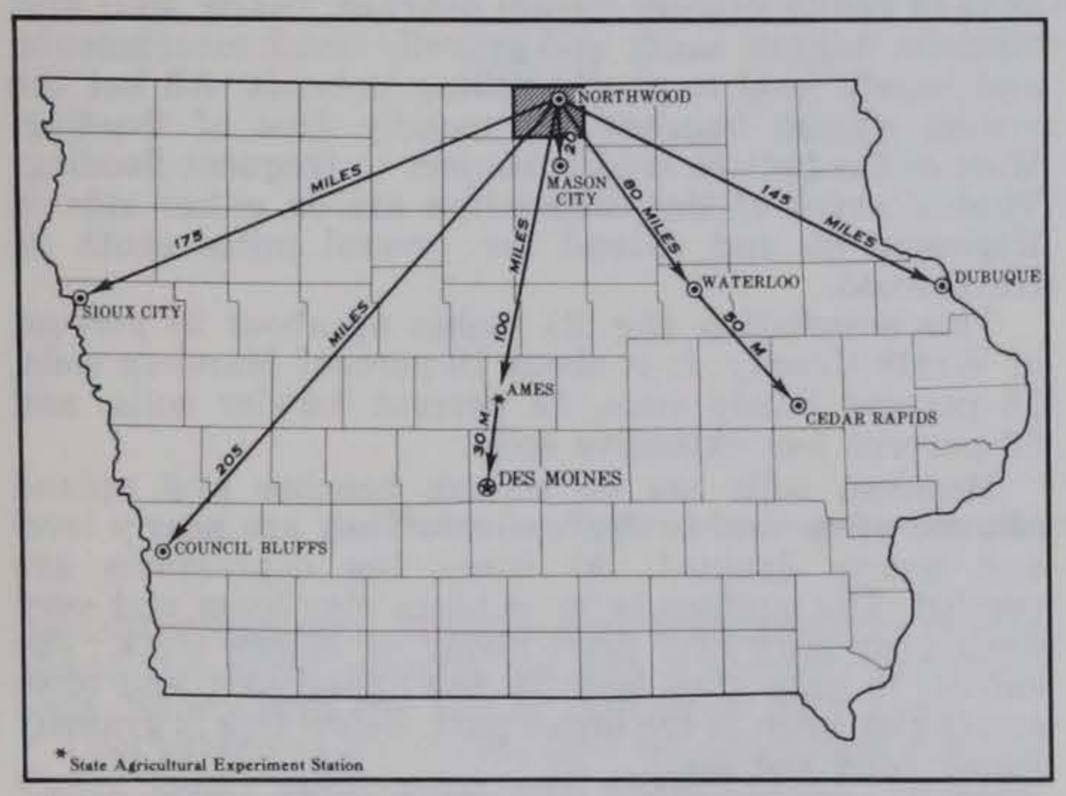


***Figure 1.*—Location of Worth County in Iowa.**

Most of Worth County is in farms. The principal crops are corn, soybeans, oats, hay, and pasture. Except for soybeans, most of the crops are fed to livestock. Beef cattle, hogs, and dairying are the chief sources of income.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Worth County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down to the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Maxfield and Clarion, 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 natural characteristics.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Clarion loam, 0 to 2 percent slopes, is one of several phases within the Clarion series.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of

some other kind that have been seen within an area that is dominantly of a recognized soil phase.

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

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Webster-Nicollet complex, 1 to 3 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Marsh is a land type in Worth County.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland, and engineers.

On the basis of 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 the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

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

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

The names of soil associations on the general soil map do not fully agree with those on the general soil map for Mitchell Company, published at a different date. Differences are the result, mainly, of differences of patterns of the major soils in Mitchell County.

The eight soil associations in Worth County are described on the following pages.

1. *Marshan-Saude-Lawler association*

Nearly level to moderately sloping or gently rolling, poorly drained to well-drained soils that formed in loamy alluvial sediment underlain by sandy and gravelly sediment; on stream benches and uplands

This association is characterized by broad, nearly level to gently sloping stream benches, nearly level first bottoms, narrow sandy and gravelly bench escarpments, and nearly level to gently rolling uplands. All but the lowest stream benches are usually free of flooding. Most of the bottom land is subject to frequent flooding. Typical areas of this association are on either side of Highway 65 and extend for several miles south of Northwood.

This association (fig. 2) makes up about 24 percent of Worth County. It is about 19 percent Marshan soils, 16 percent Saude soils, 12 percent Lawler soils, and 53 percent less extensive soils.

Marshan soils are on stream benches and upland alluvial areas and in depressions. They are nearly level and poorly drained. At times the depressions are ponded. The surface layer is black clay loam and very dark gray silty clay loam about 21 inches thick. The subsoil is gray silty loam in the upper part and olive sandy clay loam in the lower part. Below this is gravelly loamy sand and sand.

Saude soils are on stream benches and in the uplands. About 68 percent of the acreage of these soils is nearly level, 27 percent is gently sloping or gently undulating, and 5 percent is moderately sloping or gently rolling. The soils are well drained. The surface layer is very dark brown and dark-brown loam about 17 inches thick. The subsoil is brown loam in the upper part, dark yellowish-brown fine gravelly sandy loam in the middle part, and brown loamy sand in the lower part. The substratum is loamy sand and gravelly sand.

Lawler soils are on stream benches and upland alluvial areas. They are nearly level and somewhat poorly drained. The surface layer is very dark brown loam about 16 inches thick. The subsoil is dark grayish-brown loam in the upper part, light olive-brown loam mottled with grayish brown in the middle part, and mottled yellowish brown in the lower part.

Less extensive in this association on benches and uplands are the poorly drained Talcot and Harcot soils, the well-drained Wapsie and Waukee soils, and the excessively drained Salida soils. Talcot and Harcot soils are similar to the Marshan soils in color, texture, and

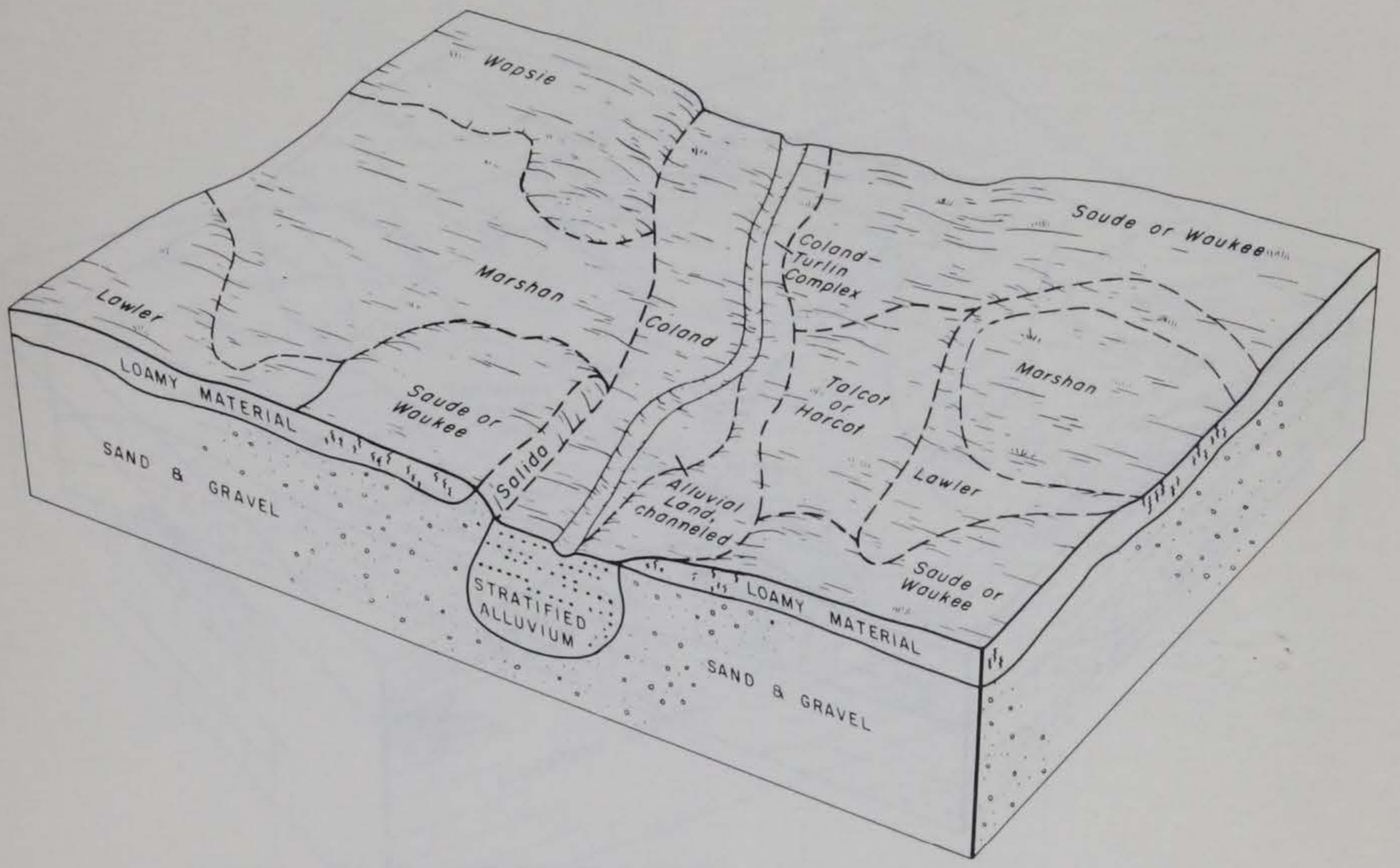


***Figure 2.*—Pattern of soils and parent material in the Marshan-Saude-Lawler association.**

landscape position. Wapsie and Waukee soils occupy about the same position on the landscape as Saude soils. Salida soils are gently sloping to very steep.

Less extensive on bottom land are the poorly drained Calco, loamy substratum, and Coland soils; the somewhat poorly drained Turlin soils; and Mixed alluvial land and Marsh. All of these are nearly level and all have a thick, dark-colored surface layer. Marsh is the result of manmade structures in most places. These soils and land types make up about 14 percent of this association.

Except for Marsh, most of the soils on benches are used for cultivated crops, and are well suited to this use. Most of the soils of the bottom lands are in permanent pasture, primarily because of the hazard of flooding and the meandering stream channels. The bottom land has a high yield potential when cultivated, but it may need protection from flooding. Most areas need tile drainage.

Management problems in this association are variable. Some areas need flood control and drainage improvement; others need control of erosion. Some areas are droughty. All of these soils need general improvement of fertility. Available water capacity ranges from very high to very low. The soils on benches are potential sources of sand and gravel.

2. *Maxfield-Klinger-Franklin association*

Nearly level and very gently sloping, poorly drained and somewhat poorly drained soils that formed in loess and the underlying glacial till; on uplands

This association is characterized by long slopes, slightly rounded hills, broad, nearly level areas, and a well-developed drainage network. Most of the soils formed in 20 to 40 inches of loess and the underlying glacial till (fig. 3). Typical areas of this association are along Highway 337 south of Grafton.

This association makes up about 20 percent of the county. It is about 36 percent Maxfield soils, 25 percent Klinger soils, 8 percent Franklin soils, and 31 percent less extensive soils.

Maxfield soils are in most of the broad areas and the drainageways. They are nearly level and poorly drained. The surface layer is black silty clay loam about 20 inches thick. The subsoil is mottled dark-gray and olive silty clay loam in the upper part and mottled yellowish-brown and grayish-brown loam in the lower part.

Klinger soils are on the sides and crests of ridges. Slopes are long and uniform. These soils are in a slightly higher position on the landscape than Maxfield soils. They are nearly level to very gently sloping and somewhat poorly drained. The surface layer is black

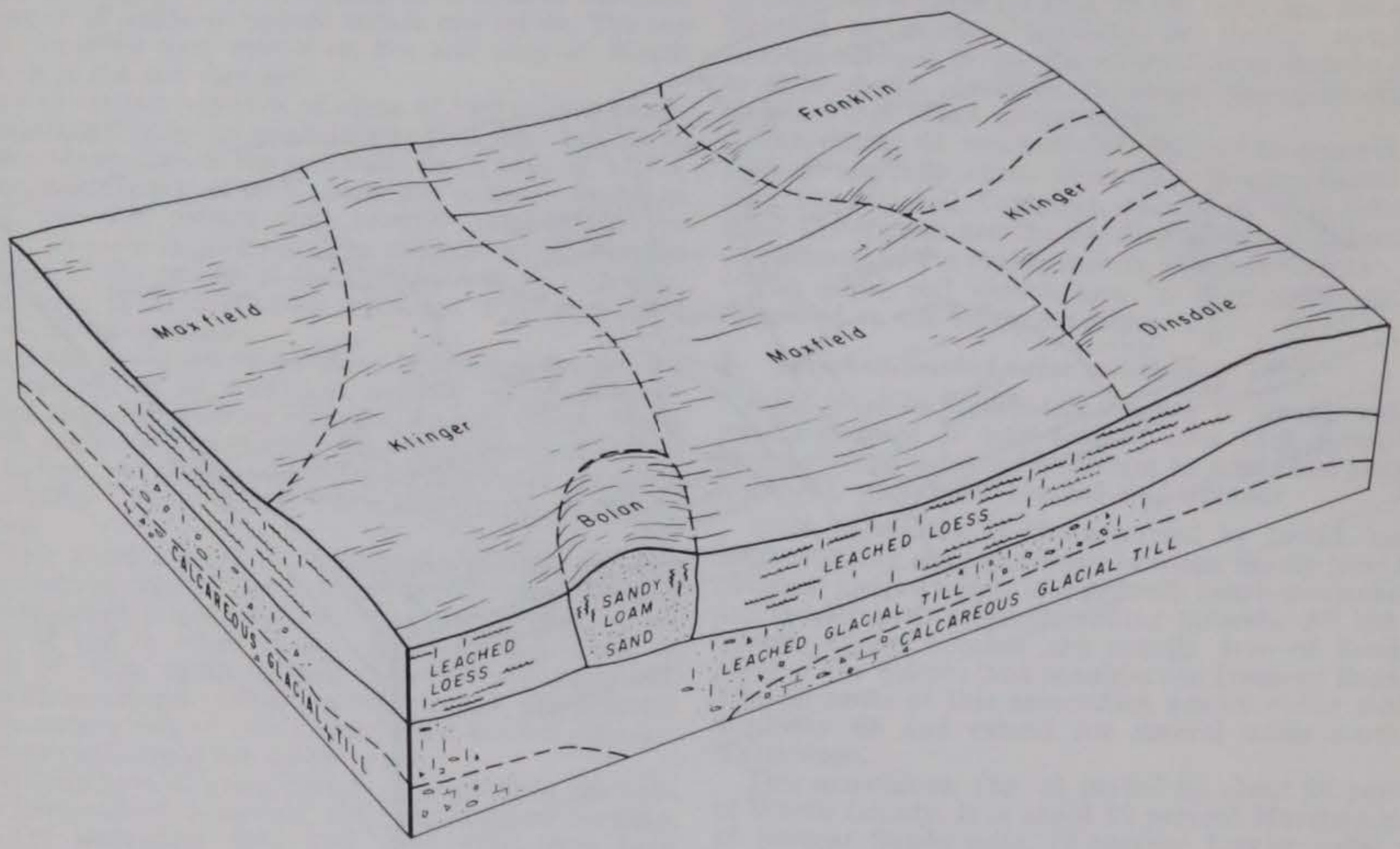


***Figure 3.*—Pattern of soils and parent material in the Maxfield-Klinger-Franklin association.**

silty clay loam about 18 inches thick. The subsoil is dark grayish-brown and yellowish-brown silty clay loam in the upper part and mottled yellowish brown and grayish brown in the lower part.

Franklin soils also are on the sides and crests of ridges and have long, uniform slopes. They are in a slightly higher position on the landscape than Maxfield soils. They are nearly level to very gently sloping and somewhat poorly drained. The surface layer is very dark gray silt loam about 8 inches thick. The subsoil is grayish-brown and strong-brown silty clay loam in the upper part and yellowish-brown and grayish-brown loam in the lower part.

Less extensive in this association are the well drained Dinsdale and Bolan soils, the moderately well drained to somewhat poorly drained Donnan soils, the poorly drained Canisteo soils, and the well drained to somewhat excessively drained Dickinson soils. Dinsdale soils are on the sides and crests of ridges. They are nearly level to gently sloping, and slopes are long and uniform. Bolan and Dickinson soils are on mounds, in dunelike areas, and on the sides and crests of ridges and are nearly level to gently sloping. Donnan soils are generally on higher positions in the landscape and some of the steeper side slopes. They are nearly level to moderately sloping. Canisteo soils are generally on the lowest part of the landscape.

Most of the soils are well suited to row crops and have high available water capacity. Although most of the poorly drained soils and some of the somewhat poorly drained soils have been tile drained, further improved drainage is needed. Control of erosion is needed in the steeper areas. Protection against soil blowing is needed in some areas.

Nearly all of this association is used for row crops. Slopes are long and uniform and are well suited to contouring and terracing.

3. Rockton-Faxon association

Nearly level to gently sloping, well-drained and poorly drained soils that formed in 20 to 40 inches of loamy glacial sediment over limestone bedrock; on stream benches and uplands

The major part of this area is nearly level. Most of the rest is gently sloping, with long uniform slopes. A few small areas are moderately sloping. Most of this association is near the Shellrock and Winnebago Rivers. Some of the lower areas are susceptible to flooding. Typical areas of this association are about a mile east of Fertile.

This association (fig. 4) makes up about 2 percent of Worth County. It is about 39 percent Rockton soils, 20 percent Faxon soils, and 41 percent less extensive soils.

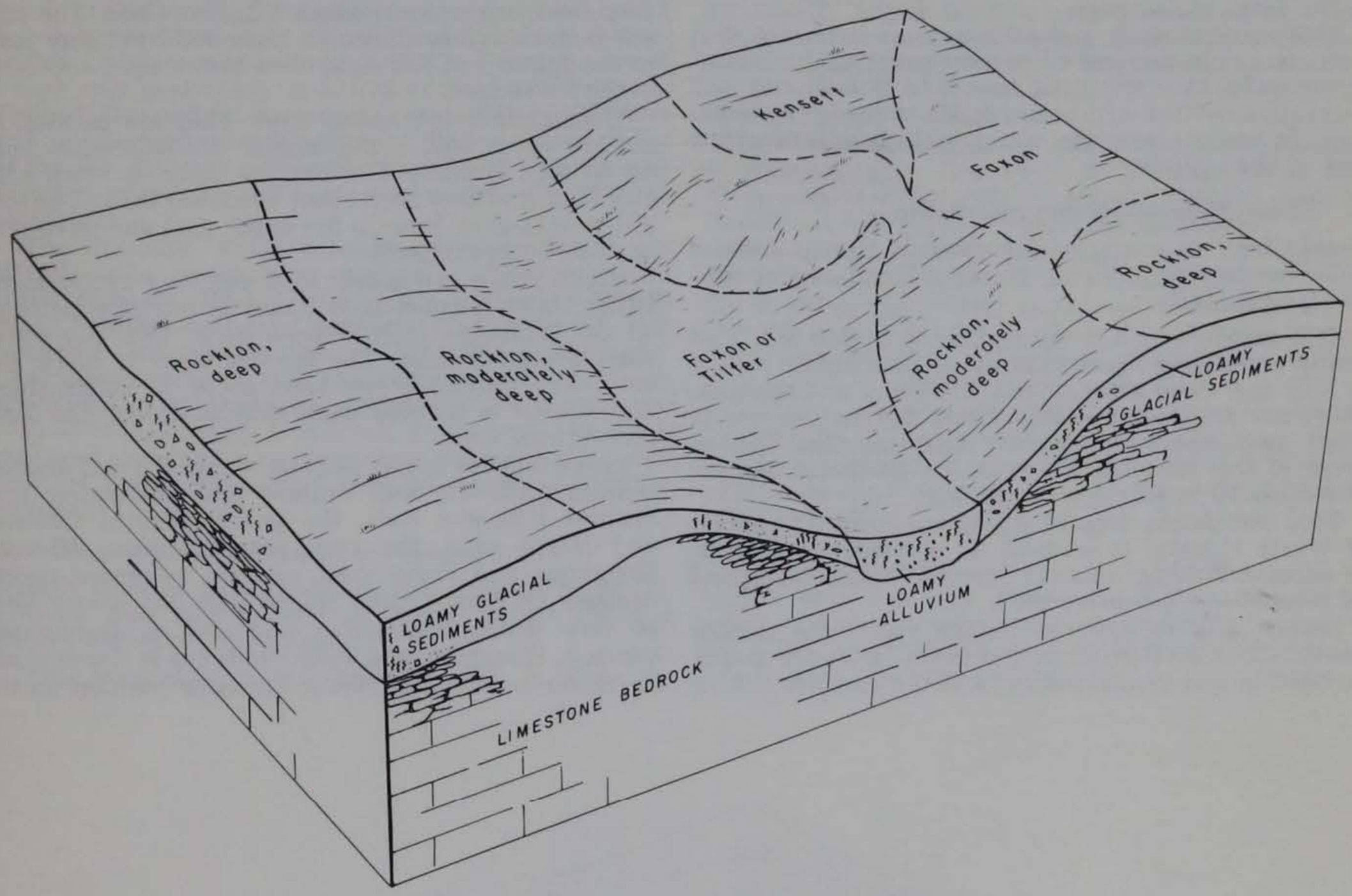


***Figure 4.*—Pattern of soils and parent material in the Rockton-Faxon association.**

Rockton soils are on higher areas on the stream benches and uplands. They are nearly level to gently sloping and are on the sides and crests of ridges. They are well drained. The surface layer is black and very dark grayish-brown loam about 12 inches thick. The subsoil is brown and dark yellowish-brown loam and sandy clay loam.

Faxon soils are in low areas on stream benches and uplands. Areas are nearly level, and slopes are smooth to slightly concave. Faxon soils are poorly drained. The surface layer is black and very dark gray silty clay loam about 18 inches thick. The subsoil is mottled dark grayish-brown and gray loam.

Less extensive in this association are the poorly drained Harcot, Marshan, Tilfer, and Talcot soils, the very poorly drained Houghton and Palms soils, the somewhat poorly drained Lawler and Kensett soils, and the well-drained Saude and Waukee soils. Tilfer and Kensett soils are the most extensive of these; each makes up about 18 percent of the association.

Tilfer soils are in low areas on stream benches. They are nearly level, and slopes are smooth to slightly concave. Colors, textures, and depths are similar to those of Faxon soils, but the Tilfer soils are calcareous. Kensett soils are on stream benches and uplands. They are nearly level, and slopes are slightly convex to slightly concave. The surface layer is black and very dark brown silt loam about 13 inches thick. The subsoil is mottled dark grayish-brown light silty clay loam. Harcot, Marshan, Tilfer, Houghton, and Palms soils occupy about the same position on the landscape as Faxon soils. Lawler soils occupy about the same position as Kensett soils. Saude and Waukee soils occupy about the same position as Rockton soils.

Row crops are grown in most of the upland areas and the greater part of the stream bench areas. Available water capacity is moderate to low on all of these soils except the Houghton and Palms, which have very high available water capacity. The major management problem on the poorly and very poorly drained soils is improvement of soil drainage. In many places installation of tile drains and drainage ditches is complicated by the presence of limestone bedrock substrata. Saude soils and the moderately deep Rockton soils are droughty unless rainfall is timely. About 40 percent of Rockton soils are susceptible to slight water erosion,

and a few steep areas are moderately eroded. In a few areas bedrock is within 20 inches of the surface or is in the form of outcrops.

This association is a good source of limestone, but water has to be pumped from most quarries. Limestone is generally at a depth of less than 3 feet and will generally interfere with construction of roads and buildings. In many places the water table is within a few feet of the surface.

4. *Lester-Webster-Nicollet association*

Nearly level to steep, well-drained to poorly drained soils that formed in loamy glacial till and glacial sediment; on uplands

This association is characterized by nearly level and gently undulating areas intermixed with gently rolling to hilly and steep areas. Slopes are short and complex. There are many depressions. Some depressions are in crops, and others are marshy and left idle. Typical areas of this association are in the northeast quarter of section 16 in Hartland Township.

This association (fig. 5) makes up about 14 percent of Worth County. It is about 35 percent Lester soils, 18 percent Webster soils, 11 percent Nicollet soils, and 36 percent less extensive soils.

Lester soils occupy the higher and more sloping areas. About 90 percent of the Lester soils are gently undulating and gently rolling, and the rest are rolling to steep. About one-third of Lester soils are moderately eroded. They are well drained. The surface layer is very dark brown loam about 7 inches thick. The subsoil is dark yellowish-brown loam and light clay loam in the upper part and light olive-brown light clay loam in the lower part.

Webster soils are nearly level. They are on most of the low areas and in the smaller drainageways. They are poorly drained. The surface layer is black silty clay loam and clay loam about 19 inches thick. The subsoil is dark-gray loam in the upper part and olive-gray loam in the lower part.

Nicollet soils are nearly level and very gently undulating. Most Nicollet soils occur in intricate patterns on the landscape with Webster soils. They are somewhat poorly drained. The surface layer is black and very dark grayish-brown loam about 19 inches thick. The subsoil is mottled dark grayish-brown and light olive-brown loam.

Less extensive in this association are the well drained Wapsie soils, the well drained and moderately well drained Kilkenny soils, the poorly drained Canisteo and Harps soils, the very poorly drained Okoboji, Houghton, and Palms soils, and the somewhat poorly drained Le Sueur soils. Harps soils are nearly level to very gently undulating and are in depressions. Okoboji, Houghton, and Palms soils are in depressions. Le Sueur soils occupy about the same position on the

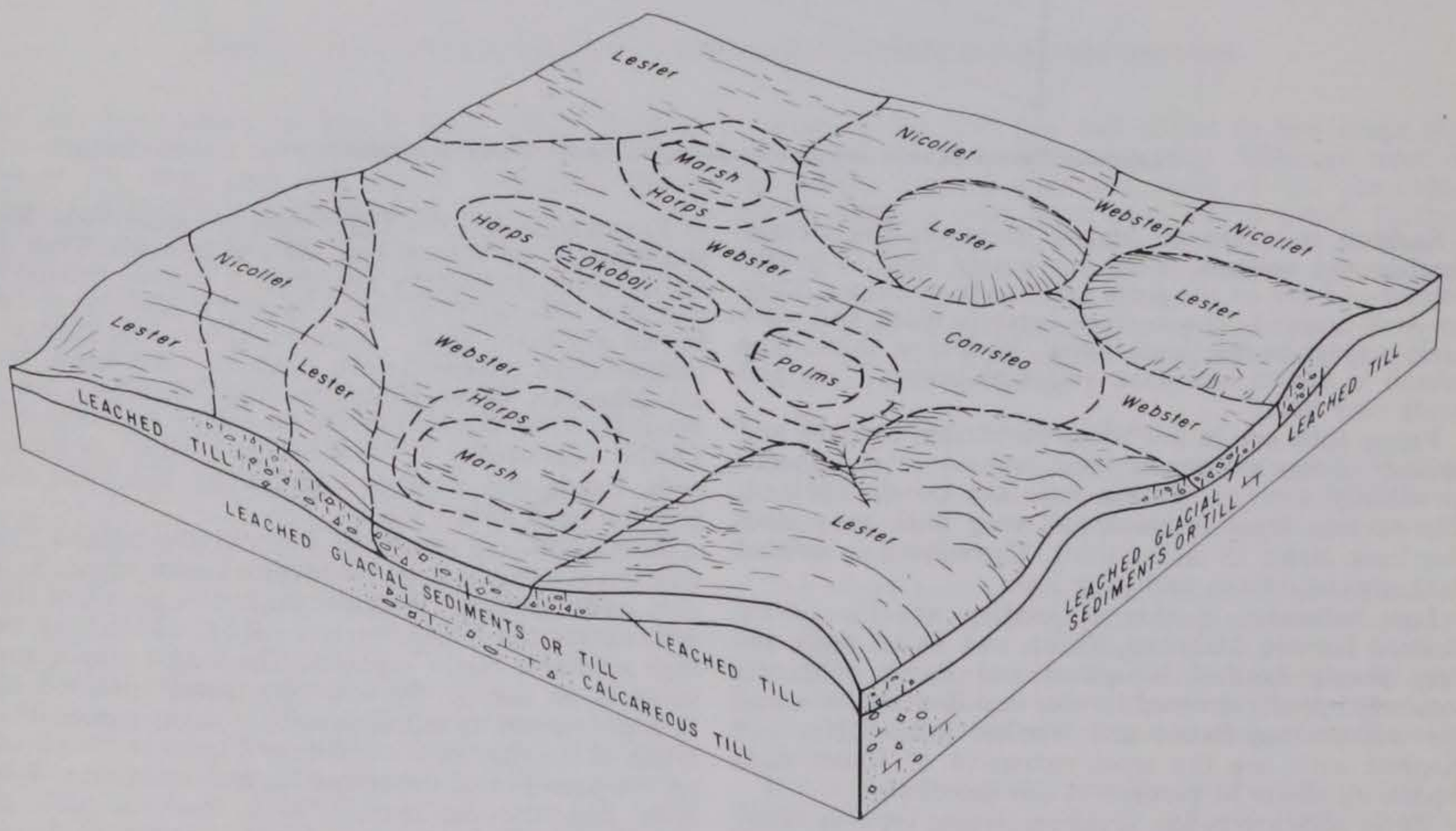


***Figure 5.*—Pattern of soils and parent material in the Lester-Webster-Nicollet association.**

landscape as Nicollet soils, and Kilkenny and Wapsie soils occupy about the same position as Lester soils.

The nearly level to gently rolling areas are well suited to row crops if properly drained and if erosion is controlled. Okoboji soils are well suited and Houghton and Palms soils moderately suited to row crops if properly drained. Drained depressions are susceptible to wetness and ponding after heavy rains or spring thaws. Some of the steeper areas within this association are not well suited to row crops and are better suited to pasture or woodland.

The available water capacity is high on all but Wapsie soils, which have moderate to low available water capacity. Most of the poorly drained soils and many depressions have been drained. Contouring and terracing are complicated by irregular topography. Controlling water erosion and improving soil drainage are the major management problems in this association.

Most of the acreage is in crops. There are a few small timbered areas and some permanent pasture and marsh. Most of the marshy areas are useful only as wildlife habitat.

5. *Clarion-Webster-Nicollet association*

Nearly level to gently rolling, well-drained to poorly drained soils that formed in loamy glacial till and glacial sediment; on uplands

This association is characterized in most places by nearly level to gently rolling areas. Some places, especially to the north and northeast of Northwood, are dominantly nearly level to very gently sloping. There are a few hilly and steep areas. Most slopes are short and complex. There are many depressions; some are in crops and others are marshy. Typical areas of this association are west of Joice.

This association (fig. 6) makes up about 22 percent of Worth County. It is about 32 percent Clarion soils, 17 percent Webster soils, 13 percent Nicollet soils, and 38 percent less extensive soils and land types.

Clarion soils occupy the higher and more sloping areas. They are nearly level to gently rolling. Nearly all of the gently rolling areas are moderately eroded. Clarion soils are well drained. The surface layer is black and very dark brown loam about 13 inches thick. The subsoil is dark yellowish-brown loam.

Webster soils are nearly level and are on most of the low areas and smaller drainageways. They are poorly drained. The surface layer is black silty clay loam and clay loam about 19 inches thick. The subsoil is dark-gray loam in the upper part and olive-gray loam in the lower part.

The somewhat poorly drained Nicollet soils are nearly level and very gently undulating. The surface layer is black and very dark grayish-brown loam about 19 inches thick. The subsoil is mottled dark grayish-brown and light olive-brown loam.

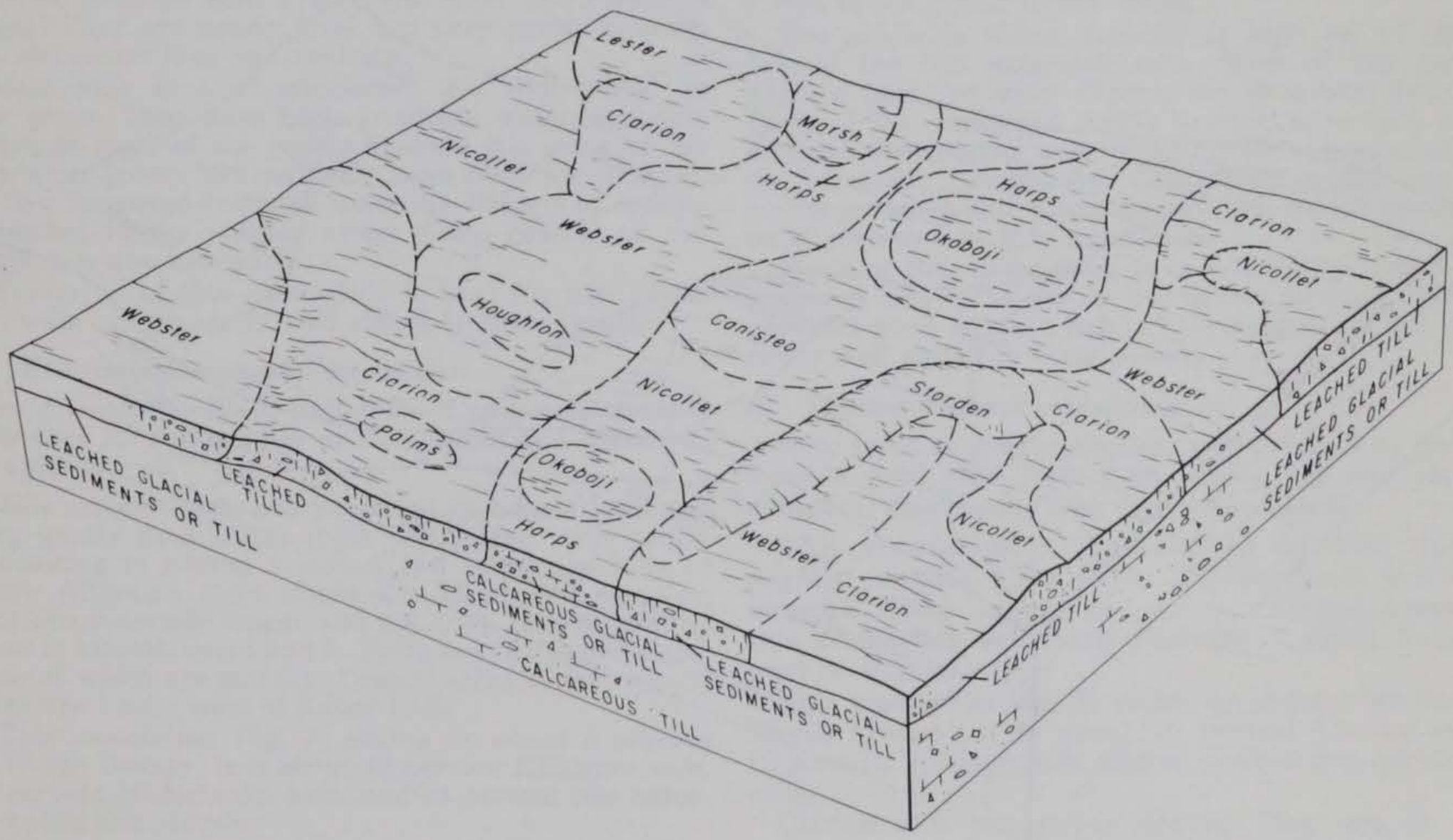


***Figure 6.*—Pattern of soils and parent material in the Clarion-Webster-Nicollet association.**

Less extensive in this association are the well-drained Lester, Saude, and Storden soils; the very poorly drained Okoboji, Houghton, and Palms soils; and Marsh. Lester and Saude soils occupy about the same position on the landscape as Clarion soils. Storden soils are on knobs and narrow ridges. Canisteo soils occupy about the same position on the landscape as Webster soils. Harps soils are nearly level to very gently undulating and are in depressions. Okoboji, Houghton, and Palms soils are in depressions; Marsh is in undrained depressions.

Most of the soils are well suited to row crops if properly drained and if erosion is controlled. Okoboji soils are well suited and Houghton and Palms soils are moderately suited to row crops if properly drained, but they are susceptible to wetness and ponding after heavy rains and spring thaws. A few steep areas and some sloping, gravelly areas are not suited to row crops.

The available water capacity is high on all but a few of the less extensive soils. Most of the poorly drained soils and many depressions have been drained. Contouring and terracing are complicated by the irregular topography. Controlling water erosion and removing excess water in the nearly level areas and depressions are the major management concerns.

Nearly all of this association is used for row crops. Nearly all the sloping areas are generally well suited to farm ponds. A few areas are timbered or in permanent pasture. Marsh provides good wildlife habitat.

6. *Clyde-Kenyon-Oran association*

Nearly level to moderately sloping, well-drained to poorly drained soils that formed in loamy sediment and the underlying glacial sediment or glacial till; on uplands

This association is characterized by long slopes, slightly rounded hills, and a well-developed drainage network. Typical areas of this association are southeast of Manly.

This association (fig. 7) makes up about 10 percent of Worth County. It is about 29 percent Clyde soils, 14 percent Kenyon soils, 13 percent Oran soils, and 44 percent less extensive soils.

Clyde soils are nearly level and are in most of the drainageways. In a few places they are on relatively large areas that have few defined drainageways. They are poorly drained. The surface layer is black and very dark gray silty clay loam. The subsoil is light olive-gray silty clay loam in the upper part and mottled light

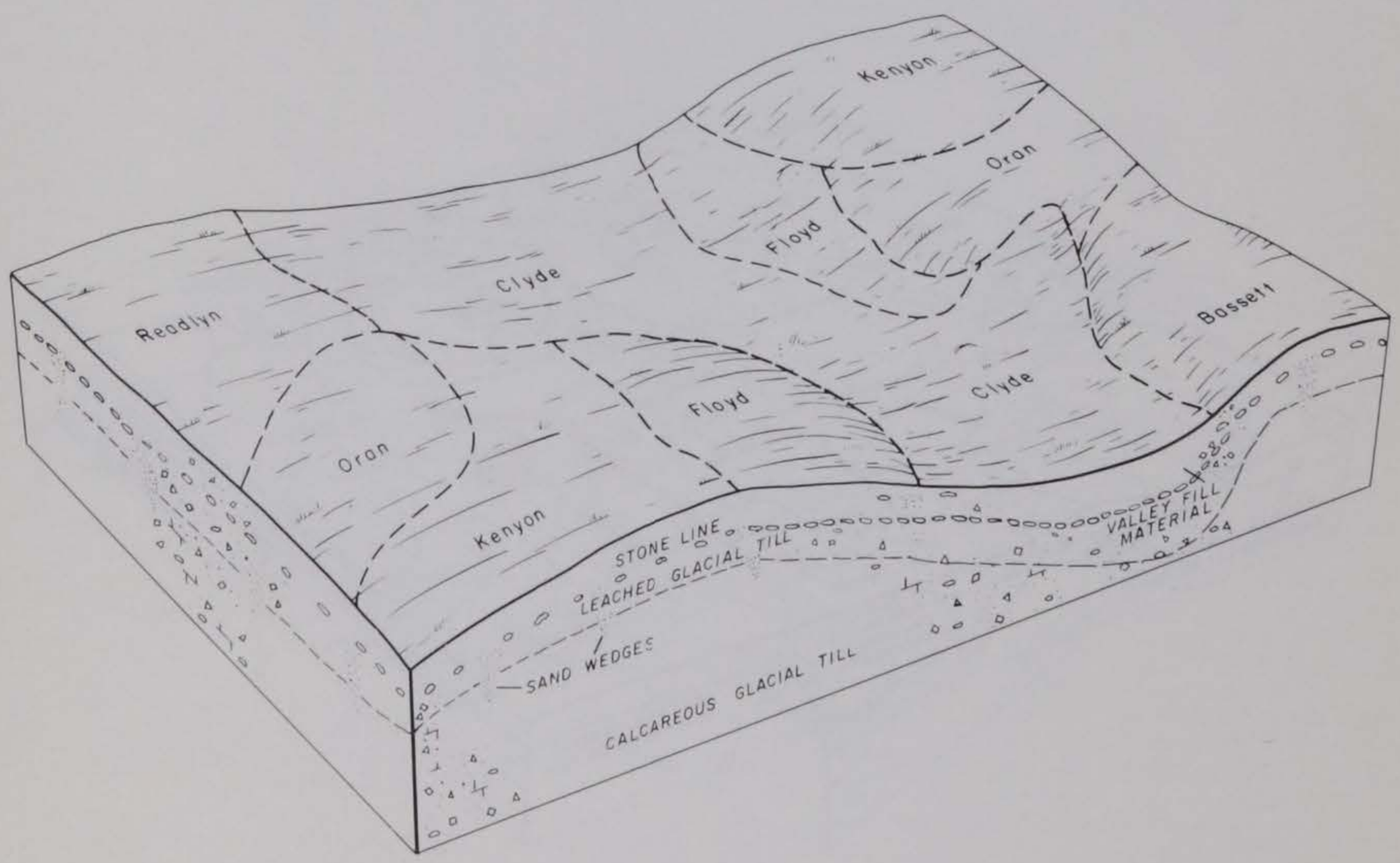


***Figure 7.*—Pattern of soils and parent material in the Clyde-Kenyon-Oran association.**

brownish-gray and yellowish-brown loam and sandy loam in the lower part.

Kenyon soils are nearly level to moderately sloping. They are on higher and generally more sloping positions on the landscape. Moderately sloping areas are moderately eroded. Most slopes are long and uniform. Kenyon soils are well drained and moderately well drained. The surface layer is very dark brown and very dark grayish-brown loam about 13 inches thick. The subsoil is brown loam in the upper part, yellowish-brown loam in the middle part, and mottled yellowish-brown loam in the lower part.

The somewhat poorly drained Oran soils are nearly level and very gently sloping. Slopes are long and uniform. The soils are mostly in Deer Creek Township. The surface layer is very dark brown silt loam. The subsoil is mottled dark grayish-brown and dark yellowish-brown silty clay loam high in sand in the upper part and mottled grayish-brown, strong-brown, and brown loam in the lower part.

Less extensive in this association are the well drained and moderately well drained Bassett soils, the somewhat poorly drained to moderately well drained Donnan soils, and the somewhat poorly drained Schley, Floyd, and Readlyn soils. Bassett and Donnan soils occupy about the same position on the landscape as Kenyon soils. Schley soils occupy about the same position as Floyd soils.

Of the less extensive soils, Floyd and Readlyn soils are the most extensive; each makes up about 12 percent of the association. Floyd soils are nearly level and very gently sloping. Slopes are slightly convex to slightly concave. Readlyn soils are on the sides and crests of ridges. They are nearly level and very gently sloping. The slopes are long and uniform.

Most soils in this association are well suited to row crops. They have high available water capacity. Although most of the poorly drained and some of the somewhat poorly drained soils have been tile drained, further improved drainage is needed. Control of erosion is needed in the steeper areas. Some control of soil blowing is also needed.

Nearly all of this association is used for row crops. The soils are generally well suited to farm ponds.

7. *Kilkenny-Minnetonka association*

Nearly level to rolling, well-drained to poorly drained soils that formed mainly in silty lacustrine sediment; on uplands

This association is characterized by nearly level and very gently undulating areas intermixed with gently undulating to rolling areas. A few areas are hilly to steep. Although most slopes are short and complex, they are generally longer and not quite so irregular as those in associations 4 and 5. There are few depressions, some of which are marshy. Typical areas of this association are 1 mile west of Silver Lake.

This association (fig. 8) makes up about 4 percent of Worth County. It is about 48 percent Kilkenny soils, 18 percent Minnetonka soils, and 34 percent less extensive soils and Marsh.

Kilkenny soils are higher and more sloping than Minnetonka soils. They are gently undulating to rolling. About 55 percent of Kilkenny soils are moderately eroded. They are well drained and moderately well drained. The surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil is dark yellowish-brown heavy silty clay loam in the upper part and mottled brown and grayish-brown heavy silty clay loam in the lower part.

Minnetonka soils are nearly level to very gently undulating. They are in drainageways and on low concave and slightly convex areas. The surface layer is black silty clay loam about 19 inches thick. The subsoil is very dark gray silty clay in the upper part and mottled olive-gray and pale-olive silty clay in the lower part.

Less extensive in this association are the well-drained Lester soils, the somewhat poorly drained Shorewood soils, the poorly drained Webster and Canisteo soils, and the very poorly drained Okoboji soils. Lester soils occupy about the same position on the landscape as Kilkenny soils. Shorewood soils are nearly level and very gently undulating, and Okoboji soils are in depressions. Webster and Canisteo soils occupy about the same position on the landscape as Minnetonka soils. A few very poorly drained areas of Houghton and Palms soils and Marsh are in depressions.

The nearly level and gently undulating areas are well suited to row crops if properly drained and if water erosion is controlled. Okoboji soils are well suited and Houghton and Palms soils are moderately suited to row crops. Drained depressions are susceptible to wetness and ponding after heavy rains and spring thaws. The more sloping soils range from moderately suited to not suited to row crops.

The available water capacity is high on all but a few of the less extensive soils. Most of the poorly drained soils and many depressions have been drained. Parts of the somewhat poorly drained soils have been drained. Contouring and terracing are complicated by the irregular topography. Controlling water erosion and improving soil drainage are the major management concerns in this association.

Much of this association is in crops. Few areas are timbered and some are in permanent pasture. Marsh provides good wildlife habitat. Sloping areas are generally well suited to farm ponds.

8. *Clarion-Webster association*

Nearly level to gently sloping, well-drained to poorly drained soils that formed in glacial till and glacial sediment; dominantly long slopes on uplands

This association is characterized by long slopes, slightly rounded hills, and a well-developed drainage network. There are no depressions. Typical areas of this association are along Highway 9 about 3 miles west of Highway 65.

This association (fig. 9) makes up about 4 percent of Worth County. It is about 45 percent Clarion soils, 22 percent Webster soils, and 33 percent less extensive soils.

Clarion soils are gently sloping. They are on the higher areas and are well drained. Slopes are long and uniform. The surface layer is black and very dark

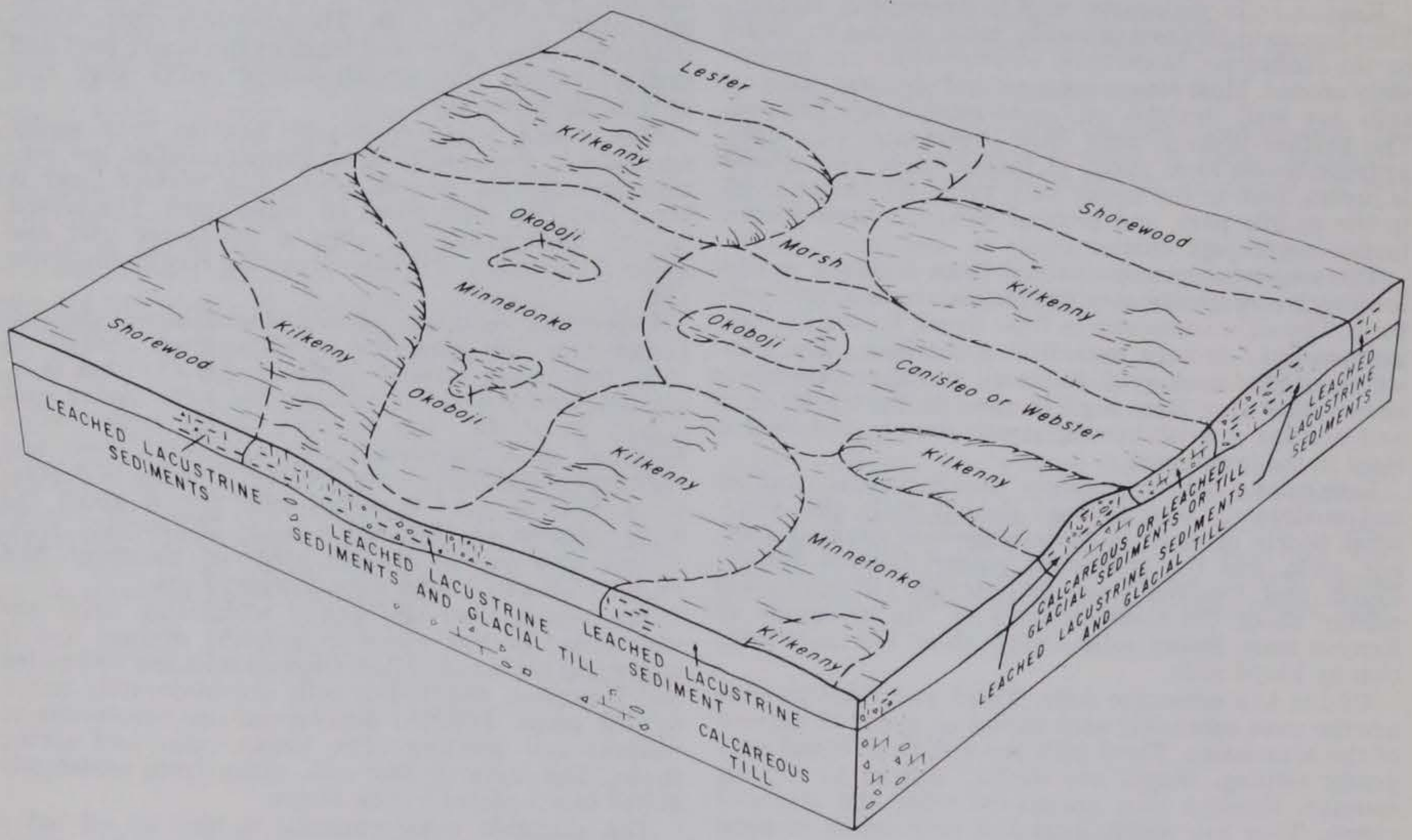


***Figure 8.*—Pattern of soils and parent material in the Kilkenny-Minnetonka association.**

brown loam 13 inches thick. The subsoil is dark yellowish-brown loam.

Webster soils are nearly level. They are in low areas and in some drainageways. They are poorly drained. The surface layer is black silty clay loam and clay loam about 19 inches thick. The subsoil is dark-gray loam in the upper part and olive gray in the lower part.

Less extensive in this association are the somewhat poorly drained Nicollet soils and the poorly drained Canisteo, Harcot, Harps, Marshan, and Talcot soils. These soils are nearly level to very gently sloping. Nicollet soils make up about 15 percent of the association. They are nearly level to very gently sloping. Slopes are long and uniform. The surface layer is black and very dark grayish-brown loam about 19 inches thick. The subsoil is mottled dark grayish brown and light olive brown.

These soils are well suited to row crops. Available water capacity is high throughout. Most of the poorly drained soils, except for some Harcot and Talcot soils, have been tile drained. Clarion soils and the more sloping Nicollet soils need control of water erosion to prevent excessive soil loss.

All but a very small part of the association is used for row crops. It is well suited to contouring and terracing. It is well suited to farm ponds, but only a few good sites are available.

Descriptions of the Soils

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

Each soil series is described in general and includes a detailed description of a profile typical of the series and a brief statement of the range in characteristics of the soils in the series, as mapped in this county. Following this, each mapping unit in the series is described individually. Color names and color symbols given are for a moist soil, unless otherwise indicated. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs. Not all mapping units, however, are members of a soil series. Mixed Alluvial land, channeled, for instance, does not belong to a soil series, but it

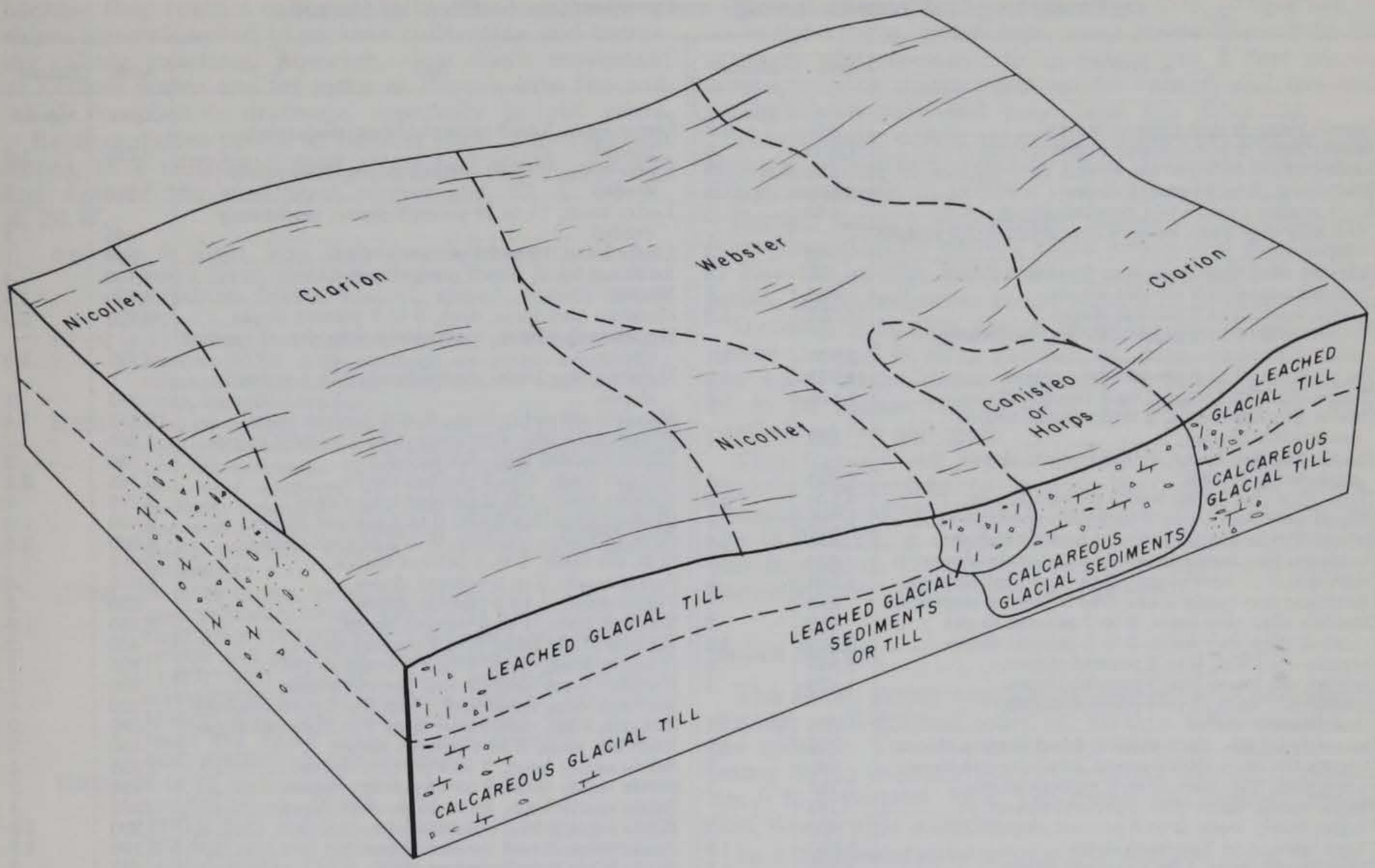


***Figure 9.*—Pattern of soils and parent material in the Clarion-Webster association.**

is nevertheless listed in alphabetic order along with the soil series.

Following the name of each unit is a number in parentheses. This number identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and the woodland group to which the mapping unit has been assigned. The pages on which each of these groups is described can be found by referring to the "Guide to Mapping Units."

Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*12*).[1]

Descriptions, names, and delineations of soils in this soil survey do not fully agree with soil maps in adjacent counties published at a different date. Differences are the result of the extent of soils within the survey. In some places it is more feasible to combine small acreages of similar soils that respond to use and management in much the same way than it is to separate these soils and give them names.

[1] Numbers in parentheses refer to Literature Cited, p. 118.

Bassett Series

The Bassett series consists of nearly level and gently sloping, well drained and moderately drained soils in the uplands. These soils formed in 13 to 20 inches of loamy material and the underlying glacial till. Slopes are 0 to 5 percent. The native vegetation was trees and grasses.

In a representative profile the surface layer is very dark grayish-brown loam about 8inches thick. The subsoil extends to a depth of 52 inches. It is dark yellowish-brown loam in the upper part, yellowish-brown loam that has a few grayish-brown mottles in the middle part, and yellowish-brown loam in the lower part. The substratum is yellowish-brown loam. A few pebbles are in the middle and lower parts of the subsoil and in the substratum.

Bassett soils have high available water capacity. Permability is moderate in the loamy upper part of the soil and moderately slow in the underlying glacial till, which causes seepy spots in some years. The subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Bassett soils are used mainly for crops. Providing both erosion control and adequate drainage is difficult

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

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Bassett loam, 0 to 2 percent slopes	390	0.2	Lester loam, 5 to 9 percent slopes, moderately eroded	3,215	1.3
Bassett loam, 2 to 5 percent slopes	1,650	.6	Lester loam, 9 to 14 percent slopes, moderately eroded	860	.3
Bolan loam, 0 to 2 percent slopes	755	.3	Lester loam, 14 to 18 percent slopes, moderately eroded	465	.2
Bolan loam, 2 to 5 percent slopes	2,005	.8	Lester loam, 18 to 25 percent slopes	260	.1
Boots mucky peat, 0 to 1 percent slopes	170	.1	Le Sueur loam, 1 to 3 percent slopes	1,100	.4
Calco silty clay loam, loamy substratum, 0 to 2 percent slopes	760	.3	Marsh	4,830	1.9
Canisteo silty clay loam, 0 to 2 percent slopes	4,790	1.9	Marshan clay loam, deep, 0 to 2 percent slopes	9,935	3.9
Clarion loam, 0 to 2 percent slopes	405	.2	Marshan clay loam, moderately deep, 0 to 2 percent slopes	2,525	1.0
Clarion loam, 2 to 5 percent slopes	13,655	5.3	Marshan clay loam, depressional, 0 to 1 percent slopes	355	.1
Clarion loam, 5 to 9 percent slopes, moderately eroded	2,930	1.1	Maxfield silty clay loam, 0 to 2 percent slopes	18,555	7.4
Clarion loam, 2 to 5 percent long slopes	4,705	1.8	Minnetonka silty clay loam, 1 to 3 percent slopes	1,855	.7
Clarion-Nicollet loams, 1 to 3 percent slopes	1,570	.6	Mixed alluvial land, channeled	550	.2
Clarion-Storden loams, 2 to 5 percent slopes, moderately eroded	220	.1	Nicollet loam, 1 to 3 percent slopes	9,345	3.6
Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded	1,030	.4	Nicollet loam, 1 to 3 percent long slopes	2,275	.9
Clyde silty clay loam, 0 to 2 percent slopes	8,140	3.2	Okoboji silty clay loam, 0 to 1 percent slopes	2,490	1.0
Coland silty clay loam, 0 to 2 percent slopes	1,725	.7	Okoboji-Harps complex, 0 to 3 percent slopes	6,800	2.6
Coland-Turlin complex, 0 to 2 percent slopes	945	.4	Oran silt loam, 1 to 3 percent slopes	3,675	1.4
Dickinson fine sandy loam, 0 to 2 percent slopes	470	.2	Palms muck, 0 to 1 percent slopes	2,040	.8
Dickinson fine sandy loam, 2 to 5 percent slopes	1,280	.5	Palms muck, 1 to 4 percent slopes	820	.3
Dickinson fine sandy loam, 5 to 9 percent slopes	215	.1	Readlyn loam, 1 to 3 percent slopes	3,355	1.3
Dinsdale silty clay loam, 0 to 2 percent slopes	610	.2	Richwood silt loam, 0 to 2 percent slopes	430	.2
Dinsdale silty clay loam, 2 to 5 percent slopes	3,515	1.4	Rockton loam, deep, 0 to 2 percent slopes	325	.1
Donnan silt loam, 0 to 2 percent slopes	1,455	.6	Rockton loam, deep, 2 to 5 percent slopes	250	.1
Donnan silt loam, 2 to 5 percent slopes	1,170	.4	Rockton loam, moderately deep, 0 to 2 percent slopes	950	.4
Donnan silt loam, 5 to 9 percent slopes, moderately eroded	200	.1	Rockton loam, moderately deep, 2 to 5 percent slopes	580	.2
Donnan silt loam, dark variant, 0 to 2 percent slopes	160	.1	Rolfe silt loam, 0 to 1 percent slopes	450	.2
Donnan silt loam, dark variant, 2 to 5 percent slopes	465	.2	Salida sandy loam, 2 to 9 percent slopes	1,335	.5
Faxon silty clay loam, 0 to 2 percent slopes	1,155	.4	Salida sandy loam, 9 to 14 percent slopes	495	.2
Flagler sandy loam, 0 to 2 percent slopes	115	(1)	Salida sandy loam, 14 to 30 percent slopes	265	.1
Flagler sandy loam, 2 to 5 percent slopes	400	.2	Saude loam, 0 to 2 percent slopes	7,290	2.8
Floyd loam, 1 to 3 percent slopes	3,395	1.3	Saude loam, 2 to 5 percent slopes	3,190	1.2
Franklin silt loam, 1 to 3 percent slopes	4,525	1.8	Saude loam, 5 to 9 percent slopes	495	.2
Harcot loam, 0 to 2 percent slopes	4,680	1.8	Schley silt loam, 1 to 3 percent slopes	840	.3
Harps loam, 1 to 3 percent slopes	4,235	1.7	Shorewood silty clay loam, 1 to 3 percent slopes	1,140	.4
Hayfield loam, deep, 0 to 2 percent slopes	960	.4	Sparta loamy fine sand, 2 to 5 percent slopes	325	.1
Hayfield loam, moderately deep, 0 to 2 percent slopes	1,065	.4	Sparta loamy fine sand, 5 to 9 percent slopes	315	.1
Hoopeston fine sandy loam, 0 to 2 percent slopes	305	.1	Storden loam, 5 to 14 percent slopes, severely eroded	530	.2
Houghton muck, 0 to 1 percent slopes	3,160	1.2	Storden loam, 14 to 18 percent slopes, severely eroded	200	.1
Kensett silt loam, 0 to 2 percent slopes	1,045	.4	Talcot clay loam, deep, 0 to 2 percent slopes	5,230	2.0
Kenyon loam, 0 to 2 percent slopes	595	.2	Talcot clay loam, moderately deep, 0 to 2 percent slopes	930	.4
Kenyon loam, 2 to 5 percent slopes	2,820	1.1	Terril loam, 2 to 5 percent slopes	770	.3
Kenyon loam, 5 to 9 percent slopes, moderately eroded	455	.2	Tilfer silty clay loam, 0 to 2 percent slopes	1,030	.4
Kilkenny silty clay loam, 2 to 5 percent slopes	2,995	1.2	Wacousta silt loam, benches, 0 to 2 percent slopes	655	.3
Kilkenny silty clay loam, 2 to 5 percent slopes, moderately eroded	530	.2	Wapsie loam, 0 to 2 percent slopes	950	.4
Kilkenny silty clay loam, 5 to 9 percent slopes, moderately eroded	1,815	.7	Wapsie loam, 2 to 5 percent slopes	3,565	1.4
Kilkenny silty clay loam, 9 to 14 percent slopes, moderately eroded	515	.2	Wapsie loam, 5 to 9 percent slopes, moderately eroded	490	.2
Klinger silty clay loam, 1 to 3 percent slopes	13,340	5.2	Waukee loam, 0 to 2 percent slopes	3,350	1.3
Lawler loam, deep, 0 to 2 percent slopes	4,910	1.9	Waukee loam, 2 to 5 percent slopes	590	.2
Lawler loam, moderately deep, 0 to 2 percent slopes	3,255	1.3	Webster silty clay loam, 0 to 2 percent slopes	14,074	5.6
Lester loam, 2 to 5 percent slopes	7,955	3.1	Webster-Nicollet complex, 1 to 3 percent slopes	7,065	2.8
Lester loam, 2 to 5 percent slopes, moderately eroded	1,095	.4	Lakes and ponds	820	.3
Lester loam, 5 to 9 percent slopes	785	.3	Gravel pits	265	.1
			Rock quarries	80	(1)
			Total	256,064	100.0

[1] Less than 0.05 percent.

because they conflict to some extent. The long, uniform slopes are well suited to contour cultivation and terracing. These practices, however, slow down movement of surface water and let more of it soak into the soil, which complicates drainage, especially in wet years.

Representative profile of Bassett loam, 2 to 5 percent slopes, in a cultivated field 1,360 feet north and 235 feet east of the southwest corner sec. 13, T. 98 N., R. 20 W.

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) heavy loam; cloddy parting to weak, fine, granular structure; friable; neutral; abrupt, smooth boundary.

B1—8 to 17 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; weak, fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

IIB21—17 to 28 inches, yellowish-brown (10YR 5/6) loam; dark yellowish-brown (10YR 4/4) coatings on peds; few discontinuous light-gray (10YR 7/2 dry) silt and sand coatings on prisms and peds; weak, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; friable; few small pebbles; medium acid; gradual, smooth boundary.

IIB22t—28 to 38 inches, yellowish-brown (10YR 5/6) loam; dark yellowish-brown (10YR 4/4) coatings on peds; light-gray (10YR 7/2 dry) silt and sand coatings on prisms and peds; few, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; firm; few, thin, patchy clay films on ped faces and lining pores of root channels; medium acid; gradual, smooth boundary.

IIB3t—38 to 52 inches, yellowish-brown (10YR 5/6) loam; grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/4) coatings on prisms; light-gray (10YR 7/2 dry) silt and sand coatings on prisms; few dark reddish-brown (5YR 2/2) and brown (10YR 4/3) clay films lining pores and root channels; weak, medium, prismatic structure; firm; few small pebbles; strongly acid; gradual, smooth boundary.

IIC—52 to 66 inches, yellowish-brown (10YR 5/6) loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; common dark reddish-brown (5YR 2/2) and few strong-brown (7.5YR 5/8) oxide concretions; massive; firm; few small pebbles; slightly acid.

The depth to carbonates ranges from 48 to 72 inches.

The Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically loam but in places is silt loam high in sand. It is 7 to 9 inches thick and is neutral or medium acid in reaction.

The A2 horizon, where present, is brown (10YR 4/3) or dark grayish brown (10YR 4/2). It is typically loam but in places is silt loam high in sand. It is 0 to 6 inches thick and is slightly acid or strongly acid in reaction.

The B1 horizon is typically brown (10YR 4/3) or dark yellowish-brown (10YR 4/4) loam 2 to 10 inches thick. It is slightly acid or strongly acid in reaction.

The IIB horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6) and has a few grayish mottles below a depth of 20 to 36 inches. It is typically loam but in places is light clay loam and sandy clay loam. It is 20 to 40 inches thick and is medium acid or strongly acid in reaction. The IIC horizon ranges from yellowish brown (10YR 5/6) with a few grayish mottles to mottled grayish brown (2.5YR 5/2) and strong brown (7.5YR 5/6). It ranges from loam to light clay loam and sandy clay loam. In some places there are lenses and pockets of sandy material. The IIC horizon is slightly acid or mildly alkaline in reaction.

Bassett soils formed in parent material similar to that of of Oran and Kenyon soils. They have higher chroma in the upper part of the B horizon than Oran soils. They have a thinner dark-colored A horizon than Kenyon soils.

Bassett loam, 0 to 2 percent slopes (171).—This soil is on broad ridges. Individual areas range from 2 to 20 acres in size. Included in mapping are a few places where grayish mottles are in the subsoil and the soil is slightly wetter and may need tile drainage.

This Bassett soil is moderate in organic-matter content and is well suited to row crops. Wetness sometimes delays fieldwork. Capability unit I-1; woodland group 2.

Bassett loam, 2 to 5 percent slopes (171B).—This soil is on long, slightly convex ridge crests and side slopes. It has the profile described as representative of the series. Individual areas range from 2 to 30 acres in size.

Included with this soil in mapping are a few places where the soil is more permeable. Also included are a few spots where dense gray clay is below a depth of 20 to 36 inches. These spots are indicated by spot symbols on the soil map.

This Bassett soil is well suited to row crops. It is slightly susceptible to erosion in cultivated areas. Because providing adequate erosion control and drainage is difficult, a combination of terracing and tiling may be needed. The organic-matter content is moderate. Capability unit IIe-1; woodland group 2.

Bolan Series

The Bolan series consists of nearly level and gently sloping, well-drained soils on stream benches and in the uplands. These soils formed in 24 to 45 inches of loamy eolian deposits overlying loamy fine sand. Slopes are 0 to 5 percent. Most are short. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loam about 14 inches thick. The subsoil extends to a depth of 37 inches. It is brown loam in the upper part, dark yellowish-brown loam in the middle part, and dark yellowish-brown fine sandy loam in the lower part. The substratum is loamy fine sand and sand in shades of yellowish brown and brown.

Bolan soils have moderate available water capacity, moderate permeability in the loamy upper part, and rapid permeability in the sandy lower part. Their subsoil is low in available phosphorus and very low in available potassium. They are generally acid unless limed during the past 5 years.

These soils are used mainly for row crops. They are subject to slight erosion in sloping areas and are slightly droughty during extended dry periods.

Representative profile of Bolan loam, 2 to 5 percent slopes, in a cultivated field 1,120 feet west and 215 feet north of the southeast corner SW¼ sec. 7, T. 98 N., R. 19 W.

Ap—0 to 9 inches, very dark brown (10YR 2/2) light loam; black (10YR 2/1) coatings on peds; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A12—9 to 14 inches, very dark grayish-brown (10YR 3/2) loam; weak, fine, very granular structure; friable; neutral; gradual, smooth boundary.

B1—14 to 19 inches, brown (10YR 4/3) loam; dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

B2—19 to 27 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium, subangular blocky structure; friable; medium acid; gradual, smooth boundary.
B3—27 to 37 inches, dark yellowish-brown (10YR 4/4) fine sandy loam; weak, medium, subangular blocky structure; very friable; medium acid; gradual, smooth boundary.
IIC1—37 to 55 inches, dark yellowish-brown (10YR 4/4) loamy fine sand; massive; very friable; medium acid; gradual, smooth boundary.
IIC1—37 to 55 inches, dark yellowish-brown (10YR 4/4) loamy fine sand; massive; very friable; medium acid; gradual, smooth boundary.
IIC2—55 to 72 inches, brown (10YR 5/3) loamy fine sand; massive; very friable; slightly acid; gradual, smooth boundary.
IIC3—72 to 102 inches, pale-brown (10YR 6/3) medium sand; single grained; loose; slightly acid; gradual boundary.
IIC4—102 to 112 inches, yellowish-brown (10YR 5/4) loamy fine sand; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; loose; slightly acid.

The depth to sandy material ranges from 24 to 45 inches. The depth to carbonates is greater than 60 inches.

The A horizon is typically black (10YR 2/1) or very dark brown (10YR 2/2), but in places is very dark grayish brown (10YR 3/2). It is loam or silt loam 10 to 20 inches thick and is neutral or medium acid in reaction.

The B1 and B2 horizons range from dark brown (10YR 3/3) or brown (10YR 4/3) in the B1 horizon to dark yellowish brown (10YR 4/4) in the B2 horizon. They are medium loam or light loam and, combined, are 8 to 21 inches thick. They are slightly acid or medium acid.

The B3 horizon ranges from yellowish brown (10YR 5/6) to dark yellowish brown (10YR 4/4). It is typically fine sandy loam, but in places is loamy fine sand. It is 6 to 13 inches thick and is slightly acid or medium acid.

The C horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). It is typically loamy fine sand, but in places is fine and medium sand. It is slightly acid or medium acid.

Bolan soils formed in parent material somewhat similar to that of Dickinson and Saude soils. They have less sand and more clay in the solum than Dickinson soils. In contrast with Saude soils, they have finer sand and no gravel in the C horizon.

Bolan loam, 0 to 2 percent slopes (174).—This soil is on stream benches and very low mounds or dunes in the uplands. Individual areas range from 2 to 15 acres in size.

Included with this soil in mapping are small areas of a sandy soil, which are indicated by a spot symbol on the soil map, and a number of areas in Deer Creek and Barton Townships where the surface layer is thinner.

This Bolan soil is high in organic-matter content and is well suited to row crops. It is susceptible to soil blowing in cultivated areas in spring. It is slightly droughty during extended dry periods. Capability unit IIs-1; woodland group 3.

Bolan loam, 2 to 5 percent slopes (174B).—This soil is on mounds or dunes in the uplands, on short, convex ridge crests, and on the sides of stream benches. It has the profile described as representative of the series. Individual areas range from 2 to 30 acres in size.

Included with this soil in mapping are small areas of sandy soils, which are indicated by spot symbols on the soil map, and a number of areas in Deer Creek and Barton Townships where the surface layer is thinner.

This Bolan soil is high in organic-matter content and is well suited to row crops. It is slightly susceptible to water erosion and soil blowing in cultivated areas. It is slightly droughty during extended dry periods. Capability unit IIe–3; woodland group 3.

Boots Series

The Boots series consists of level, very poorly drained organic soils in low lying depressions in the uplands. These soils formed in 51 to 120 inches or more of organic sediment. Slopes are 0 to 1 percent. The native vegetation was water-tolerant grasses and sedges.

In a representative profile the surface layer is black mucky peat about 9 inches thick. The next layer, which extends to a depth of 38 inches, is brown peat. Below this is very brown and black mucky peat.

Boots soils have very high available water capacity and moderately rapid permeability. They are very low in available phosphorus and potassium. They are neutral or slightly acid and seldom need liming.

These soils are used mainly for row crops if they are properly tile drained. Most undrained areas are idle, but some are pastured. The major limitation for crops or pasture is wetness. There is danger of early frost. In undrained areas the water table is generally at or near the surface. Boots soil material is used in greenhouses and other places that have use for organic soil material.

Representative profile of Boots mucky peat, 0 to 1 percent slopes, in a cultivated field 130 feet south and 60 feet east of the northwest corner sec. 19, T. 99 N., R. 22 W.

Oap—0 to 9 inches, black (5Y 2/1 broken face and rubbed) sapric material; 25 percent fiber, 8 percent rubbed; weak, fine, granular structure; very friable; neutral; clear, smooth boundary.
Oe1—9 to 38 inches, brown (7.5YR 4/3 broken) hemic material; very dark brown (10YR 2/2) on some horizontal cleavage faces; very dark grayish brown (10YR 3/2) rubbed; 65 percent fibers, 45 percent rubbed; massive; very friable; neutral; gradual, smooth boundary.
Oa2—38 to 63 inches, very dark brown (10YR 2/2 broken and rubbed) sapric material; plant fragments are coarser than in the Oe1 horizon; 30 percent fibers, 12 percent rubbed; massive; very friable; neutral; clear, smooth boundary.
Oa3—63 to 70 inches, black (10YR 2/1 rubbed) sapric material; 8 percent fibers, 1 percent rubbed; massive; very friable; neutral.

The Oap horizon ranges from very dark brown (10YR 2/2) to black (5YR 2/1). It is peat (hemic material) to muck (sapric material) 6 to 10 inches thick and is neutral or slightly acid in reaction.

The Oe1 horizon is brown (7.5YR 4/4) and has a few black (10YR 2/1) or very dark brown (10YR 2/2) horizontal cleavage faces. It is typically peat (hemic material) 24 to 40 inches thick and is neutral or slightly acid reaction.

The Oa2 horizon ranges from very dark brown (10YR 2/2) to dark brown (7.5YR 3/2) and contains a few darker colors. It is peaty muck or muck (hemic or sapric material) 0 to 30 inches thick and is neutral or slightly acid in reaction.

The Oa3 horizon ranges from black (N 2/0) to light olive gray (5Y 6/2). It typically ranges from muck (sapric material) to silt loam, but in places is silty clay loam to sand. It is generally stratified and is neutral or mildly alkaline in reaction.

Boots soils formed in parent material similar to that of Houghton and Palms soils. They contain organic matter that is not so well decomposed as in the Houghton and Palms soils.

Boots mucky peat, 0 to 1 percent slopes (321).—This soil is in depressions. Individual areas are generally circular and range from 3 to 40 acres in size. They are generally in large depressions near or adjacent to Houghton and Palms soils and areas of Marsh. Some are bordered by Harps soils. Undrained areas are hummocky unless they have been leveled.

This Boots soil is moderately suited to row crops if it is properly tile drained. Even if drained, however, it is susceptible to wetness and ponding after heavy rains and during spring thaw. Tile drainage is difficult to maintain because the tile is likely to settle. Undrained areas are poorly suited to pasture. There is danger of early frost in the fall. The thickness of the organic material ranges from 51 to more than 120 inches. Capability unit IIIw-2; woodland group 14.

Calco Series

The Calco series consists of nearly level, poorly drained, calcareous soils on the flood plains of rivers and streams. These soils formed in medium-textured and moderately fine textured alluvial sediment. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black light silty clay loam about 38 inches thick. The subsoil extends to a depth of 47 inches and is mottled gray and light olive-gray light clay loam. The substratum is light olive-gray sandy loam that has light olive-brown mottles.

Calco soils have moderately slow permeability and high available water capacity. The subsoil is very low in available phosphorus and potassium. These soils are mildly alkaline and do not need liming.

Calco soils are used chiefly for pasture. Areas that have been tile drained are used for row crops. The major limitations for row crops are wetness and some flooding.

Representative profile of Calco silty clay loam, loamy substratum, 0 to 2 percent slopes, in a pasture 220 feet west and 135 feet north of the southeast corner SW¼ sec. 27, T. 98 N., 21 W.

All—0 to 16 inches, black (10YR 2/1) light silty clay loam; weak, fine, granular structure; friable; slight effervescence; mildly alkaline; gradual, smooth boundary.

A12—16 to 38 inches, black (N 2/0) light silty clay loam; weak, fine, subangular blocky structure; friable; slight effervescence; mildly alkaline; clear, smooth boundary.

Bg—38 to 47 inches, mottled gray (5Y 5/1) and light olive-gray (5Y 6/2) light clay loam; weak, fine, subangular blocky structure; friable; slight effervescence; mildly alkaline; clear, smooth boundary.

IICg—47 to 60 inches, light olive-gray (5Y 6/2) sandy loam; common, medium, distinct, light olive-brown (2.5Y 5/4) mottles; few small pebbles; slight effervescence; mildly alkaline.

The A horizon is black (10YR 2/1 or N 2/0) in the upper part and black or very dark gray (10YR 3/1) in the lower part. It is light silty clay loam or silt loam 30 to 40 inches thick.

The B horizon ranges from very dark gray (10YR 3/1) to light gray (5Y 6/1) and has few to many mottles. It is light silty clay loam or clay loam 0 to 10 inches thick.

The C, or IIC, horizon ranges from dark gray (10YR 4/1) to light olive gray (5Y 6/2) and has few to many high-chroma mottles. It ranges from sandy loam to light clay loam.

Calco soils are in the same drainage class as Coland soils. They are mildly alkaline in the solum, whereas Coland soils are neutral or slightly acid.

Calco silty clay loam, loamy substratum, 0 to 2 percent slopes (733).—This soil is on the flood plains. A permanent or intermittent stream runs through most areas. Individual areas range from 3 to 40 acres in size. Included with this soil in mapping are small sandy areas and mucky areas, which are indicated by spot symbols on the soil map.

This Calco soil is high in organic-matter content and is well suited to row crops if adequately drained. It is susceptible to flooding, and in some places it has a high water table. Wetness often delays plowing in spring. Undrained areas are well suited to pasture. Capability unit IIw-5; woodland group 13.

Canisteo Series

The Canisteo series consists of nearly level, poorly drained, strongly calcareous soils in the uplands. In some areas these soils border depressions and occupy waterways. They formed in glacial sediment. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam and clay loam about 19 inches thick. The subsoil, which extends to a depth of 31 inches, is olive-gray loam that has olive-brown mottles in the upper part and light olive-gray loam that has strong-brown mottles in the lower part. The substratum is light olive-gray loam that has yellowish-brown mottles.

Canisteo soils have moderate permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are mildly alkaline and do not need liming.

Canisteo soils are used chiefly for row crops. Wetness is the major limitation.

Representative profile of Canisteo silty clay loam, 0 to 2 percent slopes, in a cultivated field 103 feet south and 59 feet west of the corner post near the northeast corner sec. 5, T. 99 N., R. 21 W.

Ap—0 to 8 inches, black (N 2/0) silty clay loam high in sand; cloddy parting to weak, medium, subangular blocky structure; slight effervescence; mildly alkaline; friable; clear, smooth boundary.

A12—8 to 15 inches, black (10YR 2/1) clay loam; weak, medium, subangular blocky structure; slight effervescence; mildly alkaline; clear, wavy boundary.

A3g—15 to 19 inches, very dark gray (10YR 3/1) light clay loam; very few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; slight effervescence; mildly alkaline; clear, wavy boundary.

B2g—19 to 25 inches, olive-gray (5Y 5/2) heavy loam; common, fine, distinct, olive-brown (2.5Y 4/4) mottles; weak, medium, subangular blocky structure; friable; few small olive-brown (2.5Y 4/4) oxide concretions; few small lime concretions; few small pebbles; slight effervescence; mildly alkaline; clear, smooth boundary.

B3g—25 to 31 inches, light olive-gray (5Y 6/2) light loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; strong effervescence; mildly alkaline; few small pebbles; gradual, smooth boundary.

Cg—31 to 60 inches, light olive-gray (5Y 6/2) loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; massive; friable; few red oxides; few small pebbles; violent effervescence; mildly alkaline.

The A horizon is black (N 2/0 or 10YR 2/1) in the A1 horizon and very dark gray (10YR 3/1) with a few distinct mottles in the A3g horizon. It is silty clay loam or clay loam 16 to 24 inches thick.

The B2g horizon ranges from gray (5Y 5/1) to mottled light olive gray (5Y 6/2), olive gray (5Y 5/2), and olive brown (2.5Y 4/4). It is loam or clay loam 5 to 15 inches thick.

The B3g horizon has colors similar to those of the B2g horizon. It ranges from sandy loam to loam and light clay loam and sandy clay loam and is 0 to 10 inches thick.

The Cg horizon ranges from gray (5Y 5/1) to light olive gray (5Y 6/2) and has few to many yellowish-brown (10YR 5/6) or light olive-brown (2.5Y 5/6) mottles. It ranges from sandy loam to loam and light clay loam and sandy clay loam.

Canisteo soils formed in material similar to that of Clyde, Webster, and Harps soils. They are mildly alkaline in the solum, in contrast to the neutral solum of Clyde and Webster soils and the moderately alkaline solum of Harps soils. They are in the same drainage class as Talcot soils but have a loamy C horizon, whereas those soils are underlain by sand or gravel.

Canisteo silty clay loam, 0 to 2 percent slopes (507).—This soil is in waterways and in some places borders depressions. Individual areas are irregular in shape and range from 2 to 40 acres in size.

Included with this soil in mapping are small depressions, which are indicated by spot symbols on the soil map, and small humps of well-drained soils, which also are indicated by spot symbols. Also included are a few areas of Harps and Webster soils.

This Canisteo soil is high in organic-matter content and is well suited to row crops if it is properly drained. It is susceptible to wetness during rainy seasons. Most of it has been tile drained. Undrained areas are well suited to pasture. Capability unit IIw-1; woodland group 13.

Clarion Series

The Clarion series consists of well-drained, nearly level, gently sloping or gently undulating and gently rolling soils in the uplands. Slopes are 0 to 9 percent. They are dominantly long in the south-central part of the county and are short elsewhere. These soils formed in glacial till that typically has a slight increase in sand content below a depth of about 12 to 25 inches. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown loam about 13 inches thick. The subsoil is dark yellowish-brown loam that extends to a depth of 39 inches. The substratum is yellowish-brown loam that has common light-gray mottles below a depth of about 53 inches.

Clarion soils have moderate permeability and high available water capacity. The subsoil is very low in available phosphorus and potassium. The soils are generally slightly acid unless limed during the past 5 years.

These soils are used mainly for row crops. They are subject to erosion in the gently undulating and gently rolling areas.

Representative profile of Clarion loam, 2 to 5 percent slopes, in a cultivated field 600 feet east and 60 feet north of the southeast corner SE¼ sec. 30, T. 99 N., R. 22 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; black (10YR 2/1) coatings on peds; neutral; clear, smooth boundary.

A12—8 to 13 inches, very dark brown (10YR 2/2) heavy loam; weak, fine and very fine, granular structure; friable; nearly continuous black (10YR 2/1) coatings on peds; few brown (10YR 4/3) mixings; slightly acid; clear, wavy boundary.

B1—13 to 17 inches, brown (10YR 4/3) loam; weak, fine, subangular blocky structure; friable; common very dark brown (10YR 2/2) worm casts and mixings; discontinuous dark-brown and very dark grayish-brown (10YR 3/2) coatings on peds; slightly acid; clear, wavy boundary.

B21—17 to 21 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, fine, prismatic structure parting to weak, medium, subangular blocky; discontinuous, dark yellowish-brown (10YR 3/4) coatings on prisms and peds; very few small pebbles; slightly acid; clear, wavy boundary.

B22—21 to 33 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; patchy, dark yellowish-brown (10YR 3/4) coatings on prisms and peds; very few small pebbles; slightly acid; gradual, smooth boundary.

B3—33 to 39 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium, prismatic structure; friable; few patchy, dark yellowish-brown (10YR 3/4) coatings on prisms; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; neutral; clear, wavy boundary.

C1—39 to 53 inches, yellowish-brown (10YR 5/4) loam; massive; friable; few soft, white (10YR 8/2) lime concretions; some evidence of horizontal stratification; very few small, red (2.5YR 4/8) oxide concretions; strong effervescence; mildly alkaline; gradual, smooth boundary.

C2—53 to 64 inches, yellowish-brown (10YR 5/4) loam; common, medium, prominent, light-gray (10YR 6/1) mottles; massive; friable; few pebbles; thin horizontal stratification; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 25 to 45 inches.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically loam but in places is silt loam high in sand. It is 10 to 17 inches thick and neutral or slightly acid in reaction.

The B1 horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) and has few to many darker coatings. It is typically loam but in places is silt loam high in sand. It is 2 to 8 inches thick.

The B2 horizon is dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4). It is typically loam but in places is light clay loam. It is 10 to 30 inches thick and is neutral or slightly acid in reaction.

The C horizon is typically yellowish brown (10YR 5/4), but ranges from brown (10YR 5/3) to light yellowish brown (2.5Y 6/4). It is typically loam but in places is light clay loam. Pockets of sandy material are in some places. Few to common grayish mottles are below a depth of 45 to 60 inches.

Clarion soils formed in parent material similar to that of Lester, Nicollet, and Storden soils. They typically have higher chroma in the B horizon than Nicollet soils. They have a thicker dark-colored A horizon than Lester and Storden soils and are deeper over carbonates than Storden soils.

Clarion loam, 0 to 2 percent slopes (138).—This soil is in high areas and in low, somewhat benchlike positions. Individual areas range from 2 to 8 acres in size, but most are less than 4 acres.

This Clarion soil is high in organic-matter content

and is well suited to row crops. Capability unit I–1; woodland group 2.

Clarion loam, 2 to 5 percent slopes (138B).—This soil is gently undulating. Slopes are short and irregular. Individual areas are irregular in shape and generally range from 2 to 6 acres in size. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Lester and Nicollet soils. Also included in some places are wet spots and depressions and sandy and gravelly spots, all of which are indicated by spot symbols on the soil map.

This Clarion soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight erosion if cultivated. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIe–1; woodland group 2.

Clarion loam, 5 to 9 percent slopes, moderately eroded (138C2).—This soil is gently rolling. Slopes are short and irregular. Individual areas are irregular in shape and generally range from 2 to about 6 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 10 inches thick and is not so dark colored. This soil is also shallower over carbonates.

Included with this soil in mapping are small areas of less eroded Clarion soils that have a darker colored surface layer and some severely eroded Clarion soils that have a light-colored surface layer. Also included are some small gravelly or sandy areas, which are indicated by spot symbols on the soil map, and a few small areas of Storden and Lester soils.

This Clarion soil is moderate in organic-matter content and is well suited to row crops. It is susceptible to severe erosion if cultivated or pastured intensively. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIIe–1; woodland group 2.

Clarion loam, 2 to 5 percent long slopes (169B).—This soil has long, uniform slopes. Individual areas are regular and irregular in shape and range from 50 to more than 100 acres in size. This soil has a profile similar to the one described as representative of the series, but is not so deep over carbonates.

Included with this soil in mapping are a few nearly level areas on ridge crests and a few places where the surface layer is not quite so thick and dark.

This Clarion soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight erosion if cultivated. It is easy to contour and terrace because slopes are long and uniform. Capability unit IIe–1; woodland group 2.

Clarion-Nicollet loams, 1 to 3 percent slopes (29).—This mapping unit is generally about 60 percent Clarion soil and 40 percent Nicollet soil. Slopes are short and are convex and slightly concave. The Clarion soil is in the more sloping convex areas. Individual areas are generally 2 to about 6 acres in size.

Included with these soils in mapping are small areas of Webster soils and some wet depressions. Most of the depressions are indicated by spot symbols on the soil map. Also included are a few places that are dominantly Lester and Le Sueur soils.

These Clarion and Nicollet soils are high in organic-matter content and are well suited to row crops. They are susceptible to slight wetness in rainy seasons. The more sloping convex areas are susceptible to slight erosion if cultivated. Capability unit I–2; woodland group 6.

Clarion-Storden loams, 2 to 5 percent slopes, moderately eroded (638B2).—This mapping unit is 30 to 60 percent Clarion soil and 40 to 70 percent Storden soil. It is gently undulating and is on knobs and the tops and sides of ridges. Slopes are short and irregular. The Storden soil is in the more convex areas. Individual areas are irregular in shape and range from 3 to 20 acres in size.

Included with these soils in mapping are small areas where the soil is more sloping. Also included are sandy and gravelly spots, which are indicated by spot symbols on the soil map.

These soils are well suited to row crops. The organic-matter content is moderate in the Clarion soil and low in the Storden soil. The erosion hazard is severe in cultivated areas. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIe–1; woodland group 10.

Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded (638C2).— This mapping unit is about 30 to 70 percent Clarion soil and 30 to 70 percent Storden soil. It is gently rolling and is on knobs and the tops and sides of ridges. Slopes are short and irregular. The Storden soil is in the more convex areas. Individual areas are irregular in shape and range from 3 to 20 acres (fig. 10) in size.

Included with these soils in mapping are small sandy and gravelly spots, which are indicated by spot symbols on the soil map.

These soils are well suited to row crops. The organic-matter content is moderate in the Clarion soil and low in the Storden soil. Both soils are susceptible to severe erosion if they are cultivated or pastured intensively. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIIe–1; woodland group 10.

Clyde Series

The Clyde series consists of nearly level, poorly drained soils in the uplands where they occupy drainageways or, in some places, relatively large areas with very few drainageways. These soils formed in 30 to 50 inches of loamy material and in the underlying stratified, medium and moderately coarse textured, friable glacial sediment or glacial till. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam high in sand and about 19 inches thick. The subsoil extends to a depth of about 51 inches. The upper 6 inches is light olive-gray silty clay loam high in sand. The next 9 inches is light brownish-gray loam that has yellowish-brown

Figure 10.—**Area of Clarion-Storden loams. The light-colored Storden soils are in the background.**

mottles. The next 12 inches is mottled yellowish-brown and grayish-brown sandy loam. The lower 5 inches is mottled light brownish-gray and yellowish-brown loam. The substratum is mottled light olive-gray and strong-brown loam.

Clyde soils have moderate permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. The soils are neutral or slightly acid and seldom need lime.

Clyde soils are used mainly for row crops. Wetness is the major limitation, which in some places is the result of sidehill seep.

Representative profile of Clyde silty clay loam, 0 to 2 percent slopes, in a cultivated field 138 feet west and 85 feet north of the southeast corner SW¼ sec. 33, T. 98 N., R. 20 W.

Ap—0 to 8 inches, black (N 2/0) silty clay loam high in sand; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A12—8 to 19 inches, very dark gray (10YR 3/1) silty clay loam high in sand; common, fine, distinct, dark-gray (5Y 4/1) mottles in lower 3 inches; weak, fine, granular structure; friable; neutral; clear, smooth boundary.

B21g—19 to 25 inches, light olive-gray (5Y 6/2) light silty clay loam high in sand; few, fine, distinct, yellowish-brown (10YR 5/6) and few, fine, faint, dark-gray (5Y 4/1) mottles; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B22g—25 to 34 inches, light brownish-gray (2.5Y 6/2) light loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; few dark reddish-brown (5YR 2/2) oxides; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few small pebbles; neutral; clear, smooth boundary.

B31g—34 to 46 inches, mottled yellowish-brown (10YR 5/8) and grayish-brown (2.5Y 5/2) sandy loam; olive-gray (5Y 5/2) coatings on prisms; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; very friable; few very small pebbles; neutral; clear, smooth boundary.

IIB32g—46 to 51 inches, mottled light brownish-gray (2.5Y 6/2) and yellowish-brown (10YR 5/8) loam; few dark reddish-brown (5YR 2/2) oxides; weak, coarse, prismatic structure; friable; neutral; clear, wavy boundary.

IICg—51 to 84 inches, mottled light olive-gray (5Y 6/2) and strong-brown (7.5YR 5/6) heavy loam; massive; firm; few small pebbles; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 45 to 60 inches.

The A horizon is typically black (N 2/0) in the upper part and black (10YR 2/1) or very dark gray (10YR 3/1) with a few mottles in the lower part. It is typically silty clay loam high in sand, but ranges from silt loam to clay loam. It is 14 to 24 inches thick and is neutral or slightly acid in reaction.

The B horizon ranges from gray (10YR 5/1) to light olive gray (5Y 6/2) and typically has a few high-chroma mottles. It is silty clay loam high in sand or clay loam and is 5 to 24 inches thick.

The IIB horizon ranges from gray (5Y 5/1) with a few high-chroma mottles to strong brown (7.5YR 5/6) with common to many grayish mottles. It ranges from loam to light clay loam and is 10 to 20 inches thick.

The IIC horizon is mottled and ranges from gray (5Y 5/1) to strong brown (7.5YR 5/6). It is loam, sandy clay loam, or light clay loam and is neutral or mildly alkaline in reaction.

Clyde soils formed in parent material similar to that of Canisteo and Floyd soils. They typically have higher values and generally have lower chroma in the B horizon than Floyd soils. They have a neutral solum, whereas Canisteo soils have a mildly alkaline solum. They are in the same drainage

class as Marshan soils, but have a loam, sandy clay loam, or clay loam IIC horizon, whereas those soils are underlain by sand or gravel.

Clyde silty clay loam, 0 to 2 percent slopes (84).—This soil is in drainageways and broad areas that have very few drainageways. Individual areas range from 3 to several hundred acres in size. Some areas extend across two or three farms.

Included with this soil in mapping are small mucky areas, which are generally indicated by a spot symbol on the soil map. A few delineations are 30 to 50 percent Floyd soils.

This Clyde soil is high in organic-matter content and is well suited to row crops. It is susceptible to wetness in rainy seasons, even though most of it has been tile drained. Since wetness in some places is due to sidehill seepage, a drainage system that intercepts laterally moving water in these areas is the most successful. Most areas have been tiled. Undrained areas are well suited to pasture. Capability unit IIw–1; woodland group 13.

Coland Series

The Coland series consists of poorly drained, nearly level soils on flood plains of rivers and streams. These soils formed in moderately fine textured alluvial sediment. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black silty clay loam and clay loam about 42 inches thick. The subsoil, which extends to a depth of 46 inches, is very dark gray loam that has common grayish-brown mottles. The substratum is light olive-gray loam.

Coland soils have moderately slow permeability and high available water capacity. Their subsoil is low in available phosphorus and very low in available potassium. The soils are neutral or slightly acid and very seldom need liming.

Coland soils are used chiefly for pasture. Areas that have been tile drained are used for row crops. Wetness and some flooding are the major limitations.

Representative profile of Coland silty clay loam, 0 to 2 percent slopes, in a pasture 760 feet west and 150 feet north of the southeast corner sec. 35, T. 98 N., R. 20 W.

All—0 to 12 inches, black (N 2/0) light silty clay loam high in sand; moderate, very fine, granular structure; friable; neutral; clear, smooth boundary.

A12—12 to 23 inches, black (N 2/0) silty clay loam high in medium and coarse sand; weak, fine, granular structure; friable; neutral; gradual, smooth boundary.

A13—23 to 42 inches, black (10YR 2/1) clay loam; few, fine, faint, dark grayish-brown (2.5Y 4/2) mottles; weak, fine and medium, subangular blocky structure; friable; neutral; clear, smooth boundary.

Bg—42 to 46 inches, very dark gray (10YR 3/1) loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, medium, subangular blocky structure; friable; neutral; clear, smooth boundary.

Cg—46 to 60 inches, light olive-gray (5Y 6/2) loam; massive; friable; mildly alkaline.

The depth to carbonates is greater than 60 inches.

The A horizon is black (N 2/0 or 10YR 2/1) in the upper part and very dark gray (10YR 3/1) in the lower part. It is typically silty clay loam high in sand or clay loam. It is 36 to 48 inches thick. It is typically neutral in reaction, but is slightly acid in some places.

The Bg horizon ranges from very dark gray (10YR 3/1) to light gray (5Y 6/1) with no to many high-chroma mottles. It ranges from medium loam to medium clay loam and is 0 to 10 inches thick.

The C horizon ranges from dark gray (10YR 4/1) to light olive gray (5Y 6/2) with few to many high-chroma mottles. It is typically loam or clay loam and has lenses of silty and sandy material. It is neutral or mildly alkaline in reaction.

Coland soils formed in parent material similar to that of Turlin soils, but have a thicker A horizon than those soils. They are in the same drainage class as Calco soils. They are neutral or slightly acid in the solum, whereas the Calco soils are mildly alkaline.

Coland silty clay loam, 0 to 2 percent slopes (135).—This soil is on the flood plains. A permanent or an intermittent stream runs through most of the areas. This soil has the profile described as representative of the series. Individual areas range from 3 to 40 acres in size.

Included with this soil in mapping are small sandy areas and mucky areas, which are indicated by spot symbols on the soil map. In a few places near Deer Creek and the Shellrock and Winnebago Rivers, limestone bedrock is below a depth of 30 to 50 inches.

This Coland soil is high in organic-matter content and is well suited to row crops if it is properly drained. It is susceptible to wetness caused by flooding and, in some places, by a high water table. Wetness often delays plowing in spring. Undrained areas are better suited to permanent pasture. Capability unit IIw–5; woodland group 13.

Coland-Turlin complex, 0 to 2 percent slopes (235).—This soil complex is on flood plains. A permanent or an intermittent stream runs through these areas. Individual areas range from 3 to about 60 acres in size.

The soils of this complex are about 50 percent Coland silty clay loam and 50 percent Turlin loam. Included with this complex in mapping are a few sandy areas and a few mucky areas indicated by spot symbols on the soil map. In a number of places near Deer Creek and the Shellrock and Winnebago Rivers, limestone bedrock is below a depth of 20 to 50 inches.

This complex is high in organic-matter content and is well suited to row crops if it is properly drained. It is susceptible to wetness caused by flooding and, in some places in the Coland soil, by a high water table. Wetness often delays plowing in spring. Undrained areas are well suited to pasture. Capability unit IIw–5; woodland group 13.

Dickinson Series

The Dickinson series consists of well drained to somewhat excessively drained, nearly level to moderately sloping soils on stream benches and uplands. These soils formed in fine sandy loam overlying loamy fine sand and sand. Slopes are 0 to 9 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown fine sandy loam about 18 inches thick. The subsoil, which extends to a depth of 33 inches, is brown fine sandy loam in the upper part and dark yellowish-brown light fine sandy loam in the lower part. The substratum is yellowish-brown loamy fine sand.

Dickinson soils have moderately rapid permeability in the loamy upper part, rapid permeability in the sandy lower part, and low to moderate available water capacity. They are very low in available phosphorus and potassium. The soils are generally acid unless limed during the past 4 years.

Dickinson soils are used mainly for row crops. Soil blowing, water erosion, and droughtiness are the major limitations.

Representative profile of Dickinson fine sandy loam, 2 to 5 percent slopes, in a cultivated field 500 feet west and 180 feet north of the southeast corner SW¼ sec. 7, T. 99 N., R. 19 W.

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

A12—8 to 12 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; continuous very dark brown (10YR 2/2) coatings on peds; moderate, fine, granular structure; very friable; medium acid; clear, smooth boundary.

A3—12 to 18 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, medium and fine, subangular blocky structure; very friable; medium acid; clear, smooth boundary.

B2—18 to 24 inches, brown (10YR 4/3) fine sandy loam; discontinuous dark yellowish-brown (10YR 3/4) coatings on peds; weak, medium, subangular blocky structure; very friable; medium acid; clear, smooth boundary.

B3—24 to 33 inches, dark yellowish-brown (10YR 4/4) light fine sandy loam; few brown (10YR 4/3) coatings on peds; very weak, medium and coarse, subangular blocky structure; very friable; medium acid; gradual, smooth boundary.

C1—33 to 53 inches, yellowish-brown (10YR 5/4) loamy fine sand; massive; very friable; slightly acid; abrupt, smooth boundary.

C2—53 to 72 inches, yellowish-brown (10YR 5/4) heavy loamy fine sand; massive; loose; slightly acid.

The depth to loamy sand or sand ranges from 24 to 36 inches.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically fine sandy loam, but is sandy loam in places. It is 10 to 20 inches thick and neutral or medium acid in reaction.

The B2 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) and has few to many darker coatings on the peds. It is 4 to 10 inches thick and slightly acid or strongly acid in reaction.

The B3 horizon ranges from dark yellowish brown (10YR 3/4) to yellowish brown (10YR 5/6). It ranges from light fine sandy loam to sand. It is 0 to 20 inches thick and slightly acid or medium acid in reaction.

The C horizon ranges from brown (10YR 4/3) to yellowish-brown (10YR 5/6) loamy fine sand to sand. It is slightly acid or medium acid in reaction.

Dickinson soils formed in parent material similar to that of Hoopeston and Sparta soils. They have higher chroma in the B horizon than Hoopeston soils and less sand and more clay in the solum than Sparta soils.

Dickinson fine sandy loam, 0 to 2 percent slopes (175). —This soil is on stream benches and uplands. Individual areas range from 2 to 10 acres in size.

Included with this soil in mapping along the Shellrock River northwest of Northwood are a few areas where the subsoil is silty at depths between 24 and 40 inches. Also included are a few areas of Sparta loamy fine sand, which tend to be a little more droughty than Dickinson soils.

This Dickinson soil is moderate in organic-matter content and is well suited to row crops if rainfall is normal and timely. In years of below-normal rainfall, it is droughty. It is susceptible to soil blowing if cultivated. Capability unit IIIs–1; woodland group 5.

Dickinson fine sandy loam, 2 to 5 percent slopes (175B). —This soil is on stream benches and uplands, and in some places on mounds and dunes. It has the profile described as representative of the series. Individual areas range from 3 to 5 acres in size. Slopes are short.

Included with this soil in mapping along the Shellrock River in about the first 4 miles south of the Minnesota State line are a few areas where the subsoil is silty at depths between 24 and 40 inches. In a few places a gravel substratum is below a depth of 30 to 45 inches.

This Dickinson soil is moderate in organic-matter content and is well suited to row crops if the rainfall is normal and timely. In years of below-normal rainfall, it is droughty. It is susceptible to slight water erosion and soil blowing if cultivated or pastured intensively. Capability unit IIIe–3; woodland group 5.

Dickinson fine sandy loam, 5 to 9 percent slopes (175C). —This soil is on stream benches and uplands, and in some places it is on mounds and dunes. Slopes are short. Individual areas range from 2 to 7 acres in size.

This soil has a profile similar to the one described as representative of the series, but it generally is shallower to sand and loamy sand.

On about 40 percent of the acreage, this soil has a very dark gray surface layer about 3 to 6 inches thick. Most of these thin surface areas are in timber or pasture. In a few eroded areas the surface layer is very dark grayish brown and dark brown and is about 10 to 12 inches thick.

This Dickinson soil is moderate to low in organic-matter content. It is moderately suited to row crops if rainfall is normal and timely. It is droughty unless rainfall is timely and above normal. It is susceptible to soil blowing and water erosion if cultivated or pastured intensively. Capability unit IIIe–3; woodland group 5.

Dinsdale Series

The Dinsdale series consists of well-drained, nearly level and gently sloping soils in the uplands. These soils formed in 20 to 40 inches of loess and the underlying glacial till. Slopes are 0 to 5 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown silty clay loam about 12 inches thick. The subsoil extends to a depth of 50 inches. It is brown and dark yellowish-brown silty clay loam and silt loam in the upper part, yellowish-brown loam in the middle part, and mottled yellowish-brown and grayish-brown loam in the lower part. The substratum is mottled strong-brown, yellowish-brown, and grayish-brown loam. The middle and lower parts of the subsoil and the substratum contain a few pebbles.

Dinsdale soils have moderate permeability in the loess and moderately slow permeability in the glacial till. Available water capacity is high. The subsoil is low in available phosphorus and very low in available potassium. The soils are generally acid unless limed during the past 5 years.

Dinsdale soils are used mainly for row crops. Slight water erosion in the more sloping areas is the major limitation.

Representative profile of Dinsdale silty clay loam, 2 to 5 percent slopes, in a cultivated field 980 feet south and 275 feet east of the northwest corner SW¼ sec. 23, T. 98 N., R. 19 W.

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

A12—8 to 12 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; very dark brown (10YR 2/2) coatings on peds; weak, fine, granular structure; friable; medium acid; clear, wavy boundary.

B1—12 to 20 inches, brown (10YR 4/3) light silty clay loam; dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

B21—20 to 25 inches, brown (10YR 4/3) light silty clay loam; brown (10YR 4/3) and dark yellowish-brown (10YR 3/4) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B22—25 to 30 inches, dark yellowish-brown (10YR 4/4) silt loam, high in very fine sand; brown (10YR 4/3) coatings on a few peds; weak, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

IIB23t—30 to 35 inches, yellowish-brown (10YR 5/4) light loam; weak, medium, subangular blocky structure; firm; few small pebbles; few thin clay films; medium acid; clear, wavy boundary.

IIB3t—35 to 50 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; moderate, medium, prismatic structure parting to weak, coarse, subangular blocky; firm; light-gray (10YR 7/1 dry) fine sand coatings on prism faces; clay linings on a few pores and root channels; common strong-brown (7.5YR 5/8) oxide concretions; few small pebbles; medium acid; gradual, smooth boundary.

IIC—50 to 65 inches, mottled strong-brown (7.5YR 5/8), yellowish-brown (10YR 5/6), and grayish-brown (2.5Y 5/2) heavy loam; massive; firm; few small pebbles; medium acid.

The depth to carbonates ranges from 45 to 65 inches. The thickness of loess is typically 24 to 34 inches, but ranges from 20 to 40 inches.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically light silty clay loam, but is silt loam in places. It is 10 to 18 inches thick and neutral or medium acid in reaction.

The B horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) and has few to common darker coatings on the ped faces. It is typically silty clay loam, but in places it is loam or very fine sandy loam in the lower part. It is 10 to 25 inches thick and medium acid or strongly acid in reaction.

The IIBt horizon ranges from dark yellowish brown (10YR 4/4) in the IIB2t horizon to mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) in the IIB3t horizon. It is typically loam but in places is light clay loam and sandy loam. It is 10 to 25 inches thick.

Dinsdale soils formed in parent material similar to that of Klinger and Franklin soils. They have higher chroma in the upper part of the B horizon than Klinger and Franklin soils and have a thicker, darker colored A horizon than Franklin soils.

Dinsdale silty clay loam, 0 to 2 percent slopes (377).—This soil is on broad ridge crests. Individual areas range from 3 to 20 acres in size.

Included with this soil in mapping are small areas of Klinger soils. In a few areas dense gray clay is below a depth of 20 to 36 inches. These areas are indicated by spot symbols on the soil map.

This Dinsdale soil is high in organic-matter content and is well suited to row crops. Capability unit I–1; woodland group 1.

Dinsdale silty clay loam, 2 to 5 percent slopes (377B).—This soil is on long, slightly convex ridge crests and side slopes. It has the profile described as representative of the series. Individual areas range from 2 to 30 acres in size.

Included with this soil in mapping are areas of a soil that has a dark-colored surface layer 6 to 10 inches thick. Most of these areas are in the northeastern part of Lincoln Township and the northwestern part of Union Township. In a few areas dense gray clay is below a depth of 20 to 36 inches. These areas are indicated by spot symbols on the soil map.

This Dinsdale soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight water erosion if cultivated. In some places where the loess is thin, erosion-control practices increase wetness, and a combination of terracing and tile drainage is needed. Capability unit IIe–1; woodland group 1.

Donnan Series

The Donnan series consists of somewhat poorly drained to moderately well drained, nearly level to moderately sloping soils in the uplands. These soils formed in 20 to 40 inches of loamy material and the underlying very firm, more clayey glacial till. Slopes are 0 to 9 percent. The native vegetation was trees and grasses.

In a representative profile (fig. 11) the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer is dark grayish-brown silt loam about 5 inches thick. The subsoil extends to a depth of 54 inches. The upper part, to a depth of 26 inches, is brown silty clay loam that is high in sand and contains common yellowish-brown mottles. The lower part is olive-gray heavy clay loam and gray light silty clay. The substratum is brown heavy clay loam that contains common yellowish-brown mottles.

Donnan soils have moderate permeability in the upper part of the soil, which formed in loamy material, and very slow permeability in the lower part, which formed in the clayey glacial till. They are high in available water capacity. The subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Donnan soils are used mainly for row crops. Providing both erosion control and adequate artificial drainage is difficult because they conflict to some extent. The long, uniform slopes are well suited to contour cultivation and terracing. These practices, however, slow the movement of surface water and let more of it soak into the soil, which complicates drainage, especially in wet years.

Representative profile of Donnan silt loam, 0 to 2 percent slopes, in a cultivated field 420 feet west and 69 feet south of the northeast corner sec. 26, T. 100 N., R. 20 W.

Figure 11.—**Donnan soil exposed in road cut.**

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

A2—8 to 13 inches, dark grayish-brown (10YR 4/2) heavy silt loam; few strong-brown (7.5YR 5/6) oxides; some black (10YR 2/1) mixing in upper 2 inches; weak, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21—13 to 26 inches, brown (10YR 4/3) silty clay loam, high in sand; common, fine, distinct yellowish-brown (10YR 5/6) mottles; dark grayish-brown (10YR 4/2) coatings on peds; weak, fine, subangular blocky structure; friable; strongly acid; clear, wavy boundary.

IIB22t—26 to 31 inches, olive-gray (5Y 5/2) heavy clay loam; few, fine, distinct, brown (10YR 5/3) mottles; common dark clay films on ped faces and in root channels; few light-gray (10YR 7/1 dry) sand coatings on prism and ped faces; weak, medium, prismatic structure parting to moderate, very fine, subangular blocky; firm; few small pebbles; medium acid; gradual, smooth boundary

IIB23t—31 to 46 inches, gray (5Y 5/1) light silty clay; continuous dark-gray (10YR 4/1) clay films on prism and ped faces and in root channels; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate; fine, prismatic structure parting to moderate, very fine, blocky and subangular blocky; very firm; medium acid; gradual, smooth boundary.

IIB3t—46 to 54 inches, brown (10YR 4/3) light silty clay; nearly continuous dark grayish-brown (10YR 4/2) clay films on prism faces and in root channels; few yellowish-red (5YR 5/6) and dark reddish-brown (5YR 2/2) oxide concretions; moderate, medium, prismatic structure parting to weak, coarse, subangular blocky; very firm; medium acid; gradual, smooth boundary.

IIC—54 to 72 inches, brown (10YR 4/3) heavy clay loam; common, fine, faint, dark-gray (10YR 4/1) mottles; few yellowish-red (5YR 5/6) oxide concretions; few dark-gray (10YR 4/1) clay films in root channels; massive; firm; medium acid.

The depth to very firm, fine-textured glacial till is 20 to 40 inches.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It ranges from silt loam to light clay loam. It is 6 to 9 inches thick and neutral or medium acid in reaction.

The A2 horizon is dark grayish-brown (10YR 4/2) silt loam or loam. It is 0 to 5 inches thick and slightly acid or strongly acid in reaction.

The B horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4) and contains few to common high-chroma mottles. It ranges from silty clay loam high in sand to loam and clay loam. It is 10 to 25 inches thick and medium acid or strongly acid in reaction.

The IIBt horizon ranges from gray (10YR 5/1) to light olive gray (5Y 6/2) and has few to common mottles. It ranges from heavy clay loam to clay and silty clay. It is 20 to 40 inches thick and medium acid or strongly acid in reaction.

The upper part of the soil, formed in loamy material, has a higher content of silt and a lower content of sand than is defined as the range for the series, and the lower part, formed in glacial till, does not contain enough clay to provide a contrasting texture. These differences, however, do not alter the use or management of the soils.

Donnan soils formed in parent material similar to that of the Donnan dark variant soils. They have a thinner dark-colored A horizon than those soils.

Donnan silt loam, 0 to 2 percent slopes (782).—This soil is on broad ridge crests. It has the profile described as representative of the series. Individual areas range from 3 to 40 acres in size.

Included with this soil in mapping are small areas of of Franklin, Oran, and Donnan, dark variant, soils.

This Donnan soil is moderate in organic-matter content and is moderately suited to row crops. Wetness delays fieldwork in spring and in wet seasons. Because of the very slow permeability of the lower part of the subsoil, tile drainage may not function satisfactorily in all areas. Capability unit IIw–4; woodland group 11.

Donnan silt loam, 2 to 5 percent slopes (782B).—This soil is on long, slightly convex ridge crests and side slopes. Individual areas range from 2 to 30 acres in size.

Included with this soil in mapping are a few areas of Franklin, Oran, and Donnan, dark variant, soils. In a few places the subsoil is reddish colored.

This Donnan soil is moderate in organic-matter content and is moderately suited to row crops. It is susceptible to slight erosion if cultivated. Because of the difficulty of providing adequate erosion control and drainage, a combination of terracing and tiling may be needed. Because permeability is very slow in the lower part of the subsoil, however, tile drainage may not function satisfactorily in all areas. Terracing is a problem because cutting may expose the infertile, clayey lower part of the subsoil, which is very difficult to manage. Capability unit IIe–2; woodland group 11.

Donnan silt loam, 5 to 9 percent slopes, moderately eroded (782C2).—This soil is on short slopes along the break from the uplands to the stream benches. It has a profile similar to the one described as representative of the series, but it has a dark-brown surface layer and a lower content of clay in the upper part of the subsoil. Individual areas range from 2 to 20 acres, but most are less than 4 acres. These areas are generally long and narrow and are parallel to the streams.

Included with this soil in mapping are areas where the clayey gray lower part of the subsoil is less than

20 inches from the surface. In a few places the subsoil is reddish colored.

This Donnan soil is moderately low in organic-matter content and is poorly suited to row crops. It is susceptible to severe erosion if cultivated and pastured. Due to the steepness of the slope, subsoil water moves downslope and comes to the surface in some places, creating a seepy area. A combination of terracing and tile drainage is needed to control erosion and correct wetness. Because permeability is very slow in the lower part of the subsoil, however, tile drains may not function satisfactorily. Terracing is a problem because cutting may expose the infertile clayey subsoil, which is very difficult to manage. Capability unit IVe–2; woodland group 11.

Donnan Series, Dark Variant

The Donnan series, dark variant consists of well drained and moderately well drained, nearly level and gently sloping soils on uplands. These soils formed in 20 to 40 inches of loamy material and the underlying very firm, more clayey glacial till. Slopes are 0 to 5 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silt loam about 14 inches thick. The subsoil extends to a depth of 69 inches. The upper 14 inches is brown and dark yellowish-brown loam that has a few pebbles. The lower part is gray heavy silty clay loam and silty clay loam. The substratum is olive-gray heavy loam that has common strong-brown concretions.

Donnan soils, dark variant have moderate permeability in the lower part, which formed in glacial till. Available water capacity is high. The subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Donnan soils, dark variant are used mainly for row crops. Providing both erosion control and adequate drainage is difficult because they conflict to some extent. The long, uniform slopes are well suited to contour cultivation and terracing. These practices, however, slow the movement of surface water and let more of it soak into the soil, which complicates drainage, especially in the wet years.

Representative profile of Donnan silt loam, dark variant, 2 to 5 percent slopes, in a pasture 1,080 feet west and 70 feet north of the southeast corner SW¼ sec. 35, T. 98 N., R. 19 W.

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

A12—8 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam high in sand; very dark brown (10YR 2/2) coatings on peds; weak, fine and very fine, granular structure; friable; medium acid; gradual, smooth boundary.

B1—14 to 19 inches, brown (10YR 4/3) silt loam high in sand; dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; friable; strongly acid; gradual, smooth boundary.

B21—19 to 28 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; weak, fine and medium, subangular blocky structure; friable; few small pebbles and coarse sand in lower 3 inches; strongly acid; clear, smooth boundary.

IIB22t—28 to 42 inches, gray (5Y 5/1) heavy silty clay loam; moderate, medium, prismatic structure parting to moderate, fine and medium, angular blocky and subangular blocky; very firm; common dark-gray (5Y 4/1) clay films on ped faces; light-gray (10YR 7/1 dry) silt coatings on prism faces; few yellowish-brown (10YR 5/6) oxide concretions; medium acid; gradual, smooth boundary.

IIB23t—42 to 54 inches, gray (5Y 5/1) heavy silty clay loam; common dark-gray (5Y 4/1) clay films on ped faces; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; very firm; light-gray (10YR 7/1 dry) silt coatings on prism faces; few yellowish-brown (10YR 5/6) oxide concretions; medium acid; gradual, smooth boundary.

IIB3—54 to 69 inches, gray (5Y 5/1) silty clay loam; weak, medium, prismatic structure; very firm; common yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/8) oxide concretions; few patches of light-gray (10YR 7/1 dry) silt coatings on prism faces; neutral; clear, smooth boundary.

IIC—69 to 72 inches, olive-gray (5Y 5/2) heavy loam; common strong-brown (7.5YR 5/6) oxide concretions; massive; firm; neutral.

The depth to very firm, fine-textured glacial till is 20 to 40 inches.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically silt loam high in sand, but in places is loam. It is 10 to 18 inches thick and neutral or medium acid in reaction.

The B horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) and has few to common darker coatings on the ped faces. It ranges from silt loam high in sand to loam or light clay loam. It is 10 to 25 inches thick and medium acid or strongly acid in reaction.

The IIBt horizon ranges from gray (10YR 5/1) to light olive gray (5Y 6/2) in color and has few to common mottles. It ranges from heavy silty clay loam to silty clay and clay. It is 20 to 40 inches thick and medium acid or strongly acid in reaction.

The IIC horizon ranges from olive gray (5Y 5/2) to mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2). It ranges from heavy loam or light loam to clay loam. In some places there are lenses and pockets of sandy material. This horizon is slightly acid or mildly alkaline in reaction.

The Donnan dark variant formed in parent material similar to that of Donnan soils. It has a thicker dark-colored A horizon than those soils.

Donnan silt loam, dark variant, 0 to 2 percent slopes (706).—This soil is on broad ridge crests. Individual areas range from 3 to 15 acres in size. Included in mapping are small areas of Dinsdale and Kenyon soils.

This Donnan dark variant is high in organic-matter content and is well suited to row crops. Wetness delays fieldwork in wet seasons. Capability unit IIw–4; woodland group 11.

Donnan silt loam, dark variant, 2 to 5 percent slopes (706B).—This soil is on long, slightly convex ridge crests and side slopes. It has the profile described as representative of the series. Individual areas range from 2 to 20 acres in size. Included in mapping are small areas of Dinsdale, Kenyon, and Donnan soils.

This Donnan dark variant is high in organic-matter content and is well suited to row crops. It is susceptible to slight erosion if cultivated. Because of the difficulty of providing both adequate erosion control and drainage, a combination of terracing and tiling may be needed. Because permeability is very slow in the lower part of the subsoil, however, tile drainage does not function satisfactorily in all areas. Terracing is a problem because cutting may expose the infertile, clayey

lower part of the subsoil, which is very difficult to manage. Capability unit IIe–2; woodland group 11.

Faxon Series

The Faxon series consists of poorly drained, nearly level soils. These soils are principally on low and intermediate stream benches, but in some places they occupy first bottoms, high stream benches, or uplands. They formed in 20 to 40 inches of loamy glacial sediment over limestone bedrock. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam about 18 inches thick. The subsoil extends to a depth of 30 inches. The upper part is mottled grayish-brown and gray heavy loam, and the lower part is dark grayish-brown heavy loam that has common gray and brown mottles. Below the subsoil is 2 to 3 feet of hard, shattered limestone over level-bedded limestone bedrock.

Faxon soils have moderate permeability and low to moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are neutral or slightly acid and seldom need liming.

Faxon soils are used mainly for pasture and row crops. They are subject to some flooding on the first bottoms and low benches. Wetness is the major limitation. Open-ditch and tile drainage are difficult because of the underlying limestone.

Representative profile of Faxon silty clay loam, 0 to 2 percent slopes, in a cultivated field 205 feet west of the northeast corner sec. 31, T. 98 N., R. 21 W.

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

A12—8 to 14 inches, black (10YR 2/1) silty clay loam; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; neutral; clear, smooth boundary.

A3g—14 to 18 inches, very dark gray (10YR 3/1) light silty clay loam high in sand; common, fine, distinct, olive-gray (5Y 5/2) mottles; weak, fine, subangular blocky structure; few, fine, dark reddish-brown (5YR 2/2) oxide concretions; neutral; clear, wavy boundary.

B2g—18 to 24 inches, mottled dark grayish-brown (2.5Y 4/2) and gray (5Y 5/1) heavy loam; dark-gray (5Y 4/1) and gray (5Y 5/1) coatings on peds; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, fine, subangular blocky structure; friable; few, fine, dark reddish-brown (5YR 2/2) oxide concretions; neutral; clear, wavy boundary.

B3g—24 to 30 inches, dark grayish-brown (2.5Y 4/2) heavy loam; common, fine, distinct, dark-gray (5Y 4/1) and strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few, fine, dark reddish-brown (5YR 2/2) and yellowish-red (5YR 5/8) oxide concretions; few small pebbles in matrix; 1 inch lens of gravel at 29 inches; neutral; abrupt, wavy boundary.

R—30 inches, shattered limestone bedrock.

The depth to limestone bedrock is 20 to 40 inches.

The A horizon is typically black (N 2/0 or 10YR 2/1) and very dark gray (10YR 3/1 or 5Y 3/1) in the lower part. It is typically silty clay loam, but in places is light clay loam. It is 15 to 24 inches thick and neutral or slightly acid in reaction.

The B2g horizon ranges from mottled dark grayish brown (2.5Y 4/2) and gray (5Y 5/1) to gray (5Y 5/1) and in places has common brownish mottles. It ranges from loam to clay loam and silty clay loam high in sand. It is 4 to 10 inches thick and neutral or slightly acid in reaction.

The B3g horizon ranges from dark grayish brown (2.5Y 4/2) to light gray (5Y 6/1) and contains few to common brownish mottles. It ranges from heavy loam to sandy loam and is 2 to 8 inches thick.

The IIC horizon ranges from strong brown (7.5YR 5/6) with gray (5Y 5/1) mottles to olive gray (5Y 5/2). It ranges from gravelly sand to loamy sand and commonly is 10 to 30 percent pebbles and cobblestones. It is 0 to 6 inches thick.

Faxon soils formed in parent material similar to that of Tilfer, Marshan, and Kensett soils. They are underlain by limestone, in contrast with Marshan soils, which are underlain by sand and gravel. They are neutral to slightly acid in the solum, whereas Tilfer soils are mildly alkaline. They typically have lower chroma in the B horizon than Kensett soils.

Faxon silty clay loam, 0 to 2 percent slopes (651).—Most areas of this soil are on low and intermediate stream benches, but some are on high benches and first bottoms. Small areas are in the uplands northeast of Grafton. Individual areas range from 3 to 40 acres in size.

Included with this soil in mapping are areas where depth to limestone is 40 to 50 inches. In a few places the surface layer is mucky silt loam.

This Faxon soil is high in organic-matter content and is moderately suited to row crops if it is properly drained. It is susceptible to wetness, but tiling and open ditch construction are difficult to maintain because of the moderate depth to limestone bedrock. Undrained areas are well suited to pasture. Capability unit IIIw–3; woodland group 13.

Flagler Series

The Flagler series consists of somewhat excessively drained, nearly level and gently sloping soils on stream benches and in upland outwash areas. The gently sloping areas have short slopes. These soils formed in 24 to 36 inches of sandy loam and the underlying sand and gravel. Slopes are 0 to 5 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown sandy loam about 17 inches thick. The subsoil extends to a depth of 52 inches. It is dark-brown sandy loam in the upper part, dark yellowish-brown sandy loam in the middle part, and dark yellowish-brown loamy sand and very fine gravelly loamy sand in the lower part. The substratum is dark yellowish-brown fine gravelly loamy sand.

Flagler soils have moderately rapid permeability in the loamy upper part and rapid and very rapid permeability in the sandy lower part. They have low available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 4 years.

Flagler soils are used mainly for crops and pasture. The major limitation is droughtiness in years of normal or below-normal rainfall.

Representative profile of Flagler sandy loam, 0 to 2 percent slopes, in a cultivated field 505 feet east of Shell Rock River and 85 feet south of road fence NE¼SW¼ sec. 18, T. 100 N., R. 20 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) light sandy loam; weak, very fine, granular structure; very friable; few very small pebbles; neutral; clear, smooth boundary.

A12—8 to 17 inches, very dark brown (10YR 2/2) sandy loam; weak, medium, subangular blocky structure parting to weak, very fine, subangular blocky; few very small pebbles; medium acid; gradual, smooth boundary.

B1—17 to 22 inches, dark-brown (10YR 3/3) sandy loam; weak, medium, subangular blocky structure parting to weak, very fine, subangular blocky; few very small pebbles; medium acid; gradual, smooth boundary.

B2—22 to 27 inches, dark yellowish-brown (10YR 3/4) sandy loam; few dark-brown (10YR 3/3) coatings on peds; weak, medium, subangular blocky structure parting to weak, very fine, subangular blocky; very friable; few very small pebbles; medium acid; gradual, smooth boundary.

IIB31—27 to 34 inches, dark yellowish-brown (10YR 3/4) loamy sand; very weak, medium, subangular blocky structure parting to very weak, very fine, subangular blocky; very friable; few small pebbles; medium acid; clear, smooth boundary.

IIB32t—34 to 52 inches, dark yellowish-brown (10YR 3/4) very fine gravelly loamy sand; very weak, very fine, subangular blocky structure; loose; clay bridges between sand grains; slightly acid; gradual, smooth boundary.

IIC1—52 to 65 inches, dark yellowish-brown (10YR 4/4) fine gravelly loamy sand; single grained; loose; neutral.

The depth to sand and gravel ranges from 24 to 36 inches.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 10 to 24 inches thick and neutral or medium acid in reaction.

The B1 horizon is dark brown (10YR 3/3) and brown (10YR 4/3), and the B2 horizon ranges from dark yellowish brown (10YR 3/4) to yellowish brown (10YR 5/6). The combined B1 and B2 horizon is 8 to 18 inches thick and slightly acid or medium acid in reaction.

The IIB3 horizon ranges from dark yellowish-brown (10YR 3/4) to yellowish-brown (10YR 5/6) loamy sand that contains a few pebbles to gravelly loamy sand. It is 10 to 30 inches thick and medium acid or slightly acid in reaction.

The IIC horizon ranges from brown (10YR 4/3) to yellowish-brown (10YR 5/6) fine sand to gravelly loamy sand. It is neutral or slightly acid in reaction.

Flagler soils formed in parent material similar to that of Saude and Wapsie soils. They have more sand in the A and B horizons than those soils and have a thicker dark-colored A horizon than Wapsie soils.

Flagler sandy loam, 0 to 2 percent slopes (284).—This soil is on stream benches and in upland outwash areas. It has the profile described as representative of the series. Individual areas generally range from 2 to 5 acres in size.

Included with this soil in mapping are a few areas of Saude and Wapsie soils. There are also a few small, wet areas and depressions and a few small, gravelly spots, which are indicated by spot symbols on the soil map.

This Flagler soil is moderate in organic-matter content and is moderately suited to row crops. It is susceptible to droughtiness in years of normal or below-normal rainfall. Cultivated areas are subject to wind erosion. Capability unit IIIs–1; woodland group 5.

Flagler sandy loam, 2 to 5 percent slopes (284B).—This soil is on stream benches and in upland outwash areas. Slopes are short. Individual areas range from 2 to 5 acres in size.

Included with this soil in mapping are areas that have a calcareous, mildly alkaline subsoil and substratum. These areas are generally adjacent to Salida soils. Some gravelly areas are indicated by spot symbols on the soil map.

This Flagler soil is moderate in organic-matter content and is moderately suited to row crops. It is susceptible to droughtiness in years of normal or below-normal rainfall. It is subject to water erosion and soil blowing if cultivated or pastured intensively. Capability unit IIIe–3; woodland group 5.

Floyd Series

The Floyd series consists of somewhat poorly drained, nearly level and very gently sloping soils on slightly convex to slightly concave downslope and cove positions in the uplands. These soils formed in 20 to 30 inches of loamy materials and the underlying stratified, medium and moderately coarse textured, friable sediment and glacial till. Slopes are 1 to 3 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown loam about 19 inches thick. The subsoil extends to a depth of 50 inches. The upper part is dark grayish-brown, olive-brown, and light olive-brown loam, and the lower part is light olive-brown sandy loam and light brownish-gray loam that has grayish and brownish mottles. The substratum is light brownish-gray loam and has a few mottles.

Floyd soils have moderate permeability and high available water capacity. The subsoil is very low in available phosphorus and potassium. These soils are slightly acid or neutral and generally have little need of liming.

Floyd soils are used mainly for row crops. The major limitation is wetness, especially in spring and during rainy seasons. Wetness results, in part, from sidehill seep. Some areas are subject to slight erosion when cropped.

Representative profile of Floyd loam, 1 to 3 percent slopes, in a cultivated field 1,600 feet west and 55 feet north of the southeast corner sec. 35, T. 98 N., R. 20 W.

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

A12—8 to 15 inches, very dark brown (10YR 2/2) heavy loam; moderate, fine and very fine, granular structure; friable; slightly acid; clear, wavy boundary.

A13—15 to 19 inches, very dark grayish-brown (10YR 3/2) heavy loam; very dark brown (10YR 2/2) coatings on peds; weak, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B1—19 to 24 inches, mottled dark grayish-brown (2.5Y 4/2) and olive-brown (2.5Y 4/4) heavy loam; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2—24 to 33 inches, light olive-brown (2.5Y 5/4) loam; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; few reddish-brown (5YR 4/4) and dark reddish-brown (5YR 2/2) oxide concretions; neutral; clear, smooth boundary.

B31—33 to 41 inches, light olive-brown (2.5Y 5/4) sandy loam; common, fine, distinct, light brownish-gray (2.5Y 6/2) and strong-brown (7.5YR 5/8) mottles; weak, coarse, subangular blocky structure; very friable; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; neutral; clear, smooth boundary.

IIB32—41 to 50 inches, light brownish-gray (2.5Y 6/2) loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; friable; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; neutral; gradual, smooth boundary.

IIC—50 to 60 inches, light brownish-gray (2.5Y 6/2) heavy loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; massive; firm; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; neutral.

The depth to carbonates ranges from 45 to 60 inches or more.

The A horizon ranges from black (10YR 2/1) in the upper part to very dark grayish brown (10YR 3/2) in the lower part. It is typically loam but ranges from silt loam to light clay loam. It is 16 to 24 inches thick and neutral or slightly acid in reaction.

The B horizon is dark grayish brown (10YR 4/2) to light olive brown (2.5Y 5/4) and has common to many grayish mottles. It is loam or light clay loam with strata of sandy loam, and it is neutral or slightly acid in reaction.

The IIB horizon ranges from grayish brown (2.5Y 5/2) with common high-chroma mottles to strong brown (7.5YR 5/6) with common grayish mottles. It ranges from loam or light sandy clay loam to light clay loam.

The IIC horizon ranges from strong brown (7.5YR 5/6) with common grayish mottles to light brownish gray (2.5Y 6/2) with few to common grayish mottles. It ranges from loam to sandy clay loam and light clay loam and is neutral or mildly alkaline in reaction.

Floyd soils formed in parent material similar to that of Clyde, Readlyn, and Schley soils. They typically have lower value and generally have higher chroma in the B horizon than Clyde soils. They have a thicker dark-colored A horizon than Schley soils. Floyd soils are not so acid in the B and IIB horizons as Readlyn soils, and the IIB horizon is more friable. They are in the same drainage class as Lawler soils, but have a loam IIC horizon, whereas those soils are underlain by sand and gravel.

Floyd loam, 1 to 3 percent slopes (198).—This soil is in slightly convex to slightly concave areas and cove positions below Kenyon and Readlyn soils and generally above Clyde soils. Floyd soils are in less well-defined watercourses in Worth County than in other counties. Individual areas range from 3 to 20 acres in size. Included with this soil in mapping are small sandy areas, which are indicated by spot symbols on the soil map.

This Floyd soil is high in organic-matter content and is well suited to row crops when drained. Undrained areas are well suited to pasture and moderately suited to row crops. This soil is susceptible to wetness, and some areas are susceptible to slight erosion if cultivated. Because wetness is the result in part of sidehill seep, a drainage system that intercepts laterally moving water is successful. Capability unit IIw–2; woodland group 6.

Franklin Series

The Franklin series consists of somewhat poorly drained, nearly level and very gently sloping soils in the uplands. These soils formed in 20 to 40 inches of loess and the underlying glacial till. Slopes are long and range from 1 to 3 percent. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer is dark grayish-brown silt loam about 8 inches thick. The subsoil extends to a depth of 53 inches. The upper 11 inches is mottled grayish-brown and strong-brown silty clay loam. The lower part is yellowish-brown loam that has grayish-brown mottles. The substratum is yellowish-brown loam that has grayish-brown mottles.

Franklin soils have moderate permeability in the loess and moderately slow permeability in the glacial till. They have high available water capacity. Their subsoil is low in available phosphorus and very low in available potassium. They are generally acid unless limed during the past 5 years.

Franklin soils are used mainly for row crops. The major limitation is some wetness early in the spring and during wet seasons. These soils are susceptible to slight erosion in the more sloping areas.

Representative profile of Franklin silt loam, 1 to 3 percent slopes, in a cultivated field 370 feet south and 105 feet west of the corner post in the northeast corner sec. 27, T. 99 N., R. 19 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam; weak, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A2—8 to 16 inches, dark grayish-brown (10YR 4/2) silt loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; few dark yellowish-brown (10YR 3/4) coatings on peds; weak, medium, platy structure; friable; strongly acid; clear, wavy boundary.

B21—16 to 27 inches, mottled grayish-brown (10YR 5/2) and strong-brown (7.5YR 5/6) silty clay loam; few, fine, faint, yellowish-brown (10YR 5/6) mottles; nearly continuous grayish-brown (10YR 5/2) coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

IIB22t—27 to 36 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; nearly continuous light brownish-gray (10YR 6/2) coatings on prisms; white (10YR 8/1 dry) silt and sand coatings; moderate, medium, prismatic structure parting to weak, fine, subangular blocky; friable; few grayish-brown (2.5Y 5/2) clay films lining pores and root channels; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; strongly acid; gradual, smooth boundary.

IIB3t—36 to 53 inches, yellowish-brown (10YR 5/6) heavy loam; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; discontinuous light brownish-gray (10YR 6/2) coatings on prisms; white (10YR 8/1 dry) silt and sand coatings; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; few grayish-brown (2.5Y 5/2) clay films lining pores; most root channels filled with very dark gray (10YR 3/1) clay films; common dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; medium acid; gradual, smooth boundary.

IIC—53 to 72 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; firm; few dark reddish-brown (5YR 2/2) and yellowish-red (5YR 4/6) oxide concretions; few root channels have dark clay films; few small pebbles; slightly acid.

The thickness of loess is typically 24 to 34 inches, but ranges from 20 to 40 inches. The depth to carbonates ranges from 45 to 80 inches.

The Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick and neutral to medium acid in reaction.

The A2 horizon is dark grayish brown (10YR 4/2) or 2.5Y 4/2) and has few to common high-chroma mottles. It is 4 to 8 inches thick and medium acid or strongly acid in reaction.

The B horizon ranges from dark grayish brown (10YR 4/2) to grayish brown (2.5Y 5/2) and light olive brown (2.5Y 5/4) and has few to common contrasting mottles. It is light or medium silty clay loam. It is 12 to 20 inches thick and medium acid or strongly acid in reaction.

The IIB horizon ranges from strong brown (7.5YR 5/6) with few to common grayish mottles to grayish brown (2.5Y 5/2) with few to common high-chroma mottles. It ranges from loam to light clay and sandy clay loam. It is 18 to 36 inches thick and medium acid or strongly acid in reaction.

The IIC horizon has the same colors and textures as the IIB horizon but is slightly acid to mildly alkaline in reaction.

Franklin soils formed in parent material similar to that of Dinsdale, Klinger, and Maxfield soils. They have a thinner dark-colored A horizon than those soils. They have lower chroma in the B horizon than Dinsdale soils and higher chroma in the upper part of the B horizon than Maxfield soils.

Franklin silt loam, 1 to 3 percent slopes (761).—This soil is on broad ridge crests and long side slopes. Individual areas range from 3 to more than 100 acres in size.

Included with this soil in mapping are some areas that have dense gray clay below a depth of 20 to 36 inches, most of which are indicated by a spot symbol on the soil map. Near Grafton are a few areas that have a 0 to 1 percent slope.

This soil is moderate in organic-matter content and is well suited to row crops. It is susceptible to slight erosion if cultivated. Where tile drains are installed, drainage is generally improved. Capability unit I–2; woodland group 6.

Harcot Series

The Harcot series consists of poorly drained, strongly calcareous, nearly level soils on stream benches and low alluvial plains. These soils formed in 24 to 40 inches of loamy alluvial material over sand and gravel. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black and very dark gray loam about 20 inches thick. The subsoil extends to a depth of 33 inches. The upper part is gray loam that has common strong-brown mottles, and the lower part is strong-brown loam that has common light brownish-gray mottles. The substratum is pale-brown and light brownish-gray fine sand.

Harcot soils have moderate permeability in the loamy upper part and rapid to very rapid permeability in the sandy and gravelly lower part. They have moderate to low available water capacity. Their subsoil is very low in available phosphorus and seriously deficient in available potassium. These soils are moderately alkaline and do not need lime. In many places the supply of iron is not sufficient for soybeans.

Harcot soils are used mainly for row crops if drained. Wetness is the major limitation.

Representative profile of Harcot loam, 0 to 2 percent slopes, in a cultivated field 160 feet north and 85 feet west of the southeast corner sec. 11, T. 100 N., R. 21 W.

Apca—0 to 8 inches, black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak, very fine, granular structure; friable; violent effervescence; moderately alkaline; clear, smooth boundary.

A12ca—8 to 14 inches, black (N 2/0) loam, dark gray (10YR 4/1) dry; weak, fine, granular structure; friable; violent effervescence; moderately alkaline; clear, smooth boundary.

A3ca—14 to 20 inches, very dark gray (10YR 3/1) heavy loam, gray (10YR 5/1) dry; few, fine, distinct, brown (7.5YR 4/4) mottles; weak, medium, subangular blocky structure; friable; violent effervescence; moderately alkaline; clear, smooth boundary.

B2gca—20 to 27 inches, gray (10YR 5/1) heavy loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; few dark reddish-brown (5YR 2/2) oxide concretions; weak, medium, subangular blocky structure; friable; violent effervescence; moderately alkaline; clear, wavy boundary.

B3gca—27 to 33 inches, strong-brown (7.5YR 5/6) loam; few, fine, distinct, reddish-brown (2.5YR 5/4) and common, fine, distinct, light brownish-gray (2.5Y 6/2) mottles; few dark reddish-brown (5YR 2/2) oxide concretions; very weak, coarse, subangular blocky structure; friable; strong effervescence; mildly alkaline; clear, smooth boundary.

IIC1—33 to 40 inches, pale-brown (10YR 6/3) fine sand; few, fine, distinct, yellowish-brown (10YR 5/8) mottles; single grained; loose; slight effervescence; mildly alkaline; gradual, smooth boundary.

IIC2—40 to 60 inches, light brownish-gray (2.5YR 6/2) fine sand; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; single grained; loose; slight effervescence; mildly alkaline.

The depth to sand or gravel is 24 to 40 inches.

The Aca horizons range from black (10YR 2/1) to very dark gray (10YR 3/1) in the upper part and are generally very dark gray (10YR 3/1) in the lower part. The A horizon is typically loam, but in places is light clay loam and silt loam high in sand. It is 16 to 24 inches thick and moderately alkaline in reaction.

The B2gca horizon ranges from dark gray (10YR 4/1) to light olive gray (5Y 6/2) and has few to many high-chroma mottles. It is loam, light clay loam, or sandy clay loam 6 to 14 inches thick and moderately alkaline in reaction.

The B3gca horizon is mottled with colors ranging from strong brown (7.5YR 5/6) to gray (10YR 5/1) and light gray (5Y 6/1). It is loam, sandy loam, or sandy clay loam 0 to 8 inches thick. It is mildly alkaline or, in places, neutral in reaction.

The IIC horizon ranges from yellowish brown (10YR 5/6) to gray (5Y 5/1) with few to many distinct mottles. Texture of the IIC horizon ranges from loamy fine sand to gravelly sand. This horizon is typically mildly alkaline or, in places, neutral in reaction.

Harcot soils formed in parent material similar to that of Marshan and Talcot soils. They are moderately alkaline in the upper part of the solum, whereas Talcot soils are mildly alkaline and Marshan soils are neutral or slightly acid. They are in the same drainage class as Harps soils, but are underlain by sand or gravel, whereas those soils have a loam C horizon.

Harcot loam, 0 to 2 percent slopes (335).—This soil is on stream benches and low alluvial plains. Individual areas range from 2 to more than 100 acres in size.

Included with this soil in mapping are some areas that have a fine sandy loam surface layer and subsoil. Small depressions in a few places are indicated by spot symbols on the soil map.

This Harcot soil is high in organic-matter content and is well suited to row crops if properly tile drained. Undrained areas are well suited to pasture. Most of the acreage has been tile drained, but tile placement is difficult in some places because of loose, water-bearing sands. Some low areas are subject to flooding for short periods. Wetness is a hazard during rainy periods. Capability unit IIw–6; woodland group 13.

Harps Series

The Harps series consists of poorly drained, strongly calcareous, nearly level to very gently undulating soils

on rims and low ridges around and between depressions in the uplands. These soils formed in glacial sediment. Slopes are short and are 1 to 3 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is very dark gray loam about 21 inches thick. The subsoil extends to a depth of 40 inches. The upper part is dark-gray loam, and the lower part is light olive-gray loam that has strong-brown mottles in the lower part. The substratum is mottled gray, olive-gray, and yellowish-brown loam.

Harps soils have moderate permeability and high available water capacity. Their subsoil is very low in available phosphorus and seriously deficient in available potassium. These soils are moderately alkaline and do not need lime. In many places the supply of iron is not sufficient for soybeans, and the leaves commonly turn yellow early in the growing season.

Harps soils are used mainly for row crops. Wetness is the major limitation. About 45 percent of Harps soils are mapped as a complex with Okoboji soils.

Representative profile of Harps loam, 1 to 3 percent slopes, in a cultivated field 1,550 feet north and 360 feet east of the southwest corner sec. 36, T. 100 N., R. 22 W.

Apca—0 to 7 inches, very dark gray (10YR 3/1) heavy loam, gray (N 5/0) dry; cloddy parting to moderate, fine, granular structure; very friable; violent effervescence; moderately alkaline; clear, smooth boundary.

A12ca—7 to 14 inches, very dark gray (10YR 3/1) heavy loam, gray (N 5/0) dry; weak, medium, subangular blocky structure parting to moderate, fine, granular; friable; few, fine, distinct, brown (7.5YR 4/4) mottles in lower 3 inches; violent effervescence; moderately alkaline; gradual, smooth boundary.

A3ca—14 to 21 inches, very dark gray (10YR 3/1) heavy loam, light gray (10YR 6/1) dry; few, fine, distinct, reddish-brown (2.5YR 4/4) mottles; weak, medium, subangular blocky structure; friable; very few olive-brown (2.5Y 4/4) oxide concretions; violent effervescence; moderately alkaline; clear, wavy boundary.

B1gca—21 to 27 inches, dark-gray (10YR 4/1) heavy loam; few, fine, faint, olive-brown (2.5Y 4/4) mottles; weak, medium, subangular blocky structure; friable; violent effervescence; moderately alkaline; gradual, smooth boundary.

B2gca—27 to 40 inches, light olive-gray (5Y 6/2) heavy loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; friable; few, fine, red (2.5YR 4/6) oxide concretions; violent effervescence; moderately alkaline; clear, wavy boundary.

C1gca—40 to 47 inches, gray (5Y 5/1) loam; few, fine, distinct, light olive-brown (2.5Y 5/6) mottles; massive; friable; violent effervescence; moderately alkaline; clear, wavy boundary.

C2gca—47 to 72 inches, mottled olive-gray (5Y 5/2) and yellowish-brown (10YR 5/6) loam; massive; friable; few dark reddish-brown (5YR 2/2) oxide concretions; violent effervescence; moderately alkaline.

The Aca horizon is black (10YR 2/1) or very dark gray (10YR 3/1) in the upper part and generally very dark gray (10YR 3/1) in the lower part. It is typically heavy loam, but in places is light clay loam. It is 16 to 24 inches thick.

The Bgca horizon ranges from gray (5Y 5/1) to dark gray (10YR 4/1) in the upper part and grayish brown (10YR 5/2) to light olive gray (5Y 6/2) in the lower part. Mottles are distinct and range from few to many. This horizon is typically heavy loam 15 to 30 inches thick, but in places is light clay loam and sandy clay loam.

The Cgca horizon ranges from mottled olive gray (5Y 5/2) and yellowish brown (10YR 5/8) to gray (5Y 5/1). It is typically loam, but in places is sandy clay loam.

Harps soils formed in parent material similar to that of Canisteo and Webster soils. They have moderately alkaline A and B horizons, whereas Canisteo soils are mildly alkaline and Webster soils are neutral in the A and B horizon. They are in the same drainage class as Harcot soils, but have a loam IIC horizon, whereas those soils are underlain by sand or gravel.

Harps loam, 1 to 3 percent slopes (95).—This soil is on rims around and low ridges between depressions in the uplands. This soil has the profile described as representative of the series. Individual areas are irregular in shape and range from 2 to 30 acres in size. Included in mapping are small depressions and small sandy areas, which are indicated by spot symbols on the soil map.

This Harps soil is high in organic-matter content and well suited to row crops if it is properly tile drained. Undrained areas are well suited to pasture. It is susceptible to wetness during rainy seasons. Most areas have been tile drained. Capability unit IIw–6; woodland group 13.

Hayfield Series

The Hayfield series consists of somewhat poorly drained, nearly level soils on stream benches and in upland alluvial areas. These soils formed in 24 to 40 inches of loamy alluvial sediment and the underlying sand and gravel. Slopes are 0 to 2 percent. The native vegetation was trees and grasses.

In a representative profile the surface layer is very dark gray loam about 8 inches thick. The subsurface layer is mottled dark grayish-brown loam about 4 inches thick. The subsoil, which extends to a depth of 31 inches, is brown loam that has grayish-brown mottles in the upper part, mottled dark yellowish-brown and dark grayish-brown loam in the middle part, and brown gravelly sandy loam in the lower part. The substratum is brown medium and coarse sand.

Hayfield soils have moderate permeability in the loamy upper part ond rapid to very rapid permeability in the sandy and gravelly lower part. They have moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are acid unless limed during the past 5 years.

Hayfield soils are used mainly for row crops. Soils on the lower stream benches are subject to flooding for short periods. In years of below-normal rainfall, the moderately deep Hayfield soil is slightly droughty.

Representative profile of Hayfield loam, moderately deep, 0 to 2 percent slopes, in a cultivated field 95 feet east and 135 feet north of the corner post in the southwest corner SE¼ sec. 18, T. 99 N., R. 20 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) heavy loam; black (10YR 2/1) coatings on peds; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A2—8 to 12 inches, dark grayish-brown (10YR 4/2) heavy loam; common, fine, distinct, brown (7.5YR 4/4) and few, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, platy structure; friable; strongly acid; clear, smooth boundary.

B21—12 to 20 inches, brown (10YR 4/3) loam; few, fine, distinct, grayish-brown (10YR 5/2) mottles; dis-

continuous dark grayish-brown (10YR 4/2) coatings on peds; weak, fine, subangular blocky structure; friable; few dark reddish-brown (5YR 2/2) and strong-brown (7.5YR 5/6) oxide concretions; very strongly acid; gradual, smooth boundary.

B22—20 to 27 inches, mottled dark yellowish-brown (10YR 4/4) and dark grayish-brown (10YR 4/2) loam; weak, medium, subangular blocky structure; friable; few dark reddish-brown (5YR 2/2) and strong-brown (7.5YR 5/6) oxide concretions; few small pebbles in lower 3 inches; very strongly acid; clear, smooth boundary.

IIB3t—27 to 31 inches, brown (7.5YR 4/4) gravelly sandy loam; few, fine, distinct, grayish-brown (10YR 5/2) mottles; common dark reddish-brown (5YR 2/2) oxide concretions; weak, coarse, subangular blocky structure; very friable; clay bridges between sand grains; strongly acid; clear, wavy boundary.

IIC1—31 to 47 inches, brown (7.5YR 4/4) coarse sand; single grained; loose; few small pebbles; medium acid; gradual, smooth boundary.

IIC2—47 to 60 inches, brown (10YR 5/3) medium sand; single grained; loose; slightly acid.

The depth to sand or gravel is 24 to 40 inches.

The Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically loam but in places is silt loam high in sand. It is 6 to 9 inches thick and neutral or medium acid in reaction.

The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) loam or silt loam high in sand. It is 0 to 6 inches thick and medium acid or strongly acid in reaction.

The B horizon ranges from brown (10YR 4/3) to light olive brown (2.5Y 5/4) and has common to many grayish mottles and coatings on peds. It is loam or sandy clay loam 6 to 24 inches thick and is medium acid or very strongly acid in reaction.

The IIB3 and IIC horizons range from strong brown (7.5YR 5/6) to dark grayish brown (2.5Y 4/2) and have no to many mottles. They range from gravelly sand to sand and gravelly sandy loam. The IIB3 horizon is 0 to 10 inches thick and is medium acid or strongly acid in reaction. The IIC horizon is medium acid or slightly acid.

Hayfield soils formed in parent material similar to that of Wapsie and Lawler soils. They have lower chroma in the B horizon than Wapsie soils. They have a thinner dark-colored A horizon than Lawler soils.

Hayfield loam, deep, 0 to 2 percent slopes (726).—This soil is on stream benches and in upland alluvial areas. It has a profile similar to the one described as representative of the series, but it is underlain by sand or gravel at a depth of 32 to 40 inches in most places. Individual areas range from 2 to more than 10 acres in most places, but are more than 20 acres in size in some places.

Included with this soil in mapping are a few places that are underlain by sand or gravel at a depth of 40 to 60 inches. Most of these areas are in sections 1 and 2 of Barton Township. A few places south of Deer Creek in Barton Township have limestone bedrock below a depth of about 48 inches. Also included are a few sandy spots and wet areas, which are indicated by spot symbols on the soil map.

This Hayfield soil is moderate in organic-matter content and is well suited to row crops. Wetness delays fieldwork in some seasons. Some places are slightly droughty in years of below-normal rainfall. Very little of the acreage has been tile drained. In some years tile drainage improves timeliness of fieldwork, but tile placement is difficult in places because of loose, water-bearing sand. Capability unit I–2; woodland group 6.

Hayfield loam, moderately deep, 0 to 2 percent slopes (725).—This soil is on stream benches and in upland alluvial areas. It has the profile described as representative of the series. Individual areas range from 2 to 10 acres in most places but are more than 20 acres in size in some places. The soil is underlain by sand or gravel at a depth of 24 to 32 inches in most places. Included in mapping are a few wet areas and sandy spots, most of which are indicated by spot symbols on the soil map.

This Hayfield soil is moderate in organic-matter content and is well suited to row crops. Wetness delays fieldwork in some seasons. Very little of the acreage has been tile drained. In some years tile drainage improves timeliness of fieldwork. Tile placement is difficult in places because of loose, water-bearing sands. During extended dry periods this soil is slightly droughty. Capability unit IIs–1; woodland group 6.

Hoopeston Series

The Hoopeston series consists of somewhat poorly drained, nearly level soils. These soils are principally on stream benches, but are in the uplands in a few places. They formed in 24 to 45 inches of fine sandy loam overlying sand or gravel. Slopes are 0 to 2 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and dark-brown fine sandy loam about 20 inches thick. The subsoil, which extends to a depth of 38 inches, is dark grayish-brown, heavy loamy fine sand in the upper part and grayish-brown fine sandy loam in the lower part. The substratum is pale-brown loamy sand and sand that has few distinct brown mottles.

Hoopeston soils have moderately rapid permeability and moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 4 years.

Hoopeston soils are used mainly for row crops. The major limitations are slight droughtiness during prolonged dry periods and wetness during long wet periods.

Representative profile of Hoopeston fine sandy loam, 0 to 2 percent slopes, in a cultivated field 1,190 feet north and 110 feet east of the southeast corner NW¼ sec. 13, T. 100 N., R. 21 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) light fine sandy loam, grayish brown (10YR 5/2) dry; weak, very fine, granular structure; very friable; medium acid; clear, smooth boundary.

A12—9 to 13 inches, very dark brown (10YR 2/2) light fine sandy loam, grayish brown (10YR 5/2) dry; few, fine, faint, brown (10YR 4/3) mottles; weak, very fine, granular structure; very friable; strongly acid; clear, wavy boundary.

A3—13 to 20 inches, dark-brown (7.5YR 3/2) light fine sandy loam; common, medium, distinct, brown (7.5YR 4/4 and 10YR 5/3) mottles; weak, fine, subangular blocky structure; very friable; strongly acid; clear, wavy boundary.

B21—20 to 32 inches, dark grayish-brown (10YR 4/2) heavy loamy fine sand; few, fine, distinct, brown (7.5YR 4/4) and few, fine, faint, brown (10YR 5/3) mottles; very weak, medium, subangular blocky structure; very friable; strongly acid; clear, smooth boundary.

B22—32 to 38 inches, grayish-brown (2.5Y 5/2) fine sandy loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure; very friable; nearly continuous grayish-brown (2.5Y 5/2) coatings on prisms; strongly acid; clear, smooth boundary.
C1—38 to 55 inches, pale-brown (10YR 6/3) loamy sand; common, medium, distinct, brownish-yellow (10YR 6/6) mottles; massive; loose; medium acid; gradual, smooth boundary.
C2—55 to 76 inches, pale-brown (10YR 6/3) sand; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; massive; loose; few 1- to 2-inch, oval-shaped, gray silt loam inclusions throughout horizon; medium acid.

The depth of the underlying loamy sand or sand ranges from 20 to 40 inches.

The Ap and A12 horizons are very dark brown (10YR 2/2) or black (10YR 2/1), and the A3 horizon is dark brown (7.5YR 3/2 or 10 YR 3/3) or very dark grayish brown (10YR 3/2). The A horizon ranges from light to heavy fine sandy loam. It is 15 to 24 inches thick and neutral or strongly acid in reaction.

The B21 horizon ranges from dark grayish brown (10YR 4/2) with a few brown mottles to mottled brown (10YR 4/3) and dark grayish brown (10YR 4/2). It ranges from heavy fine sandy loam to loamy fine sand. It is 4 to 14 inches thick and medium acid or strongly acid in reaction.

The B22 horizon ranges from dark grayish brown (10YR 4/2) with a few brown mottles to grayish brown (10YR 5/2) with brown mottles. It is fine sandy loam or loamy fine sand 4 to 10 inches thick and is medium acid or strongly acid in reaction.

The C horizon ranges from pale brown (10YR 6/3) to grayish brown (10YR 5/2) and has contrasting mottles. It ranges from loamy fine sand to sand and is slightly acid or medium acid in reaction.

Hoopeston soils formed in parent material similar to that of Dickinson and Sparta soils. They have lower chroma in the B horizon than those soils, and contain less sand in the solum than Sparta soils.

Hoopeston fine sandy loam, 0 to 2 percent slopes (173).—This soil is on stream benches. A few areas are in the uplands. This soil has the profile described as representative of the series. Individual areas range from about 3 to more than 50 acres in size.

Included with this soil in mapping are a number of areas where the dark-colored surface layer is 6 to 10 inches thick and some areas where the substratum is gravelly below a depth of about 30 to 45 inches. Near the Winnebago River limestone bedrock is below a depth of 4 to 6 feet. Also, in a few areas thin silty lenses are below a depth of 40 inches.

This Hoopeston soil is moderately low in organic-matter content and is well suited to row crops. It is slightly susceptible to droughtiness in dry periods and to wetness during wet periods. Tile placement is difficult in places because of the loose, water-bearing sands. A few places are subject to stream flooding. Capability unit IIIs–1; woodland group 12.

Houghton Series

The Houghton series consists of very poorly drained, nearly level soils in depressions and level areas in the uplands and on stream benches and flood plains. These soils formed in 51 inches to more than 10 feet of organic material overlying stratified loamy mineral sediment. Slopes are 0 to 1 percent. The native vegetation was water-tolerant grasses and sedges.

In a representative profile the surface layer is black muck about 9 inches thick. The next layer, which extends to a depth of 65 inches, is dark-brown mucky peat in the upper part and black muck in the lower part. The substratum is gray silt loam that has many olive mottles and some thin lenses of loamy sand.

Houghton soils have moderately rapid permeability and very high available water capacity. The material below the surface layer is very low in available phosphorus and potassium. These soils are neutral and do not need lime.

Houghton soils are used mainly for row crops where properly tile drained. Most undrained areas are pastured. Wetness is the major limitation. In depressions early frost is a hazard. Undrained areas generally have a water table at or near the surface. Houghton muck is used in greenhouses and other places that have use for organic soil.

Representative profile of Houghton muck, 0 to 1 percent slopes, in a cultivated field 660 feet south and 660 feet west of the center sec. 32, T. 99 N., R. 22 W.

Oap—0 to 9 inches, black (N 2/0 broken face and rubbed) sapric material; about 6 percent fiber, trace when rubbed; weak, fine, granular structure; very friable; neutral; clear, smooth boundary.
Oa2—9 to 17 inches; dark-brown (7.5YR 3/2 broken face) sapric material; common fine black (10YR 2/1) particles, dark brown (10YR 2/2) rubbed; about 25 percent fiber, about 10 percent when rubbed; massive parting to thick platy fragments; very friable; neutral; clear, smooth boundary.
Oa3—17 to 46 inches, black (10YR 2/0 broken face, 10YR 2/1 rubbed) sapric material with many fine dark-brown (7.5YR 3/2) fibers; about 15 percent fiber, less than 5 percent when rubbed; massive parting to thick platy fragments; very friable; neutral; clear, smooth boundary; about 5 percent fibers, trace when rubbed; massive; very friable; neutral; clear, smooth boundary.
Oa4—46 to 65 inches, black (N 2/0 broken face and rubbed) sapric material; about 5 percent fibers, trace when rubbed; massive; very friable; neutral; clear, smooth boundary.
IIC1g—65 to 75 inches, greenish-gray (5GY 5/1) silt loam; many, medium, distinct, olive (5Y 4/4) mottles; massive; friable; mildly alkaline; clear, smooth boundary.
IIC2g—75 to 96 inches, gray (5Y 5/1) silt loam that has thin lenses of loamy sand; massive; friable; mildly alkaline.

The organic layers range from black (N 2/0) to dark brown (7.5YR 3/2 and 10YR 3/3) and are 51 inches to more than 10 feet thick. These layers are predominantly sapric materials. Some places have hemic layers and fibric layers in the control section. The hemic materials have a combined thickness of less than 10 inches, and fibric materials total less than 5 inches.

The IICg horizon ranges from black (N 2/0) to greenish gray (5GY 6/1) and olive gray (5Y 5/2) and has no to many high-chroma mottles. It is typically stratified and ranges from silty clay loam to loam, fine sandy loam, and sand. Thin mucky lenses are in places. Reaction is neutral or mildly alkaline.

Houghton soils formed in parent material similar to that of Palms soils, but in thicker organic deposits than those soils.

Houghton muck, 0 to 1 percent slopes (621).—This soil is in depressions in the uplands and in depressions and in level areas on the stream benches. It is on the flood plains in a few areas. The organic material ranges from 51 inches to more than 10 feet in thickness. Individual areas are generally somewhat circular, but a few are long and narrow. Some areas are surrounded

by Harps and Harcot soils. Undrained areas are hummocky unless they have been leveled. Individual areas range from 4 to more than 200 acres in size.

Included with this soil in mapping are a few areas that have black or very dark brown loam or silt loam layers 10 to 24 inches thick overlying the organic horizons. Some areas have calcareous organic layers.

This soil is very high in organic-matter content and is moderately suited to row crops if properly tile drained. Even if drained, however, it is susceptible to wetness and ponding after heavy rains and during spring thaws. There is danger of early frost in the fall. Undrained areas are poorly suited to pasture. Tile lines may be difficult to maintain because the tile is likely to settle. Capability unit IIIw–2; woodland group 14.

Kensett Series

The Kensett series consists of somewhat poorly drained, nearly level soils. These soils are principally on high and intermediate stream benches, but occupy low benches, first bottoms, and uplands in a few places. They formed in 24 to 40 inches of loamy material over limestone bedrock. Slopes are 0 to 2 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown silt loam and light silty clay loam about 13 inches thick. The subsoil extends to a depth of 30 inches. The upper part is dark grayish-brown light silty clay loam and olive-brown heavy loam that has olive-brown mottles, and the lower part is light olive-brown sandy loam that has a few pebbles. Below the subsoil is 2 to 3 feet of hard, shattered limestone over level-bedded limestone bedrock.

Kensett soils have moderate permeability and low to moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Kensett soils are used mainly for row crops and pasture. The major limitations are wetness during wet periods and some flooding on the lower terraces and first bottoms. In years of below-normal rainfall they may be somewhat droughty.

Representative profile of Kensett silt loam, 0 to 2 percent slopes, in a cultivated field 70 feet east and 150 feet south of the northwest corner NE¼ sec. 35, T. 99 N., R. 20 W.

Ap—0 to 8 inches, black (10YR 2/1) silt loam high in sand; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

A12—8 to 13 inches, very dark brown (10YR 2/2) light silty clay loam high in sand; weak, medium, subangular blocky structure parting to weak, fine and very fine, granular; friable; medium acid; gradual, smooth boundary.

B1—13 to 18 inches, dark grayish-brown (10YR 4/2) light silty clay loam; common, fine, distinct, olive-brown (2.5Y 4/4) mottles; very dark grayish-brown (10YR 3/2) coatings on peds; moderate, fine, subangular blocky structure; friable; few strong-brown (7.5YR 5/8) oxide concretions; medium acid; clear, wavy boundary.

B2—18 to 24 inches, olive-brown (2.5Y 4/4) heavy loam; discontinuous dark grayish-brown (2.5Y 4/2) coatings on peds; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; moderate, fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

B3—24 to 30 inches, light olive-brown (2.5Y 5/4) heavy sandy loam; weak, coarse, subangular blocky structure; very friable; common strong-brown (7.5YR 5/6) and dark reddish-brown (5YR 2/2) oxide concretions; neutral; clear, smooth boundary.

IIC—30 to 32 inches, yellowish-brown (10YR 5/6) loamy sand; single grained; loose; few small pebbles; neutral; abrupt, wavy boundary.

R—32 inches, shattered limestone bedrock.

The depth to limestone bedrock is 4 to 40 inches.

The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2). It ranges from loam to light clay loam and silt loam high in sand. It is 11 to 20 inches thick and neutral or medium acid in reaction.

The B1 horizon is typically dark grayish brown (10YR 4/2 or 2.5Y 4/2) and has darker ped coatings. It ranges from silt loam to clay loam. It is 3 to 6 inches thick and slightly acid or medium acid in reaction.

The B2 and B3 horizons range from light olive brown (2.5Y 5/4) with grayish mottles to dark grayish brown (2.5Y 4/2) with olive-brown (2.5Y 4/4) mottles. The B2 horizon ranges from loam to clay loam 5 to 8 inches thick, and the B3 horizon is loam or sandy loam 4 to 10 inches thick. Both horizons are slightly acid or neutral in reaction.

The IIC horizon ranges from yellowish brown (10YR 5/6) to olive brown (2.5Y 4/4) and has many to no grayish mottles. It ranges from loamy sand containing few pebbles to gravelly sand and cobblestones. It is 0 to 5 inches thick.

Kensett soils formed in parent material similar to that of Lawler, Rockton, and Faxon soils. They are underlain by limestone, whereas Lawler soils are underlain by sand and gravel. They have lower chroma in the B horizon than Rockton soils and typically have higher chroma in the B horizon than Faxon soils.

Kensett silt loam, 0 to 2 percent slopes (188).—This soil is level and slightly convex. Most areas are on stream benches. Included in mapping are areas underlain by limestone bedrock at a depth of 40 to 50 inches. Individual areas range from 2 to 10 acres in size.

This Kensett soil is high in organic-matter content and is well suited to row crops. It is slightly susceptible to wetness in wet seasons and to droughtiness in seasons of below-normal rainfall. Areas on first bottoms are occasionally flooded. In some years tile drainage improves timeliness of fieldwork. Tile installation or the construction of open ditches is difficult because of the moderate depth to limestone. Capability unit IIs–1; woodland group 6.

Kenyon Series

The Kenyon series consists of well drained and moderately well drained, nearly level to moderately sloping soils in the uplands. These soils formed in 13 to 20 inches of loamy material and the underlying glacial till. Slopes are 0 to 9 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loam about 13 inches thick. The subsoil, which extends to a depth of 46 inches, is brown loam in the upper part, yellowish-brown loam in the middle part, and yellowish-brown loam that has a few grayish mottles in the lower part. The substratum is mottled grayish-brown and strong-brown loam. There are a few pebbles in the middle and lower parts of the subsoil and in the substratum.

Kenyon soils have moderate permeability in the loamy upper part of the profile and moderately slow permeability in the underlying glacial till, which causes seepy spots in some years. They have high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Kenyon soils are used mainly for row crops. Providing both erosion control and adequate drainage is difficult because they conflict to some extent. The long, uniform slopes are well suited to contour cultivation and terracing. These practices, however, slow down movement of surface water and let more of it soak into the soil, which complicates drainage, especially in wet years.

Representative profile of Kenyon loam, 2 to 5 percent slopes, in a cultivated field 1,000 feet south and 1,035 feet east of the northwest corner SW¼ sec. 28, T. 98 N., R. 20 W.

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

A12—8 to 13 inches, very dark grayish-brown (10YR 3/2) loam; black (10YR 2/1) and very dark brown (10YR 2/2) coatings on peds; moderate, fine, subangular blocky structure parting to moderate, fine, granular; friable; medium acid; clear, wavy boundary.

B1—13 to 21 inches, brown (10YR 4/3) loam; few dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; friable; very few small pebbles; medium acid; clear, smooth boundary.

IIB2—21 to 31 inches, yellowish-brown (10YR 5/6) loam; discontinuous brown (10YR 4/3) coatings on prisms and peds; weak, medium, prismatic structure parting to weak, fine, subangular blocky; few strong-brown (7.5YR 5/8) and dark reddish-brown (5YR 2/2) oxide concretions; friable; few small pebbles; medium acid; gradual, smooth boundary.

IIB3—31 to 46 inches, yellowish-brown (10YR 5/6) loam; dark grayish-brown (10YR 4/2) and brown (10YR 4/3) coatings on prisms and peds; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; firm; few strong-brown (7.5YR 5/8) and dark reddish-brown (5YR 2/2) oxide concretions; few dark grayish-brown (2.5Y 4/2) clay films lining root channels; few small pebbles; neutral; clear, wavy boundary.

IIC—46 to 72 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/8) heavy loam; massive; firm; few small pebbles; few accumulations of dark-gray (10YR 4/1) clay in root channels at a depth of 60 to 67 inches; slight effervescence; mildly alkaline.

The depth to carbonates ranges from 45 to 66 inches.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is typically loam, but ranges to silt loam high in sand. It is 10 to 16 inches thick and neutral to medium acid in reaction.

The B1 horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). It is 4 to 10 inches thick.

The IIB horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/8). It is typically loam but in places is light clay loam and sandy clay loam. It is 20 to 30 inches thick. The IIB2 horizon is medium acid in reaction, and the IIB3 horizon is slightly acid or neutral. A few grayish mottles are below a depth of about 20 to 36 inches.

The IIC horizon ranges from yellowish brown (10YR 5/6) with a few grayish mottles to mottled grayish brown (2.5Y 5/2) to yellowish brown (10YR 5/6) or strong brown (7.5YR 5/8). It ranges from loam to light clay and sandy clay loam and is neutral or mildly alkaline in reaction. In some places there are lenses and pockets of sandy material.

These soils typically have a thinner B2 horizon and are less acid in the lower part of the B horizon than defined in the range for the series, but these differences do not alter their use or management.

Kenyon soils formed in parent material similar to that of Readlyn and Bassett soils. They have higher chroma in the upper part of the B horizon than Readlyn soils and typically have a thicker dark-colored A horizon than Bassett soils.

Kenyon loam, 0 to 2 percent slopes (83).—This soil is on broad ridge crests. Individual areas range from 3 to 20 acres in size.

Included with this soil in mapping are a few areas that have grayish mottles in the upper or middle parts of the subsoil and are slightly wetter and may need tile drainage. Also, a few sandy spots are indicated by spot symbols on the soil map.

This Kenyon soil is high in organic-matter content and is well suited to row crops. Wetness delays fieldwork in wet seasons. Capability unit I–1; woodland group 2.

Kenyon loam, 2 to 5 percent slopes (83B).—This soil is on long, slightly convex ridge crests and side slopes. This soil has the profile described as representative of the series. Individual areas range from 2 to 40 acres in size.

Included with this soil in mapping are a few areas of a more permeable soil. A few sandy areas and a few areas where there is dense, gray clay below a depth of 20 to 36 inches are indicated by spot symbols on the soil map.

This Kenyon soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight erosion if cultivated. A combination of terracing and tile drainage may be needed because providing adequate erosion control and drainage is difficult. Capability unit IIe–1; woodland group 2.

Kenyon loam, 5 to 9 percent slopes, moderately eroded (83C2).—This soil is on short, convex slopes below gently sloping areas of Kenyon and Bassett soils. It has a profile similar to the one described as representative of the series, but the surface layer is about 10 inches thick and not quite so dark in color. Individual areas range from 2 to 6 acres in size and are elongated and irregular.

Included with this soil in mapping are some areas of Bassett soils. In a few areas dense gray clay is below a depth of 20 to 36 inches. These areas are indicated by spot symbols on the soil map.

This Kenyon soil is moderate in organic-matter content and is well suited to row crops. It is susceptible to severe erosion if cultivated. A combination of terracing and tile drainage may be needed because providing adequate erosion control and drainage is difficult. Capability unit IIIe–1; woodland group 2.

Kilkenny Series

The Kilkenny series consists of well drained and moderately well drained, gently undulating to rolling soils in the uplands. These soils formed in 20 to 45 inches of moderately fine and fine silty materials and the underlying glacial till. Slopes are 2 to 14 percent.

Most are short. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil, which extends to a depth of 56 inches, is dark yellowish-brown heavy silty clay loam in the upper part and mottled brown and grayish-brown heavy silty clay loam in the lower part. The substratum is mottled grayish-brown, olive-brown, and brown loam and clay loam.

Kilkenny soils have moderately slow permeability and high available water capacity. The subsoil is medium in available phosphorus and very low in available potassium. These soils are generally acid unless limed during the past 5 years.

These soils are used mainly for row crops. Erosion and the poor tilth in eroded areas are the major limitations.

Representative profile of Kilkenny silty clay loam, 2 to 5 percent slopes, in a cultivated field 540 feet north and 75 feet west of the southeast corner NE¼ sec. 16, T. 100 N., R. 22 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) light silty clay loam, grayish brown (10YR 5/2) dry; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; slightly acid; clear, smooth boundary.

B1—8 to 14 inches, dark yellowish-brown (10YR 4/4) heavy silty clay loam; nearly continuous very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) coatings on peds; moderate, fine and very fine, subangular blocky structure; friable; few large sand grains; medium acid; clear, smooth boundary.

B21t—14 to 27 inches, dark yellowish-brown (10YR 4/4) heavy silty clay loam; discontinuous dark-brown (10YR 3/3) clay films on prism and ped faces and lining pores and root channels; moderate, fine and very fine, subangular blocky structure; firm; few very dark brown (10YR 2/2) accumulations in root channels, few large sand grains, few dark reddish-brown (5YR 3/3) clay films; yellowish-red (5YR 4/6) oxides; medium acid; gradual, smooth boundary.

B22t—27 to 43 inches, mottled brown (10YR 4/3) and grayish-brown (2.5Y 5/2) heavy silty clay loam; nearly continuous brown (10YR 4/3) and dark-brown (10YR 3/3) clay films on prism and ped faces; moderate, fine, prismatic structure parting to moderate, fine, subangular blocky; firm; few large sand grains; medium acid; gradual, smooth boundary.

IIC1—43 to 56 inches, mottled grayish-brown (2.5Y 5/2), olive-brown (2.5Y 4/4), and brown (7.5YR 4/4) clay loam; weak, coarse, subangular blocky structure; firm; dark reddish-brown (5YR 2/2) clay accumulations in some root channels; many yellowish-red (5YR 4/6) oxides; slightly acid; clear, wavy boundary.

IIC2—56 to 80 inches, mottled grayish-brown (2.5YR 5/2) and brown (7.5YR 4/4) medium loam; massive and horizontally stratified; friable; few low-chroma and high-chroma oxides; strong effervescence; mildly alkaline.

The thickness of the silty material ranges from 20 to 45 inches on the gently sloping uneroded areas and from 0 to 15 inches on the more sloping eroded areas. The depth to carbonates ranges from 34 to 64 inches.

The Ap horizon ranges from very dark gray (10YR 3/1) to dark brown (10YR 3/3). It is typically light silty clay loam, but in places is heavy silty clay loam, heavy silt loam, and clay loam. It is 6 to 10 inches thick and slightly acid or medium acid in reaction.

The A2 horizon, where present, is brown (10YR 4/3) or dark grayish brown (10YR 4/2) light silty clay loam or silt loam, 0 to 4 inches thick. It is slightly acid or medium acid in reaction. A few darker coatings are on the peds.

The B horizon ranges from brown (10YR 4/3) to light olive brown (2.5Y 5/4). It is typically heavy silty clay loam, but ranges from medium silty clay loam to light clay. It is 20 to 40 inches thick and medium acid or strongly acid in reaction. Thickness of the silty A and B horizons decreases with increasing slope. Olive colors and grayish mottles increase with increasing depth.

The IIB horizon ranges from dark yellowish brown (10YR 4/4) to olive brown (2.5Y 4/4) within about 24 inches of the surface and is mottled grayish brown (2.5Y 5/2) and olive brown (2.5Y 4/4) below. It ranges from light to heavy clay loam. It is 10 to 30 inches thick and neutral to medium acid in reaction. The IIC horizon ranges from olive brown (2.5Y 4/4) to mottled grayish brown (2.5Y 5/2) and brown (7.5YR 4/4) loam to light clay. It is slightly acid to mildly alkaline in reaction.

Kilkenny soils formed in parent material similar to that of Minnetonka and Shorewood soils, but have a thinner dark-colored A horizon and higher chroma in the upper part of the B horizon than those soils.

Kilkenny silty clay loam, 2 to 5 percent slopes (836B).—This gently undulating soil has short and irregular slopes. It is generally at a slightly higher elevation than Lester soils, with which it is associated. It has the profile described as representative of the series. Individual areas are irregular in shape and range from 2 to 25 acres in size. An estimated 8 percent is in timber and pasture.

Included with this soil in mapping are a few areas where the surface layer is clay loam and the surface layer and subsoil contain small shale particles. In a few places are large areas of a soil that has a fine-textured subsoil.

This Kilkenny soil is moderate in organic-matter content and is well suited to row crops. It is susceptible to slight and moderate erosion if cultivated. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. In some cuts the heavy silty clay loam subsoil is exposed, and this material is difficult to plow and cultivate. Capability unit IIe–1; woodland group 7.

Kilkenny silty clay loam, 2 to 5 percent slopes, moderately eroded (836B2).—This gently undulating soil has short and irregular slopes. It is generally at a slightly higher elevation than Lester soils, with which it is associated. It has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish-brown heavy silty clay loam. Individual areas are irregular in shape and range from 2 to 10 acres in size.

Included with this soil in mapping are some areas where the surface layer is clay loam and the surface layer and subsoil contain small shale particles. There are a few pebbles on the surface and in the subsoil in a few places.

This Kilkenny soil is moderately low in organic-matter content and is well suited to row crops. It is susceptible to severe erosion when cultivated. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. This soil is difficult to plow and cultivate. Capability unit IIe–1; woodland group 7.

Kilkenny silty clay loam, 5 to 9 percent slopes, moderately eroded (836C2).—This gently rolling soil has short and irregular slopes. It is generally at a slightly higher elevation than Lester soils, with which it is associated. It has a profile similar to the one described as representative of the series, but the surface layer is dark-brown heavy silty clay loam and the depth to the clay loam glacial till is about 20 inches. Individual areas range from 2 to 40 acres in size. An estimated 12 percent of the acreage is in timber and pasture.

Included with this soil in mapping are some areas where the surface layer is heavy clay loam and the surface layer and subsoil contain small shale particles. In a few small, severely eroded areas the surface layer is dark yellowish-brown heavy silty clay loam or clay loam. A few delineations have a black or very dark grayish-brown surface layer. A few pebbles are on the surface and in the subsoil in a few places.

This Kilkenny soil is moderately low in organic-matter content and is moderately suited to row crops. It is susceptible to severe erosion if cultivated and pastured. Contouring is difficult because the topography is irregular. In some places parallel terracing requires considerable cutting and filling. This soil is difficult to plow and cultivate. Capability unit IIIe–1; woodland group 7.

Kilkenny silty clay loam, 9 to 14 percent slopes, moderately eroded (836D2).—This rolling soil has short and irregular slopes. It is generally at a slightly higher elevation than Lester soils with which it is associated. This soil has a profile similar to the one described as representative of the series, but the surface layer is dark-brown heavy silty clay loam or heavy clay loam and the depth to loam or clay loam glacial till is about 10 to 15 inches. Individual areas range from 2 to 6 acres in size. An estimated 5 percent is in timber and pasture.

Included with this soil in mapping are small, severely eroded areas where the surface layer is dark yellowish-brown or olive-brown heavy silty clay loam or clay loam. A few pebbles and small shale particles are on the surface and in the subsoil in a few places.

This Kilkenny soil is moderately low in organic-matter content and is moderately to poorly suited to row crops. It is susceptible to severe erosion if cultivated and pastured. Contouring is difficult because the topography is irregular. In most places parallel terracing requires considerable cutting and filling. This soil is difficult to plow and cultivate. Capability unit IVe–2; woodland group 7.

Klinger Series

The Klinger series consists of somewhat poorly drained, nearly level and very gently sloping soils in the uplands. These soils formed in 20 to 40 inches of loess and the underlying glacial till. Slopes are long and are 1 to 3 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black silty clay loam about 18 inches thick. The subsoil extends to a depth of 45 inches. It is dark grayish-brown silty clay loam in the upper part, mottled dark grayish-brown and yellowish-brown silty clay loam in the middle part, and yellowish-brown loam mottled with grayish-brown in the lower part. The substratum is mottled grayish-brown and yellowish-brown loam.

Klinger soils have moderate permeability in the loess and moderately slow permeability in the glacial till. They have high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Klinger soils are used mainly for row crops. The major limitation for row crops is some wetness early in spring and during wet seasons. There is some erosion in the more sloping areas.

Representative profile of Klinger silty clay loam, 1 to 3 percent slopes, in a cultivated field 580 feet south and 180 feet east of the northwest corner NE¼ sec. 21, T. 98 N., R. 19 W.

Ap—0 to 8 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

A12—8 to 18 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

B1—18 to 23 inches, dark grayish-brown (2.5Y 4/2) light silty clay loam; nearly continuous very dark brown (10YR 2/2) coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B21—23 to 33 inches, mottled dark grayish-brown (2.5Y 4/2) and yellowish-brown (10YR 5/6) light silty clay loam; weak, medium, subangular blocky structure; friable; common dark reddish-brown (5YR 2/2) and yellowish-red (5YR 4/6) oxide concretions; medium acid; clear, smooth boundary.

IIB22t—33 to 45 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; discontinuous grayish-brown (2.5Y 5/2) sand coatings on prisms; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; dark grayish-brown (2.5Y 4/2) clay films lining some pores and root channels; common dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; slightly acid; gradual, smooth boundary.

IIC—45 to 60 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) heavy loam; massive; firm; common dark reddish-brown (5YR 2/2) oxide concretions; slightly acid.

The thickness of loess is typically 24 to 34 inches, but ranges from 20 to 40 inches. The depth to carbonates ranges from 45 to 65 inches.

The A horizon is black (10YR 2/1) in the upper part and ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) in the lower part. It is typically silty clay loam, but in places is silt loam. It is 16 to 22 inches thick and medium acid or slightly acid in reaction.

The B horizon ranges from light to medium silty clay loam. It is 10 to 15 inches thick.

The IIBt horizon ranges from yellowish brown (10YR 5/6) with dark grayish-brown (2.5Y 4/2) or grayish-brown (2.5Y 5/2) mottles to mottled dark grayish brown (2.5Y 4/2) and yellowish brown (10YR 5/6). The IIB22t horizon is loam or light clay loam. It is 4 to 20 inches thick and slightly acid or medium acid in reaction.

The IIC horizon ranges from loam to light clay loam and is slightly acid or mildly alkaline in reaction. In some places it is calcareous and mildly alkaline in the lower part.

Klinger soils formed in parent material similar to that of Dinsdale, Maxfield, and Franklin soils. They have lower chroma in the upper part of the B horizon than Maxfield soils. They have a thicker dark-colored A horizon than Franklin soils.

Klinger silty clay loam, 1 to 3 percent slopes (184).—This soil is on broad ridge crests and long side slopes. Individual areas range from 3 to more than 100 acres in size. Small areas of sandy soils are indicated by spot symbols on the soil map.

This Klinger soil is high in organic-matter content and is well suited to row crops. It is susceptible to wetness in wet seasons. The more sloping areas are subject to slight erosion. Where tile drains are installed, drainage is generally improved. Capability unit I–2; woodland group 6.

Lawler Series

The Lawler series consists of somewhat poorly drained, nearly level soils on stream benches and in upland alluvial areas. These soils formed in 24 to 40 inches of loamy material and the underlying sand and gravel. Slopes are 0 to 2 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown loam about 16 inches thick. The subsoil extends to a depth of 37 inches. It is dark grayish-brown loam in the upper part, light olive-brown loam that has common grayish-brown mottles in the middle part, and yellowish-brown sand that has a few grayish-brown and strong-brown mottles in the lower part. The substratum is yellowish-brown gravelly sand.

Lawler soils have moderate permeability in the upper part that formed in loamy material and rapid to very rapid permeability in the underlying sand and gravel. They have moderate to low available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Lawler soils are used mainly for row crops. On the lower parts of stream benches they are subject to flooding for short periods. On the moderately deep soils, the major limitation is slight droughtiness in years of below-normal rainfall.

Representative profile of Lawler loam, moderately deep, 0 to 2 percent slopes, in a cultivated field 200 feet north and 138 feet west of the southeast corner SW¼ sec. 28, T. 98 N., R. 21 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy loam; black (10YR 2/1) coatings on peds; weak, fine and very fine, granular structure; friable; neutral; clear, smooth boundary.

A12—8 to 16 inches, very dark brown (10YR 2/2) heavy loam; black (10YR 2/1) coatings on peds; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; medium acid; clear, wavy boundary.

B1—16 to 21 inches, dark grayish-brown (10YR 4/2) heavy loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; clear, wavy boundary.

B2—21 to 28 inches, light olive-brown (2.5Y 5/4) heavy loam; common, fine, faint, grayish-brown (2.5Y 5/2) mottles; discontinuous grayish-brown (2.5Y 5/2) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

IIB3—28 to 37 inches, yellowish-brown (10YR 5/4) sand; few, fine, distinct, grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) mottles; weak, coarse, subangular blocky structure; loose; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; medium acid; clear, smooth boundary.

IIC1—37 to 50 inches, yellowish-brown (10YR 5/6) gravelly sand; single grained; loose; estimated 15 percent gravel; neutral; clear, wavy boundary.

IIC2—50 to 60 inches, yellowish-brown (10YR 5/6) gravelly sand; single grained; loose; estimated 7 percent gravel; slight effervescence; mildly alkaline.

The depth to sandy or gravelly material ranges from 24 to 40 inches. The depth to carbonates ranges from 48 to more than 72 inches.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) in the lower part. It is typically loam, but in places is silt loam high in sand. It is 12 to 22 inches thick and neutral or medium acid.

The B1 horizon is typically dark grayish brown (10YR 4/2 or 2.5Y 4/2). It is 0 to 8 inches thick and has a few mottles in places.

The B2 horizon is typically light olive brown (2.5Y 5/4) and has few to common grayish-brown (2.5Y 5/2) mottles. It is typically heavy loam, but in places is sandy clay loam. It is 6 to 18 inches thick and medium acid or slightly acid in reaction.

The IIB3 and IIC horizons range from brown (10YR 4/3) to light olive brown (2.5Y 5/6) and have no to common mottles. These horizons range from medium and coarse sand to gravelly sand. The IIB3 horizon is 0 to 10 inches thick and medium acid or slightly acid. The IIC horizon is slightly acid to mildly alkaline in reaction.

Lawler soils formed in parent material similar to that of Saude, Waukee, Marshan, and Hayfield soils. They have lower chroma in the B horizon than Saude and Waukee soils and higher chroma in the B horizon than Marshan soils. They have a thicker dark-colored A horizon than Hayfield soils.

Lawler loam, deep, 0 to 2 percent slopes (226).—This soil is on stream benches and upland alluvial areas. It has a profile similar to the one described as representative of the series, but it is underlain by sand or gravel at a depth of 32 to 40 inches in most places. Individual areas range from 2 to more than 60 acres. Included with this soil in mapping are a few places that are underlain by sand or gravel at a depth of 40 to 60 inches.

This Lawler soil is high in organic-matter content and is well suited to row crops. Some places are slightly droughty in years of below-normal rainfall. Wetness delays fieldwork in some seasons. Very little of the acreage has been tile drained. In some years tile drainage improves the timeliness of fieldwork, but tile placement is difficult in some places because of loose, water-bearing sands. Capability unit I–2; woodland group 6.

Lawler loam, moderately deep, 0 to 2 percent slopes (225).—This soil is on stream benches and in upland alluvial areas. It has the profile described as representative of the series. Individual areas range from 2 to more than 60 acres in size.

Depth to sand or gravel varies from 24 to 32 inches in most places. Included with this soil in mapping are a few sandy spots that are indicated by spot symbols on the soil map.

This Lawler soil is high in organic-matter content and is well suited to row crops. During extended dry periods it is somewhat droughty. Wetness delays fieldwork in some seasons. Very little of the acreage has been tile drained. In some years tile drainage improves the timeliness of fieldwork, but tile placement may be difficult in some places because of loose, water-bearing sands. Capability unit IIs–1; woodland group 6.

Lester Series

The Lester series consists of well-drained, gently undulating to steep soils in the uplands. These soils formed in glacial till that generally has a slight increase in sand below a depth of about 12 to 25 inches. Slopes are short and range from 2 to 25 percent. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is very dark brown loam about 7 inches thick. The subsoil extends to a depth of 42 inches. The upper 29 inches is dark yellowish-brown loam and light clay loam. The lower part is light olive-brown light clay loam. The substratum, to a depth of about 48 inches, is yellowish-brown loam. Below this is mottled yellowish-brown and grayish-brown loam.

Lester soils have moderate permeability and high available water capacity. Their subsoil is medium in available phosphorus and very low in available potassium. These soils are generally acid unless limed during the past 5 years.

The gently undulating to rolling soils are used chiefly for crops, the hilly soils are used for crops and pasture, and the steep soils are used for pasture and timber. Erosion is the major limitation.

Representative profile of Lester loam, 2 to 5 percent slopes, in a cultivated field 595 feet south and 30 feet west of the northeast corner NW¼ sec. 11, T. 100 N., R. 22 W.

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam, black (10YR 2/1) coatings on peds; weak, fine and very fine, granular structure; friable; slightly acid; clear, smooth boundary.

B1—7 to 13 inches, dark yellowish-brown (10YR 4/4) heavy loam, brown (10YR 4/3) coatings on peds; few light brownish-gray (10YR 6/2 dry) silt and sand coatings; weak, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t—13 to 22 inches, dark yellowish-brown (10YR 4/4) light clay loam, brown (10YR 4/3) coatings on peds; very fine prismatic structure parting to weak, fine, subangular blocky; friable; thin patchy dark-brown (10YR 3/3) clay films on prism and ped faces; slightly acid; gradual, smooth boundary.

B22t—22 to 29 inches, dark yellowish-brown (10YR 4/4) light clay loam, brown (10YR 4/3) coatings on prisms and peds; weak, fine, prismatic structure parting to weak, medium, subangular blocky; friable; few dark-brown (10YR 3/3) clay films on prism and ped faces; few small pebbles; slightly acid; clear, wavy boundary.

B31t—29 to 36 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, medium, prismatic structure parting to weak, coarse, subangular blocky; friable; few, thin, patchy, dark-brown (10YR 3/3) clay films on prism faces; few small pebbles; slightly acid; clear, wavy boundary.

B32t—36 to 42 inches, light olive-brown (2.5Y 5/4) light clay loam; weak, medium, prismatic structure; friable; few dark-brown (10YR 3/3) patchy clay films on prism faces and some dark reddish-brown (5YR 2/2) clay films lining root channels; common dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; neutral; clear, wavy boundary.

C1—42 to 48 inches, yellowish-brown (10YR 5/4) light loam; massive; friable; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; slight effervescence; mildly alkaline; clear, wavy boundary.

C2—48 to 72 inches, mottled yellowish-brown (10YR 5/4 and 5/8) and grayish-brown (2.5Y 5/2) loam; massive; friable; dark reddish-brown (5YR 2/2) clay films lining few root channels; violent effervescence; mildly alkaline.

The depth to carbonates is 30 to 48 inches.

The Ap horizon ranges from black (10YR 2/1) to dark brown (10YR 3/3). It is 6 to 9 inches thick and slightly acid or medium acid in reaction.

If an A2 horizon is present, it is brown (10YR 4/3) or dark grayish brown (10YR 4/2). It is 0 to 4 inches thick and slightly acid or medium acid in reaction.

The B horizon ranges from brown (10YR 4/3) or dark yellowish brown (10YR 4/4) in the B1 and B2t horizons to dark yellowish brown (10YR 4/4) or light olive brown (2.5Y 5/4) in the B3t horizon. It is typically loam or light clay but in places has thin strata of sandy loam. It is 24 to 40 inches thick and slightly acid or medium acid in reaction except in the lower part of the B3 horizon, which is slightly acid or neutral.

The C horizon is typically yellowish brown (10YR 5/4), but ranges from brown (10YR 5/3) to light yellowish brown (2.5Y 6/4). It is typically loam but in places is light clay loam. There are pockets of sandy material in some places. Few to common grayish mottles are below a depth of 45 to 60 inches.

Lester soils formed in parent material similar to that of Clarion, Le Sueur, and Storden soils. They have a thinner dark-colored A horizon than Clarion soils and higher chroma in the B horizon than Le Sueur soils. They are more acid and deeper over carbonates than Storden soils.

Lester loam, 2 to 5 percent slopes (236B).—This soil has short and irregular slopes. It has the profile described as representative of the series. Individual areas are irregular in shape and generally range from 2 to 6 acres in size. An estimated 5 percent is in timber or pasture.

Included with this soil in mapping are small depressions and sandy or gravelly spots indicated by spot symbols on the soil map. There are also a few nearly level areas. Also in some timbered areas the surface layer ranges from very dark gray to dark brown and is 2 to 6 inches thick.

This Lester soil is moderate in organic-matter content and is well suited to row crops. The erosion hazard is slight or moderate in cultivated areas. Contouring is difficult because the topography is irregular. In places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIe–1; woodland group 2.

Lester loam, 2 to 5 percent slopes, moderately eroded (236B2).—This soil has short and irregular slopes. It has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown. Individual areas are irregular in shape and are generally 2 to 6 acres in size.

Included with this soil in mapping are wet spots and depressions and sandy or gravelly spots, all of which are indicated by spot symbols on the soil map.

This soil is moderately low in organic-matter content but is moderately suited to well suited to row crops. It is susceptible to erosion if cultivated. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIe–1; woodland group 2.

Lester loam, 5 to 9 percent slopes (236C).—This soil has short and irregular slopes. Individual areas are irregular in shape and about 2 to 7 acres in size. An estimated 65 percent is in timber or pasture.

Included with this soil in mapping are a few sandy or gravelly spots that are identified by spot symbols on the soil map. Also, some timbered areas have a very dark gray to dark-brown surface layer 2 to 6 inches thick.

This Lester soil is moderate in organic-matter content and is well suited to row crops. The erosion hazard is moderate in intensively cultivated or pastured areas. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIIe–1; woodland group 2.

Lester loam, 5 to 9 percent slopes, moderately eroded (236C2).—This soil has short and irregular slopes. It has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown and dark brown. Individual areas are irregular in shape and about 2 to 7 acres in size.

Included with this soil in mapping are some areas of severely eroded Lester soil that have a dark yellowish-brown surface layer. There are also some areas of Storden soil and some sandy and gravelly spots that are indicated by spot symbols on the soil map.

This Lester soil is moderately low in organic-matter content, but is moderately suited to well suited to row crops. The erosion hazard is severe in intensively cultivated or pastured areas. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIIe–1; woodland group 2.

Lester loam, 9 to 14 percent slopes, moderately eroded (236D2).—This soil is on short and irregular slopes, mainly below less sloping Lester soils. It has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown and dark brown. Individual areas are irregular in shape and 2 to 6 acres in size. An estimated 20 percent is in timber.

Included with this soil in mapping are some severely eroded areas that have a dark yellowish-brown surface layer. A few areas of Clarion soils are also included. In some timbered areas the surface layer is very dark gray to dark brown and is 2 to 6 inches thick. A few sandy and gravelly spots are indicated by spot symbols on the soil map.

This Lester soil is moderately low in organic-matter content, but is moderately suited to well suited to row crops. The erosion hazard is severe in intensively cultivated or pastured areas. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IIIe–1; woodland group 2.

Lester loam, 14 to 18 percent slopes, moderately eroded (236E2).—This soil is on short and irregular slopes mainly below less sloping Lester and Kilkenny soils. It has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown and dark brown in cultivated areas. Individual areas are irregular in shape and are generally 2 to 15 acres in size.

Included with this soil in mapping are areas of Kilkenny soils, which make up about 30 percent of the total acreage. In some of the timbered areas the surface layer is very dark gray to dark brown and 2 to 6 inches thick.

This Lester soil is moderately low in organic-matter content and is poorly suited to row crops. An estimated 33 percent of the acreage is in timber or pasture. The erosion hazard is severe in cultivated or pastured areas. Contouring is difficult because the topography is irregular. In some places parallel terracing requires a considerable amount of cutting and filling. Capability unit IVe–1; woodland group 2.

Lester loam, 18 to 25 percent slopes (236F).—This soil has short slopes and is mostly on escarpments adjacent to streams or lake beds and below areas of less sloping Lester or Kilkenny soils. Individual areas generally range from 3 to 25 acres in size. About 96 percent is in timber or pasture. Included in mapping are areas of Kilkenny soils, which make up about 38 percent of the total acreage.

This Lester soil is moderate in organic-matter content and is not suited to row crops. The erosion hazard is moderate and severe in cultivated or pastured areas. Capability unit VIe–1; woodland group 4.

Le Sueur Series

The Le Sueur series consists of somewhat poorly drained, nearly level and very gently undulating soils in the uplands. These soils formed in glacial till that generally increases slightly in content of sand below a depth of about 12 to 25 inches. Slopes are 1 to 3 percent and most are short. The native vegetation was trees and grasses.

In a representative profile the surface layer is very dark gray loam about 8 inches thick. The subsurface layer is dark grayish-brown loam about 4 inches thick. The subsoil extends to a depth of 36 inches. It is mottled olive-brown and dark grayish-brown light clay loam in the upper part, dark grayish-brown loam that has olive-brown mottles in the middle part, and light olive-brown loam that has grayish-brown and yellowish-brown mottles in the lower part. The substratum is light olive-brown loam mottled with yellowish brown and grayish brown.

Le Sueur soils have moderate permeability and high available water capacity. Their subsoil is medium in available phosphorus and very low in available potassium. These soils are generally acid unless limed during the past 5 years.

Le Sueur soils are used mainly for row crops. The major limitation is wetness early in spring and during wet seasons. There is some erosion where the longer slopes approach 3 percent.

Representative profile of Le Sueur loam, 1 to 3 percent slopes, in a cultivated field 860 feet west and 65 feet north of the southeast corner NE¼ sec. 28, T. 100 N., R. 21 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) loam; gray (5Y 5/1) dry; moderate, fine and very fine, granular structure; friable; slightly acid; clear, smooth boundary.

A2—8 to 12 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish-brown (10YR 3/2) coatings on peds; light brownish-gray (10YR 6/2 dry) silt and sand coatings; weak, thin, platy structure parting to weak, fine, subangular blocky; friable; little mix-

ing of olive brown (2.5Y 4/4); medium acid; clear, wavy boundary.

B21t—12 to 19 inches, mottled olive-brown (2.5Y 4/4) and dark grayish-brown (2.5Y 4/2) light clay loam; common very dark gray (10YR 3/1) and dark-gray (10YR 4/1) clay films on prism and ped faces and lining pores and root channels; few light brownish-gray (10YR 6/2) silt and sand coatings; moderate, fine, prismatic structure parting to moderate, fine, subangular blocky; friable; very few strong-brown (7.5YR 5/6) oxide concretions; few small pebbles; medium acid; clear, wavy boundary.

B22t—19 to 29 inches, dark grayish-brown (2.5Y 4/2) loam; many, fine, faint, olive-brown (2.5Y 4/4) mottles; few very dark gray (10YR 3/1) clay films on prism and ped faces and lining pores and root channels; weak, fine, prismatic structure parting to weak, medium, subangular blocky; friable; few yellowish-red (5YR 5/6) oxide concretions; few small pebbles; medium acid; gradual, smooth boundary.

B3—29 to 36 inches, light olive-brown (2.5Y 5/6) loam; common, fine, distinct, grayish-brown (2.5Y 5/2) and few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, medium, subangular blocky structure; friable; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; neutral; clear, wavy boundary.

C—36 to 60 inches, light olive-brown (2.5Y 5/4) loam; common, fine, distinct, yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) mottles; massive; friable; few red (2.5YR 5/6) oxide concretions; few small pebbles; violent effervescence; mildly alkaline.

The depth to carbonates is 24 to 48 inches.

The Ap horizon ranges from very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and very dark grayish brown (10 YR 3/2). It is typically loam but in places is silt loam high in sand. It is 6 to 8 inches thick and slightly acid or medium acid in reaction.

The A2 horizon is dark grayish brown (10YR 4/2). It is typically loam but in places is silt loam high in sand. It is 2 to 6 inches thick and slightly acid or medium acid in reaction. Few to many dark coatings are on peds.

The Bt horizon ranges from olive brown (2.5Y 4/4) with grayish-brown (2.5Y 5/2) mottles to olive (5Y 5/3) with yellowish-brown (10YR 5/6) mottles. It ranges from loam to light clay loam and sandy clay loam that are slightly acid or medium acid in reaction.

The C horizon is light olive brown (2.5Y 5/4) with few to many grayish-brown (2.5Y 5/2) mottles and no to common yellowish-brown (10YR 5/6) mottles. It ranges from loam to sandy clay loam and sandy loam.

These soils have a thinner dark-colored A horizon than is defined in the range for the series, but this does not alter their use or management.

Le Sueur soils formed in parent material similar to that of Lester and Nicollet soils. They have lower chroma in the upper part of the B horizon than Lester soils, and a thinner dark-colored A horizon than Nicollet soils.

Le Sueur loam, 1 to 3 percent slopes (325).—This soil has slightly convex to slightly concave slopes. Individual areas are generally small and irregularly shaped. Included in mapping are some small, very poorly drained depressions that are indicated by spot symbols on the soil map. An estimated 5 percent of the acreage is in timber.

This Le Sueur soil is moderate in organic-matter content and is well suited to row crops. It is susceptible to slight wetness in rainy seasons. Where tile drains are installed, drainage is generally improved. Capability unit I–2; woodland group 6.

Marsh

Marsh (354) is on flats or in depressions in the uplands and on first bottoms and stream benches. Because Marsh is flooded most of the time, the soil material has not been examined. The material in the uplands has been identified as Palms and Houghton muck. Marsh created by manmade structures is on the lower terraces and between the artificial ponds or lakes and the uplands. The water table is at or near the surface.

Marsh is intermixed with ponds, intermittent ponds, and shallow lakes. It remains wet the year around. The natural vegetation is cattails, rushes, sedges, and other water-tolerant grasses. In areas that have been flooded since the dams were built, the prairie grasses and trees have died or are dying.

Marsh has little value for farming. In dry years some areas are used for hay and pasture. Many areas provide important habitat for waterfowl, muskrat, and other wetland wildlife (fig. 12). Capability unit VIIw–1; woodland group 14.

Marshan Series

The Marshan series consists of poorly drained, nearly level soils on stream benches and upland alluvial plains. In places these soils are in depressions. They formed in 24 to 40 inches of loamy alluvial sediment over sand and gravel. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black clay loam and very dark gray silty clay loam about 21 inches thick. The subsoil, which extends to a depth of 33 inches, is gray silty clay loam in the upper part and olive sandy clay loam in the lower part. The substratum is grayish-brown gravelly loamy sand and gray sand.

Marshan soils have moderate permeability in the loamy upper part and rapid to very rapid permeability in the sandy and gravelly lower part. They have moderate to low available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are neutral or slightly acid and seldom need liming.

Marshan soils are used mainly for row crops where tile drained. Most depressions are undrained. Wetness is the major limitation.

Marshan clay loam, deep, 0 to 2 percent slopes, in a cultivated field 100 feet north and 100 feet west of the southeast corner sec. 36, T. 99 N., R. 21 W.

Ap—0 to 8 inches, black (N 2/0) light clay loam; weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

A12—8 to 16 inches, black (N 2/0) light clay loam; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; neutral; clear, smooth boundary.

A3g—16 to 21 inches, very dark gray (10YR 3/1) light silty clay loam; few, fine, distinct, light olive-brown (2.5Y 5/4) mottles in lower 2 inches; weak, fine, subangular blocky structure; friable; neutral; gradual, smooth boundary.

B2g—21 to 28 inches, gray (5Y 5/1) light silty clay loam; few, fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak, medium, subangular blocky structure; friable; few yellowish-red (5YR 4/8) oxide concretions; neutral; clear, smooth boundary.

B3g—28 to 33 inches, olive (5Y 5/3) light sandy clay loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few yellowish-red (5YR 4/8) oxide con-

Figure 12.—**Area of Marsh in Worth County.**

cretions; few small pebbles; neutral; clear, smooth boundary.

IIC1g—33 to 38 inches, grayish-brown (2.5Y 5/2) gravelly loamy sand; common, fine, distinct, strong-brown (7.5YR 5/8) mottles; massive; very friable; common yellowish-red (5YR 4/8) oxide concretions; mildly alkaline; few pebbles; clear, smooth boundary.

IIC2—38 to 60 inches, gray (5Y 5/1) fine and medium sand; single grained; loose; few high-chroma mottles; few very small pebbles; neutral.

The depth to sand or gravel ranges from 24 to 40 inches. The depth to carbonates ranges from 48 to more than 72 inches.

The A horizon ranges from black (N 2/0 or 10YR 2/1) in the upper part to very dark gray (10YR 3/1) in the lower part. It is typically light clay loam, but in places is silty clay loam high in sand. It is 14 to 24 inches thick and neutral or slightly acid in reaction.

The B2g horizon ranges from gray (N 5/0) to olive gray (5Y 4/2) and has few to common mottles. It ranges from light silty clay loam to loam and clay loam and is 6 to 14 inches thick.

The B3g horizon ranges from dark gray (5Y 4/1) to yellowish brown (10YR 5/6) and has few to many mottles. It ranges from loam to sandy clay loam and sandy loam and is 0 to 8 inches thick.

The IIC horizon ranges from olive yellow (2.5Y 6/6) to gray (5Y 4/1) and has few to many mottles. It ranges from loamy sand to gravelly sand.

Marshan soils formed in material similar to that of Talcot and Lawler soils. They are neutral or slightly acid in the solum, whereas Talcot soils are mildly alkaline. They have lower chroma in the B horizon than Lawler soils.

Marshan clay loam, deep, 0 to 2 percent slopes (152).—This soil is on stream benches and in upland alluvial areas. It has the profile described as representative of the series. The depth to sand or gravel is 32 to 40 inches in most places. Individual areas range from 3 to 40 acres in size in most places, but some are more than 100 acres.

Included with this soil in mapping are a few places that are underlain by sand or gravel at a depth of 40 to 60 inches. A few areas have small depressions that are indicated by spot symbols on the soil map.

This Marshan soil is high in organic-matter content and is well suited to row crops if it is properly drained. Even if drained, however, it is susceptible to wetness during rainy seasons. Most areas have been tile drained. Undrained areas are well suited

to pasture. Tile placement is difficult in some places because of loose, water-bearing sands. Some low areas are subject to flooding for short periods. Capability unit IIw–1; woodland group 13.

Marshan clay loam, moderately deep, 0 to 2 percent slopes (151).—This soil is on stream benches and in upland alluvial areas. It has a profile similar to the one described as representative of the series, but the depth to sand or gravel is 24 to 32 inches in most places. Most individual areas range from 3 to 40 acres in size, but some are more than 100 acres.

Included with this soil in mapping are a few places that are underlain by sand or gravel at a depth of 16 to 24 inches. A few areas have small depressions that are indicated by spot symbols on the soil map.

This Marshan soil is high in organic-matter content and is well suited to row crops if it is properly drained. Even if drained, however, it is susceptible to wetness during rainy seasons. Most areas have been tile drained. Undrained areas are well suited to pasture. Tile placement is difficult in some places because of loose, water-bearing sands. Some low areas are subject to flooding for short periods. Capability unit IIw–1; woodland group 13.

Marshan clay loam, depressional, 0 to 1 percent slopes (153).—This soil is in depressional areas on nearly level stream benches and in upland alluvial areas. Individual areas generally range from 2 to 4 acres in size.

The depth to sand or gravel is 32 to 40 inches in most places but ranges from 24 to 40 inches. Included with this soil in mapping are some areas where the surface layer is dark colored and 24 to 30 inches thick.

This Marshan soil is high in organic-matter content and is well to moderately suited to row crops if it is properly drained. It is susceptible to wetness and ponding. In undrained areas, the water table is within a few inches of the surface most of the year during years of normal rainfall, and the soil is poorly suited to pasture. Tile placement is difficult in some places because of loose, water-bearing sands. Some low areas are subject to flooding and ponding for prolonged periods. Capability unit IIIw–1; woodland group 13.

Maxfield Series

The Maxfield series consists of poorly drained, nearly level soils in the uplands. These soils formed in 20 to 40 inches of loess and the underlying glacial till. Slopes are 0 to 2 percent. The native vegetation was water-tolerant prairie grasses.

In a representative profile the surface layer is black silty clay loam about 20 inches thick. The subsoil extends to a depth of 49 inches. It is mottled dark-gray and olive silty clay loam in the upper part, mottled yellowish-brown and dark-gray loam in the middle part, and mottled strong-brown and grayish-brown loam in the lower part. The substratum is gray loam that has light olive-brown and yellowish-brown mottles. A few small pebbles are in the middle and lower parts of the subsoil and in the substratum.

Maxfield soils have moderate permeability in the loess and moderately slow permeability in the glacial till. They have high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are neutral or slightly acid and seldom need liming.

Maxfield soils are used mainly for row crops. Wetness is the major limitation.

Representative profile of Maxfield silty clay loam, 0 to 2 percent slopes, 200 feet south and 335 feet west of corner post in the northeast corner SE¼NE¼ sec. 24, T. 98 N., R. 19 W.

Ap—0 to 9 inches, black (N 2/0) silty clay loam; cloddy parting to weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

A12—9 to 20 inches, black (N 2/0) silty clay loam; common, fine, distinct, olive (5Y 5/3) mottles and a few yellowish-brown (10YR 5/6) oxide concretions below a depth of 17 inches; moderate, very fine, granular structure; friable; neutral; gradual, smooth boundary.

B1g—20 to 27 inches, mottled dark-gray (5Y 4/1) and olive (5Y 4/3) light silty clay loam; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

11B21g—27 to 31 inches, mottled yellowish-brown (10YR 5/6) and dark-gray (10YR 4/1) loam; discontinuous dark-gray (5Y 4/1) coatings on prisms and peds; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; few black (10YR 2/1) organic coatings lining root channels; few small pebbles; neutral; clear, wavy boundary.

IIB22g—31 to 39 inches, mottled strong-brown (7.5Y 5/6) and grayish-brown (2.5Y 5/2) loam; early continuous dark-gray (5Y 4/1) coatings on prisms and discontinuous grayish-brown (2.5Y 5/2) coatings on peds; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; few small pebbles; neutral; clear, wavy boundary.

IIB3—39 to 49 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown (2.5Y 5/2) loam; discontinuous grayish-brown (2.5Y 5/2) coatings on prisms; few dark reddish-brown (5YR 2/2) and yellowish-red (5YR 4/8) oxide concretions; weak, medium, prismatic structure; firm; few small pebbles; neutral; clear, wavy boundary.

IICg—49 to 72 inches, gray (5Y 5/1) loam; common, fine, distinct, light olive-brown (2.5Y 5/4) and yellowish-brown (10YR 5/6) mottles; few dark reddish-brown (5YR 2/2) oxide concretions; massive; firm; few, small, hard limestone concretions; few small pebbles; strong effervescence; milky alkaline.

The thickness of loess is typically 24 to 34 inches, but it ranges from 20 to 40 inches. The depth to carbonates ranges from 40 to 56 inches.

The A horizon is black (N 2/0) in the upper part and black (N 2/0 or 10YR 2/1) to very dark gray (10YR 3/1) in the lower part. It is 15 to 24 inches thick and neutral or slightly acid in reaction.

The Bg horizon ranges from dark gray (5Y 4/1) with olive (5Y 4/3 or 5Y 5/3) mottles to olive (5Y 5/3) with gray mottles. It is 5 to 20 inches thick.

The IIBg horizon ranges from olive gray (5Y 5/2) with a few yellowish-brown (10YR 5/6) mottles to mottled strong brown (7.5YR 5/6) and gray (5Y 5/1). It ranges from loam to light clay loam or sandy clay loam and is 12 to 24 inches thick.

The IICg horizon has soil colors and textures similar to those of the IIBg horizon.

Maxfield soils formed in parent material similar to that of Klinger, Franklin, and Dinsdale soils. They typically have lower chroma in the upper part of the B horizon than the somewhat poorly drained Klinger and Franklin soils and the well-drained Dinsdale soils. They have a thicker dark-colored A horizon than Franklin soils.

Maxfield silty clay loam, 0 to 2 percent slopes (382).—This soil is on long, slightly concave to slightly convex

slopes in the uplands. Individual areas range from 3 to 300 acres in size. The larger areas are located on the higher landscape positions.

Included with this soil in mapping are small sandy areas and some areas where a dense gray clay layer is below a depth of 20 to 36 inches. Some of these areas are indicated by spot symbols on the soil map.

This Maxfield soil is high in organic-matter content and is well suited to row crops if properly tile drained. It is susceptible to wetness after heavy rains and during wet seasons. Most areas have been tile drained. Undrained areas are well suited to pasture. Capability unit IIw–1; woodland group 13.

Minnetonka Series

The Minnetonka series consists of poorly drained, nearly level to very gently undulating soils in the uplands. These soils occupy drainageways, lower concave slopes, and low-lying, slightly convex slopes. They formed in fine and moderately fine silty sediment. Slopes are 1 to 3 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black silty clay loam about 19 inches thick. The subsoil extends to a depth of 52 inches. It is very dark gray silty clay in the upper part, olive-gray silty clay that has common olive-brown mottles in the middle part, and pale-olive silty clay loam that has common yellowish-brown mottles in the lower part. The substratum is pale-olive silty clay loam that has common strong-brown mottles.

Minnetonka soils have slow permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are neutral to medium acid and need lime in some places.

Minnetonka soils are used chiefly for row crops. Wetness is the major limitation, but tilth is a concern in some places where the surface layer has high content of clay.

Representative profile of Minnetonka silty clay loam, 1 to 3 percent slopes, in a cultivated field 455 feet west and 60 feet south of the northeast corner SE¼SE¼ sec. 9, T. 100 N., R. 22 W.

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; cloddy parting to weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

A12—7 to 19 inches, black (10YR 2/1) silty clay loam; moderate, fine and very fine, granular structure; friable; slightly acid; clear, smooth boundary.

B1tg—19 to 24 inches, very dark gray (10YR 3/1) silty clay; nearly continuous black (10YR 2/1) pressure faces or clay films; weak, medium, prismatic structure parting to moderate, fine, subangular blocky; firm; common, fine yellowish-red (5YR 4/6) oxide concretions; slightly acid; clear, smooth boundary.

B21tg—24 to 28 inches, olive-gray (5Y 5/2) silty clay; common, fine, distinct, olive-brown (2.5Y 4/6) mottles; nearly continuous very dark gray (10YR 3/1) coatings on prisms and very dark gray (10YR 3/1) and dark grayish-brown (2.5Y 4/2) clay films on ped faces; moderate, medium, prismatic structure parting to moderate, fine and medium, subangular blocky; firm; few yellowish-red (5YR 5/8) oxide concretions; neutral; clear, wavy boundary.

B22tg—28 to 37 inches, olive-gray (5Y 5/2) light silty clay; common, fine, distinct, light olive-brown (2.5Y 5/4) mottles; patchy very dark gray (10YR 2/1) clay films and streaks on prism faces; weak, medium, prismatic structure parting to very weak, medium, subangular blocky; firm; few black (10YR 2/1) clay films lining pores and root channels; few yellowish-red (5YR 5/8) oxide concretions; neutral; clear, wavy boundary.

B3tg—37 to 52 inches, pale-olive (5Y 6/3) light silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/8) mottles; black (10YR 2/1) clay films lining most pores and root channels; very weak, medium, prismatic structure; friable; few yellowish-red (7.5YR 5/8) oxide concretions; mildly alkaline; clear, wavy boundary.

Cg—52 to 72 inches, pale-olive (5Y 6/3) light silty clay loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; black (10YR 2/1) clay films lining some pores and root channels; massive; friable; slight effervescence; mildly alkaline.

The depth to carbonates ranges from 36 to 52 inches.

The A horizon is black (10YR 2/1 or N 2/0). It ranges from light to heavy silty clay loam. It is 14 to 20 inches thick and medium acid or neutral.

The B1tg horizon ranges from very dark gray (10YR 3/1) to olive gray (5Y 5/2). It is silty clay or heavy silty clay loam 3 to 8 inches thick and slightly acid or medium acid in reaction. Mank dark clay films and coatings are on the peds.

The B2t horizon ranges from olive gray (5Y 5/2) to light gray (10YR 6/1) and has olive-brown (2.5Y 4/4) to strong-brown (7.5YR 5/6) mottles. It is typically silty clay, but in places is heavy silty clay loam. It is 9 to 18 inches thick and slightly acid or neutral in reaction.

The B3t horizon ranges from pale olive (5Y 6/3) to gray (N 5/0) and has few to common high-chroma mottles. It is typically silty clay loam, but in places is heavy silt loam. It is 3 to 16 inches thick and neutral or mildly alkaline in reaction.

The C horizon is gray (5Y 5/1) to pale olive (5Y 6/3) and has few to common high-chroma mottles. It is silt loam or silty clay loam and mildly alkaline in reaction.

Minnetonka soils formed in parent material similar to that of Okoboji and Shorewood soils. They have a thinner dark-colored A horizon than Okoboji soils and higher value and generally lower chroma in the B horizon than Shorewood soils.

Minnetonka silty clay loam, 1 to 3 percent slopes (583).—This soil occupies drainageways, lower slopes, and in a few places broad, nearly level areas. Individual areas range from about 3 to 20 acres in size.

Included with this soil in mapping are small areas of Okoboji soils. In some drainageways lenses of sandy materials are in the lower part of the subsoil. A few areas are about 40 percent Shorewood soils. A few slopes adjacent to steeper soils are 4 to 5 percent.

This Minnetonka soil is high in organic-matter content and is well suited to row crops if properly drained. It is susceptible to wetness in rainy seasons even if it has been tile drained. Tile drains do not always function well and may need closer spacing than on soils with a lower clay content in the subsoil. In most places there is enough slope to prevent ponding except after intense rains. Undrained areas are well suited to pasture. Capability unit IIw–3; woodland group 13.

Mixed Alluvial Land, Channeled

Mixed alluvial land, channeled (C315) is on flood plains along rivers and streams. It is nearly level and contains many low natural levees, small ponds, sloughs, and small oxbows. It is subject to frequent overflow and is dissected by channels that vary in size. Water stands in some of the deeper channels the year around.

Poorly drained and somewhat poorly drained, dark-colored soils make up about 70 percent of the area. The rest consists of well-drained, dark-colored sandy soils and recent deposits of sand and some gravelly material. Some areas of Marsh are included in mapping.

Mixed alluvial land, channeled, is not suited to row crops. Some parts are well suited to pasture and timber. The principal use is pasture. Organic-matter content ranges from high to low. Capability unit Vw–1; woodland group 13.

Nicollet Series

The Nicollet series consists of somewhat poorly drained, nearly level and very gently undulating soils in the uplands. These soils formed in glacial till that generally has a slight increase in sand below a depth of 12 to 25 inches. Slopes are 1 to 3 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown loam about 19 inches thick. The subsoil extends to a depth of 31 inches. The upper part is dark grayish-brown loam that has common olive-brown mottles, and the lower part is mottled grayish-brown and light olive-brown loam that has common, yellowish-brown mottles. The substratum is mottled grayish-brown and yellowish-brown loam.

Nicollet soils have moderate permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally slightly acid unless limed during the past 5 years.

Nicollet soils are used mainly for row crops. The major limitation is some wetness early in spring and during wet seasons. There is some erosion where the longer slopes approach 3 percent.

Representative profile of Nicollet loam, 1 to 3 percent slopes, in a cultivated field 135 feet north and 90 feet east of the southwest corner NE¼ sec. 33, T. 100 N., R. 22 W.

Ap—0 to 7 inches, black (10YR 2/1) loam; cloddy parting to moderate, very fine, granular structure; friable; slightly acid; clear, smooth boundary.

A12—7 to 16 inches, black (10YR 2/1) heavy loam; moderate, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A3—16 to 19 inches, very dark grayish-brown (2.5Y 3/2) loam; very dark brown (10YR 2/2) coatings on peds; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2—19 to 26 inches, dark grayish-brown (2.5Y 4/2) loam; common, fine, faint, olive-brown (2.5Y 4/4) mottles; few very dark brown (10YR 2/2) coatings on peds; weak, fine, subangular blocky structure; friable; few small pebbles; neutral; clear, smooth boundary.

B3—26 to 31 inches, mottled grayish-brown (2.5Y 5/2) and light olive-brown (2.5Y 5/4) loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few small dark reddish-brown (5YR 2/2) and yellowish-red (5YR 5/6) oxide concretions; few small pebbles; neutral; clear, wavy boundary.

C—31 to 60 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) loam; massive; friable; few dark reddish-brown (5YR 2/2) and yellowish-red (5YR 5/6) oxide concretions; few small, white, soft lime accumulations; few small pebbles; violent effervescence; mildly alkaline.

The depth to carbonates ranges from 24 to 40 inches.

The A horizon is black (10YR 2/1) in the upper part to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in the lower part. It is typically loam but in places is light clay loam. It is 14 to 24 inches thick and neutral or slightly acid.

The B horizon ranges from dark grayish brown (10YR 4/2 or 2.5Y 4/2) to light olive brown (2.5Y 5/4) and contains few to common mottles. It is typically loam but in places is light clay loam. It is 10 to 20 inches thick and neutral or slightly acid in reaction.

The C horizon is light olive brown (2.5Y 5/4) with few mottles to mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/6). It is loam or light clay loam.

Nicollet soils formed in parent material similar to that of Clarion, Le Sueur, and Webster soils. They have a thicker dark-colored A horizon than Le Sueur soils, typically have lower chroma in the B horizon than Clarion soils, and have higher chroma in the B horizon than Webster soils.

Nicollet loam, 1 to 3 percent slopes (55).—This soil has short and slightly convex to slightly concave slopes. It has the profile described as representative of the series. Individual areas range from 2 to 5 acres in size and are irregularly shaped. A few areas are 30 acres in size. Included in mapping are some small. very poorly drained depressions and some areas of Webster soils that are indicated by spot symbols on the soil map.

This Nicollet soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight wetness in rainy seasons. Where tile drains are installed, drainage is generally improved. Capability unit I–2; woodland group 6.

Nicollet loam, 1 to 3 percent long slopes (755).—This soil has long, uniform slopes and a well-developed drainage network. It is similar to Nicollet loam, 1 to 3 percent slopes, but has no depressional areas. Most areas range from 10 to more than 30 acres in size.

This Nicollet soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight erosion, but slopes are well suited to soil conserving practices. The more sloping areas are slightly wet in rainy seasons. Where tile drains are installed, timeliness of fieldwork is improved. Capability unit I–2; woodland group 6.

Okoboji Series

The Okoboji series consists of very poorly drained, level soils in depressions in the uplands. These soils formed in silty sediment. Slopes are 0 to 1 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black silty clay loam about 33 inches thick. The subsoil is black silty clay loam about 5 inches thick that has a few gray mottles. The substratum is gray light silty clay loam that has common light olive-brown mottles.

Okoboji soils have slow permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. They are neutral and do not need liming.

Tile-drained areas are used mainly for cultivated crops. Undrained areas are idle or in pasture. Wetness is the major limitation. Ponding occurs after heavy rain. In some years crops are drowned out.

Representative profile of Okoboji silty clay loam, 0 to 1 percent slopes, in a cultivated field 600 feet north

and 335 feet east of the southwest corner NW¼ sec. 15, T. 100 N., R. 22 W.

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

A12—8 to 16 inches, black (N 2/0) silty clay loam; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A13—16 to 23 inches, black (N 2/0) silty clay loam; weak, medium, subangular blocky structure; friable; neutral; clear, wavy boundary.

A14—23 to 33 inches, black (N 2/0) heavy silty clay loam; red (2.5YR 4/8) oxide accumulations lining some root channels; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; neutral; clear, wavy boundary.

B—33 to 38 inches, black (10YR 2/1) heavy silty clay loam; few, fine, distinct, gray (5Y 5/1) mottles; very weak, medium, prismatic structure; friable; neutral; gradual, smooth boundary.

Cg—38 to 72 inches, gray (5Y 5/1) light silty clay loam; common, fine, distinct, light olive-brown (2.5Y 5/4) mottles; few, strong-brown (7.5YR 5/6) oxides; massive; friable; slight effervescence; mildly alkaline.

The depth to carbonates is typically 25 to 40 inches, but in places ranges from 20 to 40 inches.

The A1 horizon is black (N 2/0). It is typically light silty clay loam 24 to 40 inches thick.

The Bg horizon is black (10YR 2/1) to olive gray (5Y 5/2) and has few to common distinct mottles. It is medium or heavy silty clay loam 4 to 12 inches thick and neutral or mildly alkaline.

The Cg horizon ranges from dark gray (10YR 4/1) to light olive gray (5Y 6/2) and has few to common distinct mottles. It is typically light silty clay loam, but ranges from silty clay loam to silt loam.

Okoboji soils formed in parent material similar to that of Minnetonka and Rolfe soils. They have a thicker A1 horizon than either of those soils. They differ from Rolfe soils in not having an A2 horizon.

Okoboji silty clay loam, 0 to 1 percent slopes (6).—This soil is in depressions in the uplands, in places in a series of depressions connected by narrow, less shallow depressions. In many places it is surrounded by Harps soil. It has the profile described as representative of the series. Individual areas are circular or oblong and range from 2 to about 30 acres in size.

Included with this soil in mapping are areas where the surface layer and subsoil are calcareous, areas where they are silt loam, and a few small areas where the surface layer is mucky silt loam.

This Okoboji soil is high in organic-matter content and is well suited to row crops if adequately drained. Unless tile drained, it is susceptible to wetness and ponding after heavy rain and during spring thaw. Most areas have been tile drained. Undrained areas are poorly suited to pasture. Frost early in fall is a hazard. Capability unit IIIw–1; woodland group 13.

Okoboji-Harps complex, 0 to 3 percent slopes (956).—This mapping unit is about equal parts Okoboji soil and Harps soil. The Okoboji soil is in depressions, and the Harps soil is on rims and low ridges around and between the depressions. Each soil has the profile described as representative of its series. The Okoboji soil has slopes of 0 to 1 percent, and the Harps soil slopes of 1 to 3 percent. Individual areas range from about 3 to 150 acres in size.

Included with these soils in mapping are a few areas where the Okoboji soil has a calcareous surface layer. Also included are areas of Canisteo silty clay loam, which make up about 10 to 20 percent of the mapping unit.

These soils are high in organic-matter content and are well suited to row crops if adequately tile drained; but even in drained areas, they are susceptible to wetness and ponding after heavy rain and during spring runoff. Most areas have been tile drained. Undrained areas are moderately suited to pasture. Frost early in fall is a hazard. Capability unit IIIw–1; woodland group 13.

Oran Series

The Oran series consists of somewhat poorly drained, nearly level and very gently sloping soils in the uplands. These soils formed in 14 to 24 inches of loamy material and the underlying glacial till. Slopes are 1 to 3 percent. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is very dark brown silt loam high in sand and about 8 inches thick. The subsurface layer is dark grayish-brown light silty clay loam high in sand and about 4 inches thick. The subsoil extends to a depth of 52 inches. The upper 7 inches is mottled dark grayish-brown and dark yellowish-brown light silty clay loam high in sand. The lower part is mottled grayish-brown, strong-brown, and brown loam. The substratum is mottled grayish-brown and strong-brown loam.

Oran soils have moderate permeability in the loamy upper part of the profile and moderately slow permeability in the underlying glacial till, which results in seepy spots in some years. The available water capacity is high. The subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Oran soils are used chiefly for row crops. Wetness early in spring and in wet seasons is the major limitation. The longer and more sloping areas are subject to slight water erosion. Providing both erosion control and adequate drainage is difficult because they conflict to some extent. The long, uniform slopes are well suited to contour cultivation and terracing. These practices, however, slow down movement of surface water and let more of it soak into the soil, thereby complicating drainage, especially in wet years.

Representative profile of Oran silt loam, 1 to 3 percent slopes, in a cultivated field 615 feet east and 195 feet south of the northwest corner sec. 36, T. 100 N., R. 19 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy silt loam high in sand; weak, fine, granular structure; friable; medium acid; clear, smooth boundary.

A2—8 to 12 inches, dark grayish-brown (2.5Y 4/2) light silty clay loam high in sand; common, fine, distinct, brown (7.5YR 4/4) mottles; few very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

B1—12 to 19 inches, mottled dark grayish-brown (2.5Y 4/2) and dark yellowish-brown (10YR 4/4) light silty clay loam high in sand; few grayish-brown (2.5Y 5/2) coatings on peds; few strong-brown (7.5YR 5/8) oxide concretions; weak, fine, subangular

blocky structure; friable; strongly acid; clear, smooth boundary.

IIB21—19 to 29 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown (10YR 5/2) loam; thick discontinuous grayish-brown (2.5Y 5/2) sand coatings on prisms and peds, light gray (10YR 7/2) dry; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; few yellowish-red (5YR 5/6) oxide concretions; few small pebbles; medium acid; gradual, smooth boundary.

IIB22t—29 to 36 inches, mottled brown (10YR 5/3) and strong-brown (7.5YR 5/6) loam; brown (10YR 5/3) continuous sand coatings on prisms and peds, light gray (10YR 7/2) dry; moderate, medium, prismatic structure parting to weak, fine, subangular blocky; firm; clay bridges between some sand grains; dark grayish-brown (2.5Y 4/2) clay films lining root channels and pores; few small pebbles; medium acid; clear, wavy boundary.

IIB31t—36 to 43 inches, strong-brown (7.5YR 5/8) light sandy clay loam; brown (10YR 5/3) discontinuous sand coatings, light gray (10YR 7/2) dry; weak, medium, prismatic structure; firm; few dark yellowish-brown (10YR 3/4) patchy clay films on prism faces; some clay bridges between sand grains; few clay films lining root channels; few small pebbles; medium acid; gradual, smooth boundary.

IIB32—43 to 52 inches, mottled grayish-brown (10YR 5/2) and strong-brown (7.5YR 5/8) loam; weak, medium, prismatic structure; firm; few grayish-brown (10YR 5/2) coatings; common dark reddish-brown (5YR 2/2) oxides; few small pebbles; medium acid, gradual, smooth boundary.

IIC—52 to 72 inches, mottled grayish-brown (10YR 5/2) and strong-brown (7.5YR 5/8) loam; massive, firm; common dark reddish-brown (5YR 2/2) oxides; few small pebbles; slightly acid.

The depth to carbonates ranges from 45 to 75 inches.

The Ap horizon is typically very dark brown (10YR 2/2), but in places is very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2). It ranges from silt loam high in sand to loam and light clay loam. It is 6 to 9 inches thick and neutral or medium acid in reaction.

The A2 horizon is typically dark grayish brown (10YR 4/2 or 2.5Y 4/2) and has few to common high-chroma mottles. It ranges from silt loam high in sand to loam and light silty clay loam high in sand. It is 0 to 6 inches thick and medium acid or strongly acid in reaction.

The B1 horizon is dark grayish brown (10YR 4/2 or 2.5Y 4/2) with a few high-chroma mottles to yellowish brown (10YR 5/6) with many grayish mottles. It ranges from light silty clay loam high in sand to loam and light clay loam. It is 4 to 8 inches thick and medium acid or strongly acid in reaction.

The IIB horizon ranges from dark grayish brown (2.5Y 4/2) with many high-chroma mottles to strong brown (7.5YR 5/6) with common grayish mottles. It is loam or sandy clay loam 24 to 40 inches thick and medium acid to strongly acid in reaction.

These soils have less sand in the upper part of the solum than is defined in the range for the series, but this difference does not alter their use or management.

Oran soils formed in parent material similar to that of Bassett and Readlyn soils. They have lower chroma in the B horizon than Bassett soils and a thinner dark-colored A horizon than Readlyn soils.

Oran silt loam, 1 to 3 percent slopes (471).—This soil is on broad ridge crests and long side slopes. Individual areas range from 3 to more than 100 acres in size.

Included with this soil in mapping are some areas of soils that have 3 to 5 percent slopes and a few small areas of a soil that has dense gray clay below a depth of 20 to 36 inches. These included soils are generally at the higher elevations and are indicated by spot symbol on the soil map.

This Oran soil is moderate in organic-matter content and is well suited to row crops. It is susceptible to wetness in wet seasons. The more sloping areas are subject to slight water erosion if cultivated. Because providing both adequate erosion control and drainage is difficult, a combination of terracing and tile drainage may be needed. Where tile drains are installed, drainage is generally improved. Capability unit I–2; woodland group 6.

Palms Series

The Palms series consists of very poorly drained, level to gently sloping soils. The level and nearly level soils are in drainageways in the uplands and on stream benches and flood plains. The gently sloping soils are in seepy areas in the uplands. These soils formed in 16 to 50 inches of organic material over stratified loamy mineral sediment. Slopes are 0 to 4 percent. The native vegetation was water-tolerant grasses and sedges.

In a representative profile the surface layer and the next layer are black muck that extends to a depth of about 28 inches. The upper part of the substratum is black silt loam that has a few brown mottles, and the lower part is stratified, very dark gray silt loam and very dark grayish-brown mucky silt loam that has a few brown mottles.

Palms soils have moderately rapid permeability in the organic layers and moderate permeability in the loamy underlying material. They have very high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are neutral and do not need lime.

Palms soils are used mainly for row crops where properly tile drained. Most undrained areas are idle, though some are pastured. Wetness is the major limitation. In depressions early frost is a hazard. In undrained areas a water table is generally at or near the surface.

Representative profile of Palms muck, 0 to 1 percent slopes, in a cultivated field 1,450 feet south and 670 feet east of the northwest corner sec. 36, T. 100 N., R. 22 W.

Oap—0 to 7 inches, black (N 2/0 broken face and rubbed) sapric material; about 4 percent fiber, 0 percent when rubbed; weak, fine and medium, subangular blocky structure; very friable; neutral; abrupt, smooth boundary.

Oa2—7 to 28 inches, black (10YR 2/1 broken face and rubbed) sapric material; about 5 percent fiber, trace when rubbed; massive; very friable; neutral; clear, smooth boundary.

IICl g—28 to 45 inches, black (10YR 2/1) silt loam; massive; friable; brown (7.5YR 4/4) stains lining few root channels; neutral; clear, smooth boundary.

IIC2—45 to 72 inches, stratified very dark gray (10YR 3/1) silt loam that has a few distinct mottles and very dark grayish-brown (10YR 3/2) mucky silt loam that has common brown (7.5YR 4/4) stains and particles; mildly alkaline.

The organic layers are black (N 2/0) or very dark brown (10YR 2/2). They are typically 20 to 40 inches thick but range from 16 to 50 inches. The organic material is typically sapric, but in some places hemic layers total less than 10 inches in thickness.

The IICg horizon ranges from black (10YR 2/1) to dark olive gray (5Y 3/2) and has no to common high-chroma

mottles. It ranges from silt loam or silty clay loam to loam and fine sandy loam and is 6 to 20 inches thick.

The IIC2 horizon ranges from black (10YR 2/1) to light olive gray (5Y 6/2) and has no to many mottles. It is typically stratified and ranges from silt loam or silty clay loam to loam, fine sandy loam, and sand. Some places have thin mucky lenses. This horizon is neutral or mildly alkaline in reaction.

Palms soils formed in parent material similar to that of Houghton soils, but in thinner organic deposits than those soils.

Palms muck, 0 to 1 percent slopes (221).—This soil is in depressions in the uplands and in depressions and level areas on the stream benches. It consists of organic material about 16 to 50 inches thick over a mineral soil. This soil has the profile described as representative of the series. Individual areas are generally somewhat circular, but a few are long and narrow. They range from 2 to 80 acres in size. In some places they are surrounded by Harps or Harcot soils. Undrained areas are hummocky unless they have been leveled.

Included with this soil in mapping are a few areas where a black or very dark brown silt loam layer 10 to 24 inches thick overlies the organic horizons. Also included are a few areas where less than 16 inches of organic material overlies a mineral soil and some areas where the organic layer is calcareous.

This Palms soil is very high in organic-matter content and is moderately suited to row crops if properly tile drained. Even if tile drained, however, it is susceptible to wetness and ponding after heavy rains and during spring thaws. Early frost is a hazard in fall. Much of the acreage has been tile drained. Undrained areas are poorly suited to pasture. Capability unit IIIw–2; woodland group 14.

Palms muck, 1 to 4 percent slopes (221B).—This soil is on lower parts of hillsides and in narrow and broad drainageways. It is about 16 to 50 inches of muck over a mineral soil. Individual areas are generally long and narrow and range from 3 to 30 acres in size. Undrained areas are hummocky unless they have been leveled. In many places adjoining soils on higher landscapes have a sand and gravel substratum.

Included with this soil in mapping are some areas where the organic material is only 10 to 16 inches thick and other places where it is more than 50 inches thick. Some included areas have a calcareous organic layer, and a few places have a black or very dark brown loam layer 10 to 24 inches thick overlying the organic horizon.

This muck soil is very high in organic-matter content and is moderately suited to row crops if properly drained, but adequate drainage is difficult. Even if tile drained, however, the soil is susceptible to wetness during wet seasons. Undrained areas are poorly suited to pasture. Most of the acreage has not been tile drained. Capability unit IIIw–2; woodland group 14.

Readlyn Series

The Readlyn series consists of somewhat poorly drained, nearly level and very gently sloping soils in the uplands. These soils formed in 14 to 24 inches of loamy material and the underlying glacial till. Slopes are 1 to 3 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black loam about 12 inches thick. The subsoil extends to a depth of 42 inches. The upper part, to a depth of 23 inches, is dark grayish-brown loam. The lower part is dark yellowish-brown and yellowish-brown loam that has grayish-brown mottles. The substratum is mottled yellowish-brown and grayish-brown loam.

Readlyn soils have moderate permeability in the loamy upper layers and moderately slow permeability in the underlying glacial till, which causes seepy spots in some years. The available water capacity is high. The subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Readlyn soils are used chiefly for row crops. Wetness early in spring and during rainy seasons is the major limitation. The long and more sloping areas are subject to slight water erosion. Providing both erosion control and adequate drainage is difficult because they conflict to some extent. The long, uniform slopes are well suited to contour cultivation and terracing. These practices, however, slow down movement of surface water and let more of it soak into the soil, thereby complicating drainage, especially in wet years.

Representative profile of Readlyn loam, 1 to 3 percent slopes, in a cultivated field 955 feet north and 585 feet east of the southwest corner sec. 12, T. 100 N., R. 19 W.

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

A12—8 to 12 inches, black (10YR 2/1) loam; weak, medium, granular structure; friable; medium acid; clear, smooth boundary.

B1—12 to 15 inches, dark grayish-brown (10YR 4/2) heavy loam; few very dark gray (10YR 3/1) coatings on peds; moderate, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

11B21—15 to 23 inches, dark grayish-brown (10YR 4/2) heavy loam; discontinuous dark grayish-brown (10YR 4/2) coatings on peds; weak, medium, prismatic structure parting to weak, fine, subangular blocky; friable; few dark reddish-brown (5YR 2/2) and strong-brown (7.5YR 5/6) oxide concretions; few small pebbles; medium acid; gradual, smooth boundary.

IIB22—23 to 35 inches, dark yellowish-brown (10YR 4/4) heavy loam; common, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; common dark reddish-brown (5YR 2/2) and few strong-brown (7.5YR 5/6) oxide concretions; few small pebbles; medium acid; gradual, smooth boundary.

IIB3—35 to 42 inches, yellowish-brown (10YR 5/6) heavy loam; many, medium, distinct, grayish-brown (2.5Y 5/2) mottles; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky; firm; common dark reddish-brown (5YR 2/2) and few strong-brown (7.5YR 5/6) oxide concretions; few small pebbles; neutral; abrupt, wavy boundary.

IIC—42 to 60 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; massive; firm; common dark reddish-brown (5YR 2/2) oxide concretions; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 42 to 60 inches.

The A horizon is black (10YR 2/1) in the upper part and black (10YR 2/1) to very dark grayish brown (10YR 3/2) in the lower part. It is typically loam but ranges from silt

loam to light clay loam. It is 11 to 19 inches thick and neutral or medium acid in reaction.

The B1 horizon is dark grayish brown (10YR 4/2 or 2.5Y 4/2) and has no to common faint mottles. It is typically loam but ranges to silt loam high in sand and clay loam and is 2 to 6 inches thick.

The IIB horizon ranges from dark grayish brown (2.5Y 4/2) with a few mottles to yellowish brown (10YR 5/6) with common to many mottles. It is typically loam but ranges to sandy clay loam and is 24 to 40 inches thick.

The IIC horizon is mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2). It ranges from loam to sandy clay loam.

These soils typically have a thinner dark-colored A horizon than is defined in the range for the series, but this difference does not alter their use and management.

Readlyn soils formed in parent material similar to that of Oran and Kenyon soils. They have lower chroma throughout the B horizon than Kenyon soils and a thicker dark-colored A horizon than Oran soils.

Readlyn loam, 1 to 3 percent slopes (399).—This soil is on broad ridge crests and long side slopes. Individual areas range from 3 to 40 acres in size. Included in mapping are some slopes that are 3 to 5 percent. A few sandy spots are indicated by spot symbols on the soil map.

This Readlyn soil is high in organic-matter content and is well suited to row crops. It is susceptible to wetness in wet seasons. The more sloping areas are subject to slight water erosion if cultivated. Providing both adequate erosion control and drainage is difficult, therefore a combination of terracing and tile drainage may be needed. Where tile drains are installed, drainage is generally improved. Capability unit I–2; woodland group 6.

Richwood Series

The Richwood series consists of well-drained, nearly level soils on stream benches. These soils formed in 46 to 60 inches of alluvial deposits over sand or gravel. Slopes are 0 to 2 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown silt loam about 21 inches thick. The subsoil, which extends to a depth of 51 inches, is brown very fine sandy loam and dark yellowish-brown silt loam in the upper part and dark yellowish-brown light silty clay loam in the lower part. The substratum is brown loamy sand.

Richwood soils have moderate permeability and high available water capacity. Their subsoil is low in available phosphorus and very low in available potassium. These soils are generally acid unless limed during the past 4 years.

Richwood soils are used mainly for row crops. Some of the lower areas may flood during spring thaws or after heavy rains.

Representative profile of Richwood silt loam, 0 to 2 percent slopes, in a cultivated field 1,050 feet east and 62 feet south of the northwest corner NE¼ sec. 16, T. 99 N., R. 20 W.

Ap—0 to 7 inches, black (10YR 2/1) silt loam; cloddy parting to weak, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A12—7 to 16 inches, black (10YR 2/1) silt loam; moderate, medium, granular structure parting to weak, fine, granular; friable; slightly acid; gradual, smooth boundary.

A3—16 to 21 inches, very dark grayish-brown (10YR 3/2) light silt loam; very dark brown (10YR 2/2) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B1—21 to 29 inches, brown (10YR 4/3) very fine sandy loam; very weak, medium, subangular blocky structure; very friable; medium acid; clear, smooth boundary.

B2—29 to 37 inches, dark yellowish-brown (10YR 4/4) silt loam, high in sand; discontinuous brown (10YR 4/3) coatings on peds, very few very pale brown (10YR 7/3 dry) silt coatings; weak, medium, prismatic structure parting to weak, medium and fine, subangular blocky; friable; medium acid; gradual, smooth boundary.

B31—37 to 45 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; brown (10YR 4/3) and yellowish-brown (10YR 5/4) coatings on peds; very few, very pale brown (10YR 7/3 dry) silt coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; medium acid; clear, wavy boundary.

B32—45 to 51 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; brown (10YR 5/3) coatings on peds; nearly continuous white (10YR 8/2 dry) silt coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; slightly acid; clear, smooth boundary.

IIC—51 to 65 inches, brown (10YR 4/3) heavy loamy sand; massive; very friable; few small pebbles; slightly acid.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3) in the lower part. It is 15 to 24 inches thick and neutral or medium acid in reaction.

The B1 horizon is brown (10YR 4/3), and the B2 horizon is yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4). The combined B1 and B2 horizon is 15 to 25 inches thick and typically medium acid, but in places it is strongly acid.

The B3 horizon is typically yellowish brown (10YR 5/4) or dark yellowish brown (10YR 4/4) but ranges to grayish brown (2.5Y 5/2) that has mottles. It is light silty clay loam to loam and silt loam high in sand. It is 10 to 20 inches thick and slightly acid or medium acid in reaction.

The IIC horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). It is loamy sand to gravelly sand and slightly acid to mildly alkaline in reaction.

Richwood soils formed in parent material somewhat similar to that of Waukee and Lawler soils, but have less sand in the upper part of the solum than those soils.

Richwood silt loam, 0 to 2 percent slopes (977).—This soil is on stream benches. Individual areas range from 2 to more than 50 acres in size.

This soil is high is organic-matter content and is well suited to row crops. It is near less well drained soils that are a source of water for shallow wells. It is suited to septic tank filter fields, but pollution of shallow underground water may be a hazard. Capability unit I–1; woodland group 1.

Rockton Series

The Rockton series consists of well-drained, nearly level to gently sloping soils on long ridge crests and side slopes on stream benches and in the uplands. These soils formed in 20 to 40 inches of loamy glacial sediment over limestone bedrock. Slopes are 0 to 5 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown loam about 12 inches thick. The subsoil, which extends to a depth of 30 inches, is brown loam in the upper part and dark yellowish-brown light sandy clay loam in the lower part. Below the subsoil is 1 to 3 feet of hard, shattered limestone over level-bedded limestone bedrock.

Rockton soils have moderate permeability and moderate to low available water capacity. Their subsoil is very low in available phosphorus and potassium. It is slightly acid.

Rockton soils are used mainly for row crops. The major limitation is slight erosion in the more sloping areas and slight droughtiness in dry seasons on the moderately deep phase.

Representative profile of Rockton loam, moderately deep, 0 to 2 percent slopes, in a cultivated field 30 feet west and 335 feet south of the northeast corner NW¼ sec. 35, T. 99 N., R. 20 W.

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

A12—8 to 12 inches, very dark grayish-brown (10YR 3/2) loam; very dark brown (10YR 2/2) coatings on peds; weak, fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B1—12 to 20 inches, brown (10YR 4/3) loam; dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B2—20 to 30 inches, dark yellowish-brown (10YR 4/4) light sandy clay loam; weak, medium, subangular blocky structure; friable; few brown (10YR 4/3) coatings on peds; few small pebbles; 1-inch lens of gravelly loamy sand at a depth of 29 to 30 inches; neutral; abrupt, wavy boundary.

R—30 inches, shattered limestone bedrock.

The depth to bedrock ranges from 20 to 40 inches.

The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) in the A1 horizon and from very dark grayish brown (10YR 3/2) to dark brown (10YR 3/3) in the A3 horizon. It is typically loam but in places is silt loam high in sand. It is 10 to 17 inches thick.

The B1 horizon ranges from brown (10YR 4/3) with dark-brown (10YR 3/3) coatings on peds to dark yellowish brown (10YR 4/4). It is typically loam but in places is light clay loam. It is 4 to 12 inches thick and slightly acid or medium acid in reaction.

The B2 horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6). It ranges from loam to sandy clay loam and light clay loam and is 5 to 20 inches thick. It is neutral to medium acid in reaction. Thin strata of coarse-textured material are common just above the limestone.

The R horizon is 1 to 3 feet of shattered limestone bedrock resting on level-bedded limestone bedrock.

These soils do not have clay films in the B horizon or a clayey IIB horizon as is defined in the range for the series, but this does not affect their use or management.

Rockton soils formed in parent material similar to that of Kensett and Saude soils. They have higher chroma in the B horizon than Kensett soils. They are underlain by limestone bedrock, whereas Saude soils are underlain by sand and gravel.

Rockton loam, deep, 0 to 2 percent slopes (213).—This soil is principally on stream benches above stream flooding and in the uplands adjacent to the Shellrock and Winnebago Rivers. It has a profile similar to the one described as representative of the series, but it is underlain by limestone bedrock at a depth of 30 to 40 inches. Included in mapping are places where depth to limestone is 40 to 60 inches and a few places that have a thinner dark-colored surface layer.

This Rockton soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight droughtiness in years of below-normal rainfall. Capability unit I–1; woodland group 3.

Rockton loam, deep, 2 to 5 percent slopes (213B).—This soil is mainly on stream benches above stream flooding and in the uplands adjacent to the Shellrock and Winnebago Rivers. It has a profile similar to the one described as representative of the series, but it is underlain by limestone bedrock at a depth of 30 to 40 inches. Included in mapping are a few places where depth to limestone is 40 to 60 inches and a few places that have a thinner dark-colored surface layer.

This Rockton soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight water erosion. In years of below-normal rainfall it is susceptible to slight droughtiness. Capability unit IIe–1; woodland group 3.

Rockton loam, moderately deep, 0 to 2 percent slopes (214).—This soil is mainly on stream benches, mostly above stream flooding. Some areas are in the uplands adjacent to the Shellrock and Winnebago Rivers. It has the profile described as representative of the series. Individual areas range from 2 to 40 acres in size. Depth to bedrock ranges from 20 to 30 inches.

Included with this soil in mapping are a few areas that have a thinner dark-colored surface layer and a few places where depth to limestone is less than 20 inches. A few places near the Winnebago River where limestone bedrock crops out are indicated by spot symbols on the soil map.

This Rockton soil is high in organic-matter content and is well suited to row crops. It is susceptible to droughtiness in years of normal or below-normal rainfall. Capability unit IIs–1; woodland group 5.

Rockton loam, moderately deep, 2 to 5 percent slopes (214B).—This gently sloping soil is mainly on stream benches above stream flooding. It is also in the uplands adjacent to the Shellrock and Winnebago Rivers. Individual areas range from 2 to 8 acres in size. Depth to bedrock ranges from 20 to 30 inches.

Included with this soil in mapping are some areas along the Shellrock River where slopes are 5 to 9 percent and a few small areas where limestone is within 15 inches of the surface or crops out on the surface. The limestone outcrops are indicated by spot symbols on the soil map. Also included are some areas that have a thinner dark-colored surface layer.

This Rockton soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight water erosion and is slightly droughty in years of normal or below-normal rainfall. Capability unit IIe–3; woodland group 5.

Rolfe Series

The Rolfe series consists of very poorly drained, level and nearly level soils in depressions, swales, and shallow drainageways. These soils are mainly in the uplands but a few areas are on high stream benches. They formed in silty sediment. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black silt loam about 7 inches thick. The subsurface layer is very dark gray silt loam about 3 inches thick. The subsoil extends to a depth of 39 inches. It is very dark gray light silty clay in the upper part, light olive-gray, heavy silty clay loam in the middle part, and olive-gray loam in the lower part. The substratum is stratified and mottled dark grayish-brown, dark yellowish-brown, and gray sandy loam and loam.

Rolfe soils have slow permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. They are generally acid unless limed during the past 5 years.

Rolfe soils are used mainly for row crops where they are tile drained; undrained areas are in pasture or are idle. Wetness is the major limitation. After heavy rain Rolfe soils in depressions are ponded, and in some years the row crops are drowned out.

Representative profile of Rolfe silt loam, 0 to 1 percent slopes, in a cultivated field 800 feet north and 145 feet east of the southwest corner SE¼NW¼ sec. 23, T. 100 N., R. 21 W.

Ap—0 to 7 inches, black (10YR 2/1) silt loam; moderate, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A2—7 to 10 inches, very dark gray (10YR 3/1) silt loam, light gray (10YR 6/1) dry; moderate, fine, subangular blocky structure; friable; slightly acid; clear, wavy boundary.

B21t—10 to 18 inches, very dark gray (10YR 3/1) light silty clay; few, fine, distinct, light olive-gray (5Y 6/2) mottles; continuous black (10YR 2/1) clay films on prism and ped faces and lining pores and root channels; moderate, fine, prismatic structure parting to moderate, very fine, subangular blocky structure; friable; slightly acid; gradual, smooth boundary.

B22t—18 to 24 inches, light olive-gray (5Y 6/2) heavy silty clay loam; nearly continuous black (10YR 2/1) and very dark gray (10YR 3/1) clay films on prism and ped faces and lining pores and root channels; moderate, fine, prismatic structure parting to moderate, fine, subangular blocky; friable; few brown (7.5YR 4/4) oxide concretions; neutral; gradual, smooth boundary.

B23t—24 to 32 inches, light olive-gray (5Y 6/2) heavy silty clay loam; discontinuous dark-gray (5Y 4/1) clay films on prism and ped faces and lining pores and root channels; weak, fine, prismatic structure parting to moderate, fine and medium, subangular blocky; firm; few very small pebbles; neutral; clear, wavy boundary.

IIB3—32 to 39 inches, olive-gray (5Y 5/2) loam; common, fine, distinct, dark-gray (10YR 4/1) mottles; weak, coarse, subangular blocky structure; friable; few small pebbles; neutral; clear, smooth boundary.

IIC1—39 to 55 inches, dark grayish-brown (2.5Y 4/2) coarse sandy loam; massive; very friable; few small pebbles; neutral; clear, smooth boundary.

IIC2—55 to 65 inches, mottled dark yellowish-brown (10YR 4/4) and gray (5Y 5/1) sandy loam; massive; very friable; neutral; clear, smooth boundary.

IIC3—65 to 72 inches, gray (5Y 5/1) loam; common, fine, distinct, dark grayish-brown (2.5Y 4/2) mottles; massive; friable; neutral.

The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). It is typically silt loam but in places is loam and light silty clay loam. It is 6 to 14 inches thick and medium acid or neutral in reaction.

The A2 horizon is very dark gray (10YR 3/1) or dark gray (10YR 4/1) when moist and is light gray (10YR 6/1) when dry. It is silt loam 3 to 8 inches thick and slightly acid or medium acid in reaction.

The B2t horizon ranges from very dark gray (10YR 3/1) with a few mottles in the B21t horizon to light olive gray (5Y 6/2) in the B22t and B23t horizons. It ranges from light silty clay to heavy silty clay loam 16 to 30 inches thick and is slightly acid or neutral in reaction.

The B3 horizon ranges from gray (5Y 5/1) silty clay loam to olive-gray (5Y 5/2) loam or clay loam. It is 6 to 10 inches thick.

The C horizon ranges from mottled light-gray (5Y 6/1) and yellowish-brown (10YR 5/6) light silty clay loam to stratified and mottled gray (5Y 5/1) and yellowish-brown (10YR 5/6) loam and sandy loam. It is neutral or mildly alkaline in reaction.

Rolfe soils formed in parent material similar to that of Okoboji soils, but they have a thinner A1 horizon and have an A2 horizon, which those soils lack.

Rolfe silt loam, 0 to 1 percent slopes (274).—This soil is in small depressions and shallow drainageways. Most areas are in the uplands, but a few are on high stream benches. Individual areas range from 2 to 4 acres in size, but a few are as much as 8 acres. Depressional areas are somewhat circular, and the nearly level areas are generally narrow and elongated.

Included with this soil in mapping are a few areas that are light colored in the upper part of the subsoil and are lower in organic-matter content. A very few areas have a 2- to 4-inch thick black surface layer and a light colored subsoil.

This Rolfe soil is high in organic-matter content and is well suited to row crops if properly drained. Because of the slowly permeable subsoil, some tiled areas may not drain satisfactorily, and surface drainage may be needed to remove ponded water. Even if tile drained, this soil is susceptible to wetness and ponding after heavy rains and during spring thaws. Much of this soil has been tile drained. Undrained areas are poorly suited to pasture. Capability unit IIIw–1; woodland group 13.

Salida Series

The Salida series consists of excessively drained, gently sloping to steep soils on knobs, ridges, escarpments, and side slopes in the uplands and on the stream benches. These soils formed in sandy and gravelly alluvial and glacial deposits. Slopes are short and are 2 to 30 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown light sandy loam that has a few pebbles and is about 10 inches thick. The subsoil, which extends to a depth of 15 inches, is brown fine gravelly loamy sand. The substratum is brown, loose, calcareous gravelly loamy sand and loamy gravel.

Salida soils have very rapid permeability and very low available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils do not need liming except in a few places east of Highway 65.

Salida soils are used chiefly for pasture or are idle. Droughtiness is the major limitation. Cultivated areas are subject to water erosion and soil blowing.

Representative profile of Salida sandy loam, 2 to 9 percent slopes, in a cultivated field 400 feet east of the Shellrock River and 400 feet south of road fence NE¼SW¼ sec. 18, T. 100 N., R. 20 W.

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

B—10 to 15 inches, brown (10YR 4/3) fine gravelly heavy loamy sand; few dark-brown (10YR 3/3) coatings on peds; very weak, very fine, subangular blocky structure; very friable; some clay bridges between sand grains; neutral; clear, wavy boundary.

C1—15 to 34 inches, brown (10YR 4/3) fine gravelly loamy coarse sand; single grained; loose; few ½- to 1-inch pebbles; slight effervescence; mildly alkaline; gradual, smooth boundary.

C2—34 to 60 inches, brown (10YR 4/3) loamy gravel; single grained; loose; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 0 to 20 inches.

The A horizon is very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). It ranges from sandy loam to gravelly loamy sand. It is 5 to 10 inches thick and slightly acid or mildly alkaline in reaction.

The B horizon is brown (10YR 4/3) to dark yellowish brown (10YR 4/4). It ranges from fine gravelly loamy sand to gravelly sand. It is 0 to 8 inches thick and neutral or mildly alkaline in reaction.

The C horizon ranges from brown (10YR 4/3) to light yellowish brown (10YR 6/4). It ranges from gravelly loamy sand to gravel and contains lenses of sand.

Salida soils formed in parent material similar to that of Flagler soils, but contain more gravel in the solum and have a thinner, less acid solum than those soils.

Salida sandy loam, 2 to 9 percent slopes (73C).—This soil is on escarpments and side slopes on the stream benches and knobs, ridges, and side slopes in the uplands. It has the profile described as representative of the series. Individual areas are small and irregular in shape. On the escarpments they are long and narrow. They range from 2 to 40 acres in size.

Included with this soil in mapping are eroded areas of Salida soils that have a dark yellowish-brown gravelly surface layer. To the east of Highway 65 are areas that have a medium acid surface layer and subsoil.

This Salida soil is low in organic-matter content in most places and very low in eroded areas. It is poorly suited to row crops and is moderately suited to pasture. It is susceptible to droughtiness, and cultivated or pastured areas are subject to soil blowing and water erosion. Capability unit IVs–1; woodland group 9.

Salida sandy loam, 9 to 14 percent slopes (73D).—This soil is on escarpments on the stream benches and on knobs, ridges, and side slopes in the uplands. Individual areas are mainly small and irregular in shape. On the escarpments they are long and narrow. They range from 2 to 20 acres in size.

Included with this soil in mapping are eroded areas of a Salida soil that has a dark yellowish-brown gravelly surface layer. Many of the eroded areas are mildly alkaline in the surface layer. East of Highway 65 are a few areas that have a medium acid surface layer and subsoil.

This Salida soil is low in organic-matter content in uneroded areas and very low in eroded areas. It is not suited to row crops. It is susceptible to droughtiness, and areas that are cultivated or pastured intensively are subject to soil blowing and water erosion. Capability unit VIs–1; woodland group 9.

Salida sandy loam, 14 to 30 percent slopes (73F).—This soil is chiefly on escarpments along stream benches, but occupies a few knobs in the uplands. Most individual areas are small, but they are long and narrow on the escarpments. They range from 2 to 20 acres in size.

Included with this soil in mapping are a few eroded areas that have a dark yellowish-brown gravelly surface layer. All the eroded spots and some of the uneroded spots are mildly alkaline in the surface layer.

This Salida soil is low in organic-matter content where uneroded and very low where eroded. It is not suited to row crops and is poorly suited to pasture. It is susceptible to droughtiness, and where cultivated or pastured it is subject to soil blowing and water erosion. Capability unit VIIs–1; woodland group 9.

Saude Series

The Saude series consists of well-drained, nearly level to moderately sloping soils on the stream benches and nearly level to gently rolling soils in the uplands. These soils formed in 18 to 36 inches of medium and moderately coarse textured alluvial sediments and the underlying sand and gravel. Slopes are 0 to 9 percent. The native vegetation was prairie grasses.

In a representative profile (fig. 13) the surface layer is very dark brown and dark-brown loam about 17 inches thick. The subsoil, which extends to a depth of 36 inches, is brown loam in the upper part, dark yellowish-brown gravelly sandy loam in the middle part, and brown loamy sand in the lower part. The substratum is dark yellowish-brown loamy sand and gravelly sand.

Saude soils have moderate permeability in the upper part of the soil that formed in alluvial sediment and rapid to very rapid permeability in the underlying sand and gravel. They have low to moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Saude soils are used chiefly for row crops. Droughtiness and erosion are the major limitations.

Representative profile of Saude loam, 0 to 2 percent slopes, in a cultivated field 117 feet east and 105 feet north of the southwest corner sec. 23, T. 99 N., R. 20 W.

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

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

A3—13 to 17 inches, dark-brown (10YR 3/3) light loam; continuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

B2—17 to 26 inches, brown (10YR 4/3) loam; discontinuous dark yellowish-brown (10YR 3/4) coatings on peds; weak, moderate and fine, subangular blocky structure; friable; medium acid; clear, smooth boundary.

11B31t—26 to 30 inches, dark yellowish-brown (10YR 3/4) gravelly sandy loam; estimated 20 percent fine gravel; weak, medium and fine, subangular blocky structure; very friable; clay bridges between sand grains; medium acid; clear, smooth boundary.

IIB32—30 to 36 inches, brown (7.5YR 4/4) loamy sand; weak, coarse, subangular blocky structure; very friable; slightly acid; gradual, smooth boundary.

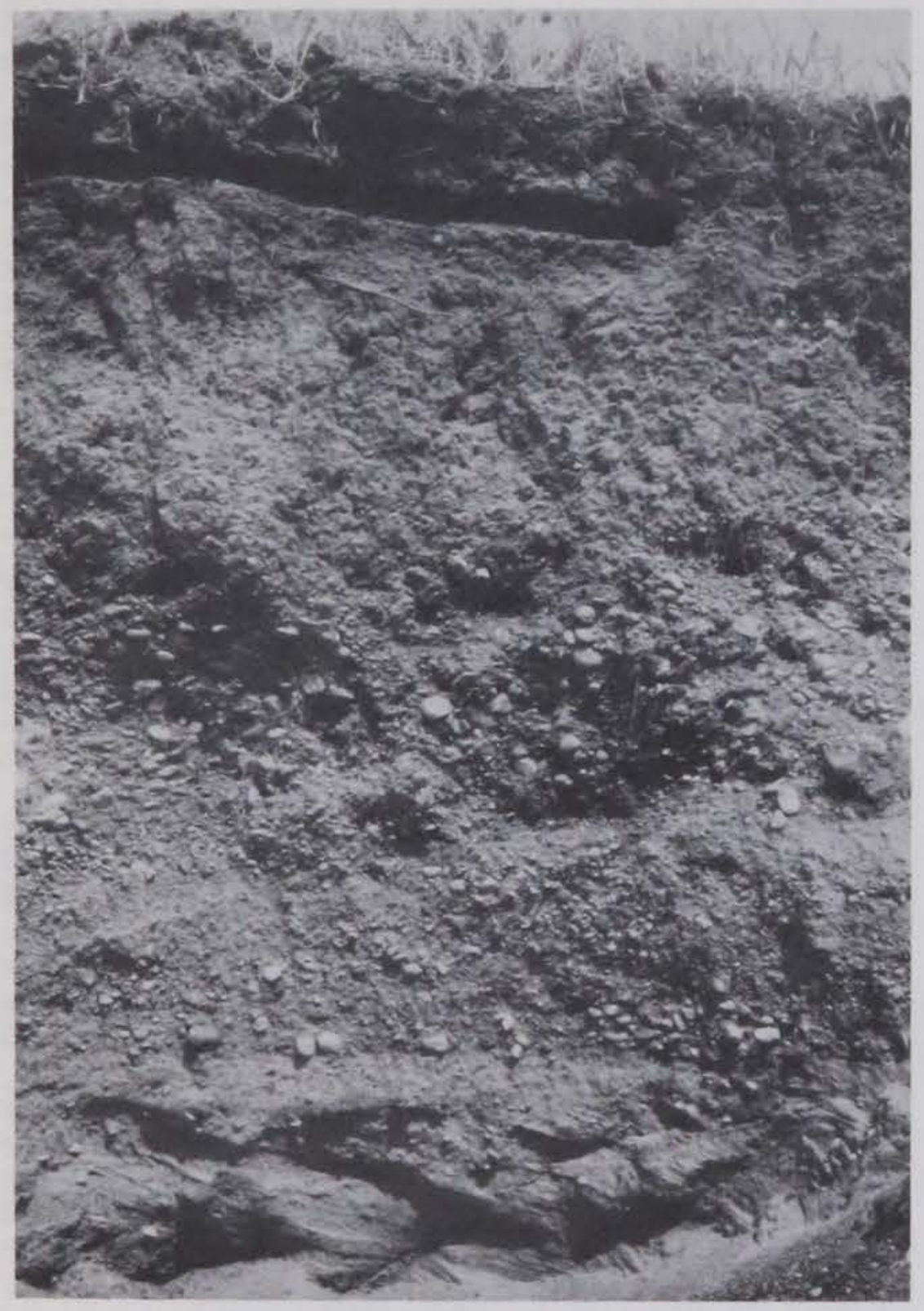


Figure 13.—**Profile of Saude loam showing sand and gravel at a depth of about 2 feet.**

IIC1—36 to 53 inches, dark yellowish-brown (10YR 4/4) loamy sand; few small pebbles below a depth of 45 inches; single grained; loose; slightly acid; gradual, smooth boundary.

IIC2—53 to 60 inches, dark yellowish-brown (10YR 4/4) gravelly sand; single grained; loose; slightly acid.

The depth to sand or gravel ranges from 18 to 36 inches. The depth to carbonates ranges from 48 to more than 72 inches.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark brown (10YR 3/2) to dark brown (10YR 3/3) in the lower part. It is 11 to 16 inches thick and neutral or medium acid in reaction.

The B horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). It is loam or light sandy clay loam and, in places, has a thin horizon of sandy loam in the lower part. It is 5 to 20 inches thick and slightly acid or medium acid in reaction. Few to many darker coatings are on the peds.

The IIB3 horizon ranges from dark yellowish-brown (10YR 3/4) to brown (7.5YR 4/4) and yellowish-brown (10YR 5/6) fine gravelly sandy loam to gravelly loamy sand. It is 0 to 15 inches thick and slightly acid or medium acid in reaction.

The IIC horizon ranges from dark yellowish-brown (10YR 4/4) to yellowish-brown (10YR 5/6) loamy sand to gravelly sand and is slightly acid or medium acid in reaction to a depth of at least 48 inches. Below a depth of about 48 inches the horizon is slightly acid to mildly alkaline in reaction.

Saude soils formed in parent material similar to that of Lawler, Wapsie, and Waukee soils. They have lower chroma in the B horizon than Lawler soils, are shallower over sand and gravel than Waukee soils, and have a thicker dark-colored A horizon than Wapsie soils.

Saude loam, 0 to 2 percent slopes (177).—This soil is on stream benches and uplands. It has the profile described as representative of the series. Individual areas range from 3 to 100 acres in size. Included in mapping are small sandy spots and some wet areas that are indicated by spot symbols on the soil map.

This Saude soil is high in organic-matter content and is well suited to row crops if rainfall is timely. It is droughty during extended dry periods. On the benches it is associated with less well drained soils that are a source of water for shallow wells. The hazard of pollution from septic tank filter fields is greater on stream benches than in the uplands. Capability unit IIs–1; woodland group 5.

Saude loam, 2 to 5 percent slopes (177B).—This soil is gently sloping on the stream benches and gently undulating on the uplands. Individual areas range from 3 to 50 acres in size.

Included with this soil in mapping are some areas of sand and gravel that are indicated by spot symbols on the soil map. A few small areas are underlain by calcareous sand and gravel below a depth of about 24 to 30 inches.

This Saude soil is high in organic-matter content and is well suited to row crops when rainfall is normal and timely. It is droughty during extended dry periods. It is subject to slight water erosion and soil blowing if cultivated. Terrace cuts should be held to a minimum to prevent exposure of the sandy and gravelly material. On the benches this soil is associated with less well drained soils that are a source of water for shallow wells. The hazard of pollution from septic tank filter fields is greater on stream benches than in the uplands. Capability unit IIe–3; woodland group 5.

Saude loam, 5 to 9 percent slopes (177C).—This soil is moderately sloping on the stream benches and gently rolling on the uplands. It has a profile similar to the one described as representative of the series, but it is not quite so deep over sand or gravel. Individual areas range from 2 to 7 acres in size.

About 40 percent of this mapping unit is moderately eroded and has a very dark grayish brown surface layer. A few areas of sand and gravel are indicated by spot symbols on the soil map.

This Saude soil is high to moderate in organic-matter content and is moderately suited to row crops when rainfall is normal and timely. It is subject to soil blowing if cultivated and to moderate and severe water erosion if cultivated or pastured intensively. Terrace cuts should be held to a minimum to prevent exposure

of the sandy or gravelly material. On the benches this soil is associated with less well drained soils that are a source of water for shallow wells. The hazard of pollution from septic tank filter fields is greater on stream benches than in the uplands. This soil is droughty. Capability unit IIIe–2; woodland group 5.

Schley Series

The Schley series consists of somewhat poorly drained, nearly level and very gently sloping soils on slightly convex to concave downslope and cove positions in the uplands. These soils formed in 20 to 30 inches of loamy material and the underlying stratified, medium and moderately coarse textured, friable sediment and glacial till. Slopes are 1 to 3 percent. The native vegetation was grasses and trees.

In a representative profile the surface layer is very dark gray silt loam about 7 inches thick. The subsoil extends to a depth of 47 inches. It is dark grayish-brown and grayish-brown loam mottled with yellowish brown in the upper part, mottled strong-brown and grayish-brown loam and sandy clay loam in the middle part, and mottled strong-brown and grayish-brown sandy loam in the lower part. The substratum is mottled strong-brown and grayish-brown loam.

Schley soils have moderate permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Schley soils are used chiefly for row crops. The major limitation is wetness, which is partly the result of sidehill seep, especially in spring and during rainy seasons. Some areas are subject to slight erosion when cropped.

Representative profile of Schley silt loam, 1 to 3 percent slopes, in a cultivated field 500 feet north and 445 feet west of the southeast corner NE¼ sec. 23, T. 98 N., R. 20 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam high in sand; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

B1—7 to 14 inches, dark grayish-brown (10YR 4/2) light silty clay loam high in sand; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; few dark-gray (10YR 4/1) coatings on peds; weak, fine, subangular blocky structure; friable; very strongly acid; clear, smooth boundary.

B21—14 to 23 inches, grayish-brown (10YR 5/2) loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; few grayish-brown (2.5Y 5/2) coatings on peds; weak, medium, subangular blocky structure; few dark reddish-brown (5YR 2/2) and yellowish-red (5YR 5/8) oxide concretions; very strongly acid; clear, smooth boundary.

IIB22—23 to 28 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) heavy loam; very pale brown (10YR 7/3 dry) silt and sand coatings; weak, medium, subangular blocky structure; friable; few small pebbles; very strongly acid; clear, wavy boundary.

IIB23—28 to 35 inches, strong-brown (7.5YR 5/8) light sandy clay loam; many, fine, distinct, grayish-brown (10YR 5/2) mottles; light-gray (10YR 7/2 dry) silt and sand coatings; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; estimated 10 percent fine gravel; common dark reddish-brown (5YR 2/2) oxide concretions; medium acid; gradual, smooth boundary.

IIB3t—35 to 47 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown (2.5Y 5/2) sandy loam; very weak, coarse, prismatic structure; very friable; clay bridges between sand grains; few small pebbles; medium acid; clear, smooth boundary.

IIC—47 to 60 inches, mottled strong-brown (7.5YR 5/6) and grayish-brown (2.5Y 5/2) loam; massive; firm; medium acid.

The depth to carbonates ranges from 45 to 70 inches.

The Ap horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1) and very dark brown (10YR 2/2). It ranges from silt loam to loam 6 to 9 inches thick and is neutral or medium acid in reaction.

The B horizon ranges from dark grayish brown (10YR 4/2) with no mottles to grayish brown (2.5Y 5/2) with common to many brownish mottles. It ranges from silty clay loam high in sand to loam and light clay loam. It is 10 to 24 inches thick and strongly acid or very strongly acid in reaction.

The IIB horizon is typically strong brown (7.5YR 5/6) or yellowish brown (10YR 5/6) mottled with grayish brown (2.5Y 5/2). It ranges from loam to sandy loam and sandy clay loam. It is 20 to 36 inches thick. Reaction is very strongly acid in the upper part and medium acid in the lower part.

The IIC horizon is strong brown (7.5YR 5/6) or yellowish brown (10YR 5/6) mottled with grayish brown (2.5Y 5/2) to light gray (5Y 6/1). It ranges from loam to sandy clay loam and light clay loam and is medium acid or neutral in reaction.

Schley soils formed in parent material similar to that of Clyde and Floyd soils. They have a thinner dark-colored A horizon than those soils and lower values and generally higher chroma in the B horizon and upper part of the IIB horizon than Clyde soils.

Schley silt loam, 1 to 3 percent slopes (407).—This soil is on slightly convex to slightly concave slopes and cove positions below Bassett, Donnan, and Oran soils, and is generally above Clyde soils. It is in drainageway positions in a few places. Individual areas range from 2 to 4 acres in size. Included in mapping are small areas of Donnan soils that are indicated by symbols on the soil map.

This Schley soil is moderate in organic-matter content and is well suited to row crops if it is properly tile drained. Undrained areas are well suited to pasture and moderately suited to row crops. It is susceptible to wetness and some areas are susceptible to slight erosion if cultivated. Since wetness is the result, at least in part, of sidehill seepage, a drainage system that intercepts laterally moving water is most successful. Capability unit IIw–2; woodland group 6.

Shorewood Series

The Shorewood series consists of somewhat poorly drained, nearly level and very gently undulating soils in the uplands. These soils formed in 40 to 60 inches or more of fine and moderately fine silty material over glacial till. Slopes are 1 to 3 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam about 18 inches thick. The subsoil, which extends to a depth of 52 inches, is dark grayish-brown silty clay that has a few yellowish-brown mottles in the upper part and grayish brown silty clay that has common, strong-brown

mottles in the lower part. The substratum is olive-gray silty clay loam.

Shorewood soils have moderately slow to slow permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Shorewood soils are used chiefly for row crops. Wetness is the major limitation, although tilth is a problem in some places where the clay content of the surface layer is high.

Representative profile of Shorewood silty clay loam, 1 to 3 percent slopes, in a cultivated field 720 feet west and 105 feet south of the northeast corner sec. 18, T. 100 N., R. 22 W.

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; weak, very fine, granular structure; friable; slightly acid; clear, smooth boundary.

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

A3—13 to 18 inches, very dark gray (10YR 3/1) heavy silty clay loam; few gray (10YR 5/1 dry) silt coatings; moderate, fine, granular structure; friable; medium acid; clear, wavy boundary.

B21t—18 to 24 inches, dark grayish-brown (2.5Y 4/2) silty clay; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; nearly continuous very dark gray (10YR 3/1) clay films on ped faces; moderate, very fine, subangular blocky structure; friable; strongly acid; clear, wavy boundary.

B22t—24 to 32 inches, dark grayish-brown (2.5Y 4/2) silty clay; nearly continuous very dark gray (10YR 3/1) and dark-gray (10YR 4/1) clay films on prism and ped faces; moderate, medium, prismatic structure parting to moderate, fine, subangular blocky; firm; medium acid; gradual, smooth boundary.

B3t—32 to 52 inches, grayish-brown (2.5Y 5/2) silty clay; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; discontinuous dark-gray (10YR 4/1) and very dark gray (10YR 3/1) clay films on prism and ped faces and lining pores and root channels; weak, medium, prismatic structure parting to weak, medium, subangular blocky; firm; few red (2.5YR 4/6) and dark reddish-brown (5YR 2/2) oxide concretions; slightly acid; gradual, smooth boundary.

C—52 to 84 inches, olive-gray (5Y 5/2) light silty clay loam; massive; friable; black (10YR 2/1) clay films lining pores and on some vertical faces; common yellowish-red (5YR 5/8) oxide concretions; some vertical cleavage; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 36 to 56 inches.

The A horizon ranges from black (10YR 2/1) in the upper part to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in the lower part. It ranges from light to heavy silty clay loam. It is 14 to 22 inches thick and neutral or medium acid in reaction.

The B2t horizon ranges from dark grayish brown (10YR 4/2) to olive (5Y 5/3) and has few to common distinct mottles and few to many dark clay films. It is silty clay or heavy silty clay loam 10 to 20 inches thick and medium acid or strongly acid in reaction.

The B3t horizon ranges from dark grayish brown (2.5Y 4/2) to light yellowish brown (2.5Y 6/4) and has few to common distinct mottles and dark clay films. It is silty clay or heavy silty clay loam 15 to 25 inches thick and slightly acid or mildly alkaline in reaction.

The C horizon ranges from olive gray (5Y 5/2) to olive brown (2.5Y 4/4) and is loam, silt loam, or silty clay loam.

Shorewood soils have a thicker solum and are deeper over free carbonates than is defined in the range for the series, but this difference does not alter their use or management.

Shorewood soils formed in parent material similar to that of Kilkenny, Minnetonka, and Rolfe soils. They have a thicker dark-colored A horizon than Kilkenny and Rolfe soils, lower values and generally higher chromas than Minnetonka and Rolfe soils, and lower chromas in the upper part of the B horizon than Kilkenny soils.

Shorewood silty clay loam, 1 to 3 percent slopes (855).—This soil is on slightly convex to slightly concave slopes. Most slopes are short. Individual areas range from 3 to 5 acres in size. Included in mapping are a few areas where slopes are greater than 3 percent and some areas where the dark-colored surface layer is about 8 inches thick.

This Shorewood soil is high in organic-matter content and is well suited to row crops. It is susceptible to slight wetness, especially in spring or during rainy seasons. Tile drains do not always function well and may need closer spacing than on soils that have less clay in the subsoil. Where tile drains are installed, drainage is generally improved. Some of the more sloping areas are susceptible to erosion if cultivated. Capability unit IIw–4; woodland group 7.

Sparta Series

The Sparta series consists of excessively drained, gently sloping, gently undulating, and gently rolling soils in the uplands and on the stream benches. These soils formed in loamy fine sand. Slopes are 2 to 9 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark grayish-brown loamy fine sand about 13 inches thick. The subsoil, which extends to a depth of 28 inches, is brown loamy fine sand. The substratum is yellowish-brown loamy fine sand.

Sparta soils have rapid permeability and low available water capacity. They are very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 4 years.

Sparta soils are used chiefly for row crops because they are closely associated with soils that are well suited to row crops. Droughtiness is the major limitation.

Representative profile of Sparta loamy fine sand, 2 to 5 percent slopes, in a cultivated field 600 feet east and 595 feet south of the northwest corner SE¼ sec. 18, T. 100 N., R. 20 W.

Ap—0 to 9 inches, very dark grayish-brown (10YR 3/2) loamy fine sand; weak, very fine, granular structure; very friable; slightly acid; clear, smooth boundary.

A12—9 to 13 inches, very dark grayish-brown (10YR 3/2) loamy fine sand; very weak, very fine, granular structure; very friable; slightly acid; gradual, smooth boundary.

B—13 to 28 inches, brown (10YR 4/3) loamy fine sand; very weak, very fine, subangular blocky structure; very friable; slightly acid; gradual, smooth boundary.

C1—28 to 60 inches, yellowish-brown (10YR 5/4) loamy fine sand; massive; loose; slightly acid.

The A horizon ranges from black (10YR 2/1) to very dark grayish-brown (10YR 3/2) loamy fine sand. It is 10 to 20 inches thick and neutral or medium acid in reaction.

The B horizon ranges from brown (10YR 4/3) to yellowish-brown (10YR 5/6) loamy fine sand. It is 10 to 20 inches thick and slightly acid or medium acid to reaction.

The C horizon ranges from brown (10YR 4/3) to yellowish-brown (10YR 5/6) loamy fine sand to sand. It is neutral or slightly acid in reaction.

Sparta soils formed in parent material similar to that of Dickinson and Hoopeston soils, but contain more sand and less clay in the solum than in those soils. They have higher chroma in the B horizon than Hoopeston soils.

Sparta loamy fine sand, 2 to 5 percent slopes (41B).—This soil is in the uplands and on stream benches. In some places it is on mounds and dunes. It has the profile described as representative of the series. Individual areas range from 2 to 5 acres in size. Slopes are short.

Included with this soil in mapping is a soil that has a thin brown surface layer. This lighter colored soil is mostly in timber, and some eroded areas are cultivated.

This Sparta soil is moderately low to low in organic-matter content and is moderately suited to row crops if rainfall is normal and timely. It is droughty unless rainfall is timely and above normal. It is subject to soil blowing and water erosion if cultivated or pastured. Capability unit IVs–1; woodland group 8.

Sparta loamy fine sand, 5 to 9 percent slopes (41C).—This soil is in the uplands and on stream benches. In some places it is on mounds or dunes. Individual areas range from about 2 to 5 acres in size. Slopes are short.

Included with this soil in mapping is a soil that has a thin brown surface layer. This lighter colored soil is mostly in timber, and some eroded areas are cultivated.

This Sparta soil is moderately low and low in organic-matter content and is poorly suited to row crops and moderately suited to hay and pasture. It is droughty most years. It is subject to soil blowing and water erosion if cultivated or pastured. Capability unit IVs–1; woodland group 8.

Storden Series

The Storden series consists of well-drained, calcareous, gently rolling to hilly soils on knobs and ridges. These soils formed in calcareous glacial till. Slopes are short and are 5 to 18 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is mixed brown and very dark grayish-brown loam about 8 inches thick. The substratum is light olive-brown loam that has very few small dark-gray shale fragments, a few small soft lime concretions, and a few pebbles. A few reddish-brown and strong-brown iron concretions are below a depth of 39 inches.

Storden soils have moderate permeability and high available water capacity. The subsoil is very low in available phosphorus and potassium. These soils are mildly alkaline and do not need lime.

Storden soils are used chiefly for row crops and pasture. The major limitations are the hazard of erosion and, in some places, steepness of slope.

Representative profile of Storden loam, 5 to 14 percent slopes, severely eroded; in a cultivated field 295 feet west of the northeast corner SE¼SW¼ sec. 17, T. 99 N., R. 22 W.

Ap—0 to 8 inches, mixed brown (10YR 5/3) and very dark grayish-brown (10YR 3/2) loam; weak, medium, subangular blocky structure; friable; very few small pebbles; strong effervescence; mildly alkaline; clear, wavy boundary.

C1—8 to 23 inches, light olive-brown (2.5Y 5/4) light loam; massive; friable; few very small soft lime concretions; very few small dark-gray (5Y 4/1) shale fragments; few small pebbles; violent effervescence; mildly alkaline; gradual, smooth boundary.

C2—23 to 39 inches, light olive-brown (2.5Y (5/4) heavy loam; massive; friable; very few small shale fragments; few small soft lime concretions; few small pebbles; violent effervescence; mildly alkaline; clear, wavy boundary.

C3—39 to 68 inches, mixed light olive-brown (2.5Y 5/4) and light yellowish-brown (2.5Y 6/4) loam; few strong-brown (2.5Y 5/8) and reddish-brown (5YR 4/4) oxide concretions; few small soft lime accumulations; few small pebbles; violent effervescence; mildly alkaline.

The A horizon in uncultivated areas ranges from very dark brown (10YR 2/2) to dark brown (10YR 3/3) loam. It is 6 to 10 inches thick and neutral or mildly alkaline in reaction.

The Ap horizon ranges from brown (10YR 5/3) to light olive-brown (2.5Y 5/4) loam 6 to 8 inches thick and mildly alkaline in reaction.

The C1 horizon ranges from yellowish-brown (10YR 5/4) to light yellowish-brown (2.5Y 6/4) loam mildly alkaline in reaction.

Storden soils formed in parent material similar to that of Clarion and Lester soils. They are more shallow to carbonates than those soils and have a thinner A horizon than Clarion soils.

Storden loam, 5 to 14 percent slopes, severely eroded (62D3).—This soil occupies knobs, ridgetops, and shoulders of hills. Slopes are short and irregular. The topography is rolling. This soil has the profile described as representative of the series. Individual areas are circular to long, thin, and irregular and range from 2 to 10 acres in size.

Included with this soil in mapping are a few uneroded areas of Storden soils that have a darker colored surface layer and a few areas of Salida soils, most of which are indicated by symbols on the soil map.

This Storden soil is very low in organic-matter content in most places but some areas are low and moderately low. It is moderately suited to row crops. It is susceptible to severe erosion if cultivated or pastured intensively. Contouring and terracing are difficult because the topography is irregular. Parallel terracing requires a considerable amount of cutting and filling. Capability unit IIIe–1; woodland group 10.

Storden loam, 14 to 18 percent slopes, severely eroded (62E3).—This soil occupies knobs, ridgetops, and shoulders of hills. Slopes are short. Individual areas are circular to long, thin, and irregular and range from 2 to 20 acres in size.

Included with this soil in mapping are a few uneroded areas of Storden soils that have a very dark grayish-brown surface layer. Also included are a few small areas of Salida soils, most of which are indicated by symbols on the soil map. A few slopes are 18 to 25 percent.

This Storden soil is low in organic-matter content in most places but in places is moderately low and very low. It is poorly suited to row crops. It is susceptible to severe erosion if cultivated or pastured intensively. Contouring and terracing are difficult because the topography is irregular. Parallel terracing requires a considerable amount of cutting and filling. Capability unit IVe–1; woodland group 10.

Talcot Series

The Talcot series consists of poorly drained, calcareous, nearly level soils on stream benches and upland alluvial areas. These soils formed in 24 to 40 inches of loamy alluvial sediment over sand or gravel. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black and very dark gray clay loam about 21 inches thick. The subsoil, which extends to a depth of 35 inches, is olive-gray loam in the upper part and light olive-gray loam in the lower part. The substratum, to a depth of 41 inches, is light olive-gray loamy coarse sand. Below this, it is mottled light olive-brown and brown gravelly sand.

Talcot soils have moderate permeability in the loamy upper part and rapid to very rapid permeability in the sandy and gravelly lower part. They have moderate to low available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are mildly alkaline and do not need liming.

Talcot soils are used mainly for row crops where tile drained. Wetness is the major limitation.

Representative profile of Talcot clay loam, deep, 0 to 2 percent slopes, in a cultivated field 600 feet west and 790 feet south of the northeast corner NW¼ sec. 34, T. 98 N., R. 21 W.

A11—0 to 11 inches, black (N 2/0) light clay loam; weak, fine, granular structure; friable; strong effervescence; mildly alkaline; gradual, smooth boundary.

A12—11 to 17 inches, black (10YR 2/1) clay loam; weak, fine, subangular blocky structure; slight effervescence; mildly alkaline; clear, smooth boundary.

A3g—17 to 21 inches, very dark gray (10YR 3/1) light clay loam; few, fine, distinct, olive-gray (5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; slight effervescence; mildly alkaline; clear, smooth boundary.

B2g—21 to 28 inches, olive-gray (5Y 5/2) clay loam; common, fine, distinct, dark-gray (5Y 4/1) mottles; weak, medium, subangular blocky structure; friable; few small pebbles; slight effervescence; mildly alkaline; clear, smooth boundary.

B3g—28 to 35 inches, light olive-gray (5Y 6/2) light loam; weak, coarse, subangular blocky structure; friable; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; slight effervescence; mildly alkaline; clear, smooth boundary.

IIC1—35 to 41 inches, light olive-gray (5Y 6/2) loamy coarse sand; few, medium, distinct, yellowish-brown (10YR 5/6) mottles; single grained; loose; few small pebbles; slight effervescence; mildly alkaline; clear, smooth boundary.

IIC2—41 to 60 inches, mottled light olive-brown (2.5Y 5/4) and brown (7.5YR 4/4) gravelly sand; single grained; loose; slight effervescence; mildly alkaline.

The depth to sand or gravel ranges from 24 to 40 inches.

The A horizon ranges from black (10YR 2/1 or N 2/0) in the upper part to very dark gray (10YR 3/1) in the lower part. It is typically clay loam, but in places is silty clay loam high in sand. It is 14 to 24 inches thick.

The B2g horizon ranges from dark gray (N 4/0) to olive gray (5Y 5/2) and has few to many mottles. It is clay loam or silty clay loam high in sand. It is 3 to 8 inches thick where there is a B3g horizon and 6 to 14 inches thick where there is no B3g horizon.

The B3g horizon ranges from dark gray (5Y 4/1) to yellowish brown (10YR 5/4) and has no to many mottles. It ranges from loam to sandy clay loam and sandy loam. It is 0 to 8 inches thick and typically mildly alkaline in reaction but is neutral in some areas.

The IIC horizon ranges from olive yellow (2.5Y 6/6) to olive gray (5Y 4/2) and has few to many mottles. It ranges from loamy sand to gravelly sand. It is typically mildly alkaline in reaction but is neutral in some areas.

Talcot soils formed in parent material similar to that of Harcot, Marshan, and Canisteo soils. They are mildly alkaline in the solum, whereas Harcot soils are moderately alkaline and Marshan soils are neutral to slightly acid. They have a loamy sand to gravel IIC horizon, whereas Canisteo soils have a loam C horizon.

Talcot clay loam, deep, 0 to 2 percent slopes (559).—This soil is on stream benches and in upland alluvial areas. It has the profile described as representative of the series. Individual areas range from 3 to 40 acres in size in most places, but some are more than 100 acres.

The depth to sand and gravel is 32 to 40 inches in most places. Included with this soil in mapping are a few places that are 40 to 60 inches deep over sand or gravel. A few small depressions are indicated by spot symbols on the soil map.

This Talcot soil is high in organic-matter content and is well suited to row crops if it is properly drained. It is susceptible to wetness during rainy seasons. Most of it has been tile drained. Undrained areas are well suited to pasture. Tile placement is difficult in some places because of loose, water-bearing sands. Some low areas are subject to flooding for short periods. Capability unit IIw–1; woodland group 13.

Talcot clay loam, moderately deep, 0 to 2 percent slopes (558).—This soil is on stream benches and in upland alluvial areas. It has a profile similar to the one described as representative of the series, but the depth to sand or gravel is 24 to 32 inches in most places. Individual areas range from 3 to 40 acres in size in most places, but some are more than 100 acres.

Included with this soil in mapping are a few places that are underlain by sand or gravel at a depth of 16 to 24 inches. A few small depressions are indicated by spot symbols on the soil map.

This Talcot soil is high in organic-matter content and is well suited to row crops if properly drained. It is susceptible to wetness during rainy seasons and some droughtiness during prolonged dry seasons. Most areas have been tile drained. Undrained areas are well suited to pasture. Tile placement is difficult in some places because of loose, water-bearing sands. Some low areas are subject to flooding for short periods. Capability unit IIw–1; woodland group 13.

Terril Series

The Terril series consists of dark-colored, well-drained, gently sloping soils on waterways and foot slopes. Most areas of these soils are in the uplands but some are on stream benches. These soils formed in medium-textured, local alluvial sediment. Slopes are 2 to 5 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and black loam about 27 inches thick. The subsoil, which extends to a depth of 54 inches, is dark-brown loam in the upper part, dark yellowish-brown loam in the middle part, and dark yellowish-brown

heavy sandy loam in the lower part. The substratum is yellowish-brown loam.

Terril soils have moderate permeability and high available water capacity. They are very low in available phosphorus and potassium. These soils are neutral to slightly acid and need lime in some places unless limed during the past 5 years.

Terril soils are used mainly for row crops. Slight erosion is the major limitation.

Representative profile of Terril loam, 2 to 5 percent slopes, in a cultivated field 400 feet north and 190 feet east of the southwest corner SE¼SW¼ sec. 15, T. 99 N., R. 21 W.

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

A12—9 to 27 inches, black (10YR 2/1) loam; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; neutral; clear, smooth boundary.

B1—27 to 34 inches, dark-brown (10YR 3/3) loam, discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium, subangular blocky structure parting to weak, fine, subangular blocky; friable; slightly acid; clear, smooth boundary.

B2—34 to 46 inches, dark yellowish-brown (10YR 4/4) loam; brown (10YR 4/3) coatings on prisms and peds; weak, medium, prismatic structure parting to weak, medium, subangular blocky; friable; slightly acid; clear, smooth boundary.

B3—46 to 54 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam, brown (10YR 4/3) coatings on prisms; weak, medium, prismatic structure; very friable; neutral; clear, smooth boundary.

C—54 to 72 inches, yellowish brown (10YR 5/4) loam; massive; friable; neutral.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2) in the lower part. It is loam or silt loam high in sand. It is 24 to 36 inches thick and neutral or slightly acid in reaction.

The B1 horizon is dark brown (10YR 3/3) or brown (10YR 4/3) with darker coatings on the peds and the B2 horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). These horizons are loam or light clay loam and have a combined thickness of 10 to 15 inches. They are neutral or slightly acid in reaction.

The B3 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). It ranges from sandy loam to light clay loam. It is 3 to 15 inches thick and neutral or slightly acid in reaction.

The C horizon ranges from brown (10YR 4/3) to light olive brown (2.5Y 5/6). It is typically loam, but ranges from sandy loam to clay loam. It is neutral or mildly alkaline in reaction.

Terril soils formed in parent material similar to that of Turlin soils. They have higher chroma in the B and C horizon than those soils.

Terril loam, 2 to 5 percent slopes (27B).—This soil occupies foot slopes and waterways. Individual areas range from 2 to about 15 acres in size in most places. Most are long and narrow.

Included with this soil in mapping are some nearly level areas and some moderately sloping areas. In a few places on the stream benches loamy sand and sand is below a depth of 36 to 48 inches.

This Terril soil is high in organic-matter content and is well suited to row crops. It is subject to slight sheet and gully erosion if cultivated. Some areas receive runoff from higher slopes. Capability unit IIe–1; woodland group 2.

Tilfer Series

The Tilfer series consists of poorly drained, calcareous, nearly level soils principally on low stream benches but in places on first bottoms and intermediate stream benches. These soils formed in 20 to 40 inches of loamy material over limestone bedrock. Slopes are 0 to 2 percent. The native vegetation was water-tolerant prairie grasses.

In a representative profile the surface layer is black silty clay loam about 19 inches thick. The subsoil, which extends to a depth of 35 inches, is light olive-gray and olive-gray loam. Below the subsoil is 2 to 3 feet of hard, shattered limestone over level-bedded limestone bedrock.

Tilfer soils are moderately permeable and have low to moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils have an excess of lime. In some years iron deficiencies are noticeable in soybeans.

Tilfer soils are used mainly for pasture and row crops. Wetness is the major limitation. These soils are subject to some flooding on the first bottoms and low benches. Open-ditch and tile drainage is difficult because of the limestone substratum. These soils are mildly alkaline. No lime is needed.

Representative profile of Tilfer silty clay loam, 0 to 2 percent slopes, in a cultivated field 1,000 feet east and 120 feet north of the southwest corner sec. 36, T. 99 N., R. 20 W.

Ap—0 to 8 inches, black (N 2/0) light silty clay loam; moderate, medium, subangular blocky structure parting to weak, fine, granular; friable; strong effervescence; mildly alkaline; clear, smooth boundary.

A12—8 to 19 inches, black (N 2/0) silty clay loam; few, fine, distinct, olive (5Y 5/3) mottles in the lower 3 inches; weak, medium, subangular blocky structure parting to weak, fine, granular; friable; strong effervescence; mildly alkaline; clear, wavy boundary.

B2g—19 to 27 inches, light olive-gray (5Y 6/2) loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual, smooth boundary.

B3g—27 to 35 inches, olive-gray (5Y 5/2) loam; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, coarse, subangular blocky structure; friable; few, small, rounded, hard limestone pebbles and few small granitic pebbles; strong effervescence; mildly alkaline; abrupt, wavy boundary.

R—35 inches, fractured limestone bedrock.

The A horizon is typically black (N 2/0) but includes very dark gray (10YR 3/1 or 5Y 3/1) in the lower fringe. It ranges from silty clay loam to loam and light clay loam. It is 15 to 24 inches thick.

The B2g horizon is typically light olive gray (5Y 6/2) or olive gray (5Y 5/2) and has no to common high-chroma mottles. It ranges from loam to clay loam and silty clay loam high in sand. It is 4 to 10 inches thick.

The B3g horizon ranges from dark grayish brown (2.5Y 4/2) to light gray (5Y 6/1) and has few to common high-chroma mottles. It ranges from loam to sandy loam. It is 2 to 10 inches thick.

The IIC horizon ranges from strong brown (7.5YR 5/6) with gray (5Y 5/1) mottles to olive gray (5Y 5/2). It ranges from gravelly sand to loamy sand and commonly has 10 to 30 percent cobblestones and pebbles. It is 0 to 6 inches thick.

Tilfer soils formed in parent material similar to that of Faxon and Talcot soils. They are mildly alkaline in reaction

in the solum, whereas Faxon soils are neutral to slightly acid. They are underlain by limestone bedrock, whereas Talcot soils are underlain by sand and gravel.

Tilfer silty clay loam, 0 to 2 percent slopes (695).—Most areas of this soil are on low stream benches, but in a few places it is on first bottoms and intermediate benches. Individual areas range from 3 to 40 acres in size.

Included with this soil in mapping are areas where depth to limestone bedrock is 40 to 50 inches and a few areas where the surface layer is mucky silt loam.

This Tilfer soil is high in organic-matter content and is moderately suited to row crops if it is properly drained. It is susceptible to wetness. Drainage by means of tile and open ditch is difficult because of the limestone bedrock. Undrained areas are well suited to moderately suited to pasture. Capability unit IIIw–3; woodland group 13.

Turlin Series

The Turlin series consists of somewhat poorly drained, nearly level soils on flood plains of rivers and streams and on low stream benches. These soils formed in medium-textured alluvial sediment. Slopes are 0 to 2 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is black loam about 31 inches thick. The subsoil, which extends to a depth of 43 inches, is dark grayish-brown loam that has many yellowish-brown mottles. The substratum is light olive-gray stratified loam and sandy loam that has common yellowish-brown and yellowish-red mottles.

Turlin soils have moderate permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are neutral to slightly acid and may need liming unless limed during the past 5 years.

Turlin soils are used mainly for row crops and pasture. The major limitation is some wetness early in spring or during wet seasons. These soils are subject to some flooding. Turlin soils are mapped only in complex with Coland soils.

Representative profile of Turlin loam in an area of Coland-Turlin complex, 0 to 2 percent slopes, in a pasture 880 feet west and 720 feet north of the southeast corner sec. 35, T. 98 N., R. 20 W.

A11—0 to 12 inches, black (10YR 2/1) loam; moderate, very fine, granular structure; very friable; neutral, gradual, smooth boundary.

A12—12 to 23 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; neutral, gradual, smooth boundary.

A13—23 to 31 inches, black (10YR 2/1) heavy loam; weak, fine, granular structure; friable; neutral; clear, wavy boundary.

B—31 to 43 inches, dark grayish-brown (10YR 4/2) heavy loam; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; some very dark gray (10YR 3/1) clayey material in root channels; very few small pebbles; neutral; gradual, smooth boundary.

C—43 to 60 inches, light olive-gray (5Y 6/2) stratified loam and sandy loam; common, medium, distinct, yellowish-brown (10YR 5/6) and yellowish-red (5YR 5/8) mottles; massive; friable; neutral.

The A horizon ranges from black (10YR 2/1) to very dark brown (10YR 2/2) in the upper part and from black to very dark grayish brown (10YR 3/2) in the lower part. It is typically loam, but in places has lenses of sandy loam. It is 24 to 36 inches thick and neutral or slightly acid in reaction.

The B horizon is dark grayish brown (10YR 4/2 or 2.5Y 4/2) and has no to many high-chroma mottles. It is typically loam, but in places is light clay loam and some lenses of sandy loam. It is 10 to 20 inches thick and neutral or slightly acid in reaction.

The C horizon ranges from light olive gray (5Y 6/2) to yellowish brown (10YR 5/6) and has common to many mottles. It is typically loam or stratified loam and sandy loam.

Turlin soils formed in parent material similar to that of Coland and Terril soils. They have a thinner A horizon than Coland soils and lower chroma in the B and C horizon than Terril soils.

Wacousta Series

The Wacousta series consists of poorly drained, nearly level soils on stream benches. These soils formed in medium and moderately fine textured silty alluvial sediment. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black and very dark gray silt loam about 20 inches thick. The subsoil, which extends to a depth of 26 inches, is light olive-gray silt loam that has a few olive-yellow mottles. The substratum is mottled pale-olive and yellowish-brown light silt loam to a depth of about 40 inches and mottled light-gray and yellowish-brown silt below this.

Wacousta soils have moderate permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are neutral or mildly alkaline and do not need lime.

Wacousta soils are used mainly for row crops. Wetness is the major limitation.

Representative profile of Wacousta silt loam, benches, 0 to 2 percent slopes, in a cultivated field 69 feet east of center of T intersection and 66 feet north of road fence NW¼ sec. 14, T. 100 N., R 21 W.

Ap—0 to 7 inches, black (N 2/0) heavy silt loam; cloddy parting to weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

A12—7 to 12 inches, black (N 2/0) heavy silt loam; moderate, fine and very fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A13—12 to 16 inches, black (5Y 2/1) heavy silt loam; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

A3g—16 to 20 inches, very dark gray (5Y 3/1) silt loam; few, fine, distinct, olive (5Y 5/3) mottles; weak, fine, subangular blocky structure; friable; slight effervescence; mildly alkaline; clear, smooth boundary.

Bg—20 to 26 inches, light olive-gray (5Y 6/2) silt loam; few, fine, distinct, olive-yellow (2.5Y 6/6) mottles; massive; thinly stratified; friable; common fine pores; violent effervescence; mildly alkaline; gradual, smooth boundary.

Cg—26 to 64 inches, mottled pale-olive (5Y 6/3) and yellowish-brown (10YR 5/6) light silt loam with a gradual transition below a depth of about 40 inches to mottled light-gray (10YR 6/1) and yellowish-brown (10YR 5/6) medium silt; massive; thinly stratified; friable; common small dark reddish-brown (5YR 2/2) oxide concretions below a depth of 40 inches; violent effervescence; mildly alkaline.

The A horizon is black (N 2/0 or 10YR 2/1) in the upper part and very dark gray (10YR 3/1, N 3/0, or 5Y 3/1) in the lower part. It is typically silt loam or light silty clay loam 16 to 24 inches thick. It is typically neutral and noncal-

careous, but after prolonged wet seasons it is slightly effervescent and mildly alkaline in reaction.

The Bg horizon ranges from gray (5Y 5/1) to light olive gray (5Y 6/2) and has many high-chroma mottles. It is typically silt loam to light silty clay loam 4 to 8 inches thick.

Wacousta soils formed in parent material similar to that of Okoboji soils, but contain less clay and have a thinner dark-colored A horizon than those soils.

Wacousta silt loam, benches, 0 to 2 percent slopes (T506).—This soil is on low bench positions in most places. Nearly all of it is on the benches along Goose Creek in Hartland Township. Individual areas range from 30 to 80 acres in size.

Included with this soil in mapping are some areas that are moderately alkaline in the surface layer. When dry, these areas are lighter colored than the main body of the soil. These high-lime areas are associated with small depressions and shallow drainageways. Some of the depressions are indicated by a spot symbol on the soil map.

The Wacousta soil is high in organic-matter content and is well suited to row crops if it is properly drained. Wetness delays fieldwork in spring and in rainy seasons, although most of this soil has been tile drained. Getting a good outlet for tile drainage is difficult in most places. Undrained areas are well suited to pasture. Capability unit IIw-1; woodland group 13.

Wapsie Series

The Wapsie series consists of well-drained soils that are nearly level to moderately sloping on the stream benches and are gently undulating and gently rolling in the uplands. These soils formed in 18 to 36 inches of medium and moderately coarse textured alluvial sediment and the underlying sand and gravel. Slopes are 0 to 9 percent. The native vegetation was trees and grasses.

In a representative profile the surface layer is very dark grayish-brown loam about 8 inches thick. The subsoil, which extends to a depth of 36 inches, is brown and dark yellowish-brown loam in the upper part, brown sandy loam in the middle part, and brown loamy sand in the lower part. The substratum is brown gravelly sand that is calcareous below a depth of about 54 inches.

Wapsie soils have moderate permeability in the upper part of the soil that formed in alluvial sediment and rapid to very rapid permeability in the underlying sand and gravel. They have low to moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Wapsie soils are used chiefly for row crops. Droughtiness and erosion are the major limitations.

Representative profile of Wapsie loam, 2 to 5 percent slopes, in a cultivated field 125 feet west and 225 feet north of the southeast corner SW¼/SW¼ sec. 6, T. 99 N., R. 20 W.

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam; brown (10YR 5/3) dry; few brown (10YR 4/3) mixings in lower 2 inches; cloddy parting to weak, very fine, granular structure; friable; medium acid; abrupt, smooth boundary.

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

B21—14 to 25 inches, dark yellowish-brown (10YR 4/4) loam; nearly continuous dark yellowish-brown (10YR 3/4) coatings on peds; weak, fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

B22t—25 to 30 inches, brown (10YR 4/3) sandy loam; few patchy dark-brown (10YR 3/3) clay films on ped faces; clay bridges between sand grains; weak, fine, subangular blocky structure; friable; few dark reddish-brown (5YR 2/2) oxide concretions; few small pebbles; strongly acid; clear, smooth boundary.

IIB3t—30 to 36 inches, brown (7.5YR 4/4) loamy sand; few, thin, patchy, brown (10YR 4/3) clay films on ped faces; some clay bridges between sand grains; weak, coarse, subangular blocky structure; very friable; few small pebbles; medium acid; clear, wavy boundary.

IIC1—36 to 54 inches, brown (7.5YR 4/4) gravelly sand; single grained; loose; medium acid; clear, wavy boundary.

IIC2—54 to 60 inches, brown (10YR 5/3) gravelly sand; single grained; loose; slightly effervescent; mildly alkaline.

The depth to sand and gravel ranges from 18 to 36 inches. The depth to carbonates ranges from 48 to more than 72 inches.

The A horizon ranges from very dark grayish brown (10YR 2/2) and very dark gray (10YR 3/1). It is loam or silt loam high in sand. It is 6 to 10 inches thick and neutral or medium acid in reaction.

The A2 horizon, where present, is brown (10YR 5/3) to dark grayish brown (10YR 4/2). It is loam or silt loam high in sand. It is 0 to 8 inches thick and medium acid or strongly acid in reaction.

The B horizon ranges from brown (10YR 4/3) to strong brown (7.5YR 5/8) and generally has few to many darker coatings on the peds. It is loam or light sandy clay loam and may include a thin horizon of sandy loam in the lower part. It is 9 to 23 inches thick and medium acid or strongly acid in reaction.

The IIB3 horizon ranges from dark yellowish-brown (10YR 4/4) to strong-brown (7.5YR 5/6) fine gravelly sandy loam to loamy sand. It is 2 to 15 inches thick and medium acid or strongly acid in reaction.

The IIC horizon ranges from brown (7.5YR 4/4) to yellowish-brown (10YR 5/6) sand or gravelly sand that is slightly acid or medium acid to a depth of at least 48 inches. Below this the IIC horizon ranges from brown (10YR 5/3) to yellowish-brown (10YR 5/6) sand and gravelly sand and is slightly acid to mildly alkaline in reaction.

Wapsie soils formed in parent material similar to that of Saude and Hayfield soils. They have higher chroma than Hayfield soils and have a thinner dark-colored A horizon than Saude soils.

Wapsie loam, 0 to 2 percent slopes (777).—This soil is on stream benches. Individual areas range from 3 to 40 acres in size. Included in mapping are some small sandy areas and wet spots, most of which are indicated by spot symbols on the soil map.

This Wapsie soil is moderate in organic-matter content and is well suited to row crops when rainfall is timely. It is droughty during extended dry periods. On the benches it is associated with more poorly drained soils that are a source for shallow wells. The hazard of pollution from septic tank filter fields is greater on the stream benches than in the uplands. Capability unit IIs–1; woodland group 5.

Wapsie loam, 2 to 5 percent slopes (777B).—This soil is gently sloping on the stream benches and gently undulating on the uplands. It has the profile described as representative of the series. Individual areas range from 2 to 40 acres in size.

Included with this soil in mapping are a few eroded areas that have a slightly thinner and lighter colored surface layer. A few sandy and gravelly areas are indicated by spot symbols on the soil map. A few small areas of Lester soils are also included.

This Wapsie soil is moderate in organic-matter content and is well suited to row crops if rainfall is normal and timely. It is droughty during extended dry periods. It is slightly subject to water erosion and soil blowing if cultivated. Terrace cuts should be held to a minimum to avoid exposing the sandy and gravelly material. On the benches this soil is associated with less well drained soils that are a source of water for shallow wells. The hazard of pollution from septic tank filter fields is greater on the stream benches than in the uplands. Capability unit IIe–3; woodland group 5.

Wapsie loam, 5 to 9 percent slopes, moderately eroded (777C2).—This soil is moderately sloping on the stream benches and gently rolling on the uplands. Most areas are in the uplands. This soil has a profile similar to the one described as representative of the series, but it is not quite so deep over sand and gravel and generally has a slightly thinner and lighter colored surface layer. Individual areas range from 2 to 7 acres in size.

About 40 percent of this soil is somewhat less eroded. Most of the less eroded areas are in trees or pasture. Some slopes are steeper than 9 percent. A few sandy and gravelly areas are included, most of which are indicated by spot symbols on the soil map.

This Wapsie soil is moderately low in organic-matter content and is moderately suited to row crops if rainfall is normal and timely. It is highly susceptible to water erosion if cultivated or pastured intensively and to soil blowing if cultivated. Terrace cuts should be held to a minimum to avoid exposing the sandy or gravelly material. On the benches this soil is associated with less well drained soils that are a source of water for shallow wells. The hazard of pollution from septic tank filter fields is greater on stream benches than in the uplands. This soil is droughty. Capability unit IIIe–2; woodland group 5.

Waukee Series

The Waukee series consists of well-drained, nearly level and gently sloping soils on stream benches and in the uplands. These soils formed in 30 to 40 inches of medium-textured alluvial sediment and the underlying sand and gravel. Slopes are 0 to 5 percent. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loam about 18 inches thick. The subsoil, which extends to a depth of 40 inches, is dark yellowish-brown loam in the upper part and brown fine gravelly sandy loam in the lower part. The substratum, to a depth of about 54 inches, is yellowish-brown fine gravelly loamy sand. Below this, it is pale-brown gravelly sand.

Waukee soils have moderate permeability in the upper part of the soil formed in alluvial sediment and rapid to very rapid permeability in the underlying sand and gravel. They have moderate available water capacity. Their subsoil is very low in available phosphorus and potassium. These soils are generally acid unless limed during the past 5 years.

Waukee soils are used mainly for row crops. They have no major limitations.

Representative profile of Waukee loam, 0 to 2 percent slopes, in a cultivated field 60 feet south and 195 feet west of the northeast corner sec. 27, T. 99 N., R. 20 W.

Ap—0 to 10 inches, very dark brown (10YR 2/2) heavy loam; cloddy parting to moderate, fine, granular structure; friable; slightly acid; clear, smooth boundary.

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

B2—18 to 36 inches, dark yellowish-brown (10YR 4/4) heavy loam; many brown (10YR 4/3) and few dark-brown (10YR 3/3) coatings on peds; weak, fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

IIB3t—36 to 40 inches, brown (7.5YR 4/4) fine gravelly sandy loam; clay bridges between sand grains; weak, medium, subangular blocky structure; very friable; medium acid; clear, smooth boundary.

IIC1—40 to 54 inches, yellowish-brown (10YR 5/4) fine gravelly loamy sand; single grained; loose; medium acid; clear, wavy boundary.

IIC2—54 to 68 inches, pale-brown (10YR 6/3) gravelly sand; single grained; loose; slight effervescence; mildly alkaline.

The depth to sand or gravel ranges from 30 to 40 inches. The depth to carbonates ranges from 48 to more than 72 inches.

The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and black to very dark grayish brown (10YR 3/2) in the lower part. It is loam or silt loam high in sand. It is 12 to 22 inches thick and neutral or medium acid in reaction.

The B horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6) and has few to many darker coatings on peds. It is loam or sandy clay loam and may have a thin sandy loam horizon in the lower part. It is 12 to 22 inches thick and medium acid or slightly acid in reaction.

The IIB3 horizon ranges from dark yellowish-brown (10YR 3/4) to brown (7.5YR 4/4) and yellowish-brown (10YR 5/6) fine gravelly sandy loam to loamy sand. It is 3 to 10 inches thick and slightly acid or medium acid in reaction.

The IIC horizon ranges from pale-brown (10YR 6/3) to dark yellowish-brown (10YR 4/4) and yellowish-brown (10YR 5/6) loamy sand to gravelly sand that is slightly acid or medium acid to a depth of at least 48 inches. Below this depth it is slightly acid or mildly alkaline in reaction.

Waukee soils formed in parent material similar to that of Lawler, Richwood, and Saude soils. They have higher chroma in the B horizon than Lawler soils and are deeper over sand and gravel and contain slightly more clay in the B horizon than Saude soils. Below a depth of about 30 to 40 inches, they are underlain by sand and gravel, whereas Richwood soils are underlain by silty and loamy material.

Waukee loam, 0 to 2 percent slopes (178).—This soil is on stream benches and in upland areas. It has the profile described as representative of the series. Individual areas range from 3 to 40 acres in size.

Included with this soil in mapping in about 5 percent of the areas are soils that have a very dark grayish-

brown surface layer about 8 inches thick. In places there are sandy spots and wet areas, most of which are indicated by spot symbols on the soil map.

This Waukee soil is high in organic-matter content and is well suited to row crops. It is slightly droughty in years of below-normal rainfall. On the benches it is associated with less well drained soils that are a source of water for shallow wells. The hazard of pollution from septic tank filter fields is greater on the stream benches than in the uplands. Capability unit I-1; woodland group 3.

Waukee loam, 2 to 5 percent slopes (178B).—This soil is on stream benches and uplands. Individual areas range from 3 to 20 acres in size.

Included with this soil in mapping in about 20 percent of the areas is a soil that is similar to Waukee loam in the upper part but has a loamy substratum. In a few places sandy spots are indicated by spot symbols on the soil map.

This Waukee soil is high in organic-matter content and is well suited to row crops. It is slightly droughty in years of below-normal rainfall. It is slightly susceptible to water erosion if cultivated. Terrace cuts should be held to a minimum to avoid exposing the sandy and gravelly material. On the benches this soil is associated with less well drained soils that are a source of water for shallow wells. The hazard of pollution from septic tank filter fields is greater on the stream benches than in the uplands. Capability unit IIe-1; woodland group 3.

Webster Series

The Webster series consists of poorly drained, nearly level soils in the uplands. These soils formed in glacial sediment. Slopes are 0 to 2 percent. The native vegetation was water-tolerant grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam and clay loam about 19 inches thick. The subsoil extends to a depth of 32 inches. It is dark-gray loam in the upper part and olive-gray loam in the lower part. The substratum is light olive-gray loam that grades to mottled strong-brown and grayish-brown loam at a depth of about 44 inches.

Webster soils have moderate to moderately slow permeability and high available water capacity. Their subsoil is very low in available phosphorus and potassium. They are neutral and do not need lime.

These soils are used mainly for row crops. Wetness is the major limitation.

Representative profile of Webster silty clay loam, 0 to 2 percent slopes, in a cultivated field 164 feet south and 60 feet west of the northeast corner SE¼ SE¼ sec. 19, T. 99 N., R. 21 W.

Ap—0 to 8 inches, black (N 2/0) light silty clay loam high in sand; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A12—8 to 13 inches, black (10YR 2/1) light clay loam; moderate, medium, subangular blocky structure parting to weak, fine, granular; friable; neutral; gradual, smooth boundary.

A13—13 to 19 inches, very dark gray (10YR 3/1) light clay loam; weak, fine, granular structure; friable; neutral; clear, wavy boundary.

B1g—19 to 23 inches, dark-gray (5Y 4/1) heavy loam; few, fine, distinct, olive (5Y 5/3) mottles; weak, fine, subangular blocky structure; friable; neutral; clear, smooth boundary.

B2g—23 to 32 inches, olive-gray (5Y 5/2) heavy loam; few mixings of very dark gray (10YR 3/1); weak, medium, subangular blocky structure; friable; neutral; clear, wavy boundary.

C1g—32 to 44 inches, light olive-gray (5Y 6/2) loam; few, fine, distinct, yellowish-red (5YR 5/8) and strong-brown (7.5YR 5/6) mottles; few dark reddish-brown (5YR 2/2) oxide concretions; massive; friable; stratified; some horizontal strata of sandy loam; few small pebbles; strong effervescence; mildly alkaline; gradual, smooth boundary.

C2—44 to 60 inches, mottled strong-brown (7.5YR 5/8) and grayish-brown (2.5Y 5/2) light loam; few yellowish-red (5YR 5/8) and dark reddish-brown (5YR 2/2) oxide concretions; massive; friable; few small pebbles; violent effervescence; mildly alkaline.

The depth to carbonates ranges from 24 to 36 inches.

The A horizon ranges from black (N 2/0) in the upper part to very dark gray (10YR 3/1) in the lower part. It ranges from silty clay loam high in sand to loam and clay loam and is 16 to 24 inches thick.

The B1g horizon is typically dark gray (5Y 4/1) and has few to many distinct mottles. It ranges from loam to clay loam and silty clay loam high in sand and is 0 to 6 inches thick.

The B2g horizon ranges from gray (5Y 5/1) to mottled olive gray (5Y 5/2) and olive brown (2.5Y 4/4). It is loam or clay loam 5 to 15 inches thick.

The B3g horizon, where present, has about the same color and texture as the B2g horizon. It is 0 to 6 inches thick and neutral or mildly alkaline.

The C horizon ranges from gray (5Y 5/1) or light olive gray (5Y 6/2) with a few mottles to mottled strong brown (7.5YR 5/8) and grayish brown (2.5Y 5/). It is generally medium loam but in places is light loam to light clay loam.

Webster soils formed in parent material similar to that of Canisteo and Nicollet soils. They are similar to the poorly drained Marshan soils, but have a C horizon of loam, whereas those soils are underlain by sand or gravel. They are neutral in the solum, in contrast with Canisteo soils, which are mildly alkaline. They have lower chroma in the B horizon than Nicollet soils.

Webster silty clay loam, 0 to 2 percent slopes (107).—This soil is along many of the waterways. Individual areas range from 2 to more than 40 acres in size.

Included with this soil in mapping are small areas of Clarion, Storden, Harps, and Okoboji soils. Also included are a few sandy spots, which are indicated by spot symbols on the soil map, and small areas where the substratum contains lenses of silt loam and sandy loam.

This Webster soil is high in organic-matter content and is well suited to row crops if it is properly drained. Wetness is a hazard during rainy periods. Most areas are tile drained. Undrained areas are well suited to pasture. Capability unit IIw-1; woodland group 13.

Webster-Nicollet complex, 1 to 3 percent slopes (329).—This mapping unit is generally about 60 percent Webster soil, 30 percent Nicollet soil, and 10 percent Clarion soil. In places it is very gently undulating. Slopes are short and are convex and concave. The Webster soil is in the lower areas. Individual areas range from 3 to more than 100 acres in size, and many are irregular in shape. Included in mapping are a few areas of Le Sueur soils.

These Webster and Nicollet soils are high in organic-matter content and are well suited to row crops if they

are properly drained. Wetness is a hazard during rainy seasons. Most areas are tile drained. Undrained areas are well suited to pasture. Capability unit IIw-1; woodland group 13.

Use and Management of the Soils

This section briefly describes the use and management of the soils in the county for crops and pasture. It explains the system of capability classification used by the Soil Conservation Service and suggests management of the soils by capability units. It also shows predicted yields for all the arable soils in the county. This section also contains information on woodland and wildlife and gives facts about the soils that affect their suitability for engineering projects.

The information given in this section is not a substitute for the detailed information that can be provided by a local representative of the Soil Conservation Service or by the county extension agent. It may, however, help the farmer or others plan suitable management for the soils.

Management for Crops and Pasture

In Worth County about 216,080 acres, or 84 percent of the county, is used for crops. About 12,250 acres, or 5 percent, is used for pasture; and 5,000 acres, or less than 2 percent, is used for timber. These figures are taken from the Iowa Conservation Needs Inventory published in 1970.

Corn, soybeans, oats, and legume-grass are the main farm crops grown. Most of the permanent pastures in the county are bluegrass and grasses tolerant of excessive wetness. Some have been renovated, and birdsfoot trefoil has been introduced. Grass-legume mixtures, such as alfalfa-bromegrass, are also pastured. Most of the permanent bluegrass pastures are not cultivated, because they are wet and need tile drainage. Each year more acres are being tile drained and converted to cropland. Okobji, Palms, Tilfer, and Faxon soils are the dominant ones remaining in pasture that need tile drainage.

Many soils are subject to water erosion. The major soils that need erosion control are the Bassett, Clarion, Dinsdale, Donnan, Donnan dark variant, Kenyon, Kilkenny, Lester, Rockton, Storden, Saude, and Wapsie soils. Grassed waterways are needed to control gullying in watercourses.

Dickinson, Flagler, Salida, and Sparta soils are generally subject to both soil blowing and water erosion. Cover crops, minimum tillage, and, in the more sloping areas, mechanical control of runoff, assist in erosion control.

In the spring, especially in April, all plowed fields are subject to soil blowing, the degree depending upon the amount of trash or residue left on the surface, the distance from and height of a physical barrier that slows wind velocity, and the roughness of the plowed surface. Where there is some vegetation, the direction of the field rows in relation to wind direction and the height and density of the vegetation greatly affect the amount of soil blowing.

Providing adequate erosion control and drainage is difficult because they conflict to some extent. In the Bassett, Donnan, Donnan dark variant, and Kenyon soils permeability in the loamy overburden is appreciably different from permeability in the glacial till of the subsoil. Water moves rapidly in the over burden and then tends to accumulate at the till contact. This gives rise to a seasonally perched water table and sidehill seepage in wet years. Because of this difficulty, a combination of terracing and tiling is most likely to be successful.

Fertilizer and lime should be applied according to the kinds and amounts indicated by soil tests and the crops to be grown. Crop residues and manure are needed to maintain organic-matter content and good tilth and protect the soil against erosion.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but the classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for trees, or for engineering uses.

In the capability system, the kinds of soil are grouped at three levels, the capability class, the subclass, and the unit. These levels are described in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

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

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

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

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit

their use largely to pasture, range, woodland, or wildlife.

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

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Worth County)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage) ; *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, but not in Worth County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management. and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–1 or IIIe–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, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units of Worth County are described and suggestions for the management of the soils are given. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all the soils of a given series appear in the unit. To find the names of all of the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I–1

This unit consists of well drained and moderately well drained, nearly level soils of the uplands and stream benches. These are soils of the Bassett, Clarion, Dinsdale, Kenyon, Richwood, Rockton, and Waukee series.

These soils are well aerated and are moderately and moderately slowly permeable. All but the Rockton and Waukee soils have high available water capacity. These two soils have moderate available water capacity. The deep Rockton soil is underlain by limestone bedrock, and the Waukee soil is underlain by sand and gravel at a depth of about 3 feet. They are slightly droughty in years of below-normal rainfall.

The soils of this unit are well suited to row crops. They have no major management problems. They generally have good tilth.

CAPABILITY UNIT I–2

This unit consists of somewhat poorly drained, nearly level, very gently sloping and very gently undulating soils of the uplands and stream benches. These are soils of the Clarion, Nicollet, Franklin, Hayfield, Klinger, Lawler, Le Sueur, Oran, and Readlyn series.

These soils are moderately or moderately slowly permeable. Hayfield and Lawler soils, however, are underlain at a depth of about 3 feet by sand and gravel that is rapidly to very rapidly permeable. Available water capacity is moderate in Hayfield and Lawler soils and high in the rest. Hayfield and Lawler soils are somewhat droughty during periods of below-normal rainfall.

The soils of this unit have good tilth and are well suited to row crops. The major limitation is wetness early in spring and during wet seasons. Tile drains have been installed in some areas. Installing tile is difficult in places in Hayfield and Lawler soils because the underlying sand is loose and water bearing. The longer, more sloping areas, especially in Franklin, Klinger, Nicollet, Oran, and Readlyn soils, are subject to slight water erosion.

CAPABILITY UNIT IIe–1

This unit consists of well drained and moderately well drained, gently sloping and gently undulating soils of the uplands and stream benches. These are soils of the Bassett, Clarion, Storden, Dinsdale, Kenyon, Kilkenny, Lester, Rockton, Terril, and Waukee series.

These soils are well aerated and are moderately and moderately slowly permeable. Available water capacity is moderate in the deep Rockton and the Waukee soils and high in the rest. The deep Rockton soils are underlain by limestone bedrock. Waukee soils are underlain by sand and gravel at a depth of about 3 feet. Both are slightly droughty in years of below-normal rainfall.

The major management needs are controlling erosion and maintaining the levels of fertility and organic-matter content. All the Kilkenny soils have good tilth. Eroded areas of Kilkenny soils are difficult to plow and cultivate.

The soils of this unit are well suited to row crops. If terraced, they can be cropped intensively. Terrace cuts should be held to a minimum in the deep Rockton soils and the Waukee soils so that the underlying limestone or sand and gravel is not exposed in the terrace channel. Cuts should also be held to a minimum to avoid exposing the underlying glacial till in Bassett, Dinsdale, and Kenyon soils and the subsoil of Kilkenny

soils because it is low in fertility and difficult to till. Building parallel terraces on Clarion, Lester, and Kelkenny soils is likely to require much cutting and filling because the topography is irregular. Bassett, Clarion, Dinsdale, Kenyon, and most of the deep Rockton and the Waukee soils have long, uniform slopes.

CAPABILITY UNIT IIe–2

This unit consists of gently sloping, well drained to somewhat poorly drained soils of the uplands. These are soils of the Donnan and Donnan dark variant series.

These soils are moderately permeable in the surface layer and upper part of the subsoil and very slowly permeable in the lower part of the subsoil and in the substratum. The movement of water and air is somewhat restricted in the lower part of the subsoil.

Terrace cuts should be held to a minimum so that the underlying clayey subsoils are not exposed in the channels. Both providing adequate drainage and at the same time controlling erosion are difficult because they conflict to some extent. The long uniform slopes are well suited to contouring and terracing. These practices slow down the movement of surface water and let more of it soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. Because of the difficulty of providing adequate control and drainage, a combination of terracing and tile drainage is needed. Careful placement and spacing of tile are important because of the slowly permeable subsoil.

The major management problems are providing drainage for the very slowly permeable subsoil, the control of erosion, and the maintenance of organic-matter content and fertility. These soils generally have good soil tilth. The Donnan soil is moderately suited and the Donnan dark variant is well suited to row crops. Both are well suited to hay and pasture. Most of the soils are used for row crops.

CAPABILITY UNIT IIe–3

This unit consists of well-drained, gently sloping and gently undulating soils of the stream benches and uplands. These soils are underlain by loamy fine sand, sand and gravel, or limestone bedrock at a depth of about 1½ to 3½ feet. These are soils of the Bolan, Rockton, Saude, and Wapsie series. These soils are moderately permeable and have low to moderate available water capacity.

The major management needs are erosion control, conservation of moisture, and maintenance of organic-matter content and fertility. The number of corn plants per acre should be somewhat less than recommended for deeper soils because of the limited root zone and smaller ability to store water. Terrace cuts should be held to a minimum so that the underlying sand, gravel, or bedrock is not exposed. The bedrock may interfere with terrace construction in Rockton soils.

The soils of this unit are well suited to row crops when rainfall is normal and timely. They are mainly used for row crops. They generally have good tilth and moderate depth for root development. In dry periods they are somewhat droughty.

CAPABILITY UNIT IIw–1

This unit consists of nearly level and very gently undulating, poorly drained and somewhat poorly drained soils in the uplands and on stream benches. These are soils of the Canisteo, Clyde, Marshan, Maxfield, Nicollet, Talcot, Wacousta, and Webster series.

These soils have seasonal high water tables and need tile drainage for satisfactory row crop production. They are moderately to moderately slowly permeable. Marshan and Talcot soils have low to moderate available water capacity. All the other soils have high available water capacity.

When properly drained, the soils of this unit are well suited to row crops. Undrained areas are well suited to hay and pasture plants. Most of the acreage is used for row crops. The major management needs are improving drainage and maintaining good soil tilth. Installing tile is difficult in places in Marshan and Talcot soils because the underlying sand is loose and water bearing.

CAPABILITY UNIT IIw–2

This unit consists of nearly level to very gently sloping, somewhat poorly drained soils of the uplands. These are soils of the Floyd and Schley series. In periods of high rainfall and early in spring, the water table is near the surface unless drained. In many places tile drainage is needed for satisfactory crop production.

These soils are moderately permeable and have high available water capacity.

The major management needs are tile drainage and the maintenance of fertility. These soils generally have good tilth. The more sloping areas are subject to some erosion if cultivated. Wetness in some areas of these soils is due in part to seepage from the Bassett, Donnan dark variant, and Kenyon soils upslope. A drainage system that intercepts sidehill seepage is most likely to be successful.

The soils of this unit are well suited to row crops when properly drained. Undrained areas are moderately suited to row crops. Most of the acreage is used for row crops.

CAPABILITY UNIT IIw–3

This unit consists of the poorly drained Minnetonka soils. They are on nearly level to very gently undulating uplands. They are slowly permeable and have high available water capacity.

The water table is seasonally high and tile drainage is needed for satisfactory row crop production. If properly drained, these soils are well suited to row crops. Undrained areas are well suited to pasture. Most areas are used for row crops. The major management needs are improving drainage and maintaining good tilth. In some places tilth is a problem because the surface layer has a high clay content. Tile drains do not always function well and may need closer spacing than in soils with less clay in the subsoil.

CAPABILITY UNIT IIw–4

This unit consists of nearly level and very gently undulating, somewhat poorly drained to moderately well drained soils of the uplands. These are soils of

the Donnan, Donnan dark variant, and Shorewood series. In some places they need tile drainage for satisfactory crop production.

Donnan and Donnan dark variant soils are very slowly permeable in the lower part of the subsoil. Shorewood soils are moderately slowly to slowly permeable. They all have high available water capacity.

When properly drained Shorewood and Donnan dark variant soils are well suited and Donnan soils are moderately suited to row crops. Tile drains do not always function well and may need closer spacing than in soils that have less clay in the subsoil. This is generally more of a problem in Donnan and Donnan dark variant than in Shorewood soils. Most of these soils are used for row crops. The major management needs are improving drainage and maintaining fertility. Donnan and Donnan dark variant soils generally have good tilth. Shorewood soils have a problem of poor tilth in some places because of the high clay content of the surface layer. Some of the more sloping areas of Shorewood soils are susceptible to slight water erosion.

CAPABILITY UNIT IIw–5

This unit consists of poorly drained and somewhat poorly drained, nearly level soils on flood plains of rivers and streams. These are soils of the Calco, Coland, and Turlin series.

These soils have seasonal high water tables and are subject to some flooding. They need tile drainage for satisfactory crop production. They are moderately to moderately slowly permeable and have high available water capacity.

The major management needs are improving drainage and maintaining good soil tilth. Good tile outlets are not available in all places. In some places sandy lenses complicate placement of drain tile and stability of open ditches. When properly drained these soils are well suited to row crops. Undrained areas are well suited to pasture.

CAPABILITY UNIT IIw–6

This unit consists of nearly level and very gently undulating, poorly drained soils in the uplands and on stream benches. These are soils of the Harcot and Harps series.

The water table is seasonally high, and tile drainage is needed for satisfactory row crop production. These soils are moderately permeable. Harps soils have high available water capacity, and Harcot soils have low to moderate available water capacity.

The major management needs are improving drainage and maintaining good soil tilth. In Harcot soils tile installation is difficult in some places because the underlying sand is loose and water bearing.

When properly drained, these soils are well suited to row crops. Undrained areas of Harps soils are well suited to hay and pasture plants, and undrained areas of Harcot soils are generally well suited. Most of the soils in the capability unit have been tile drained.

CAPABILITY UNIT IIs–1

This unit consists of well-drained and somewhat poorly drained, nearly level soils of the uplands and stream benches. These are soils of the Bolan, Hayfield, Kensett, Lawler, Rockton, Saude, and Wapsie series. They are moderately deep over loamy fine sand, sand and gravel, or limestone bedrock.

These soils are moderately permeable and have low to moderate available water capacity.

The major management need is conserving available moisture in dry years. Corn plants per acre should be somewhat fewer than recommended for deeper soils because the root zone is shallower. Installing tile is difficult in places in Hayfield and Lawler soils because the underlying sand is loose and water bearing. Tile installation is also difficult in Kensett soils because these soils are only moderately deep over limestone.

The soils of this unit are well suited to row crops, and most of the acreage is used for row crops. They generally have good tilth, but they have only a moderately deep root zone and are somewhat droughty during dry periods.

CAPABILITY UNIT IIIe–1

This unit consists of well drained and moderately well drained, moderately sloping and gently rolling soils of the uplands. These are soils of the Clarion, Kenyon, Kilkenny, Lester, and Storden series.

These soils are moderately or moderately slowly permeable. They are well aerated and have high available water capacity. They are susceptible to severe erosion if cultivated.

The major management needs are controlling erosion and maintaining organic-matter content and fertility. All except the Kilkenny soils have good tilth. Kilkenny soils are difficult to plow and cultivate.

Clarion and Kenyon soils and the gently rolling areas of Clarion-Storden loams and Lester soils are well suited to row crops and are mostly used for row crops. Kilkenny soils and the rolling areas of Clarion-Storden loams and Lester soils are moderately suited to row crops. Where terraced, the exposure of glacial till in Kenyon soils and of subsoil in Kilkenny soils should be held to a minimum because this material is low in fertility and has unfavorable characteristics for tillage operations. Building parallel terraces on Clarion, Storden, Lester, and Kilkenny soils may require much cutting and filling because the topography is irregular. A combination of terracing and tile drainage may be needed on Kenyon soils because it is difficult to provide both erosion control and drainage.

CAPABILITY UNIT IIIe–2

This unit consists of well-drained, moderately sloping soils on stream benches and gently rolling soils of the uplands. These are soils of the Saude and Wapsie series.

These soils are underlain by sand and gravel at a depth of about 18 to 36 inches. They are moderately permeable and have low available water capacity.

The major management needs are controlling erosion, conserving moisture, and maintaining organic-matter content and fertility. The number of corn plants per acre should be somewhat less than recommended for deeper soils because of the limited root zone. These soils generally have good tilth. Where ter-

raced, the cuts should be held to a minimum to avoid exposing the sand or gravel.

The soils of this unit are moderately suited to row crops when rainfall is normal and timely. They are susceptible to moderate and severe water erosion when cultivated or pastured intensively. Cultivated areas are subject to soil blowing.

CAPABILITY UNIT IIIe-3

This unit consists of well drained to somewhat excessively drained, gently sloping to moderately sloping soils of the stream benches and uplands. These are soils of the Dickinson and Flagler series.

These soils are moderately rapidly permeable in the surface layer and subsoil and rapidly to very rapidly permeable in the underlying loamy sand, sand, and gravel. Dickinson soils have low to moderate available water capacity, and Flagler soils have low available water capacity.

The major management needs are controlling erosion, conserving moisture, and maintaining organic-matter content and fertility. The number of corn plants per acre should be less than on soils that contain more silt and clay. The soils of this unit have good tilth. Where terraced, cuts should be held to a minimum to avoid exposing the sand or gravel.

The gently sloping Dickinson soils are well suited to row crops if the rainfall is normal and timely. The gently sloping Flagler and moderately sloping Dickinson soils are moderately suited to row crops if the rainfall is normal and timely. The soils of this unit are subject to slight water erosion and soil blowing if cultivated or pastured intensively.

CAPABILITY UNIT IIIw-1

This unit consists of poorly drained and very poorly drained soils in depressions and on nearly level and very gentle slopes in the uplands and on stream benches. These are soils of the Harps, Marshan, Okoboji, and Rolfe series.

Marshan, Okoboji, and about 55 percent of Rolfe soils are in depressions that collect water and are frequently ponded in the spring or after heavy rains. Harps soils are on rims around and ridges between Okoboji soils. The water table is seasonally high in all these soils, and tile drainage is needed for satisfactory crop production.

Harps and Marshan soils are moderately permeable, and Okoboji and Rolfe soils are slowly permeable. Marshan soils are underlain by sand and gravel at a depth of about 24 to 42 inches. This underlying material is rapidly to very rapidly permeable. Marshan soils have low to moderate available water capacity. All the other soils have high available water capacity.

In depressions, tile drains generally cannot keep the soils properly drained. Shallow ditches or open inlets into tile lines are needed in some places in addition to tile drains, especially to reduce ponding. In places the outlets to tile drains must be placed very deep. Installing tile is difficult in some places in Marshan soils because the underlying sand is loose and water bearing. Some Okoboji and Rolfe soils may not drain well because of the slowly permeable subsoil.

When properly drained, Okoboji, Harps, and Rolfe soils are well suited to row crops, and Marshan soils are well to moderately suited to row crops. Undrained areas of Marshan, Okoboji, and Rolfe soils are poorly suited to pasture. Undrained areas of Okoboji-Harps soils are moderately suited to pasture.

CAPABILITY UNIT IIIw-2

This unit consists of very poorly drained organic soils in depressions and on nearly level and gently sloping hillsides and drainageways. They are in the uplands and on stream benches and flood plains. These are soils of the Boots, Houghton, and Palms series.

The depressions collect water and are frequently ponded in spring and after heavy rains. These soils have seasonal water tables at or near the surface and need tile drains for crop production. They are moderately or moderately rapidly permeable and have very high available water capacity.

Undrained areas are usually wet and boggy and much of the time are too unstable to support the weight of grazing animals. Tile maintenance is difficult in Boots and Houghton soils, because the tile is likely to settle. In depressions there is danger of early frost in fall.

When properly drained, the soils of this unit are moderately suited to row crops. Undrained areas are poorly suited to pasture. Most of the larger depressions and nearly level areas have been drained by tile drains, open ditches, or both. If suitable outlets are available, tile drains usually function well, but open ditches or intake drains leading to tile lines may be needed to reduce ponding. On the sloping areas of Palms soils, the drainage systems designed to intercept seepage water are most likely to be successful.

CAPABILITY UNIT IIIw-3

This unit consists of nearly level, poorly drained soils on stream benches, first bottoms, and uplands. These are soils of the Faxon and Tilfer series.

The water table is seasonally high, and tile drainage is needed for satisfactory row crop production. These soils are underlain by limestone bedrock below a depth of about 20 to 40 inches. Tiling and open ditch construction are difficult because of the bedrock. These soils are moderately permeable, and they have low to moderate available water capacity.

The major management needs are improving drainage and improving and maintaining good soil tilth. These soils are subject to some flooding on the low benches and first bottoms.

The soils of this unit are moderately suited to row crops if properly drained. Undrained areas of Faxon soils are well suited to pasture, and undrained areas of Tilfer soils are well suited to moderately suited to pasture.

CAPABILITY UNIT IIIs-1

This unit consists of somewhat poorly drained to somewhat excessively drained soils on nearly level stream benches and uplands. These are soils of the Dickinson, Flagler, and Hoopeston series.

These soils are moderately rapidly permeable in the surface layer and subsoil and rapidly to very rapidly permeable in the underlying loamy sand, sand, and gravel. Dickinson and Hoopeston soils have low to moderate available water capacity. Flagler soils have low available water capacity.

The major management needs are conserving moisture and maintaining organic-matter content and fertility. The number of corn plants per acre should be less than on soils that contain more silt and clay. Installing tile is difficult in places in Hoopeston soils because the underlying sand is loose and water bearing.

Flagler soils are moderately suited and Dickinson and Hoopeston soils are well suited to row crops. Hoopeston soils are not so well aerated as Dickinson and Flagler soils, and in some years tile drainage improves fieldwork. The soils of this unit have good tilth. They have moderate depth for root development. Flagler soils are droughty and Dickinson and Hoopeston soils are slightly droughty in years of below-normal rainfall. Cultivated areas are susceptible to soil blowing.

CAPABILITY UNIT IVe–1

This unit consists of well-drained, hilly soils of the uplands. These are soils of the Lester and Storden series. These soils are moderately permeable, have high available water capacity, and are well aerated.

The soils of this unit are poorly suited to row crops. They are susceptible to severe erosion if cultivated or pastured. The major management needs are controlling erosion and maintaining organic-matter content and fertility. Building parallel terraces may require a considerable amount of cutting and filling because the topography is irregular.

CAPABILITY UNIT IVe–2

This unit consists of well drained, moderately well drained, and somewhat poorly drained soils of the uplands. They are soils of the Donnan series in moderately sloping areas and of the Kilkenny series on rolling topography.

Donnan soils are very slowly permeable in the lower part of the subsoil, and Kilkenny soils are moderately slowly permeable. Both have high available water capacity.

Donnan soils generally have good to fair tilth. Kilkenny soils are difficult to plow and cultivate. When terracing the soils of this unit, exposure of the subsoil should be held to a minimum. The subsoil is infertile and has unfavorable characteristics for tillage operations. Providing both erosion control and drainage on Donnan soils is difficult; therefore, a combination of terracing and tile drainage is needed to control erosion and correct wetness. Because of the very slow permeability of the subsoil, tile drains may not function. Building parallel terraces on Kilkenny soils may require a considerable amount of cutting and filling because the topography is irregular.

The soils of this unit are poorly suited to row crops. They are susceptible to severe erosion if cultivated and pastured. The major management needs are controlling erosion and maintaining organic-matter content and fertility.

CAPABILITY UNIT IVs–1

This unit consists of excessively drained, gently sloping and moderately sloping soils on stream benches and gently undulating and gently rolling areas in the uplands. These are soils of the Salida and Sparta series.

Sparta soils are rapidly permeable and have low available water capacity. Salida soils are very rapidly permeable and have very low available water capacity.

The major management needs are controlling erosion, conserving moisture, and maintaining organic matter content and fertility. The number of corn plants per acre should be less than on soils that contain more silt and clay. These soils are droughty. Extreme year-to-year variation in yields may be expected because of the droughtiness.

Salida soils are poorly suited to row crops and moderately suited to pasture. If rainfall is normal and timely, the gently sloping and gently undulating Sparta soils are moderately suited to row crops, and the moderately sloping and gently rolling soils are poorly suited. The soils of this unit are subject to water erosion and soil blowing if cultivated and pastured.

CAPABILITY UNIT Vw–1

Only nearly level Mixed alluvial land, channeled, is in this unit. It is on flood plains and is dissected by stream channels, oxbows, and sloughs. Most areas are poorly drained, but some are somewhat poorly drained to excessively drained. The soil material is mainly loam, silty clay loam, and clay loam. Some areas are Marsh. Some areas are sandy and a few are gravelly. In most places the water table is seasonally high.

Because this land is dissected and frequently flooded, it is usually not suited to row crops. Most areas are in pasture, and a few are in timber. In some years small areas are used for row crops.

If the stream channels are straightened, flooding is controlled, and artificial drainage is provided, some areas are suited to row crops. In the present state, the best use of this unit is for pasture, woodland, wildlife, and recreation.

CAPABILITY UNIT VIe–1

This unit consists of well-drained Lester soils. They are on steep slopes, and most of them are on escarpments adjacent to streams or lakebeds. They are moderately permeable and have high available water capacity.

The soils of this unit are not suited to row crops but are suited to permanent pasture, woodland, or wildlife habitat. They are subject to moderate and severe erosion if cultivated or pastured. The major management needs are controlling erosion and maintaining organic-matter content and fertility.

CAPABILITY UNIT VIs–1

This unit consists of the excessively drained, strongly sloping Salida soils. They are on stream bench escarpments and occupy knobs, ridge crests, and side slopes in rolling upland topography. They are very rapidly permeable and have very low available water capacity.

The major management needs are controlling erosion, conserving moisture, and maintaining organic-matter content and fertility. The soils of this unit are not suited to row crops and are moderately suited to pasture. They are droughty and are subject to water erosion and soil blowing if cultivated or pastured.

CAPABILITY UNIT VIIw–1

Only Marsh is in this unit. It consists of soils in depressions and flat areas in the uplands, on stream benches, and on the flood plains. This soil is wet throughout the year and impounds water part of the year.

The water table is at or near the surface throughout the year. Marsh is near ponds and, in places, consists of intermittent ponds and soil.

Most areas are difficult to drain adequately for cultivated crops without large expenditures. The quality of pasture on Marsh is poor, because the natural vegetation includes cattails, rushes, sedges, and other water-tolerant plants that are unpalatable to grazing animals.

Most areas of Marsh are best utilized as wildlife habitat. Preserved in their natural state, they offer a refuge for waterfowl and other wildlife.

CAPABILITY UNIT VIIs–1

This unit consists of the excessively drained Salida soils. These are dominantly moderately steep to very steep soils on escarpments along stream benches. Some are hilly and steep soils on uplands. All have very low available water capability and are very rapidly permeable.

The major management needs are controlling erosion, conserving moisture, and maintaining the levels of fertility and organic-matter content. These soils are not suited to row crops and are poorly suited to pasture. They are droughty and are subject to water erosion and soil blowing.

Yield predictions

In table 2 the average yields per acre of the principal crops are predicted for soils of the county under high-level management. Under this level of management, seedbed preparation, planting, and tillage practices provide for adequate stands of adapted varieties; erosion is controlled; the organic matter content and soil tilth are maintained; the level of fertility for each crop is maintained (as indicated by soil tests and field trials); the water level in wet soils is controlled; excellent weed and pest control are provided; and operations are timely.

Many available sources of yield information were used to make these estimates, including data from the Federal census and the Iowa farm census, data from experimental farms and cooperative experiments with farmers, and the on-farm experience of soil scientists, extension workers, and others.

The yield predictions are meant to serve as guides. They are approximate values only and should be so considered. Of more value than actual yield figures to many users will be the comparative yields between soils. Another consideration is that actual yields have been increasing in recent years. If they continue to increase as expected, predicted yields in this table will soon be too low.

Management for Woodland

The soils of Worth County have been placed in woodland groups to assist owners in planning the use of their soils for wood crops. Each group is made up of soils that are suited to the same kinds of trees; that need approximately the same kind of management when the vegetation on them is similar; and that have about the same potential productivity.

Each woodland group is identified by a number. These groupings are based on field determinations of average site indexes. Site index is the height, in feet, that the dominant trees of a given species, on a specified kind of soil, reach in a natural, unmanaged stand in a stated number of years. For the merchantable hardwoods and softwoods in this county, the site index is the height reached in 50 years. For cottonwood, the index is the height reached in 30 years.

The woodland groups are based on field determination of the average site index of an indicator forest type or species. For this survey, conversions of average site index into volumetric growth and yield are based on research for upland oaks (*10*).

Important parts of the description of each woodland group are the verbal ratings made for the hazard of erosion, the limitation to the use of equipment, the hazard of seedling mortality, and the risk of competition from undesirable plants. These ratings are always *slight*, *moderate*, or *severe*. The following explanations of these ratings apply to the descriptions of all woodland groups in Worth County.

Erosion refers to the potential hazard of soil losses in woodland. The hazard is *slight* if expected soil losses are small; *moderate* if some soil losses are expected and care is needed during logging and construction to reduce soil losses; and *severe* if special methods of operation are necessary for preventing excessive soil losses. In Worth County only steep soils are subject to severe erosion.

Equipment limitations are rated on the basis of soil characteristics that restrict or prohibit the use of equipment commonly used in tending and harvesting trees. In Worth County, soil characteristics having the most limiting effects are drainage, depth to the water table, slope, and texture of the surface layer. *Slight* means there is no restriction in the kind of equipment or in the time of year it is used; *moderate* means that use of equipment is restricted for less than 3 months of the year; and *severe* means that special equipment is needed and its use is restricted for more than 3 months of the year.

Seedling mortality refers to the expected degree of mortality of planted seedlings as influenced by kinds of soil when plant competition is not a limiting factor. Considered in the ratings are depth to the water table, hazard of flooding, drainage, soil depth and structure, and degree of erosion. Normal rainfall, good planting stock, and proper planting are assumed. A rating of *slight* indicates an expected loss of less than 25 percent

TABLE 2.—*Predicted average yields per acre of principal crops under high-level management*

[Dashes indicate that the crop is not suited to the soil specified or is not generally grown on it. Only arable soils are listed]

Soil	Corn	Soybeans	Oats	Alfalfa-brome hay	Alfalfa-brome pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD* [1]
Bassett loam, 0 to 2 percent slopes	107	40	86	4.5	225
Bassett loam, 2 to 5 percent slopes	105	40	84	4.5	225
Bolan loam, 0 to 2 percent slopes	90	33	72	3.7	195
Bolan loam, 2 to 5 percent slopes	88	32	71	3.6	190
Boots mucky peat, 0 to 1 percent slopes	72	27	49	3.0	150
Calco silty clay loam, loamy substratum, 0 to 2 percent slopes	95	36	82	3.9	195
Canisteo silty clay loam, 0 to 2 percent slopes	103	39	83	4.2	210
Clarion loam, 0 to 2 percent slopes	110	42	88	4.6	230
Clarion loam, 2 to 5 percent slopes	108	41	86	4.5	225
Clarion loam, 5 to 9 percent slopes, moderately eroded	100	38	80	4.2	210
Clarion loam, 2 to 5 percent long slopes	117	44	94	4.8	240
Clarion-Nicollet loams, 1 to 3 percent slopes	112	42	90	4.7	235
Clarion-Storden loams, 2 to 5 percent slopes, moderately eroded	102	38	81	4.3	215
Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded	95	36	78	4.1	205
Clyde silty clay loam, 0 to 2 percent slopes	108	41	86	4.3	210
Coland silty clay loam, 0 to 2 percent slopes	100	38	80	4.2	210
Coland-Turlin complex, 0 to 2 percent slopes	105	40	84	4.4	220
Dickinson fine sandy loam, 0 to 2 percent slopes	81	31	65	3.0	150
Dickinson fine sandy loam, 2 to 5 percent slopes	79	30	63	2.9	145
Dickinson fine sandy loam, 5 to 9 percent slopes	74	28	57	2.8	140
Dinsdale silty clay loam, 0 to 2 percent clopes	119	45	91	5.0	250
Dinsdale silty clay loam, 2 to 5 percent slopes	117	44	89	5.0	250
Donnan silt loam, 0 to 2 percent slopes	72	27	58	2.9	145
Donnan silt loam, 2 to 5 percent slopes	70	26	56	2.8	140
Donnan silt loam, 5 to 9 percent slopes, moderately eroded	60	22	48	2.4	120
Donnan silt loam, dark variant, 0 to 2 percent slopes	82	31	66	3.4	170
Donnan silt loam, dark variant, 2 to 5 percent slopes	78	30	62	3.3	165
Faxon silty clay loam, 0 to 2 percent slopes	80	30	64	3.4	170
Flagler sandy loam, 0 to 2 percent slopes	63	24	50	2.6	130
Flagler sandy loam, 2 to 5 percent slopes	61	23	48	2.5	130
Floyd loam, 1 to 3 percent slopes	112	42	90	4.8	235
Franklin silt loam, 1 to 3 percent slopes	117	44	89	5.0	250
Harcot loam, 0 to 2 percent slopes	78	29	63	3.2	180
Harps loam, 1 to 3 percent slopes	93	34	76	4.0	200
Hayfield loam, deep, 0 to 2 percent slopes	92	35	75	3.9	200
Hayfield loam, moderately deep, 0 to 2 percent slopes	77	29	63	3.3	150
Hoopeston fine sandy loam, 0 to 2 percent slopes	85	32	68	3.2	160
Houghton muck, 0 to 1 percent slopes	75	30	52	3.3	170
Kensett silt loam, 0 to 2 percent slopes	85	32	68	3.6	180
Kenyon loam, 0 to 2 percent slopes	113	43	90	4.9	240
Kenyon loam, 2 to 5 percent slopes	111	42	89	4.8	235
Kenyon loam, 5 to 9 percent slopes, moderately eroded	103	39	82	4.4	220
Kilkenny silty clay loam, 2 to 5 percent slopes	90	35	72	4.0	200
Kilkenny silty clay loam, 2 to 5 percent slopes, moderately eroded	80	32	64	3.7	195
Kilkenny silty clay loam, 5 to 9 percent slopes, moderately eroded	65	28	52	3.0	175
Kilkenny silty clay loam, 9 to 14 percent slopes, moderately eroded	50	20	40	2.7	145
Klinger silty clay loam, 1 to 3 percent slopes	123	46	98	5.2	260
Lawler loam, deep, 0 to 2 percent slopes	98	37	78	4.2	210
Lawler loam, moderately deep, 0 to 2 percent slopes	83	31	67	3.6	180
Lester loam, 2 to 5 percent slopes	102	39	82	4.4	220
Lester loam, 2 to 5 percent slopes, moderately eroded	100	38	80	4.3	215
Lester loam, 5 to 9 percent slopes	93	35	74	4.0	200
Lester loam, 5 to 9 percent slopes, moderately eroded	90	34	72	3.9	195
Lester loam, 9 to 14 percent slopes, moderately eroded	81	31	65	3.5	175
Lester loam, 14 to 18 percent slopes, moderately eroded	66	25	53	2.9	145
Lester loam, 18 to 25 percent slopes			40	2.0	100
Le Sueur loam, 1 to 3 percent slopes	110	42	88	4.7	235
Marshan clay loam, deep, 0 to 2 percent slopes	99	37	79	4.0	200
Marshan clay loam, moderately deep, 0 to 2 percent slopes	89	34	71	3.6	190
Marshan clay loam, depressional, 0 to 1 percent slopes	77	28	62	3.2	160
Maxfield silty clay loam, 0 to 2 percent slopes	117	49	94	5.0	250
Minnetonka silty clay loam, 1 to 3 percent slopes	94	36	76	4.0	200
Mixed alluvial land, channeled					120
Nicollet loam, 1 to 3 percent slopes	116	44	93	5.0	250
Nicollet loam, 1 to 3 percent long slopes	123	46	98	5.2	260
Okoboji silty clay loam, 0 to 1 percent slopes	82	31	67	4.0	200
Okoboji-Harps complex, 0 to 3 percent slopes	87	32	70	4.0	200
Oran silt loam, 1 to 3 percent slopes	106	40	86	4.6	230
Palms muck, 0 to 1 percent slopes	80	34	71	3.4	180
Palms muck, 1 to 4 percent slopes	65	25	45	3.0	150
Readlyn loam, 1 to 3 percent slopes	112	43	90	4.8	240
Richwood silt loam, 0 to 2 percent slopes	118	45	94	5.0	250

TABLE 2.—*Predicted average yields per acre of principal crops under high-level management*—Continued

Soil	Corn	Soybeans	Oats	Alfalfa-brome hay	Alfalfa-brome pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD* [1]
Rockton loam, deep, 0 to 2 percent slopes	96	36	77	4.1	210
Rockton loam, deep, 2 to 5 percent slopes	94	34	75	3.9	200
Rockton loam, moderately deep, 0 to 2 percent slopes	76	29	61	3.4	155
Rockton loam, moderately deep, 2 to 5 percent slopes	74	28	59	3.2	150
Rolfe silt loam, 0 to 1 percent slopes	84	32	68	3.4	150
Salida sandy loam, 2 to 9 percent slopes	35	15	25	1.6	75
Salida sandy loam, 9 to 14 percent slopes				1.0	50
Salida sandy loam, 14 to 30 percent slopes				.5	25
Saude loam, 0 to 2 percent slopes	76	29	61	3.3	180
Saude loam, 2 to 5 percent slopes	74	28	59	3.2	175
Saude loam, 5 to 9 percent slopes	66	25	53	2.9	160
Schley silt loam, 1 to 3 percent slopes	98	37	78	4.2	210
Shorewood silty clay loam, 1 to 3 percent slopes	105	39	84	4.4	230
Sparta loamy fine sand, 2 to 5 percent slopes	60	23	47	2.2	130
Sparta loamy fine sand, 5 to 9 percent slopes	54	21	42	2.0	115
Storden loam, 5 to 14 percent slopes, severely eroded	75	27	60	3.5	175
Storden loam, 14 to 18 percent slopes, severely eroded	57	22	46	3.0	150
Talcot clay loam, deep, 0 to 2 percent slopes	94	35	75	3.8	190
Talcot clay loam, moderately deep, 0 to 2 percent slopes	84	32	68	3.4	180
Terril loam, 2 to 5 percent slopes	116	44	94	5.0	250
Tilfer silty clay loam, 0 to 2 percent slopes	73	28	58	3.1	155
Wacousta silt loam, benches, 0 to 2 percent slopes	103	38	83	4.2	210
Wapsie loam, 0 to 2 percent slopes	70	26	56	3.0	150
Wapsie loam, 2 to 5 percent slopes	68	25	54	2.9	145
Wapsie loam, 5 to 9 percent slopes, moderately eroded	60	23	48	2.6	130
Waukee loam, 0 to 2 percent slopes	96	36	77	3.9	205
Waukee loam, 2 to 5 percent slopes	94	35	75	3.8	200
Webster silty clay loam, 0 to 2 percent slopes	108	41	86	4.4	220
Webster-Nicollet complex, 1 to 3 percent slopes	110	42	88	4.6	230

[1] Animal-unit-days is the number of days that 1 acre will provide grazing for one animal unit, 1,000 pounds live weight, without damage to the pasture.

of the planted seedlings; *moderate,* a loss of 25 to 50 percent of the seedlings; and *severe,* a loss of more than 50 percent of the seedlings. Special preparation of the site is needed before planting for soils rated severe and for most soils rated moderate.

Plant competition is rated on the basis of the degree to which unwanted plants invade openings in the tree canopy. Considered in the ratings are available water capacity, fertility, drainage, and degree of erosion. A rating of *slight* means that competition from other plants is not a problem; *moderate,* that plant competition delays development of fully stocked stands of desirable trees; and *severe,* that plant competition prevents establishment of a desirable stand unless intensive site preparation and such practices as weeding are used to control undesirable plants.

WOODLAND GROUP 1

This group consists of well drained and moderately well drained, medium textured or moderately fine textured, nearly level to moderately steep soils of the Dinsdale and Richwood series. Permeability is moderate or moderately slow. Available water capacity is high.

Suitability of these soils is very high for upland oaks. The site index for upland oaks ranges from 76 to 85. Estimated suitability for conifers and cottonwoods is very high. Estimated annual growth of existing timber ranges from 250 to 300 board feet per acre in well-managed and fully stocked stands.

Trees to be favored in existing stands are black walnut, white oak, northern red oak, green ash, sugar maple, American basswood, and black cherry.

Trees most suitable for open planting are eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, black walnut, green ash, hackberry, and sugar maple.

Trees suitable for interplanting in existing stands are eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, black walnut, green ash, northern red oak, white oak, hackberry, sugar maple, and American basswood.

Seedling mortality is slight. Plant competition from grass is slight to severe. Equipment limitations are slight. Erosion is a slight to moderate hazard.

Trees most suitable for windbreaks are eastern white pine, red pine, Norway spruce, white spruce, eastern redcedar, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry.

Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and cardinal autumn-olive.

WOODLAND GROUP 2

This group consists of well drained and moderately well drained, medium textured and moderately fine textured, nearly level to moderately steep and hilly soils of the Bassett, Clarion, Kenyon, Lester, and Terril series.

Permeability is moderate to moderately slow. Available water capacity is high.

Suitability of these soils is high for conifers and upland oaks and very high for cottonwoods. The site index for upland oaks ranges from 66 to 75. Estimated annual growth of existing timber ranges from 200 to 249 board feet per acre.

Trees to be favored in existing stands are northern red oak, eastern cottonwood, white oak, green ash, black walnut, American basswood, hackberry, and sugar maple.

Trees most suitable for open planting are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut, green ash, and hackberry.

Trees suitable for interplanting in existing stands are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut, green ash, hackberry, red oak, white oak, and basswood.

Seedling mortality is slight. Plant competition from grass is slight to moderate. Equipment limitations are slight. Erosion is a slight to moderate hazard.

Trees most suitable for windbreaks are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, Douglas-fir, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry.

Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and cardinal autumn-olive.

WOODLAND GROUP 3

This group consists of nearly level to gently sloping soils of the Bolan, Rockton, and Waukee series, mainly in the eastern half of Iowa. These soils are medium textured in the upper part and have sand and gravel or gravel or bedrock at a depth of 32 to 40 inches. Permeability is moderate to moderately rapid. Available water capacity is moderate.

Suitability of these soils is high for upland oaks, conifers, and cottonwoods. The site index for upland oaks ranges from 66 to 75. Estimated annual growth of existing timber ranges from 200 to 249 board feet per acre or more.

Trees to be favored in existing stands are red oak, white oak, green ash, black walnut, American basswood, hackberry, and sugar maple.

Trees most suitable for open planting are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglar-fir, walnut, green ash, and hackberry.

Trees suitable for interplanting in existing stands are red oak, white oak, green ash, black walnut, American basswood, hackberry, sugar maple, eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, and walnut.

Seedling mortality is slight. Plant competition from grass is slight to moderate. Equipment limitations are slight. Erosion is a slight to severe hazard, depending on slope.

Trees most suitable for windbreaks are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, Douglas-fir, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. Also suitable for windbreaks is the shrub, honeysuckle.

Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and cardinal autumn-olive.

WOODLAND GROUP 4

This group consists of well-drained, medium textured and moderately fine textured, steep soils of the Lester series. Permeability is moderate or moderately slow. Available water capacity is high or moderate.

Suitability of the soils is moderately high for upland oaks, moderately high for conifers, and high for cottonwoods. The site index for upland oaks ranges from 56 to 65. Estimated annual growth of existing timber ranges from 150 to 199 board feet per acre.

Trees to be favored in existing stands are northern red oak, white oak, green ash, black walnut, American basswood, hackberry, and sugar maple.

Trees most suitable for open planting are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut, green ash, and hackberry.

Trees suitable for interplanting in existing stands are northern red oak, white oak, green ash, black walnut, American basswood, hackberry, sugar maple, eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, and Douglar-fir.

Seedling mortality is slight. Plant competition from grass is moderate. Equipment limitations are moderate. Erosion is a severe hazard.

Trees most suitable for windbreaks are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, Douglas-fir, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry.

Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and cardinal autumn-olive.

WOODLAND GROUP 5

This group consists of nearly level to moderately sloping soils of the Dickinson, Flagler, Rockton, Saude, and Wapsie series. These soils are moderately coarse textured throughout or they are medium textured or moderately fine textured in the upper part and are underlain by sand and gravel or bedrock at a depth of 24 to 32 inches. Permeability is moderate to moderately rapid. Available water capacity is low to moderate.

Suitability of these soils is moderately high for upland oaks, conifers, and cottonwoods. The site index for upland oaks ranges from 56 to 65. Estimated annual growth of existing timber ranges from 150 to 199 board feet per acre or more.

Trees to be favored in existing stands are northern red oak, white oak, green ash, black walnut, American basswood, hackberry, and sugar maple.

Trees most suitable for open planting are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut, green ash, and hackberry.

Trees suitable for interplanting in existing stands are northern red oak, white oak, green ash, black walnut, American basswood, hackberry, sugar maple, east-

ern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, and Douglas-fir.

Seedling mortality is slight. Plant competition from grass is slight or moderate. Equipment limitations are slight. Erosion is a slight to severe hazard, depending on slope.

Trees most suitable for windbreaks are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, Douglas-fir, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. Also suitable for windbreaks is the shrub, honeysuckle.

Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and cardinal autumn-olive.

WOODLAND GROUP 6

This group consists of somewhat poorly drained, medium textured and moderately fine textured, nearly level or gently sloping and gently undulating Clarion, Floyd, Franklin, Hayfield, Kensett, Klinger, Lawler, Le Sueur, Nicollet, Oran, Readlyn, and Schley soils. Runoff is slow. Permeability is moderate or moderately slow. Available water capacity is moderately high to high, except in the moderately deep phases of Hayfield and Lawler soils, where it is low.

Suitability of these soils is moderately high for upland oaks and conifers and high for cottonwoods. The site index for hardwood trees ranges from 56 to 65. Estimated annual growth of existing timber ranges from 150 to 199 board feet per acre.

Trees to be favored in existing stands are green ash, hackberry, white oak, northern red oak, and eastern cottonwood.

Trees most suitable for open planting are eastern white pine, Scotch pine, Norway spruce, eastern redcedar, European larch, green ash, black walnut, and hackberry.

Trees suitable for interplanting in existing stands are green ash, hackberry, white oak, northern red oak, eastern cottonwood, eastern white pine, Scotch pine, Norway spruce, eastern redcedar, European larch, black walnut, and American basswood.

Seedling mortality is slight. Plant competition from undesirable species is moderate. Equipment limitations are slight. The erosion hazard ranges from none to slight.

Trees most suitable for windbreaks and wildlife plantings are eastern white pine, Scotch pine, Norway spruce, eastern redcedar, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. Also suitable are the shrubs, honeysuckle and red-osier dogwood.

WOODLAND GROUP 7

This group consists of moderately well drained and somewhat poorly drained, fine textured, nearly level to rolling soils of the Kilkenny and Shorewood series. Permeability is slow to moderately slow. Available water capacity is high.

Suitability of the soils is moderate for upland oaks, moderately high for conifers, and high for cottonwoods. The site index for upland oaks ranges from 46 to 55. Estimated annual growth of existing timber ranges from 100 to 149 board feet per acre.

Trees to be favored in existing stands are green ash, hackberry, and American cottonwood.

Trees most suitable for open planting are eastern white pine, Scotch pine, eastern redcedar, Norway spruce, black walnut, green ash, hackberry, and sugar maple.

Trees suitable for interplanting in existing stands are green ash, hackberry, American cottonwood, eastern white pine, Scotch pine, eastern redcedar, Norway spruce, black walnut, sugar maple, northern red oak, white oak, and American basswood.

Seedling mortality is slight. Plant competition from grass is slight or moderate. Equipment limitations are slight. Erosion is a slight hazard.

Trees most suitable for windbreaks are eastern white pine, Scotch pine, eastern redcedar, Norway spruce, green ash, hackberry, and cottonwood.

Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and cardinal autumn-olive.

WOODLAND GROUP 8

This group consists of excessively drained, coarse-textured, gently sloping and moderately steep soils of the Sparta series. Permeability is rapid or very rapid. Available water capacity is low or very low.

Suitability of these soils is moderate for upland oaks. The site index for upland oaks ranges from 46 to 55. Estimated suitability for conifers and cottonwoods is moderately high. Estimated annual growth of existing timber ranges from 100 to 149 board feet per acre.

Trees to be favored in existing stands are northern red oak, white oak, green ash, hackberry, and eastern cottonwood.

Trees most suitable for open planting are eastern white pine, red pine, Scotch pine, European larch, and eastern redcedar.

Trees suitable for interplanting in existing stands are northern red oak, white oak, green ash, hackberry, eastern cottonwood, eastern white pine, red pine, Scotch pine, European larch, eastern redcedar, and American basswood.

Seedling mortality is severe in some years because of droughty conditions. Plant competition from grass is slight or moderate. Equipment limitations are slight. Erosion is a slight to severe hazard, depending on slope.

Trees most suitable for windbreaks are eastern white pine, red pine, Scotch pine, eastern redcedar, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. Also suitable for windbreaks is the shrub, honeysuckle.

Species suitable for wildlife plantings are honeysuckle, viburnum, ninebark, lilac, dogwood, and cardinal autumn-olive.

WOODLAND GROUP 9

This group consists of excessively drained, coarse-textured soils of the Salida series that are shallow over sand and gravel. Permeability is very rapid. Available water capacity is very low.

Suitability of these soils is low for upland oaks. The site index for upland oaks is less than 45. Estimated suitability for conifers and cottonwoods is low. Estimated annual growth of existing timber is less than 100 board feet per acre.

Trees to be favored in existing stands are green ash, hackberry, northern red oak, and white oak.

Trees suitable for open planting are eastern white pine, Scotch pine, red pine, European larch, eastern redcedar, and eastern cottonwood.

Trees suitable for interplanting in existing stands are green ash, hackberry, northern red oak, white oak, eastern white pine, Scotch pine, red pine, European larch, eastern redcedar, eastern cottonwood, and American basswood.

Seedling mortality is slight to severe on these soils, depending on the amount of competition from grass and the variation in water supply. Equipment limitations are slight on slopes of less than 18 percent and moderate to severe on slopes greater than 18 percent. Erosion is a slight to severe hazard, depending on slope.

Trees most suitable for windbreaks are eastern white pine, Scotch pine, red pine, and eastern redcedar.

Species most suitable for wildlife plantings are honeysuckle and ninebark.

WOODLAND GROUP 10

This group consists of well-drained, medium-textured, gently undulating to hilly soils of the Storden series and of the Clarion-Storden loams. Permeability is moderate. Available water capacity is high. These soils are calcareous at the surface or at a shallow depth.

Suitability of these soils is low for upland oaks and conifers and moderate for cottonwoods. The site index for the upland oaks is less than 45. Estimated annual growth of existing timber is less than 100 board feet per acre.

Trees most suitable for noncommercial planting are ponderosa pine, Austrian pine, Scotch pine, hackberry, eastern cottonwood, and green ash.

Seedling mortality is moderate to severe. Plant competition from grass is severe. Equipment limitations are moderate or severe. Erosion is a severe hazard. Alkalinity and a climate that provides insufficient moisture for tree growth are severe limitations.

Trees most suitable for windbreaks on these soils are ponderosa pine, Austrian pine, Scotch pine, Norway poplar, Siouxland poplar, Robusta poplar, green ash, hackberry, and Russian-olive.

Species suitable for wildlife plantings are the wild plum, honeysuckle, aromatic sumac, Russian-olive, and redcedar.

WOODLAND GROUP 11

This group consists of moderately well drained to somewhat poorly drained, nearly level to moderately sloping soils of the Donnan and the Donnan dark variant series that have a fine-textured subsoil. Runoff is rapid. Permeability is very slow. Available water capacity is high.

Suitability of these soils is low for upland oaks, conifers, and cottonwoods. The site index for upland hardwoods is less than 45. Estimated annual growth of upland hardwoods is less than 100 board feet per acre.

Trees to be favored in existing hardwood stands are green ash, hackberry, and eastern cottonwood.

Trees most suitable for open planting are redcedar, Scotch pine, green ash, hackberry, and eastern cottonwood.

Seedling mortality is slight. Plant competition from undesirable species is slight. Equipment limitations are moderate. Erosion is a slight or moderate hazard.

Trees most suitable for windbreaks are redcedar, Scotch pine, green ash, hackberry, and cottonwood. Windbreak site quality is good for green ash, hackberry, and eastern cottonwood and poor for redcedar and Scotch pine.

WOODLAND GROUP 12

This group consists of somewhat poorly drained, moderately coarse textured, nearly level soils of the Hoopeston series on benches and in the uplands. Runoff is slow. Permeability is moderately rapid. Available water capacity is low to moderate.

Suitability of these soils is low for upland oaks and conifers and moderately high to high for bottom-land hardwoods.

Trees to be favored in existing stands are the eastern cottonwood, silver maple, and green ash. These soils are not well suited to upland hardwoods or conifers.

Seedling mortality is slight or moderate. Plant competition from undesirable species is moderate or severe. Equipment limitations are slight. Erosion is a slight hazard.

Trees most suitable for windbreaks are eastern cottonwood, silver maple, and green ash. Windbreak site quality is high for cottonwood and silver maple.

WOODLAND GROUP 13

This group consists of poorly drained, nearly level and very gently sloping, medium to fine soils of the Calco, Canisteo, Clyde, Coland, Faxon, Harcot, Harps, Marshan, Maxfield, Minnetonka, Nicollet, Okoboji, Rolfe, Talcot, Tilfer, Turlin, Wacousta, and Webster series and Mixed alluvial land. Permeability is moderate to slow. Available water capacity is high to moderate.

These soils are not well suited to commercial wood production. Suitability of these soils is low for upland oaks and conifers and moderate to high for cottonwoods.

Trees most suitable for these soils are silver maple, eastern cottonwood, sycamore, willow, green ash, and hackberry.

Trees less suitable for these soils are redcedar, eastern white pine, Scotch pine, Norway spruce, and European larch. These conifers are suitable mainly for upland and terrace soils.

WOODLAND GROUP 14

This group consists of Marsh and very poorly drained Boots, Houghton, and Palms soils. Suitability for cottonwood and willow is moderate on Boots, Houghton, and Palms soils and very low on Marsh.

Species suitable for wildlife plantings are red-osier dogwood and buttonball bush.

Management for Wildlife[2]

A proper plant cover, determined mainly by soil characteristics, is a basic requirement of all wildlife populations. Other soil characteristics, such as slope, permeability, and drainage, determine the development potential of natural wet areas for waterfowl or construction of ponds for fish. This combination of vegetative cover and specific soil characteristics allows identification of three general forms of wildlife habitat found in Worth County: woodland, wetland, and openland. Other factors, such as disease, extreme weather conditions, predation, and hunting pressure, affect wildlife populations; therefore, good wildlife habitat is not a guarantee of abundant wildlife populations.

Table 3 rates the potential for each soil series in Worth County to produce seven habitat elements as good, fair, poor, or very poor. This evaluation is then used to determine the potential of each soil series to develop openland, woodland, or wetland wildlife habitat.

The Kilkenny-Minnetonka and Clarion-Webster soil associations are the most productive for the woodland habitat required by whitetail deer. The 1971 estimated population in the county is 280 deer. This woodland habitat also produces moderate populations of both the eastern fox squirrel and eastern gray squirrel. Pheasants are moderately abundant, and production is best on the intensively farmed areas in the Maxfield-Klinger-Franklin soil association. Although the population of cottontail rabbits in Worth County is low, the best production is on the Maxfield-Klinger-Franklin soil association. There are large populations of mink, muskrat, raccoon, and many species of waterfowl in the county due to scattered wetland areas. The Mayfield-Klinger-Franklin soil association is the most productive for wetland habitat. The red fox population is moderate, and the animal is generally adapted to all areas in the county. Opossum, striped skunk, and badger are abundant and adapted to most areas of Worth County.

Except for the Rockton-Faxon soil association, where limestone outcroppings are a problem, pond construction is generally feasible wherever adequate sloping landscapes can be found. These ponds can provide good fishing when properly stocked with largemouth bass, bluegill, bullhead, or channel catfish.

Use of the Soils in Engineering

For many years engineers have studied soil properties and characteristics that affect construction, and have devised systems of soil classification based on these characteristics. Most studies have been at the site of construction because general information about the soils with regard to engineering practices has not been readily available.

With a soil map for identification, the interpretations reported here will be useful in engineering planning. It is emphasized that additional sampling and testing for specific engineering works may be needed, especially where heavy loads and deep excavations are involved. In nearly all situations, however, the soil map is useful for planning these additional investigations, since it suggests the kinds of problems that may be expected in a given area.

At many construction sites, major differences occur in a soil within the depth of proposed excavation, and several soil units can occur within short distances. The soil engineer can concentrate on the major soil units by referring to the survey report. He can then determine the minimum number of samples for further laboratory testing and can make adequate investigations at minimum cost.

This soil survey contains information that can assist engineers in—

1. Making studies of soil and land use that aid in the selection and development of industrial, business, residential, and recreational sites.
2. Assisting in planning and designing drainage and irrigation structures, and in planning all structural work for soil and water conservation.
3. Making general surveys of soil and ground conditions that aid in selecting highway and airport locations, and in planning more detailed soil surveys for these locations if needed.
4. Locating probable sources of sand, gravel, or rock for structural use.
5. Correlating pavement and road rock performance with kinds of soils, and thus developing information useful in development and maintenance of roads, culverts, bridges, and so on.
6. Determining the suitability of soils for cross-country movement of heavy equipment.
7. Supplementing information obtained from aerial photographs, other published reports, and miscellaneous soil information obtained from other sources.

Some terms have special meanings in soil science that may be unfamiliar to engineers. These and other special terms are defined in the Glossary in the back of this survey.

Most of the information in this section is presented in tables 4 and 5.[3]

Engineering classification systems

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

Some engineers prefer to use the Unified Soil Classification System (*14*). In this system, soil materials are identified as coarse-grained (8 classes), fine-

[2] By BILL D. WELKER, biologist, Soil Conservation Service.

[3] Tables 4 and 5 were prepared with the help of DONALD A. ANDERSON, soil engineer, Iowa Highway Commission; and VOLNEY H. SMITH, assistant state conservation engineer, Soil Conservation Service.

grained (6 classes), or highly organic. Approximate classification can be made in the field. Estimated classification of the soils in the county is given in table 4.

Engineering interpretations

Information and interpretation of most significance to engineers are given in tables 4 and 5. The data in table 4 are based on information in other parts of the survey and on experience with similar soils in other counties. Additional information can be obtained from other parts of the survey, especially from the sections "General Soil Map," "Descriptions of the Soils," and "Formation and Classification of the Soils."

The percentage passing sieves, shown in table 4, is the normal range of soil particles passing the respective screen sizes.

Permeability refers to the rate of movement of water through undisturbed soil. Permeability depends largely on soil texture and structure.

Available water capacity is the amount of water in a moist soil, at field capacity, that can be removed by plants. These ratings, expressed in inches of water per inch of soil depth, are of particular value to engineers engaged in irrigation.

Shrink-swell potential is the ability of soil material to change volume when subjected to changes in moisture. Soil material rated high is normally undesirable from the engineering standpoint, since the increase in volume when the dry soil is moistened generally is accompanied by a loss in bearing capacity. In general, soils classed as CH and A–7 have high shrink-swell potential. Clean sand and gravel (single-grained) and soils containing a small amount of nonplastic to slightly plastic fines have low shrink-swell potential.

Interpretations of engineering properties of the soils are given in table 5. In this table are estimates of the suitability of the soils of the county as a source of topsoil and road fill. Also in the table are estimates of soil features affecting suitability of the soils for various engineering purposes. Engineers and others should not apply specific values to the estimates given for bearing capacity of soils.

Soil features affecting highway work [4]

The soils in Worth County that affect roadbuilding formed mainly in glacial till, loess, and alluvium. The underlying material is shallow limestone bedrock in a few places in the county, however, especially in the valleys of the Shellrock and Winnebago Rivers. The glacial till is rock debris, mainly sandy and clayey material that contains pebbles and boulders and occasional pockets and strata of sand and gravel. It has a maximum thickness of about 250 feet, but this thickness is variable. Loess, or windblown silt, mantles the glacial till in parts of the county. Loess ranges from about 20 to 40 inches in thickness.

The glacial till in Worth County has a relatively high in-place density. It is relatively stable at any moisture content and can be compacted readily to high density. The textural composition varies, but where dry it has enough fines and coarse material to provide a firm riding surface with little rebound after loading. The glacial till has good bearing capacity if loosened and compacted to maximum practical density, but it loses this bearing capacity when moisture is absorbed.

The Bassett, Clarion, Kenyon, Lester, Nicollet, Oran, and Readlyn soils formed in glacial till. The textures of these soils are loam, clay loam, and sandy clay loam. The surface layer is classified chiefly A–6, but in places A–4 or A–7. Pockets and lenses of sand are common in these soils and in many places are water bearing, especially in the Bassett, Kenyon, Oran, and Readlyn soils. Where the road grade cuts through such deposits, frost heaving is likely unless the sandy soil material is drained or the material above it is replaced with a granular backfill or with the more uniform clayey glacial till. These soils are a good source of material for highway subgrade.

Dinsdale, Franklin, Klinger, and Maxfield soils are loess derived. They are silt loam and silty clay loam in texture and are mostly classified A–7 except in the surface layer and lower part of the subsoil. Dinsdale, Klinger, and Maxfield soils have highly organic surface layers that are difficult to compact to good density and are unsuitable for subgrade. These soils have a subsoil that is silty clay loam in the upper part and loam, sandy clay loam, or light clay loam in the lower part. These materials lose stability under wheelloads if saturated and do not make a desirable upper subgrade in cut areas where moisture is high. Loess soils erode readily if runoff is concentrated. Sod, pavement, or check dams may be needed in gutters and ditches to prevent excessive erosion.

Poorly drained Canisteo, Clyde, Harps, and Webster soils formed in glacial sediments and are classified chiefly A–7 and A–6. These soils have highly organic surface layers, a high moisture content, and are generally difficult to compact to high inplace density.

The moderately well drained Kilkenny, somewhat poorly drained Shorewood, and poorly drained Minnetonka soils formed in lacustrine deposits or lacustrine deposits and glacial sediment. The Kilkenny soils are classified as A–7 and A–6 and the Minnetonka and Shorewood soils as A–7. These soils are difficult to work due to the high clay content.

Calco, Coland, and Turlin soils of the bottom lands formed in recent alluvium washed from hills and uplands. They have a thick organic surface layer that may consolidate erratically under an embankment load and have low in-place density and low strength. Therefore, if an embankment is to be more than 15 feet in height, the soil should be carefully analyzed to be sure it is strong enough to support it. Roadways through bottom lands should be constructed on a continuous embankment that extends above the flood level.

Limestone bedrock underlies the glacial till and loess and in a very few places comes to the surface. Faxon, Kensett, Rockton, and Tilfer soils are shallow over bedrock in Worth County. Rockton soils are classified A–4 and A–6; the others have high organic-matter content in the surface layer and are classified A–7 and A–6. Faxon and Tilfer soils have a seasonal high water table. Kensett soils have a seasonal water table at a depth of 2 to 4 feet. All these soils are a good source of lime-

[4] By DONALD A. ANDERSON, soil engineer, Iowa State Highway Commission.

TABLE 3.—*Potential of the soils for elements*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs
Bassett: 171, 171B	Good	Good	Good	Good
Bolan: 174, 174B	Good	Good	Good	Good
Boots: 321	Poor	Poor	Poor	Poor
Calco: 733	Good	Good	Good	Fair
Canisteo: 507	Good	Good	Good	Fair
Clarion:				
138, 138B, 169B	Good	Good	Good	Good
138C2	Fair	Good	Good	Good
Clarion-Nicollet: 29	Good	Good	Good	Good
Clarion-Storden:				
638B2	Good	Good	Good	Fair
638C2	Fair	Good	Good	Fair
Clyde: 84	Good	Good	Good	Fair
Coland: 135	Good	Good	Good	Fair
Coland-Turlin: 235	Goos	Goos	Good	Fair
Dickinson:				
175, 175B	Good	Good	Good	Fair
175C	Fair	Good	Good	Fair
Dinsdale: 377, 377B	Good	Good	Good	Good
Donnan:				
782, 782B	Fair	Fair	Fair	Fair
782C2	Fair	Fair	Fair	Fair
Donnan, dark variant: 706, 706B	Good	Good	Good	Good
Faxon: 651	Fair	Fair	Fair	Fair
Flagler: 284, 284B	Fair	Fair	Fair	Fair
Floyd: 198	Good	Good	Good	Good
Franklin: 761	Good	Good	Good	Good
Harcot: 335	Good	Good	Good	Poor
Harps: 95	Good	Good	Good	Poor
Hayfield: 725, 726	Good	Good	Good	Good
Hoopeston: 173	Fair	Good	Good	Good
Houghton: 621	Poor	Poor	Poor	Poor
Kensett: 188	Fair	Good	Good	Good
Kenyon:				
83, 83B	Good	Good	Good	Good
83C2	Fair	Good	Good	Good
Kilkenny:				
836B, 836B2	Good	Good	Good	Good
836C2, 836D2	Fair	Good	Good	Good
Klinger: 184	Good	Good	Good	Good
Lawler: 225, 226	Good	Good	Good	Good
Lester:				
236B, 236B2	Good	Good	Good	Good
236C, 236C2	Fair	Good	Good	Good
236D2, 236E2, 236F	Poor	Fair	Good	Fair
Le Sueur: 325	Good	Good	Good	Good
Marsh: 354	Very poor	Very poor	Very poor	Very poor
Marshan:				
151, 152	Good	Good	Good	Fair
153	Fair	Fair	Fair	Poor
Maxfield: 382	Good	Good	Good	Fair
Minnetonka: 583	Fair	Good	Fair or good	Fair
Mixed alluvial land, channeled: C315	Fair	Fair	Fair	Fair
Nicollet: 55, 755	Good	Good	Good	Good
Okoboji: 6	Fair	Fair	Fair	Poor
Okoboji-Harps: 956	Fair	Good	Fair	Poor
Oran: 471	Good	Good	Good	Good
Palms:				
221	Fair	Poor	Fair	Poor
221B	Poor	Poor	Poor	Poor
Readlyn: 399	Good	Good	Good	Good
Richwood: 977	Good	Good	Good	Good
Rockton:				
213, 213B	Good	Good	Good	Good
214, 214B	Fair	Good	Good	Good
Rolfe: 274	Fair	Fair	Fair	Poor
Salida:				
73C, 73D	Poor	Poor	Poor	Poor
73F	Very poor	Poor	Poor	Poor
Saude:				
177, 177B	Fair	Good	Good	Good
177C	Fair	Good	Good	Good

of wildlife habitat and kinds of wildlife

Elements of wildlife habitat–Continued			Kinds of wildlife		
Coniferous plants and shrubs	Wetland plants	Shallow water areas	Openland	Woodland	Wetland
Good	Fair	Poor	Good	Good	Poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Poor	Poor	Good.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.
Good	Poor	Very poor	Good	Good	Poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Fair	Poor	Very poor	Good	Fair	Very poor.
Fair	Very poor	Very poor	Good	Fair	Very poor.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Good	Fair	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Fair	Very poor	Very poor	Good	Good	Poor.
Fair	Fair	Fair	Fair	Fair	Fair.
Fair	Poor	Poor	Fair	Fair	Poor.
Good	Fair	Fair	Good	Good	Fair.
Poor	Good	Good	Fair	Fair or poor	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Very poor	Good	Good	Fair	Fair	Good.
Very poor	Good	Good	Fair	Poor	Good.
Good	Fair	Poor	Good	Good	Poor.
Good	Fair	Fair or poor	Fair	Good	Fair or poor.
Poor	Good	Good	Poor	Poor	Good.
Good	Fair	Poor	Good	Good	Poor.
Good	Fair	Poor	Good	Good	Poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Fair	Fair	Fair	Fair	Fair	Poor.
Fair	Poor	Poor	Fair	Fair	Poor.
Good	Fair	Fair	Good	Good	Fair.
Poor	Good	Good	Fair	Fair or poor	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Very poor	Good	Good	Fair	Fair	Good.
Very poor	Good	Good	Fair	Poor	Good.
Good	Fair	Poor	Good	Good	Poor.
Good	Fair	Fair or poor	Fair	Good	Fair or poor.
Poor	Good	Good	Poor	Poor	Good.
Good	Fair	Poor	Good	Good	Poor.
Good	Fair	Poor	Good	Good	Poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Fair	Fair	Good	Fair	Fair.
Very poor	Good	Good	Very poor	Very poor	Good.
Poor	Good	Good	Good	Fair	Good.
Very poor	Good	Good	Fair	Poor	Good.
Poor	Good	Good	Good	Fair	Good.
Poor	Good	Good	Fair	Fair	Good.
Poor	Good or fair	Good	Fair	Fair	Good.
Good	Fair	Fair	Good	Fair	Fair.
Very poor	Good	Good	Fair	Fair	Good.
Very poor	Good	Good	Fair	Fair	Good.
Good	Fair	Fair	Good	Fair	Fair.
Poor	Good	Good	Fair	Fair	Good.
Poor	Good	Fair	Poor	Poor	Fair.
Good	Fair	Fair	Good	Fair	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Very poor	Good	Good	Fair	Fair	Good.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.

TABLE 3.—*Potential of the soils for elements*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs
Schley: 407	Good	Good	Good	Good
Shorewood: 855	Good	Good	Good	Fair
Sparta: 41B, 41C	Poor	Fair	Fair	Fair
Storden:				
62D3	Fair	Good	Good	Fair
62E3	Poor	Fair	Fair	Fair
Talcot: 558, 559	Good	Good	Good	Fair
Terril: 27B	Good	Good	Good	Good
Tilfer: 695	Fair	Fair	Fair	Poor
Wacousta: T506	Good	Good	Good	Fair
Wapsie:				
777, 777B	Fair	Good	Good	Good
777C2	Fair	Good	Good	Good
Waukee: 178, 178B	Good	Good	Good	Good
Webster: 107	Good	Good	Good	Fair
Webster-Nicollet: 329	Good	Good	Good	Fair

of wildlife habitat and kinds of wildlife—Continued

Elements of wildlife habitat–Continued			Kinds of wildlife		
Coniferous plants and shrubs	Wetland plants	Shallow water areas	Openland	Woodland	Wetland
Good	Fair	Fair	Good	Fair	Fair.
Fair	Fair	Fair	Good	Fair	Fair.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Good	Good	Good	Fair	Good.
Good	Poor	Poor	Good	Good	Poor.
Poor	Good	Good	Fair	Poor	Good.
Poor	Good	Good	Good	Fair	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good	Fair	Good.
Poor	Fair or good	Fair	Good	Fair	Fair.

TABLE 4.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds to follow carefully the instructions for referring to other series that appear in the first

Soil series and map symbols	Depth to		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHO
	Feet	*Feet*	*Inches*			
Bassett: 171,171B	>10	(1)	0–17	Loam	CL or CL-ML	A–6 or A–4
			17–52	Loam	CL	A–6
			52–66	Loam	CL	A–6
Bolan: 174, 174B	> 5	> 5	0–19	Loam	CL or ML	A–4 or A–6
			19–37	Loam and fine sandy loam	CL or SC or SM	A–4 or A–6
			37–72	Loamy fine sand	SM	A–2
Boots: 321	>10	0–3	0–70	Peat and mucky peat	Pt	----------
Calso: 733	> 5	1–3	0–38	Light silty clay loam	CL, CH, OL or OH	A–7–6
			38–47	Light clay loam	CL	A–6
			57–60	Sandy loam	SC or SM	A–4 or A–2–4
Canisteo: 507	>10	1–3	0–19	Silty clay loam high in sand and clay loam.	CL, CH, OL, or OH	A–7–6 or A–7–5
			19–31	Loam	CL	A–6 or A–7–6
			31–60	Loam	CL	A–6
*Clarion: 138, 138B, 138C2, 169B, 29, 638B2, 638C2. For Nicollet part of 29, see Nicollet series; for Storden part of 638B2 and 638C2, see Storden series.	>10	> 5	0–13	Loam	CL or CL-ML	A–4 or A–6
			13–39	Loam	CL	A–6
			39–64	Loam	CL	A–6
Clyde: 84	>10	1–3	0–19	Silty clay loam	CL, OH, OL, or CH	A–7–6 or A–7–5
			19–51	Light silty clay loam high in sand, loam, and sandy loam.	CL, SC	A–6
			51–84	Heavy loam	CL	A–6
*Coland: 135, 235 For Turlin part of 235, see Turlin series.	>10	1–3	0–42	Light silty clay loam high in sand and clay loam.	CL, OL, OH, or CH	A–7–6 or A–7–5
			42–60	Loam	CL	A–6
Dickinson: 175, 175B, 175C	>10	> 5	0–33	Fine sandy loam	SM-SC or SC	A–4
			33–72	Loamy fine sand	SM or SP-SM	A–2–4 or A–3
Dinsdale: 377, 377B	>10	> 5	0–12	Light silty clay loam	CL or ML	A–6 or A–7–6
			12–30	Light silty clay loam	CL	A–7–6
			30–65	Loam	CL	A–6
Donnan: 782, 782B, 782C2	>40	(1)	0–13	Silt loam	CL or ML	A–6 or A–4
			13–26	Silty clay loam high in sand	CL	A–6 or A–7
			26–72	Light silty clay and heavy clay loam.	CH	A–7–6
Donnan, dark variant: 706, 706B	>10	(3)	0–19	Silt loam high in sand	ML or CL	A–6
			19–28	Loam	CL	A–6
			28–54	Heavy silty clay loam	CH	A–7–6
			54–72	Silty clay loam and heavy loam	CL	A–6
Faxon: 651	1½–3½	1–3	0–18	Silty clay loam	CL, OH, CH, or OL	A–7–6 or A–7–5
			18–29	Heavy loam	CL	A–6
			29–30	Gravel	SW or SM	A–1–b
			30	Limestone bedrock.		
Flagler: 284, 284B	>10	> 5	0–17	Sandy loam	SM-SC or SC	A–2–4
			17–27	Sandy loam	SM-SC or SC	A–2–4
			27–65	Loamy sand and fine gravelly sand.	SP, SW, or SW-SM	A–2–4 or A–1–b
Floyd: 198	>10	2–4	0–19	Loam	CL, ML, or MH	A–7–5 or A–7–6
			19–41	Loam and sandy loam	CL, SC, ML, or SM	A–2 or A–4
			41–60	Loam	CL	A–6

significant in engineering

of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary
column of this table. The symbol > means more than; the symbol < means less than]

Percentage less than 3 inches in diameter passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
	100	85–95	65–80	20–35	5–15	0.6–2.0	0.19–0.21	5.6–7.3	Moderate.
95–100	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.16–0.18	5.1–6.0	Moderate.
95–100	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.15–0.17	6.1–7.8	Moderate.
	100	85–95	55–80	25–35	7–15	0.6–2.0	0.17–0.20	5.6–7.3	Moderate.
	100	85–95	40–65	20–35	7–15	0.6–2.0	0.15–0.18	5.6–6.5	Moderate to low.
	100	70–95	20–35		[2]NP	6.0–20	0.10–0.12	5.6–6.5	Low.
						0.6–2.0	0.25–0.30	6.1–7.3	High.
	100	90–100	80–95	45–60	20–30	0.6–2.0	0.21–0.23	7.4–7.8	High.
100	95–100	90–100	70–80	30–40	20–30	0.2–0.6	0.15–0.19	7.4–7.8	Moderate to high.
95–100	90–100	60–70	30–40	10–20	3–10	2.0–6.0	0.11–0.13	7.4–7.8	Low.
100	95–100	90–100	70–90	45–60	20–30	0.6–2.0	0.20–0.22	7.4–7.8	Moderate to high.
95–100	90–100	85–95	60–80	35–45	25–30	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.
95–100	90–100	75–90	50–75	30–40	15–20	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.
95–100	95–100	85–95	50–75	25–40	5–20	0.6–2.0	0.20–0.22	6.1–7.3	Moderate.
90–100	90–100	75–90	50–65	30–40	11–20	0.6–2.0	0.17–0.19	6.1–7.3	Moderate.
90–100	90–95	75–90	50–65	25–35	11–15	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.
	100	95–100	75–90	45–60	15–25	0.6–2.0	0.21–0.23	6.1–7.3	High.
95–100	90–100	60–95	35–75	20–40	15–25	0.6–6.0	0.15–0.19	6.6–7.3	Moderate.
95–100	90–95	75–90	50–65	25–35	11–20	0.2–0.6	0.16–0.18	6.6–7.8	Moderate.
	100	90–100	70–90	45–60	20–30	0.6–2.0	0.20–0.22	6.1–7.3	High.
95–100	90–100	80–90	50–65	30–40	20–30	0.2–0.6	0.17–0.19	6.6–7.8	Moderate.
	100	70–95	40–50	15–25	4–10	2.0–6.0	0.15–0.18	5.6–7.3	Low.
	100	60–95	5–30		NP	6.0–20	0.09–0.11	5.6–6.5	Low or none.
	100	95–100	90–100	30–50	11–20	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
	100	90–100	80–95	41–50	15–25	0.6–2.0	0.18–0.20	5.1–6.0	Moderate.
95–100	90–95	75–90	50–65	25–35	11–20	0.2–0.6	0.15–0.17	5.6–6.0	Moderate.
	100	95–100	75–90	30–40	5–15	0.6–2.0	0.20–0.22	5.6–7.3	Moderate.
	100	90–100	80–95	35–45	15–25	0.6–2.0	0.17–0.19	5.1–6.0	Moderate.
95–100	95–100	80–100	65–95	60–70	30–40	<0.06	0.12–0.17	5.1–6.0	High.
	100	90–100	70–90	30–40	11–20	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
	100	85–95	60–75	30–40	11–20	0.6–2.0	0.17–0.19	5.1–6.0	Moderate.
	100	95–100	85–95	60–70	30–40	<0.06	0.14–0.18	5.1–6.0	High.
95–100	90–100	80–100	50–90	30–40	15–20	0.06–0.6	0.16–0.18	6.1–7.8	Moderate.
	100	95–100	70–90	45–60	20–25	0.6–2.0	0.21–0.23	6.1–7.3	High.
95–100	90–100	85–95	50–75	30–40	15–25	0.6–2.0	0.17–0.19	6.1–7.3	Moderate.
80–90	65–80	25–50	4–15		NP	>20.0	0.02–0.04	7.4–7.8	None.
95–100	90–100	70–90	30–35	15–25	5–10	2.0–6.0	0.13–0.15	5.6–7.3	Low.
95–100	80–100	60–80	25–40	15–25	5–10	2.0–6.0	0.12–0.14	5.6–6.5	Low.
75–95	60–95	40–50	3–12		NP	6.0–20	0.02–0.07	6.1–7.3	None.
	100	85–95	70–85	41–60	15–20	0.6–2.0	0.20–0.22	6.1–7.3	Moderate to high.
90–95	80–95	60–95	20–65	15–35	0–10	0.6–6.0	0.12–0.19	6.1–7.3	Moderate to low.
90–95	85–95	70–90	50–65	25–40	11–25	0.2–0.6	0.16–0.18	6.6–7.8	Moderate.

TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Depth to		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHO
	Feet	*Feet*	*Inches*			
Franklin: 761	>10	2–4	0–16	Silt loam	ML or CL	A–6 or A–4
			16–27	Silty clay loam	CL	A–7–6
			27–72	Heavy loam	CL	A–6
Harcot: 335	>10	1–3	0–20	Loam and heavy loam	CH, OL, CL, or OH	A–7–5 or A–7–6
			20–33	Loam and heavy loam	CL	A–6
			33–60	Fine sand	SM, SW, or SP	A–2–4, A–1–b; A–3
Harps: 95	>10	1–3	0–21	Heavy loam	OL, CL, OH, or CH	A–7–5 or A–7–6
			21–40	Heavy loam	CL or ML	A–6 or A–7–6
			40–72	Loam	CL	A–6
Hayfield:						
726	>10	2–4	0–8	Loam	CL or ML	A–6 or A–4
			8–36	Loam	CL	A–6
			36–60	Sand with some gravel	SM, SP-SM, or SW-SM	A–2–4 or A–1–b
725	>10	2–4	0–8	Loam	CL or ML	A–6 or A–4
			8–27	Loam	CL	A–6
			27–60	Sand with some gravel	SM, SP, or SW-SM	A–2–4 or A–1–b
Hoopeston: 173	> 5	2–4	0–20	Light fine sandy loam	SM-SC or SC	A–4
			20–38	Loamy fine sand and fine sandy loam.	SM or SC	A–4 or A–2–4
			38–76	Loamy sand and sand	SM or SP	A–2–4 or A–3
Houghton: 621	> 5	0–3	0–65	Muck and mucky peat	Pt	----------
			65–96	Silt loam with lenses of loamy sand.	CL	A–6
Kensett: 188	2–3½	2–4	0–13	Silt loam high in sand and light silty clay loam high in sand.	CL, OL, or ML	A–6, A–7–5, or A–7–6
			13–24	Light silty clay loam and loam.	CL	A–6 or A–7–6
			24–32	Heavy sandy loam and loamy sand.	SC or SM–SC	A–2–4
			32	Limestone bedrock.		
Kenyon: 83, 83B, 83C2	>10	(1)	0–21	Loam	CL	A–6
			21–46	Loam	CL	A–6
			46–72	Heavy loam	CL	A–6
Kilkenney: 836B, 836B2, 836C2, 836D2,	>10	> 5	0–8	Light silty clay loam	CL or ML	A–6, A–7–6, or A–7–5
			8–43	Heavy silty clay loam	CH	A–7–6 or A–7–5
			43–80	Loam and clay loam	CL	A–6 or A–7–6
Klinger: 184	>10	2–4	0–18	Light silty clay loam	OL, ML, or CL	A–7–6 or A–7–5
			18–33	Light silty clay loam	CL	A–7–6
			33–60	Heavy loam	CL	A–6
Lawler:						
226	>10	2–4	0–16	Heavy loam	CL or OL	A–6, A–7–6, or A–7–5
			16–36	Heavy loam	CL	A–6
			36–60	Sand with some gravel	SM, or SW-SM	A–2–4 or A–1–b
225	>10	2–4	0–16	Heavy loam	CL or OL	A–6, A–7–6, or A–7–5
			16–28	Heavy loam	CL	A–6
			28–60	Sand with some gravel	SM, or SW-SM	A–2–4 or A–1–b
Lester: 236B, 236B2, 236C, 236C2, 236D2, 236E2, 236F.	>10	> 5	0–13	Loam	CL or ML	A–4 or A–6
			13–42	Loam and light clay loam	CL	A–6
			42–72	Loam	CL	A–6

significant in engineering—Continued

Percentage less than 3 inches in diameter passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	100	95–100	90–100	25–40	5–15	0.6–2.0	0.21–0.23	5.1–7.3	Moderate.
----------	100	95–100	90–100	41–50	20–25	0.6–2.0	0.18–0.20	5.1–6.0	Moderate to high.
95–100	90–95	75–90	50–65	25–35	11–20	0.2–0.6	0.16–0.18	5.1–6.5	Moderate.
100	95–100	80–90	65–80	41–55	15–25	0.6–2.0	0.20–0.22	7.9–8.4	Moderate to high.
95–100	95–100	75–85	60–80	30–40	11–25	0.6–2.0	0.17–0.19	7.9–8.4	Moderate.
80–95	70–95	40–55	4–25	----------	NP	6.0–20	0.02–0.07	7.9–8.4	None.
100	95–100	85–95	65–80	41–55	15–25	0.6–2.0	0.20–0.22	7.9–8.4	Moderate or high.
95–100	90–100	85–95	60–80	30–45	15–25	0.6–2.0	0.17–0.19	7.9–8.4	Moderate.
95–100	90–100	85–95	60–80	30–40	15–20	0.6–2.0	0.17–0.19	7.9–8.4	Moderate.
95–100	95–100	85–95	65–80	30–40	8–15	0.6–2.0	0.18–0.20	5.6–7.3	Moderate.
95–100	90–100	70–85	50–75	25–35	11–20	0 6–2.0	0.17–0.19	4.5–5.6	Moderate.
80–95	70–90	40–50	5–25	----------	NP	6.0–20	0.02–0.07	5.1–6.5	None.
95–100	95–100	85–95	65–80	30–40	8–15	0.6–2.0	0.18–0.20	5.6–7.3	Moderate.
95–100	90–100	70–85	50–75	25–35	11–20	0.6–2.0	0.17–0.19	4.5–5.6	Moderate.
80–95	70–90	40–50	5–25	----------	NP	6.0–20	0.02–0.07	5.1–6.5	None.
----------	100	70–90	40–50	15–25	4–10	2.0–6.0	0.16–0.18	5.1–7.3	Low.
----------	100	60–90	20–50	15–25	3–8	2.0–6.0	0.12–0.17	5.1–5.6	Low.
----------	100	50–75	4–20	----------	NP	6.0–20	0.05–0.08	5.6–6.5	Very low.
----------	----------	----------	----------	----------	----------	2.0–6.0	0.25–0.50	6.6–7.3	Moderate.
----------	100	80–100	60–80	20–40	11–20	0.6–2.0	0.17–0.19	6.6–7.8	Moderate.
95–100	95–100	90–100	70–90	35–45	11–20	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
95–100	95–100	85–100	65–85	35–45	15–25	0.6–2.0	0.17–0.19	5.6–7.3	Moderate.
80–95	70–90	40–65	15–35	15–25	5–10	6.0–20	0.10–0.12	6.1–7.3	Low.
----------	100	85–95	55–80	30–40	11–20	0.6–2.0	0.20–0.22	5.6–7.3	Moderate.
90–95	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.16–0.18	5.6–6.5	Moderate.
90–95	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.15–0.17	6.6–7.8	Moderate.
----------	100	90–100	75–90	35–50	12–18	0.6–2.0	0.20–0.22	5.6–6.5	Moderate.
----------	100	80–95	60–80	55–70	25–35	0.2–0.6	0.14–0.16	5.1–6.0	High.
95–100	90–95	75–90	55–75	35–45	18–25	0.2–0.6	0.14–0.16	5.6–7.8	High or moderate.
----------	100	95–100	90–100	41–50	15–20	0.6–2.0	0.21–0.23	5.6–6.5	Moderate.
----------	100	95–100	90–100	41–50	20–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate to high.
95–100	90–95	75–90	50–65	25–35	11–20	0.2–0.6	0.16–0.18	5.6–7.8	Moderate.
95–100	95–100	85–95	65–80	35–45	11–20	0.6–2.0	0.20–0.22	5.6–7.3	Moderate.
95–100	90–100	70–85	50–75	25–35	11–20	0.6–2.0	0.17–0.19	5.6–6.5	Moderate.
80–95	70–90	40–50	5–25	----------	NP	6.0–20	0.02–0.07	5.6–7.8	None.
95–100	95–100	85–95	65–85	35–45	15–20	0.6–2.0	0.20–0.22	5.6–7.3	Moderate.
95–100	90–100	70–80	50–75	25–35	11–20	0.6–2.0	0.17–0.19	5.6–6.5	Moderate.
80–95	70–90	40–50	5–25	----------	NP	6.0–20	0.02–0.07	5.6–7.8	None.
95–100	95–100	85–95	50–75	25–35	7–15	0.6–2.0	0.19–0.21	5.6–6.5	Moderate.
95–100	95–100	85–95	55–80	30–40	15–20	0.6–2.0	0.16–0.19	5.6–6.5	Moderate.
90–100	90–95	75–90	50–65	25–35	11–15	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.

TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Depth to		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHO
	Feet	*Feet*	*Inches*			
Le Sueur: 325	>10	2–4	0–12	Loam	CL or ML	A–6 or A–4
			12–36	Loam and light clay loam	CL	A–6 or A–7–6
			36–60	Loam	CL	A–6
Marsh: 354[4]	> 5	0–1	0–60			
Marshan: 152	> 5	1–3	0–21	Light clay loam and light silty clay loam.	CL, OL, OH, or CH	A–7–5 or A–7–6
			21–33	Light silty clay loam and light sandy clay loam.	CL	A–6 or A–7
			33–60	Gravelly loamy sand, fine sand, and medium sand.	SM, SW-SM, or SW	A–2–4 or A–1–b
151	> 5	1–3	0–21	Light clay loam	CL, OL, OH, or CH	A–7–5 or A–7–6
			21–28	Light clay loam and light sandy clay loam.	CL	A–6 or A–7
			28–60	Gravelly loamy sand, fine sand, and medium sand.	SM or SW	A–2–4 or A–1–b
153	> 5	0–3	0–21	Light clay loam and light silty clay loam.	OL or OH	A–7–5 or A–7–6
			21–36	Light clay loam	CL	A–6 or A–7
			36–60	Gravelly loamy sand, fine sand, and medium sand.	SM or SW	A–2–4 or A–1–b
Maxfield: 382	> 5	1–3	0–20	Silty clay loam	CH, OH, OL, or CL	A–7–5 or A–7–6
			20–27	Light silty clay loam	CL or CH	A–7–6
			27–72	Loam	CL	A–6
Minnetonka: 583	>10	1–3	0–17	Silty clay loam	CH, OH, CL, or OL	A–7–6 or A–7–5
			17–37	Silty clay	CH or MH	A–7–6 or A–7–5
			37–72	Light silty clay	CL	A–7–6
Mixed alluvial land, channeled: C315[4]	> 5	1–3	0–60			
Nicollet: 55, 755	>10	2–4	0–16	Loam	CL or OL	A–7–6
			16–31	Loam	CL	A–6 or A–7–6
			31–60	Loam	CL	A–6
*Okoboji: 6, 956 For Harps part of unit 956, see Harps series.	>10	0–3	0–33	Silty clay loam	OH or CH	A–7–6 or A–7–5
			33–72	Silty clay loam	CH, CL, or MH	A–7–6
Oran: 471	>10	2–4	0–19	Silt loam high in sand and silty clay loam high in sand.	CL	A–6 or A–4
			19–52	Loam	CL	A–6
			52–72	Loam	CL	A–6
Palms: 221, 221B	> 5	0–3	0–28	Muck	Pt	
			28–72	Silt loam and mucky silt loam	CL, MH, or OH	A–6, A–7–5, or A–7–6
Readlyn: 399	>10	2–4	0–15	Loam	CL or ML	A–6
			15–42	Loam	CL	A–6
			42–60	Loam	CL	A–6
Richwood: 977	> 5	> 5	0–21	Silt loam	ML or CL	A–4 or A–6
			21–37	Silt loam	CL	A–6
			37–51	Light silty clay	CL or ML	A–6 or A–7–6
			51–65	Heavy loamy sand	SM or SM–SP	A–2–4 or A–3
Rockton:						
213, 213B	2½–3½	> 5	0–15	Loam	CL	A–6
			15–37	Loam and light sandy clay loam	CL	A–6
			37	Limestone bedrock.		
214, 214B	1½–2½	> 5	0–12	Loam	CL	A–6
			12–30	Loam and light sandy clay loam	CL	A–6
			30	Limestone bedrock.		

significant in engineering—Continued

Percentage less than 3 inches in diameter passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
95–100	95–100	85–95	50–75	30–40	8–16	0.6–2.0	0.19–0.21	5.6–6.5	Moderate.
95–100	95–100	75–95	55–80	30–45	15–25	0.6–2.0	0.16–0.19	5.6–6.5	Moderate.
90–100	90–95	75–90	50–65	25–35	11–15	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.
100	95–100	90–100	70–90	41–60	15–25	0.6–2.0	0.20–0.22	6.1–7.3	High to moderate.
95–100	90–100	70–90	50–75	25–40	15–25	0.6–2.0	0.16–0.19	6.6–7.3	Moderate.
80–95	70–90	40–50	3–25	----------	NP	6.0–20	0.02–0.07	6.6–7.3	None.
100	95–100	65–90	50–75	41–60	15–25	0.6–2.0	0.20–0.22	6.1–7.3	High to moderate.
80–95	90–100	65–90	50–75	25–40	15–25	0.6–2.0	0.15–0.18	6.6–7.3	Moderate.
80–95	70–90	40–50	4–25	----------	NP	6.0–20	0.02–0.07	6.6–7.3	None.
100	95–100	90–100	70–90	41–60	15–25	0.6–2.0	0.20–0.22	6.1–7.3	High to moderate.
100	95–100	70–90	50–75	20–40	15–25	0.6–2.0	0.16–0.18	6.6–7.3	Moderate.
80–95	70–90	40–50	4–25	----------	NP	6.0–20	0.02–0.07	6.6–7.3	None.
----------	100	95–100	90–100	45–60	15–25	0.6–2.0	0.21–0.23	6.1–7.3	High.
----------	100	95–100	90–100	45–55	25–30	0.6–2.0	0.18–0.20	6.6–7.3	High.
95–100	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.16–0.18	6.6–7.8	Moderate.
95–100	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.15–0.17	7.4–7.8	Moderate.
----------	100	95–100	90–100	45–65	20–30	0.2–0.6	0.20–0.22	5.6–7.3	High.
----------	100	95–100	90–100	60–75	30–45	0.06–0.2	0.11–0.13	5.6–7.3	High.
----------	100	95–100	90–100	41–50	25–30	0.2–0.6	0.18–0.20	6.6–7.8	Moderate to high.
95–100	95–100	85–95	65–80	41–50	11–20	0.6–2.0	0.20–0.22	6.1–7.3	Moderate.
95–100	90–100	80–95	60–80	35–45	15–25	0.6–2.0	0.17–0.19	6.1–7.3	Moderate.
90–100	85–100	75–90	55–80	25–35	11–15	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.
----------	100	95–100	90–100	50–75	25–35	0.06–0.2	0.20–0.22	6.6–7.3	High.
----------	100	95–100	85–95	45–70	25–35	0.06–0.2	0.18–0.20	6.6–7.8	High.
----------	100	90–100	75–90	25–35	8–15	0.6–2.0	0.20–0.22	5.1–7.3	Moderate.
95–100	90–95	75–90	50–65	30–40	11–20	0.2–0.6	0.16–0.18	5.1–6.0	Moderate.
95–100	90–95	75–90	50–65	25–35	11–20	0.2–0.6	0.15–0.17	5.6–6.0	Moderate.
----------	----------	----------	----------	----------	----------	2.0–6.0	0.25–0.50	6.6–7.3	Moderate.
----------	100	95–100	90–100	30–60	15–25	0.6–2.0	0.20–0.22	6.6–7.3	Moderate.
----------	100	90–100	55–80	30–40	11–20	0.6–2.0	0.20–0.22	5.6–7.3	Moderate.
95–100	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.16–0.18	5.6–7.3	Moderate.
95–100	90–95	75–90	50–65	30–40	15–20	0.2–0.6	0.15–0.17	7.4–7.8	Moderate.
95–100	90–95	75–90	50–65	30–40	8–16	0.6–2.0	0.22–0.24	5.6–7.3	Moderate.
----------	100	95–100	90–100	30–40	11–20	0.6–2.0	0.20–0.22	5.1–6.0	Moderate.
----------	100	95–100	90–100	35–45	15–20	0.6–2.0	0.18–0.20	5.6–6.0	Moderate to high.
90–100	80–95	50–80	6–20	----------	NP	6.0–20	0.08–0.10	6.1–7.8	Low.
----------	100	85–95	65–80	30–40	11–20	0.6–2.0	0.20–0.22	6.1–6.5	Moderate.
100	90–95	75–90	50–65	30–35	15–20	0.6–2.0	0.16–0.18	5.6–7.3	Moderate.
----------	100	85–95	65–80	30–40	11–20	0.6–2.0	0.20–0.22	6.1–6.5	Moderate.
100	90–95	75–90	50–65	30–35	15–20	0.6–2.0	0.16–0.18	5.6–7.3	Moderate.

TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Depth to		Depth from surface	USDA texture	Classification	
	Bedrock	Seasonal high water table			Unified	AASHO
	Feet	*Feet*	*Inches*			
Rolfe: 274	>10	0–3	0–10	Silt loam	OL or CL	A–6 to A–7–5
			10–34	Light silty clay and heavy silty clay loam.	CH or MH	A–7–6 or A–7–5
			34–72	Loam and sandy loam	CL and SC	A–6
Salida: 73C, 73D, 73F	>10	> 5	0–10	Light sandy loam	SM or SM–SC	A–2–4
			10–15	Gravelly loamy sand	SM or SM-SC	A–2–4 or A–1–b
			15–60	Gravelly loamy sand and loamy gravel.	SM or SW	A–2–4 or A–1–b
Saude: 177, 177B, 177C	>10	> 5	0–13	Loam	CL	A–6
			13–30	Loam and sandy loam	CL or SC	A–4 or A–6
			30–50	Loamy sand and gravelly sand	SM or SW	A–2–4 or A–1–b
Schley: 407	>10	2–4	0–23	Silt loam, light silty clay loam, and loam.	ML or CL	A–6 or A–4
			23–47	Stratified loam, sandy loam, and sandy clay loam.	CL or SC	A–4 or A–6
			47–60	Loam	CL	A–6
Shorewood: 855	>10	2–4	0–18	Silty clay loam	CL, CH, OL, or OH	A–7–6 or A–7–5
			18–32	Silty clay	CH or MH	A–7–6
			32–52	Silty clay	CH or MH	A–7–6
			52–84	Light silty clay loam	CL or ML	A–6 or A–7–6
Sparta: 41B, 41C	> 5	> 5	0–13	Loamy fine sand	SM	A–2–4
			13–60	Loamy fine sand	SM, SP-SM, or SP	A–2–4 or A–3
Storden: 62D3, 62E3	>10	> 5	0–60	Loam	CL	A–6
Talcot:						
559	> 5	1–3	0–21	Light clay loam	CL, OL, OH, or CH	A–7–5 or A–7–6
			21–35	Loam and clay loam	CL	A–6
			35–60	Loamy sand and gravelly sand	SM or SW	A–2–4 or A–1–b
558	> 5	1–3	0–20	Light clay loam	OL, OH, CL, or CH	A–7–5 or A–7–6
			20–27	Loam and clay loam	CL	A–6
			27–60	Loamy sand and gravelly sand	SM or SW	A–2–4 or A–1–b
Terril: 27B	>10	> 5	0–27	Loam	CL or ML	A–4, A–6, or A–7–5
			27–72	Loam	CL	A–6
Tilfer: 695	1½–3½	1–3	0–19	Light silty clay loam	CL, OH, CH, or OL	A–7–6 or A–7–5
			19–35	Loam	CL	A–6
			35	Limestone bedrock.		
Turlin	> 5	2–4	0–31	Loam	CL or OL	A–4 or A–6
Mapped only with Coland soils.			31–43	Loam	CL	A–6
			43–60	Stratified loam and sandy loam	CL or SC	A–4 or A–6
Wacousta: T506	> 5	1–3	0–20	Heavy silt loam	OL, OH, or CH	A–7–5 or A–7–6
			20–60	Stratified silt loam	ML or CL	A–6 or A–7–6
Wapsie: 777, 777B, 777C2	> 5	> 5	0–14	Loam	CL or ML	A–4
			14–30	Loam and sandy loam	CL or SC	A–4 or A–6
			30–60	Loamy sand and gravelly sand	SW, SP, or SW-SM	A–2–4 or A–1–b
Waukee: 178, 178B	> 5	> 5	0–18	Heavy loam	CL	A–4 or A–6
			18–36	Heavy loam	CL	A–6
			36–68	Gravelly loamy sand and gravelly sand.	SW, SP, or SW-SM	A–2–4 or A–1–b
*Webster: 107, 329	>10	1–3	0–19	Light silty clay loam and light clay loam.	OL, CL, or OH	A–7–6 or A–7–5
For Nicollet part of unit 329; see Nicollet series.			19–32	Heavy loam	CL	A–6 or A–7
			32–60	Loam	CL	A–6

[1] The seasonal high water table is generally at a depth of more than 5 feet but during extended wet periods is perched at a depth of about 2 feet.

[2] Nonplastic.

significant in engineering—Continued

Percentage less than 3 inches in diameter passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Percent		*Inches per hour*	*Inches per inch of soil*	*pH*	
----------	100	95–100	85–95	35–50	15–30	0.6–2.0	0.22–0.24	5.6–7.3	Moderate.
----------	100	95–100	90–100	60–75	30–45	0.06–0.2	0.14–0.16	6.1–7.3	High.
90–100	85–100	65–80	35–65	20–35	11–25	0.2–2.0	0.14–0.16	6.5–7.8	Moderate.
90–95	70–90	45–55	15–30	15–25	4–7	2.0–6.0	0.12–0.14	6.1–7.8	Low.
80–90	65–80	25–35	10–20	----------	NP	>20	0.06–0.08	7.4–7.8	Very low.
70–90	55–70	20–30	4–20	----------	NP	>20	0.02–0.04	7.4–7.8	None.
95–100	90–100	80–95	50–75	25–35	7–15	0.6–2.0	0.20–0.22	5.6–7.3	Moderate.
95–100	90–95	60–75	35–60	15–30	5–15	0.6–2.0	0.15–0.17	5.6–6.5	Moderate to low.
80–95	70–90	40–50	3–25	----------	NP	6.0–20	0.02–0.07	5.6–7.8	None.
----------	100	85–95	70–90	30–40	5–15	0.6–2.0	0.20–0.22	5.1–7.3	Moderate to high.
90–100	80–95	60–95	35–65	15–30	5–15	0.6–6.0	0.12–0.19	5.1–6.0	Moderate to low.
95–100	90–95	70–90	50–65	25–40	11–20	0.2–0.6	0.16–0.18	5.6–7.3	Moderate.
----------	100	95–100	90–100	41–60	15–30	0.6–2.0	0.20–0.22	5.6–7.3	High.
----------	100	95–100	90–100	60–75	30–45	0.06–0.6	0.11–0.13	5.1–6.0	High.
----------	100	95–100	90–100	60–75	30–45	0.06–0.6	0.11–0.13	6.1–7.8	High.
----------	100	95–100	90–100	35–45	20–30	0.2–0.6	0.18–0.20	7.4–7.8	Moderate to high.
----------	100	70–95	15–30	----------	NP	2.0–6.0	0.11–0.13	5.6–7.3	Low or none.
----------	100	60–95	4–30	----------	NP	6.0–20	0.09–0.11	5.1–7.3	None.
90–100	90–95	75–90	50–65	25–30	11–15	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.
100	95–100	90–100	70–90	41–55	15–25	0.6–2.0	0.20–0.22	7.4–7.8	Moderate to high.
95–100	90–100	70–90	50–75	25–40	15–25	0.6–2.0	0.16–0.19	7.4–7.8	Moderate.
80–95	70–90	40–50	4–25	----------	NP	6.0–20	0.02–0.07	7.4–7.8	None.
100	95–100	90–100	70–90	41–55	15–25	0.6–2.0	0.20–0.22	7.4–7.8	Moderate to high.
95–100	90–100	70–90	50–75	25–40	15–25	0.6–2.0	0.16–0.19	7.4–7.8	Moderate.
80–95	70–90	40–50	4–25	----------	NP	6.0–20	0.02–0.07	7.4–7.8	None.
100	95–100	85–95	50–80	30–45	8–20	0.6–2.0	0.20–0.22	6.1–7.8	Moderate.
100	90–100	75–95	50–80	25–40	11–20	0.6–2.0	0.17–0.19	6.1–7.8	Moderate.
----------	100	95–100	70–90	45–60	20–30	0.6–2.0	0.21–0.23	7.4–7.8	High.
95–100	90–100	85–95	50–75	30–40	15–25	0.6–2.0	0.17–0.19	7.4–7.8	Moderate.
100	90–100	80–95	50–80	30–40	8–12	0.6–2.0	0.20–0.22	6.1–7.3	Moderate.
95–100	90–100	80–95	50–75	30–40	11–20	0.6–2.0	0.17–0.19	6.1–7.3	Moderate.
95–100	90–100	70–90	40–60	15–35	8–16	0.6–2.0	0.14–0.16	6.6–7.3	Moderate to low.
----------	100	95–100	90–95	45–55	15–30	0.6–2.0	0.22–0.24	6.6–7.8	Moderate to high.
----------	100	95–100	90–95	34–45	15–25	0.6–2.0	0.20–0.22	7.4–7.8	Moderate.
95–100	90–100	80–95	50–75	25–35	5–10	0.6–2.0	0.19–0.21	5.1–7.3	Moderate.
95–100	90–95	60–75	35–60	20–35	5–15	0.6–2.0	0.15–0.17	5.1–6.0	Moderate to low.
80–95	70–90	40–55	3–25	----------	NP	6.0–20	0.02–0.07	5.6–7.8	None.
100	95–100	85–95	55–80	30–40	11–20	0.6–2.0	0.20–0.22	5.6–7.3	Moderate.
95–100	90–95	70–90	50–65	25–40	7–15	0.6–2.0	0.17–0.19	5.6–6.5	Moderate.
80–95	70–90	40–55	4–25	----------	NP	6.0–20	0.02–0.07	6.1–7.8	None.
100	95–100	90–100	70–90	45–65	20–30	0.6–2.0	0.20–0.22	6.6–7.3	Moderate to high.
95–100	90–100	85–95	60–80	35–45	20–30	0.2–2.0	0.17–0.19	6.6–7.8	Moderate.
95–100	90–100	75–90	50–75	30–40	15–20	0.2–2.0	0.17–0.19	7.4–7.8	Moderate.

[3] The seasonal high water table is generally at a depth of more than 5 feet, but during extended wet periods is perched at a depth of 2½ to 3 feet.

[4] Variable; no classification possible; onsite investigation needed.

TABLE 5.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Bassett: 171, 171B	Moderate to slight: questionable percolation rate; moderately slow permeability below a depth of about 2½ feet; perched water table at a depth of about 2 feet during extended wet periods.	Slight if slope is less than 2 percent, moderate if 2 to 5 percent; sand pockets in some places; moderately slow permeability.	Slight: perched water table at a depth of about 2 feet during extended wet periods; moderately slow permeability below a depth of about 2½ feet.	Slight to moderate: good to fair bearing capacity; well drained to moderately well drained; perched water table during extended wet periods; seepage in some cuts; moderate shrink-swell potential.	Good to fair: glacial till is easily compacted to high density; good to fair bearing capacity; moderate shrink-swell potential.
Bolan: 174, 174B	Slight: poor filtering material below a depth of about 3 feet may allow effluent to travel long distances.	Severe: rapid permeability below a depth of about 3 feet; danger of ground water contamination.	Severe: rapid permeability below a depth of about 3 feet.	Slight: good bearing capacity; high organic-matter content in surface layer; well drained; moderate to low shrink-swell potential.	Good: low to very low shrink-swell potential below a depth of about 2 to 3 feet; good bearing capacity.
Boots: 321	Very severe: seasonal high water table; subject to ponding.	Very severe: very high organic-matter content throughout profile; seasonal high water table; subject to ponding.	Very severe: very poorly drained; seasonal high water table; subject to ponding.	Very severe: very poorly drained; seasonal high water table; subject to ponding; very high organic-matter content to a depth of 4 to 10 feet or more.	Very poor: very high organic-matter content; very high compressibility; very low bearing capacity; seasonal high water table.
Calco: 733	Severe: seasonal high water table; subject to flooding; questionable percolation rate.	Severe: seasonal high water table; subject to flooding; high organic-matter content in surface layer.	Severe: poorly drained; seasonal high water table; subject to flooding.	Severe: poorly drained; subject to flooding; high organic-matter content to a depth of 2½ to 3½ feet; seasonal high water table.	Poor: poorly drained; seasonal high water table; high organic-matter content in upper 2½ to 3½ feet or more; high shrink-swell potential; poor bearing capacity and shear strength; high compressibility.
Canisteo: 507	Severe: seasonal high water table; subject to flooding in waterways from concentrated runoff.	Severe: seasonal high water table; high organic-matter content in surface layer; moderate permeability.	Severe: seasonal high water table; poorly drained.	Severe: poorly drained; high organic-matter content in upper 16 to 24 inches; seasonal high water table; moderate to high shrink-swell potential in upper 16 to 24 inches.	Poor: poorly drained; seasonal high water table; high organic-matter content and moderate to high shrink-swell potential in upper 16 to 24 inches.
*Clarion: 138, 138B, 138C2, 169B, 29, 638B2, 638C2. For Nicollet part of 29, see Nicollet series; for Storden part of 638B2 and 638C2, see Storden series.	Slight if slope is less than 5 percent, moderate if 5 to 9 percent; moderate permeability.	Slight if slope is less than 2 percent, moderate if 2 to 9 percent; moderate permeability.	Slight: good workability.	Slight to moderate: good to fair bearing capacity; moderate shrink-swell potential; high organic-matter content in surface layer.	Good to fair below surface layer; easily compacted to high density; moderate shrink-swell potential.

interpretations

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-that appear in the first column of this table]

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Good in upper 1 to 1½ feet, poor below.	Moderately slow permeability; sand pockets and lenses in some places; nearly level and gently sloping.	Good compaction; low compacted permeability; medium to low compressibility; large boulders in places.	Generally not needed; seepage in some spots.	Not needed on nearly level soils; low fertility in subsoil; exposed glacial till generally has poor workability; wet spots may develop and will benefit from tile drainage; generally smooth topography.
Fair for sand: poorly graded fine sand below a depth of about 2 to 3 feet. Unsuitable for gravel.	Good in upper 1 to 2 feet; fair at a depth of 2 to 3 feet; poor below.	Moderate permeability in upper 2 to 3 feet, rapid below; nearly level and gently sloping; material too porous to hold water.	Good compaction; low compacted permeability in upper 2 to 3 feet, medium to low below; subject to piping below a depth of about 3 feet.	Not needed; well drained.	Generally not needed; short slopes; sandy material below a depth of about 2 to 3 feet; difficult to maintain ridge and channel.
Unsuitable: no sand or gravel.	Poor: very poorly drained; good when mixed with mineral soil.	Depressional and level; very high organic-matter content; dug ponds feasible.	Unsuitable: lacks stability; extremely high compressibility; extremely low shear strength; high susceptibility to piping.	Very poorly drained; seasonal high water table; drain tile is likely to settle.	Not needed; smooth topography.
Unsuitable: no sand or gravel.	Fair to poor: poorly drained; high organic-matter content in upper 2½ to 3½ feet; calcareous; seasonal high water table.	Seasonal high water table; high organic-matter content in surface layer; nearly level; subject to flooding; moderately slow permeability.	High organic-matter content in upper 2½ to 3½ feet; difficult to compact; high compressibility; high shrink-swell potential; low shear strength.	Poorly drained; seasonal high water table; subject to flooding; moderately slow permeability; difficult to find good outlets.	Not needed; nearly level bottom land.
Unsuitable: no sand or gravel.	Fair to poor: poorly drained; high organic-matter content in upper 16 to 24 inches; calcareous; seasonal high water table.	Seasonal high water table; high organic-matter content in surface layer; moderate permeability; nearly level.	Fair to poor compaction, high compressibility, and low shear strength in upper part; fair to good compaction in lower part; low compacted permeability; medium shear strength.	Poorly drained; seasonal high water table; moderate permeability.	Not needed; nearly level.
Unsuitable: no sand or gravel.	Good in units 138 and 138B in upper 1 to 1½ feet, fair below; fair in unit 138C2; high organic-matter content in surface layer of units 138 and 138B.	Moderate permeability; sand pockets and lenses in places; nearly level to moderately sloping.	Good compaction; low compacted permeability; medium to low compressibility.	Not needed; well drained.	Irregular topography requires considerable cutting and filling for parallel terraces on units 138B and 138C2; smooth landscape on unit 169B; soil features favorable.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Clyde: 84	Severe: seasonal high water table; subject to flooding in waterways from concentrated runoff.	Severe: seasonal high water table; receives local runoff in waterways; high organic-matter content in surface layer; stratified in places with coarse material.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table; moderate to high shrink-swell potential in upper 14 to 24 inches.	Poor: poorly drained; seasonal high water table; high organic-matter content; high shrink-swell potential in upper 14 to 24 inches; poor bearing capacity.
*Coland: 135, 235 For Turlin part of 235, see Turlin series.	Severe: seasonal high water table; subject to flooding.	Severe: seasonal high water table; subject to flooding; high organic-matter content in surface layer.	Severe: poorly drained; seasonal high water table; subject to flooding.	Severe: poorly drained; subject to flooding; seasonal high water table; high organic-matter content in upper 3 to 4 feet.	Poor: poorly drained; seasonal high water table; high organic-matter content in upper 3 feet or more; high shrink-swell potential.
Dickinson: 175, 175B, 175C.	Slight: moderately rapid to rapid permeability; danger of contamination of wells and streams.	Severe: moderately rapid to rapid permeability; danger of contamination of wells and streams.	Severe to moderate: moderately rapid to rapid permeability.	Slight: good bearing capacity; low shrink-swell potential; loose sand may hinder hauling operations.	Good: good bearing capacity; low shrink-swell potential.
Dinsdale: 377, 377B.	Slight: moderate permeability to a depth of about 2½ to 3½ feet and moderately slow below; nearly level and gently sloping.	Slight on 377, moderate on 377B; moderately slow permeability below a depth of about 2½ to 3½ feet; sand pockets in some places.	Slight: perched water table at a depth of 5 to 6 feet during extended wet seasons; moderately slow permeability below a depth of about 2½ to 3½ feet.	Moderate: high organic-matter content in surface layer; fair bearing capacity in upper 2 to 3 feet; good to fair bearing capacity in underlying till; moderate shrink-swell potential.	Fair to poor in upper 2 to 3 feet, good to fair below a depth of 3 feet; glacial till is easily compacted to high density and has good to fair bearing capacity; moderate shrink-swell potential; high organic-matter content in surface layer.
Donnan: 782, 782B, 782C2.	Severe; very slow permeability; perched water table at a depth of 1½ to 2 feet during extended wet periods.	Slight if slope is less than 2 percent, moderate if 2 to 9 percent; sand pockets in some places; very slow permeability.	Moderate to severe: silty clay subsoil is very difficult to work; perched water table during extended wet periods.	Severe: high shrink-swell potential; perched water table at a depth of 1½ to 2 feet during extended wet periods; fair to poor bearing capacity.	Poor: fair material in upper 2 to 3 feet; silty clay below has high shrink-swell potential, is very difficult to work.
Donnan, dark variant: 706, 706B.	Severe: very slow permeability; perched water table at a depth of 2 to 3 feet during extended wet periods.	Slight if slope is less than 2 percent, moderate if 2 to 5 percent; sand pockets in in some places; very slow permeability.	Moderate to severe: silty clay subsoil is very difficult to work; perched water table during extended wet periods.	Severe: high shrink-swell potential; perched water table at a depth of 2 to 3 feet during extended wet periods; high organic-matter content in surface layer; fair to poor bearing capacity.	Poor: high organic-matter content in surface layer; below a depth of 2 to 3 feet is heavy silty clay loam or silty clay that has high shrink-swell potential and is very difficult to work.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Fair: poorly drained; seasonal high water table; suitable material and high organic-matter content in upper 14 to 24 inches, generally poor below.	Seasonal high water table; high organic-matter content in surface layer; moderate permeability; some sand lenses and pockets; nearly level.	Fair to poor compaction; high compressibility and low shear strength in upper part; fair to good compaction in lower part; low compacted permeability; medium shear strength.	Poorly drained; seasonal high water table; moderate permeability.	Not needed; nearly level.
Unsuitable: no sand or gravel.	Fair: poorly drained; seasonal high water table; suitable material and high organic-matter content in upper 3 to 4 feet.	Subject to flooding; high organic-matter content in surface layer; seasonal high water table; moderately slow permeability; nearly level.	High organic-matter content in upper 3 to 4 feet; difficult to compact; high compressibility; low shear strength.	Poorly drained; seasonal high water table; subject to flooding; moderately slow permeability; difficult to find good outlets.	Not needed; nearly level bottom land.
Fair for sand below a depth of about 2 to 3 feet; poorly graded sand. Unsuitable for gravel.	Good in upper 1½ to 2½ feet, poor below; may be difficult to revegetate borrow area.	Moderately rapid permeability in upper 2 to 3 feet, rapid below; nearly level to moderately sloping; material too porous to hold water.	Fair to good compaction; low to medium compressibility; medium to high compacted permeability; medium to high susceptibility to piping.	Not needed; well to somewhat excessively drained.	Highly erodible; difficult to maintain ridge and channel; medium to high susceptibilities to piping.
Unsuitable: no sand or gravel.	Good in upper 2 to to 3 feet, poor below; high organic-matter content in surface layer.	Moderate permeability in upper 2 to 3 feet, moderately slow below; pockets and lenses of sand in some places; nearly level and gently sloping.	Fair compaction and low to medium permeability when compacted in upper 2 to 3 feet; good compaction and low compacted permeability below a depth of 2 to 3 feet; medium compressibility; large boulders in places; medium shear strength.	Not needed; well drained; may have seepage in some spots.	Not needed on level areas; 377B generally has smooth topography; soil features are favorable; cuts should be held to a minimum to avoid exposing less fertile, more dense glacial till below a depth of about 3 feet.
Unsuitable: no sand or gravel.	Fair on 782 and 782B; suitable material in upper 2 feet; may be difficult to revegetate borrow area; poor on 782C2.	Very slow permeability; sand pockets and lenses in some places; nearly level to moderately sloping.	Fair to good compaction in upper 2 to 3 feet, fair to poor below; low compacted permeability; lower part has high shrink-swell potential and is difficult to work.	Very slow permeability; may have seepage in some spots; tile drains may not work in all areas.	Not needed on level areas; cuts should be held to a minimum to avoid the dense, difficult to work, and very infertile subsoil. A combination with tile will generally be the most successful.
Unsuitable: no sand or gravel.	Fair: high organic-matter content in surface layer and suitable material in upper 2 feet; may be difficult to revegetate borrow area.	Very slow permeability; sand pockets and lenses in some places; nearly level to gently sloping.	Fair to good compaction in upper 2 to 3 feet, fair to poor below; low compacted permeability; high shrink-swell potential and difficult to work below a depth of 2 to 3 feet.	Very slow permeability; tile drains generally not needed except on a few areas of 706; tile drains may not work in all areas.	Not needed on level areas; cuts should be held to a minimum to avoid the dense, difficult to work, and very infertile subsoil. A combination with tile generally the most successful.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Faxon: 651	Very severe: seasonal high water table; bedrock at a depth of 1½ to 3½ feet; danger of ground water contamination.	Very severe: seasonal high water table; bedrock at a depth of 1½ to 3½ feet; high organic-matter content in surface layer; danger of ground water contamination.	Very severe: seasonal high water table; bedrock at a depth of 1½ to 3½ feet; poorly drained.	Severe: poorly drained; high organic-matter content in upper 15 to 24 inches; seasonal high water table; bedrock at a depth of 1½ to 3½ feet.	Poor: poorly drained; seasonal high water table; high organic-matter content and high shrink-swell potential in upper 15 to 24 inches; bedrock at a depth of 1½ to 3½ feet.
Flagler: 284, 284B	Slight: poor filtering material may allow effluent to travel long distances; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2 feet; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability.	Slight: good bearing capacity; low to no shrink-swell potential.	Good: good bearing capacity; low to no shrink-swell potential.
Floyd: 198	Severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability below a depth of about 3½ to 4½ feet.	Moderate: seasonal high water table at a depth of 2 to 4 feet; high organic-matter content in surface layer; sand pockets and lenses in some places; moderately slow permeability below a depth of about 3½ to 4½ feet.	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained.	Moderate: somewhat poorly drained; high organic-matter content in surface layer; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential; fair bearing capacity.	Fair: high organic-matter content, poor bearing capacity, and moderate to high shrink-swell potential in upper part; good compaction and moderate shrink-swell potential in lower part.
Franklin: 761	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Slight to moderate: seasonal high water table at a depth of 2 to 4 feet; sand pockets in some places; moderately slow permeability.	Moderate: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained; moderately permeable glacial till.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate to high shrink-swell potential; fair bearing capacity.	Fair: moderate to high shrink-swell potential in upper 2 to 3 feet; glacial till has moderate shrink-swell potential and is easily compacted to high density in lower part.
Harcot: 335	Severe: seasonal high water table; danger of ground water contamination; occasional flooding.	Severe: rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table; high organic-matter content in surface layer; danger of ground water contamination; occasional flooding.	Severe: poorly drained; seasonal high water table; very rapid permeability below a depth of about 2 to 3½ feet; occasional flooding.	Severe: poorly drained; high organic-matter content in upper 16 to 24 inches; seasonal high water table; moderate to high shrink-swell potential in upper 16 to 24 inches.	Poor: poorly drained; seasonal high water table; high organic-matter content in upper 16 to 24 inches; good material below a depth of about 2 to 3½ feet; moderate to high shrink-swell potential.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: less than 6-inch lens of sand or gravel; good source of limestone; seasonal high water table.	Poor: poorly drained; seasonal high water table; high organic-matter content in upper 15 to 24 inches.	Limestone bedrock at a depth of about 1½ to 3½ feet is too porous to hold water; nearly level.	Fair to good compaction; high compressibility and low shear strength in upper part; lower part has fair compaction, low compacted permeability, and low to medium shear strength; limited material available due to limestone bedrock at a depth of about 1½ to 3½ feet.	Poorly drained; seasonal high water table; moderate permeability; tile drainage and open ditch construction difficult due to limestone bedrock at a depth of about 1½ to 3½ feet.	Not needed; nearly level.
Fair below a depth of about 2 feet; dominantly well-graded sand containing some gravel.	Fair to good in upper 1½ to 2 feet, poor below; may be difficult to revegetate borrow area.	Rapid to very rapid permeability; nearly level and gently sloping; too porous to hold water.	Fair to good compaction; low compressibility; medium to high compacted permeability; medium to high susceptibility to piping.	Not needed; somewhat excessively drained.	Subsoil is sandy and gravelly; difficult to vegetate; cuts should be held to a minimum; not needed on level area.
Unsuitable: no sand or gravel.	Good in upper 16 to 24 inches; high organic-matter content; generally poor below.	Some sand lenses and pockets; high organic-matter content in surface layer; moderately slow permeability below a depth of about 3½ to 4½ feet; nearly level to very gently sloping.	Fair compaction and medium to high compressibility in upper 1½ to 2 feet; good compaction and low to medium compressibility below; lower part has low compacted permeability.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Needed in only a few places; soil features favorable; terraces tend to increase wetness.
Unsuitable: no sand or gravel.	Good in upper 2 to 3 feet, poor below.	Moderate permeability in upper 2 to 3 feet, moderately slow below; sand pockets and lenses in some places; nearly level and very gently sloping.	Fair compaction and low to medium compacted permeability in upper 2 to 3 feet, good compaction and low permeability below; medium compressibility; large boulders may be encountered.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability below a depth of 2½ to 3½ feet.	Generally not needed due to topography; soil features favorable.
Fair below a depth of about 2 to 3½ feet; poorly graded or well-graded sand containing some gravel; seasonal-high water table.	Poor below a depth of 2 feet; poorly drained; high organic-matter content in upper 16 to 24 inches; very calcareous; seasonal high water table.	Rapid to very rapid permeability below a depth of about 2 to 3½ feet; some areas subject to flooding; nearly level; too porous to hold water.	Fair to poor compaction; high compressibility and low shear strength in upper part; subsoil has medium to low shear strength, fair to good compaction, and low compacted permeability; substratum has good compaction and medium to high compacted permeability.	Poorly drained; seasonal high water table; moderate permeability; tile placement is difficult in some places due to loose, water-bearing sand.	Not needed due to topography.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Harps: 95	Severe: seasonal high water table; subject to flooding in waterways from concentrated runoff.	Severe: seasonal high water table; high organic-matter content in surface layer; moderate permeability.	Severe: seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 16 to 24 inches; seasonal high water table; moderate to high shrink-swell potential in upper 16 to 24 inches.	Poor: poorly drained; seasonal high water table; high organic-matter content and moderate to high shrink-swell potential in upper 16 to 24 inches.
Hayfield: 726	Moderate: seasonal high water table at a depth of 2 to 4 feet; danger of contamination of wells and streams.	Severe: rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table at a depth of 2 to 4 feet.	Severe: rapid permeability below a depth of about 2½ to 3½ feet; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential.	Fair in upper part, good below a depth of about 3 feet; moderate shrink-swell potential in upper part and none below.
725	Moderate: seasonal high water table at a depth of 2 to 4 feet; danger of contamination of wells and streams.	Severe: rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table at a depth of 2 to 4 feet.	Severe: rapid permeability below a depth of about 2 to 2½ feet; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential.	Fair in upper part, good below a depth of about 2 feet; moderate shrink-swell potential in upper part and none below.
Hoopeston: 173	Severe: seasonal high water table at a depth of 2 to 4 feet; danger of contamination of wells and streams.	Severe: moderately rapid permeability; seasonal high water table at a depth of 2 to 4 feet; some areas subject to flooding.	Severe: moderately rapid permeability; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; some areas are subject to flooding.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; low shrink-swell potential.	Good: low shrink-swell potential; good workability.
Houghton: 621	Very severe: seasonal high water table; subject to ponding; some areas subject to occasional flooding.	Very severe: very high organic-matter content; seasonal high water table; subject to ponding; some areas subject to occasional flooding.	Very severe: very poorly drained; seasonal high water table; subject to ponding; some areas subject to occasional flooding.	Very severe: very poorly drained; seasonal high water table; subject to ponding; very high organic-matter content in upper 4 to 10 feet or more.	Very poor: very high organic-matter content; high compressibility; very low bearing capacity; seasonal high water table.
Kensett: 188	Severe: limestone below a depth of 2 to 3½ feet; seasonal high water table at a depth of 2 to 4 feet; danger of ground water contamination.	Severe: limestone bedrock below a depth of 2 to 3½ feet; seasonal water table at a depth of 2 to 4 feet; danger of ground water contamination.	Severe: limestone bedrock below a depth of 2 to 3½ feet; somewhat poorly drained.	Moderate: limestone bedrock at a depth of 2 to 3½ feet; somewhat poorly drained; moderate shrink-swell potential; high organic-matter content in surface layer.	Poor: somewhat poorly drained; moderate shrink-swell potential; limestone bedrock below a depth of about 2 to 3½ feet limits the amount of available material.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Poor: poorly drained; high organic-matter content in upper 16 to 24 inches; seasonal high water table; very calcareous.	Seasonal high water table; high organic-matter content in surface layer; moderate permeability; nearly level.	Fair to poor compaction, high compressibility, and low shear strength in upper part; lower part has fair to good compaction, low compacted permeability, and medium shear strength.	Poorly drained; seasonal-high water table; moderate permeability.	Not needed due to topography.
Fair below a depth of about 2½ to 3½ feet; dominantly well-graded sand containing some gravel.	Good in upper 3 feet, poor below.	Rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table at a depth of 2 to 4 feet; nearly level; too porous to hold water.	Fair to good compaction and medium compressibility in upper part; good compaction, low compressibility, and high to medium compacted permeability below a depth of about 2½ to 3½ feet.	Somewhat poorly drained; seasonal-high water table at a depth of 2 to 4 feet; tile placement difficult in some places due to loose, water-bearing sands.	Not needed due to topography.
Fair below a depth of about 2 to 2½ feet; dominantly well-graded sand containing some gravel.	Good in upper 2 feet, poor below.	Rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table at a depth of 2 to 4 feet; nearly level; too porous to hold water.	Fair to good compaction and medium compressibility in upper part; good compaction, low compressibility, and high to medium compacted permeability below a depth of about 2 to 2½ feet.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; tile placement is difficult in some places due to loose, water-bearing sand.	Not needed due to topography.
Good for sand: poorly graded sand. Unsuitable for gravel.	Good in upper 2 to 3 feet, poor below.	Rapid permeability below a depth of about 2 to 3½ feet; nearly level; seasonal high water table at a depth of 2 to 4 feet.	Fair to good compaction; low to medium compressibility; medium to high compacted permeability; high to low susceptibility to piping.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; tile placement difficult in some places due to loose, water-bearing sand.	Not needed due to topography.
Unsuitable: no sand or gravel.	Poor: very poorly drained; soil material good when mixed with mineral soil.	Seasonal high water table; very high organic-matter content; depressional and level; dug ponds feasible.	Very poor stability; very high compressibility; very low shear strength; high to medium susceptibility to piping.	Very poorly drained; seasonal high water table; drain tile likely to settle.	Not needed due to topography.
Unsuitable: no sand or gravel; good source of limestone; high seasonal water table at a depth of 2 to 4 feet.	Fair: limestone bedrock below a depth of 24 to 40 inches; high organic-matter content in surface layer.	Limestone bedrock below a depth of 24 to 40 inches is too porous to hold water; nearly level.	Fair to good compaction; medium compressibility; low compacted permeability; limestone bedrock below a depth of 24 to 40 inches.	Somewhat poorly drained; limestone bedrock below a depth of 24 to 40 inches.	Not needed due to topography.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Kenyon: 83, 83B, 83C2.	Moderate to slight: questionable percolation rate; moderately slow permeability below a depth of about 2½ feet; perched water table at a depth of about 2 feet during extended wet periods.	Slight if slope is less than 2 percent, moderate if 2 to 9 percent; sand pockets in some places; moderately slow permeability.	Slight: perched water table at a depth of about 2 feet during extended wet periods; moderately slow permeability below a depth of about 2½ feet.	Slight to moderate: good to fair bearing capacity; well to moderately well drained; perched water table during extended wet periods; seepage in some cuts; moderate shrink-swell potential; high organic-matter content in surface layer.	Good to fair: glacial till is easily compacted to high density; good to fair bearing capacity; high organic-matter content in surface layer; moderate shrink-swell potential.
Kilkenny: 836B, 836B2, 836C2, 836D2.	Severe: moderately slow permeability; 836D2 is strongly sloping.	Moderate if slope is 2 to 9 percent, severe if greater than 9 percent; moderately slow permeability.	Slight: well drained to moderately well drained; moderately slow permeability; silty clay subsoil is difficult to work.	Severe: high shrink-swell potential; well drained and moderately well drained; fair to poor bearing capacity.	Poor: high shrink-swell potential; difficult to work; below a depth of 5 to 7 feet material has moderate shrink-swell potential and is easily compacted to high density.
Klinger: 184	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Moderate: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability; high organic-matter content in surface layer.	Moderate: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained; moderately slowly permeable glacial till.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; high to moderate shrink-swell potential; high organic-matter content in surface layer; fair bearing capacity.	Fair: moderate to high shrink-swell potential in upper 2 to 3 feet; below this the glacial till has moderate shrink-swell potential and is easily compacted to high density; high organic-matter content in surface layer.
Lawler: 226	Moderate: seasonal high water table at a depth of 2 to 4 feet; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table at a depth of 2 to 4 feet.	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential; fair bearing capacity; high organic-matter content in surface layer.	Poor in upper part, good below a depth of about 3 feet; moderate shrink-swell potential in upper part and none below; high organic-matter content in surface layer.
225	Moderate: seasonal high water table at a depth of 2 to 4 feet; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table at a depth of 2 to 4 feet.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential; high organic-matter content in surface layer; fair bearing capacity.	Poor in upper part, good below a depth of about 2 feet; moderate shrink-swell potential in upper part and none below; high organic-matter content in surface layer.
Lester: 236B, 236B2, 236C, 236C2, 236D2, 236E2, 236F.	Slight if slope is less than 5 percent, moderate if 5 to 14 percent, severe if greater than 14 percent; moderate permeability.	Moderate if slope is 2 to 9 percent, severe if greater than 9 percent.	Slight if slope is less than 14 percent, moderate if greater than 14 percent; good workability.	Slight to moderate: good to fair bearing capacity; moderate shrink-swell potential.	Good to fair: easily compacted to high density; good to fair bearing capacity; moderate shrink-swell potential.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Good in upper 1 to 1½ feet, poor below; high organic-matter content in surface layer of 83 and 83B.	Moderately slow permeability; sand pockets and lenses in some places; nearly level to moderately sloping.	Good compaction; low compacted permeability; medium to low compressibility; large boulders may be encountered.	Generally not needed; well and moderately well drained; may have some seepage spots.	Not needed on level areas; exposed glacial till generally has poor workability; wet spots may develop and will benefit from tile drainage; generally smooth topography.
Unsuitable: no sand or gravel.	Fair on 836B, poor on 836B2, 836C2, and 836D2; less than 8 inches of suitable material; high clay content.	Moderately slow permeability; gently sloping to strongly sloping.	Low compacted permeability; medium to high compressibility; fair to poor compaction; difficult to work; high shrink-swell potential.	Not needed; well to moderately well drained.	Difficult to work; irregular topography may require considerable cutting and filling for parallel terraces.
Unsuitable: no sand or gravel.	Good in upper 2 to 3 feet, poor below; high organic matter content in surface layer.	Moderate permeability in upper 2 to 3 feet, moderately slow below; sand pockets and lenses in some places; nearly level and very gently sloping.	Fair compaction and low to medium compacted permeability in upper 2 to 3 feet; lower part has good compaction, low compacted permeability, and medium compressibility; large boulders in places.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability below a depth of about 2½ to 3½ feet.	Generally not needed due to topography; soil features favorable.
Fair below a depth of about 2½ to 3½ feet; dominantly well-graded sand containing some gravel.	Good in upper 2½ to 3 feet, poor below; high organic-matter content in surface layer.	Rapid to very rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table at a depth of 2 to 4 feet; nearly level.	Fair to good compaction and medium compressibility in upper part; good compaction, low compressibility, and high to medium permeability below a depth of about 2½ to 3½ feet.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; tile placement difficult in some places due to loose, water-bearing sand.	Not needed due to topography.
Fair below a depth of about 2 to 2½ feet; dominantly well-graded sand containing some gravel.	Good in upper 2 to 2½ feet, poor below; high organic-matter content in surface layer.	Rapid to very rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table at a depth of 2 to 4 feet; nearly level.	Fair to good compaction and medium compressibility in upper part; good compaction, low compressibility, and high to medium compacted permeability below a depth of about 2 to 2½ feet.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; tile placement difficult in some places due to loose, water-bearing sand.	Not needed due to topography.
Unsuitable: no sand or gravel.	Good on 236 in upper 1 to 1½ feet, fair below; fair on 236B2, 236C, 236C2, 236D2, 236E2, and 236F.	Moderate permeability; sand pockets and lenses in some places; gently sloping to steep.	Good compaction; low compacted permeability; medium to low compressibility.	Not needed; well drained.	Irregular topography which may require considerable cutting and filling for parallel terraces; soil features favorable.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Le Sueur: 325	Severe: seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Moderate: seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Moderate to slight: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained; moderately permeable glacial till.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential; fair to good bearing capacity.	Fair to good: moderate shrink-swell potential; easily compacted to high density; fair to good bearing capacity.
Marsh: 354	Very severe: water table at or near the surface; subject to flooding and ponding.	Very severe: water table at or near the surface; very high organic-matter content; subject to flooding and ponding.	Very severe: water table at or near the surface; subject to flooding and ponding; very high organic-matter content.	Severe: very high organic-matter content; water table at or near the surface; subject to flooding and ponding.	Very poor: very high organic-matter content; high compressibility; very poor bearing capacity; water table at or near the surface.
Marshan:					
152	Severe: seasonal high water table; some areas subject to flooding; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table; danger of contamination of wells and streams; high organic-matter content in surface layer	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; poorly drained; seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table; moderate to high shrink-swell potential.	Poor: moderate to high shrink-swell potential in upper part; high organic-matter content in surface layer; seasonal high water table; good below a depth of about 3 feet.
151	Severe: seasonal high water table; some areas subject to flooding; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table; danger of contamination of wells and streams; high organic-matter content in surface layer.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; poorly drained; seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table; moderate to high shrink-swell potential.	Poor: moderate to high shrink-swell potential in upper part; high organic-matter content in surface layer; seasonal high water table; good below a depth of about 2 feet.
153	Very severe: seasonal high water table; subject to flooding and ponding; danger of contamination of wells and streams.	Very severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; danger of contamination of wells and streams; high organic-matter content in surface layer.	Very severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; poorly drained; seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 14 to 24 inches; moderate to high shrink-swell potential; seasonal high water table.	Poor: moderate to high shrink-swell potential in upper part; high organic-matter content in surface layer; seasonal high water table; good below a depth of about 2½ feet.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Good in upper 1 foot, fair below.	Moderate permeability; sand pockets and lenses in some places; nearly level to very gently sloping.	Good compaction; low compacted permeability; medium to low compressibility.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Not needed due to topography.
Unsuitable: no sand or gravel.	Poor: very poorly drained; soil material good when mixed with mineral soils.	Flat or depressional areas; water table at or near the surface; subject to ponding and flooding; some places suitable for dugout ponds; level and depressional.	Very poor stability; high compressibility; poor compaction; subject to ponding and flooding.	Very poorly drained; difficult to get outlets; subject to ponding and flooding; drain tile likely to settle in some places; generally not feasible to drain.	Not needed due to topography.
Fair below a depth of about 2½ to 3½ feet; dominantly well-graded sand containing some gravel; seasonal high water table.	Fair: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table.	Rapid to very rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table; some areas subject to flooding; dug ponds feasible; nearly level.	Fair to poor compaction, high compressibility, and low shear strength in upper part; medium to low shear strength, fair to good compaction, and low compacted permeability in subsoil; good compaction and medium to high compacted permeability in substratum.	Poorly drained; seasonal high water table; moderate permeability; tile placement is difficult in some places because of loose, water-bearing sand.	Not needed due to topography.
Fair below a depth of about 2 to 2½ feet; dominantly well-graded sand containing some gravel; high water table.	Fair: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table.	Rapid to very rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table; some areas subject to flooding; dug ponds feasible; nearly level.	Fair to poor compaction, high compressibility, and low shear strength in upper part; medium to low shear strength, fair to good compaction, and low compacted permeability in subsoil; good compaction and medium to high compacted permeability in substratum.	Poorly drained; seasonal high water table; moderate permeability; tile placement is difficult in some places because of loose, water-bearing sand.	Not needed due to topography.
Good below a depth of 2½ to 3½ feet; dominantly well-graded sand containing some gravel; seasonal high water table.	Fair: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table.	Rapid to very rapid permeability below a depth of about 2½ to 3 feet; seasonal high water table; subject to flooding and ponding; level and depressional; dug ponds very feasible.	Fair to poor compaction, high compressibility, and low shear strength in upper part; medium to low shear strength, fair to good compaction, and low compacted permeability in subsoil; good compaction and medium to high compacted permeability in substratum.	Poorly drained; seasonal high water table; moderate permeability; tile placement is difficult in some places because of loose, water-bearing sand.	Not needed due to topography.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Maxfield: 382	Severe: seasonal high water table; moderately slow permeability.	Moderate: high organic-matter content in surface layer; seasonal high water table; moderately slow permeability; can be compacted to low permeability.	Severe to moderate: seasonal high water table; poorly drained; moderately slowly permeable glacial till.	Severe: poorly drained; seasonal high water table; high organic-matter content in upper 15 to 24 inches; high shrink-swell potential.	Poor: poorly drained; seasonal high water table; high organic-matter content in surface layer; high shrink-swell potential in upper 2 to 3 feet; glacial till below this has moderate shrink-swell potential and is easily compacted to high density.
Minnetonka: 583	Severe: seasonal high water table; slow permeability.	Moderate: high organic-matter content in surface layer; seasonal high water table; slow permeability.	Severe: seasonal high water table; poorly drained; silty clay subsoil is difficult to work.	Severe: poorly drained; seasonal high water table; high organic-matter content in surface layer; high shrink-swell potential; highly compressible.	Very poor: poorly drained; seasonal high water table; high organic-matter content in surface layer; high shrink-swell potential; difficult to work.
Mixed alluvial land, channeled: C315.	Very severe: subject to flooding; seasonal high water table.	Very severe: subject to flooding; seasonal high water table; variable soil material.	Severe: subject to flooding; seasonal high water table; variable soil material.	Severe: subject to flooding; seasonal high water table; variable soil material.	Good to poor: check each area; seasonal high water table.
Nicollet: 55, 755	Moderate: seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Moderate: seasonal high water table at a depth of 2 to 4 feet; high organic-matter content in surface layer; moderate permeability.	Moderate to slight: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential; fair bearing capacity.	Fair to good: high organic-matter content in upper part; below a depth of about 1½ to 2 feet is easily compacted to high density; fair to good bearing capacity; moderate shrink-swell potential.
*Okoboji: 6, 956 For Harps part of 956, see Harps series.	Very severe: seasonal high water table; slow permeability; subject to ponding.	Severe: subject to ponding; high organic-matter content in surface layer; seasonal high water table; slow permeability.	Very severe: very poorly drained; seasonal high water table.	Severe: very poorly drained; seasonal high water table; high organic-matter content in surface layer; high shrink-swell potential; highly compressible.	Very poor: very poorly drained; seasonal high water table; high organic-matter content in upper 2 to 4 feet; high shrink-swell potential.
Oran: 471	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Moderate to slight: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability; can be compacted to low permeability; sand pockets and lenses in some places.	Moderate: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained; moderately slowly permeable glacial till.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential; fair bearing capacity.	Fair to good: moderate shrink-swell potential; glacial till is easily compacted to high density; fair to good bearing capacity.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Fair: poorly drained; seasonal high water table; suitable material in upper 2 to 3 feet; high organic-matter content in surface layer.	Seasonal high water table; high organic-matter content in surface layer; moderately slow permeability below a depth of about 2½ to 3½ feet; pockets and lenses of sand in some places; nearly level.	Fair to poor compaction; high compressibility and low shear strength in upper 2 to 3 feet; good compaction, low compacted permeability, and medium shear strength in lower part; large boulders in places.	Poorly drained; seasonal high water table; moderately slow permeability.	Terraces not needed due to topography.
Unsuitable: no sand or gravel.	Poor: high clay content; poorly drained; seasonal high water table; high organic-matter content in surface layer.	Seasonal high water table; high organic-matter content in surface layer; slow permeability; nearly level to very gently sloping.	Fair to poor compaction; high compressibility and low shear strength; low compacted permeability; difficult to work; high shrink-swell potential.	Poorly drained; seasonal high water table; slow permeability; tile may need closer spacing than on soils containing less clay.	Not needed due to topography.
Variable: some areas have well graded sand and gravel; some areas have no sand or gravel; seasonal high water table.	Poor: poorly drained; variable soil material ranges from good to unsuitable.	Seasonal high water table; subject to flooding; variable compacted permeability; some ponded areas; high seepage rate in some areas; nearly level.	Soil material is variable; general high organic-matter content in surface layer; variable compaction, compacted permeability, and compressibility; check each site.	Poorly drained; seasonal high water table; variable permeability; difficult to find good outlets; some ponded areas.	Not needed due to topography.
Unsuitable: no sand or gravel.	Good in upper 14 to 24 inches, fair below; high organic-matter content in surface layer.	High organic-matter content in surface layer; moderate permeability; nearly level to very gently sloping; more likely sites on 755 than on 55.	Fair compaction and medium to high compressibility in upper 1½ to 2 feet; good compaction, medium to low compressibility, and low compacted permeability below.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate permeability.	Generally not needed due to topography; more likely on 755 than on 55; soil features favorable.
Unsuitable: no sand or gravel.	Poor: very poorly drained; high organic-matter content in upper 2 to 4 feet; seasonal high water table.	Depressional; very poorly drained; high organic-matter content in surface layer; slow permeability; dug ponds feasible; depressional and level.	Fair to poor compaction; high compressibility and low shear strength; generally difficult to work; high shrink-swell potential.	Very poorly drained; slow permeability; open intakes may be needed to reduce ponding.	Not needed due to topography.
Unsuitable: no sand or gravel.	Good in upper 1 to 1½ feet, poor below.	Moderately slow permeability; sand pockets and lenses in some places; nearly level to very gently sloping.	Good compaction; low compacted permeability; medium to low compressibility; large boulders in places.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Generally not needed due to topography; exposed glacial till has poor workability; generally smooth topography.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Palms: 221, 221B	Very severe: seasonal high water table; 221 is subject to ponding in the uplands and occasional flooding on stream benches and flood plains; 221B is sloping and receives seepage water.	Very severe: very high organic-matter content in upper 16 to 50 inches; seasonal high water table; 221 is subject to ponding in the uplands and occasional flooding on stream benches and flood plains; 221B is sloping and receives seepage water.	Very severe: very poorly drained; seasonal high water table; 221 subject to ponding and flooding.	Very severe: very poorly drained; seasonal high water table; 221 is subject to ponding in the uplands and to occasional flooding on stream benches and flood plains; very high organic-matter content in upper 16 to 50 inches; 221B receives seepage water.	Very poor: very high organic-matter content in upper 16 to 50 inches; very low bearing capacity; seasonal high water table.
Readlyn: 399	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Moderate to slight: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability; can be compacted to low permeability; sand pockets in some places; high organic-matter content in surface layer.	Moderate: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained; moderately slowly permeable glacial till.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderate shrink-swell potential; high organic-matter content in surface layer; fair bearing capacity.	Fair to good: moderate shrink-swell potential; glacial till is easily compacted to high density; good to fair bearing capacity; high organic-matter content in surface layer.
Richwood: 977	Slight: moderate permeability; may be danger of contamination of wells and streams because of sand or gravel below a depth of about 4 to 5 feet.	Moderate: moderate permeability; high organic-matter content in surface layer; difficult to compact to low permeability; danger of contamination of wells and streams.	Severe: sand or gravel; moderately rapid to very rapid permeability below a depth of about 4 to 5 feet.	Slight: well drained; high organic-matter content in surface layer; moderate shrink-swell potential above a depth of 2½ to 3½ feet; moderate to high shrink-swell potential between depths of 1 and 2 feet above sand or gravel; good to fair bearing capacity.	Fair: difficult to compact to high density in upper 4 to 5 feet; moderate shrink-swell potential above a depth of 2½ to 3½ feet and moderate to high shrink-swell potential between depths of 1 and 2 feet above sand or gravel.
Rockton: 213, 213B	Severe: limestone bedrock below a depth of about 2½ to 3½ feet; severe danger of ground water contamination.	Severe: limestone bedrock below a depth of about 2½ to 3½ feet; severe danger of ground water contamination.	Severe: limestone bedrock below a depth of about 2½ to 3½ feet; severe danger of ground water contamination.	Slight: limestone bedrock below a depth of about 2½ to 3½ feet; upper 1 to 3 feet is shattered; soil material has good to fair bearing capacity and moderate shrink-swell potential.	Fair: limestone bedrock below a depth of about 2½ to 3½ feet limits the amount of available material; soil is easily compacted to high density; moderate shrink-swell potential; good to fair bearing capacity; high organic-matter content in surface layer.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Poor: very poorly drained; soil material in upper 16 to 50 inches good when mixed with mineral soil.	Depressional and level and nearly level to gently sloping; seasonal high water table; very high organic-matter content in upper 16 to 50 inches; dug ponds feasible on level areas; ponds on sloping areas may be difficult to seal.	Very high compressibility; poor compaction; very low shear strength; high to medium susceptibility to piping.	Very poorly drained; seasonal high water table; drain tile may settle in some areas.	Not needed due to topography.
Unsuitable: no sand or gravel.	Good in upper 1 to 1½ feet, poor below; high organic-matter content in surface layer.	Moderately slow permeability; sand pockets and lenses in some places; high organic-matter content in surface layer; nearly level to very gently sloping.	Fair compaction and medium to high compressibility in upper 1 to 1½ feet; good compaction, low compacted permeability, and medium to low compressibility below; large boulders in places.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability.	Generally not needed due to topography; exposed glacial till has poor workability; generally smooth topography.
Fair below a depth of about 4 to 5 feet; well-graded to poorly graded sand containing small amounts of gravel.	Good in upper 2½ to 3½ feet, fair to 4 to 5 feet; high organic-matter content in surface layer.	Moderate permeability; high organic-matter content in surface layer; nearly level; sand or gravel below a depth of 4 or 5 feet.	Fair compaction; medium compressibility; medium to low compacted permeability; medium shear strength; medium susceptibility to piping.	Not needed; well drained.	Not needed due to topography.
Unsuitable: no sand or gravel; good source of limestone.	Good in upper 1½ feet, poor below: limestone bedrock below a depth of about 2½ to 3½ feet.	Limestone bedrock below a depth of about 2½ to 3½ feet is too porous to hold water; nearly level and gently sloping.	Relatively shallow depth to limestone bedrock limits the amount of available material; good compaction; low compacted permeability; medium to low compressibility.	Not needed; well drained.	Not needed on 213; on 213B limestone bedrock below a depth of about 2½ to 3½ feet may interfere with construction; other features favorable.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Rockton Continued—214, 214B	Severe: limestone bedrock below a depth of about 1½ to 2½ feet; severe danger of ground water contamination.	Severe: limestone bedrock below a depth of about 1½ to 2½ feet; severe danger of ground water contamination.	Severe: limestone bedrock below a depth of about 1½ to 2½ feet; severe danger of ground water contamination.	Moderate to slight: limestone bedrock below a depth of about 1½ to 2½ feet; upper 1 to 3 feet is shattered; soil material has good to fair bearing capacity and moderate shrink-swell potential.	Poor: limestone bedrock at a depth of about 1½ to 2½ feet limits the amount of available material; soil is easily compacted to high density; moderate shrink-swell potential; good to fair bearing capacity; high organic-matter content in surface layer.
Rolfe: 274	Very severe: seasonal high water table; slow permeability.	Moderate: high organic-matter content in surface layer; seasonal high water table; slow permeability.	Severe: seasonal high water table; very poorly drained; silty clay subsoil is difficult to work.	Poor: very poorly drained; seasonal high water table; high organic-matter content in surface layer; high shrink-swell potential; difficult to work.	Poor: very poorly drained; seasonal high water table; high organic-matter content in surface layer; high shrink-swell potential; difficult to work.
Salida: 73C, 73D, 73F.	Moderate if slope is less than 14 percent, severe if greater than 14 percent; rapid to very rapid permeability; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability; danger of contamination of wells and streams.	Slight if slope is less than 9 percent, moderate if 9 to 18 percent, severe if greater than 18 percent; good bearing capacity; low to no shrink-swell potential; excessively drained.	Good: good bearing capacity; low to no shrink-swell potential; erodible in fills.
Saude: 177, 177B, 177C.	Slight: rapid to very rapid permeability below a depth of about 2 to 2½ feet; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; danger of contamination of wells and streams.	Slight: good bearing capacity and moderate shrink-swell potential in upper 2 to 2½ feet; good bearing capacity and no shrink-swell potential below; high organic-matter content in surface layer; well drained.	Good: below a depth of about 2 to 2½ feet material has good bearing capacity and no shrink-swell potential, above this shrink-swell potential is moderate; high organic-matter content in surface layer.
Schley: 407	Severe: seasonal high water table at a depth of 2 to 4 feet; moderately slow permeability below a depth of about 3½ to 4½ feet.	Moderate: seasonal high water table at a depth of 2 to 4 feet; sand lenses and pockets in some places; moderately slow permeability below a depth of about 3½ to 4½ feet.	Moderate to severe: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained.	Moderate: somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; low to high shrink-swell potential; fair bearing capacity.	Fair to good: moderate to high shrink-swell potential in upper part; moderate to low shrink-swell potential in subsoil; moderate shrink-swell potential in substratum; good compaction.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel; good source of limestone.	Fair: good in upper 1½ feet, poor below; limestone bedrock below a depth of about 1½ to 2½ feet limits availability.	Limestone bedrock below a depth of about 1½ to 2½ feet is too porous to hold water; nearly level and gently sloping.	Relatively shallow depth to limestone bedrock limits the amount of available material; good compaction; low compacted permeability; medium to low compressibility.	Not needed; well drained.	Not needed on 214; on 214B limestone may hinder construction; other features favorable.
Unsuitable: no sand or gravel.	Fair: good in upper 1 foot, poor below; seasonal high water table.	Depressional or nearly level waterway positions; slowly permeable; high organic-matter content in surface layer.	Fair to poor compaction; low compacted permeability; difficult to work; high shrink-swell potential.	Poorly and very poorly drained; seasonal high water table; may need surface intakes for satisfactory tiling.	Not needed due to topography.
Fair: dominantly well-sorted sand and gravel.	Poor: too much sand and gravel.	Rapid to very rapid permeability; gently sloping to very steep; too porous to hold water.	High to medium compacted permeability; good compaction; low compressibility; medium susceptibility to piping.	Not needed; excessively drained.	Generally short slopes and irregular topography; shallow to sand and gravel; difficult to maintain ridge and channel.
Fair below a depth of about 2 to 2½ feet; dominantly well-graded sand with some gravel.	Good in upper 2 feet, poor below a depth of about 2 to 2½ feet; high organic-matter content in surface layer.	Rapid to very rapid permeability below a depth of about 2 to 2½ feet; nearly level to moderately sloping; too porous to hold water.	Good compaction and low compacted permeability in upper 2 to 2½ feet; good compaction, low compressibility, and high to medium compacted permeability below; medium susceptibility to piping.	Not needed; well drained.	Not needed on 177; generally not needed on 177B and 177C due to short slopes; deep cuts expose sand and gravel.
Unsuitable: no sand or gravel.	Good in upper 1 to 2 feet, poor below a depth of about 2 to 3 feet.	Some sand pockets and lenses; moderately slow permeability below a depth of about 3½ to 4½ feet; nearly level to very gently sloping.	Good compaction; low compacted permeability; medium to low compressibility.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Needed in only a few places; soil features favorable; terraces tend to increase wetness.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Shorewood: 855	Severe: slow permeability; seasonal high water table at a depth of 2 to 4 feet.	Slight: seasonal high water table at a depth of 2 to 4 feet; slowly permeable subsoil.	Moderate: seasonal high water table at a depth of 2 to 4 feet; somewhat poorly drained; moderately slow to slow permeability; silty clay subsoil is difficult to work.	Severe: high shrink-swell potential; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; poor bearing capacity.	Poor: high shrink-swell potential; difficult to work; high organic-matter content in surface layer in most places.
Sparta: 41B, 41C	Slight: rapid permeability; danger of contamination of wells and streams.	Severe: rapid permeability; danger of contamination of wells and streams.	Severe: rapid permeability.	Slight: good bearing capacity; low to no shrink-swell potential; loose sand may hinder hauling operations.	Good: good bearing capacity; low to no shrink-swell potential; erodible in fills.
Storden: 62D3, 62E3	Moderate if slope is less than 14 percent, severe if greater than 14 percent; moderate permeability.	Severe: steep slopes; moderate permeability.	Slight if slope is less than 14 percent, moderate if 14 to 18 percent; moderate permeability.	Moderate if slope is less than 14 percent, severe if 14 to 18 percent; good to fair bearing capacity; moderate shrink-swell potential.	Good to fair: easily compacted to high density; good to fair bearing capacity; moderate shrink-swell potential.
Talcot: 559	Severe: seasonal high water table; some areas subject to flooding; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table; danger of contamination of wells and streams; high organic-matter content in surface layer.	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; poorly drained; seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table; moderate to high shrink-swell potential.	Poor in upper part, good below a depth of about 3 feet; moderate to high shrink-swell potential in upper part; high organic-matter content in surface layer; seasonal high water table.
558	Severe: seasonal high water table; some areas subject to flooding; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table; danger of contamination of wells and streams; high organic-matter content in surface layer.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; poorly drained; seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 14 to 24 inches; seasonal high water table; moderate to high shrink-swell potential.	Poor in upper part, good below a depth of about 2 feet; moderate to high shrink-swell potential in upper part; high organic-matter content in surface layer; seasonal high water table.
Terril: 27B	Slight: moderate permeability.	Moderate: moderate permeability; high organic-matter content in surface layer.	Slight to moderate: good workability; may receive some runoff water from upslope; generally low on the landscape.	Moderate: high organic-matter content in upper 2 to 3 feet; well drained; fair bearing capacity; moderate shrink-swell potential.	Poor: high organic-matter content in upper 2 to 3 feet; moderate shrink-swell potential; fair to poor bearing capacity.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Poor: high clay content; high organic-matter content in surface layer in most places.	High organic-matter content in surface layer; slow permeability; nearly level to very gently sloping.	Fair to poor compaction; high compressibility and low shear strength; low compacted permeability; difficult to work; high shrink-swell potential.	Somewhat poorly drained; tile may need closer spacing than on soils with lower clay content.	Needed in only a few places; subsoil difficult to work due to high clay content.
Fair for sand; poorly graded sand. Unsuitable for gravel.	Poor: too much sand.	Rapid permeability; gently and moderately sloping; too porous to hold water.	Fair to good compaction; low compressibility; medium to high compacted permeability; medium to high susceptibility to piping.	Not needed; excessively drained.	Highly erodible; difficult to maintain channel and ridge; medium to high susceptibility to piping.
Unsuitable: no sand or gravel.	Fair: low in organic-matter content; calcareous.	Moderate permeability; sand pockets and lenses in some places; moderately sloping to moderately steep.	Good compaction; low compacted permeability; medium to low compressibility.	Not needed; well drained.	Irregular topography and short slopes; soil features favorable.
Fair below a depth of about 2½ to 3½ feet; dominantly well-graded sand containing some gravel; seasonal high water table.	Fair: poorly drained; calcareous; high organic-matter content in upper 14 to 24 inches; seasonal high water table.	Rapid to very rapid permeability below a depth of about 2½ to 3½ feet; seasonal high water table; some areas subject to flooding; dug ponds feasible; nearly level.	Fair to poor compaction, high com- low shear strength pressibility and in upper part; medium to low shear strength, fair to good compaction, and low compacted permeability in subsoil; good compaction and medium to high compacted permeability in substratum.	Poorly drained; seasonal high water table; moderate permeability; tile placement is difficult in some places because of loose, water-bearing sand.	Not needed due to topography.
Fair below a depth of about 2 to 2½ feet; dominantly well-graded sand containing some gravel; seasonal high water table.	Fair: poorly drained; calcareous; high organic-matter content in upper 14 to 24 inches; seasonal high water table.	Rapid to very rapid permeability below a depth of about 2 to 2½ feet; seasonal high water table; some areas subject to flooding; dug ponds feasible; nearly level.	Fair to poor compaction; high compressibility and low shear strength in upper part; medium to low shear strength, fair to good compaction, and low compacted permeability in subsoil; good compaction and medium to high compacted permeability in substratum.	Poorly drained; seasonal high water table; moderate permeability; tile placement is difficult in some places because of loose, water-bearing sand.	Not needed due to topography.
Unsuitable: no sand or gravel.	Good: high organic-matter content in upper 2 to 3 feet; well drained.	High organic-matter content in upper 2 to 3 feet; moderate permeability; gently sloping.	Fair to poor compaction; high organic matter content in upper 2 to 3 feet; medium to low compacted permeability; medium compressibility.	Not needed; well drained.	Soil features favorable; short slopes are generally on the contour.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
Tilfer: 695	Severe: seasonal high water table; bedrock at a depth of 1½ to 3½ feet; danger of ground water contamination.	Severe: seasonal high water table; bedrock at a depth of 1½ to 3½ feet; high organic-matter content in surface layer; danger of ground water contamination.	Very severe: seasonal high water table; bedrock at a depth of 1½ to 3½ feet; poorly drained.	Severe: poorly drained; high organic-matter content in upper 15 to 24 inches; seasonal high water table; bedrock at a depth of 1½ to 3½ feet.	Poor: poorly drained; seasonal high water table; high organic-matter content in surface layer; high shrink-swell potential in upper 15 to 24 inches; bedrock at a depth of 1½ to 3½ feet.
Turlin Mapped only with Coland soils.	Severe: subject to flooding; seasonal high water table at a depth of 2 to 4 feet.	Severe: subject to flooding; seasonal high water table at a depth of 2 to 4 feet; high organic-matter content in surface layer.	Severe: subject to flooding; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet.	Severe: subject to flooding; somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; high organic-matter content in upper 2 to 3 feet; fair bearing capacity; moderate shrink-swell potential.	Poor: high organic-matter content in upper 2 to 3 feet.
Wacousta: T506	Severe: seasonal high water table.	Severe: seasonal high water table; high organic-matter content in surface layer; moderate permeability.	Severe: seasonal high water table; poorly drained.	Severe: poorly drained; high organic-matter content in upper 16 to 24 inches; seasonal high water table; low bearing capacity; moderate to high shrink-swell potential.	Very poor: high organic-matter content in surface layer; poor bearing capacity; moderate to high shrink-swell potential; seasonal high water table.
Wapsie: 777, 777B, 777C2.	Slight: danger of contamination of wells and streams; rapid to very rapid permeability below a depth of about 2 to 2½ feet.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; danger of contamination of wells and streams.	Severe: rapid to very rapid permeability below a depth of about 2 to 2½ feet; danger of contamination of wells and streams.	Slight: good bearing capacity and moderate shrink-swell potential in upper 2 to 2½ feet; good bearing capacity and no shrink-swell potential below.	Good: good bearing capacity and no shrink-swell potential below a depth of about 2 to 2½ feet; moderate shrink-swell potential above.
Waukee: 178, 178B	Slight: danger of contamination of wells and streams; rapid to very rapid permeability below a depth of about 2½ to 3½ feet.	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet.	Severe: rapid to very rapid permeability below a depth of about 2½ to 3½ feet; danger of contamination of wells and streams.	Slight: good bearing capacity and moderate shrink-swell potential in upper 2½ to 3½ feet; good bearing capacity and no shrink-swell potential below; high organic-matter content in surface layer; well drained.	Good: good bearing capacity and no shrink-swell potential below a depth of about 2½ to 3½ feet; moderate shrink-swell potential above; high organic-matter content in surface layer.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel; good source of limestone; seasonal high water table.	Poor: Poorly drained; calcareous; seasonal high water table; high organic-matter content in upper 15 to 24 inches.	Limestone bedrock at a depth of about 1½ to 3½ feet is too porous to hold water; nearly level.	Fair to poor compaction, high compressibility, and low shear strength in upper part; fair compaction, low compacted permeability, and low to medium shear strength in lower part; amount of material available limited by limestone bedrock at a depth of about 1½ to 3½ feet.	Poorly drained; seasonal high water table; moderate permeability; tile and open-ditch drainage are difficult due to limestone bedrock below a depth of about 1½ to 3½ feet.	Not needed due to topography.
Unsuitable: no sand or gravel.	Good: high organic-matter content in upper 2 to 3 feet; somewhat poorly drained; seasonal high water table at a depth of 2 to 3 feet.	Subject to flooding; high organic-matter content in surface layer; seasonal high water table at a depth of 2 to 4 feet; nearly level; coarse strata below a depth of 4 feet in some places.	Fair to poor compaction; high organic-matter content in upper 2 to 3 feet; medium to low compacted permeability; medium compressibility.	Somewhat poorly drained; seasonal high water table at a depth of 2 to 4 feet; subject to flooding in some areas.	Not needed due to topography.
Unsuitable: no sand or gravel.	Good to fair: calcareous below a depth of about 16 to 24 inches and on surface in some places; high organic-matter content in surface layer.	Seasonal high water table; high organic-matter content in surface layer; moderate permeability; dug ponds may be feasible; nearly level.	Poor compaction; high compressibility; low shear strength; medium compacted permeability.	Poorly drained; seasonal high water table; moderate permeability; difficult to find good outlets in most places.	Not needed due to topography.
Fair below a depth of about 2 to 2½ feet; dominantly well-graded sand and some gravel.	Good in upper 2 feet on 777 and 777B and poor below a depth of about 2 to 2½ feet; good in upper 1 to 1½ feet on 777C2 and poor below a depth of about 2 feet.	Rapid to very rapid permeability below a depth of about 2 to 2½ feet; nearly level to moderately sloping.	Good compaction and low compacted permeability in upper 2 to 2½ feet; good compaction, low compressibility, and high to medium compacted permeability below; medium susceptibility to piping.	Not needed; well drained.	Not needed on 777; generally not needed on 777B and 777C2 due to short slopes; deep cuts expose sand and gravel.
Fair below a depth of about 2½ to 3½ feet; dominantly well-graded sand and some gravel.	Good in upper 2 to 3 feet, poor below; high organic-matter content in surface layer.	Rapid to very rapid permeability below a depth of about 2½ to 3½ feet; nearly level to gently sloping.	Good compaction and low compacted permeability in upper 2½ to 3½ feet; good compaction, low compressibility, and high to medium compacted permeability below; medium to high susceptibility to piping.	Not needed; well drained.	Not needed on 178; generally not needed on 178B due to short slopes; deep cuts expose sand and gravel.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as a source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill [1]	Local roads and streets	Road fill
*Webster: 107, 329— For Nicollet part of 329, see Nicollet series.	Severe: seasonal high water table; subject to flooding in waterways from concentrated runoff.	Severe: seasonal high water table; high organic-matter content in surface layer; moderate permeability.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; high organic-matter content in upper 16 to 24 inches; seasonal high water table; moderate to high shrink-swell potential in upper 16 to 24 inches.	Poor: poorly drained; seasonal high water table; high organic-matter content and moderate to high shrink-swell potential in upper 16 to 24 inches.

[1] Onsite study is needed of the underlying strata and water table to determine the hazards of aquifer pollution and drainage into ground water in landfill deeper than 5 or 6 feet.

interpretations—Continued

Suitability as a source of—Continued		Soil features affecting—			
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of cropland and pasture	Terraces and diversions
Unsuitable: no sand or gravel.	Fair: poorly drained; high organic-matter content in upper 16 to 24 inches; seasonal high water table.	Seasonal high water table; high organic-matter content in surface layer; moderately slow to moderate permeability; nearly level.	Fair to poor compaction, high compressibility, and low shear strength in upper part; fair to good compaction, low compacted permeability, and medium shear strength below.	Poorly drained; seasonal high water table; moderate permeability.	Not needed due to topography.

stone for road construction. Pumping is needed to lower the water table in quarries in Faxon, Kensett, and Tilfer soils (fig. 14).

Bolan, Dickinson, Flagler, Hayfield, Lawler, Marshan, Richwood, Salida, Saude, Sparta, Wapsie, and Waukee soils all formed in sandy material or have sandy material at depths of about 2 to 3 feet. These soils are possible sites for borrow for road construction. However, in Bolan, Dickinson, and Sparta soils the sand is fine-grained and poorly graded and gravel is lacking. Flagler, Hayfield, Lawler, Marshan, Salida, Saude, Wapsie, and Waukee soils are the best source of gravel. In Hayfield, Lawler, and Marshan soils the high water table may interfere with excavation and pumping may be needed.

Table 5 rates the soils of the county as a source of topsoil. Topsoil can be used to promote the growth of vegetation on embankments, in cuts on slopes, and in ditches and as a source of borrow for road construction.

Urban Uses for Soils

This section is mainly for owners of land who plan to put in septic tank filter fields or build homes. It can also be used by land planners, developers, and zoning officials. Table 5 rates the soils for septic tank filter fields and sewage lagoons. A rating of *slight* means that the soil factors are favorable. The soil is relatively free of limitations, or has limitations that are easy to overcome. *Moderate* limitations can be overcome by careful consideration and management. *Severe* limitations can be overcome by extreme management measures. *Very severe* limitations can only be overcome by very extreme management measures.

Figure 14.—**Limestone quarry in Faxon soils needs pumping in order to excavate limestone.**

When homes are built in the county, especially away from established sewer lines, septic tanks and systems of disposing of effluent are needed. The soil characteristics that affect septic tank filter fields are soil permeability, percolation rate, ground water level, flood hazard, natural drainage, landscape position, slope, and depth to bedrock and coarse-textured sand and gravel.

The rate at which effluent moves through a soil depends partly on the texture of the subsoil and underlying material. Water moves faster through coarse-textured sandy and gravelly soils than through fine-textured clayey soils. For an effective filter field the permeability of the soil should be moderate to rapid and the rate of percolation should be at least 1 inch per hour. If there is any doubt about the absorptive ability of the soil at a planned filter field location, a percolation test should be made (*2*, *15*).

If ground water rises to the level of the subsurface tile in the filter field, the soil is so saturated that it will not take the effluent from the septic tank. The effluent may rise to the surface of the ground, giving off bad odors and endangering health. The ground-water table should be at least 4 feet below the surface during the wettest periods for maximum efficiency (*2*). Generally, well-drained soils are satisfactory for these disposal systems, and poorly drained soils are not.

A disposal system for septic tanks should never be on a flood plain or near a stream that is likely to flood. An occasional flooding over the filter field impairs its efficiency, and frequent floods soon destroy its effectiveness. In many areas, local regulations require that the filter field be located 25 to 50 feet from a stream, lake, open ditch, or other watercourse into which unfiltered and contaminated effluent might enter and spread.

Bedrock (fig. 15), clay layers, or other impervious strata should be at depths greater than 4 feet below the bottom of the trench in the filter field so that there is enough soil to filter and purify the effluent. Even more depth is needed if the domestic water supply comes from wells and the bedrock is limestone. Limestone has many cracks, and unfiltered water may seep into the domestic water supply if the soil is not deep enough. Also, a depth greater than 4 feet is needed if the underlying material is sand and gravel. A disposal system works very well in a sandy soil, but where the supply of domestic water comes from a shallow course, effluent may contaminate the water.

If other characteristics of a soil are favorable for the function of filter fields, slopes up to 9 percent are satisfactory. The filter beds are easier to construct and maintain in level areas or on gentle slopes than they are in steeper areas. In steeper areas the effluent may follow the natural drainage lines through the soil or seep out to the surface before it is properly filtered. Tile lines for the system should be placed on the contour to assist in filtering the effluent.

Many communities are using sewage lagoons as a method for disposing of sewage without polluting streams. The soil properties considered are depth to water table (seasonal or year round), permeability,

Figure 15.—**Fractured limestone is too near the surface for filtering and purification of effluent.**

depth to bedrock, slope, texture, organic-matter content, and hazard of flooding.

Residential development and buildings for light industry and commercial use.—It is important to know the soil and slope before constructing any type of residential or industrial building, particularly where basements are to be constructed. Soil characteristics that should be considered are shear strength, shrink-swell potential, compressibility, consolidation characteristics, susceptibility to liquefaction and piping, soil texture and permeability, depth to bedrock, depth to water table (seasonal or permanent), and susceptibility to sliding. Other characteristics to be considered are drainage, flood hazard, landscape position, and slope.

Where there is a seasonal high water table, subsurface drainage is needed to make the soils suitable as sites for buildings. If the water table is close to the surface most of the year, the construction of basements is especially difficult. Both surface and subsurface drainage should be considered. A soil that has a permanent high water table requires a different kind of drainage than one having a seasonal high water table. Soils in rolling areas require still another kind of drainage.

Soils that are periodically wet or frequently flooded (fig. 16) are generally not satisfactory sites for buildings if basements are to be constructed. More suitable are soils that have a water table at greater depths. The depressions are also not favorable because a large amount of fill is needed to improve drainage.

Landscape positions and slopes are important too. Convex slopes are more desirable than concave slopes or drainageway positions. Some slope is desirable, but excess runoff from higher places may need to be diverted away from buildings. In steeper areas, measures to stabilize banks and buildings may be needed.

Bedrock is another feature to be considered. If a basement is to be dug where limestone is close to the surface, the removal of the limestone adds to the cost.

Formation and Classification of the Soils

This section describes the factors of soil formation and relates these factors to the soils in Worth County. It also explains the current system of classification and classifies the soils according to that system.

Factors of Soil Formation

Soil forms through the processes of the environment acting on soil material that is deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (a) the physical and mineralogical composition of the parent material, (b) the climate under which the soil has accumulated and existed since accumulation, (c) the plant and animal life on and in the soil, (d) the relief, or lay of the land, and (e) the length of time the forces of soil formation have acted on the soil material (*3*).

Climate and vegetation are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the changing of parent material into a soil profile. It may be much or little, but some time is required for horizon differentiation. Generally a long period is required for the development of distinct horizons. Man's influence on the soil is an additional important factor.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

The accumulation of parent material is the first step in the formation of a soil. Some of the soils in the county formed as the result of weathering of the bedrock. Most of the soils, however, formed in material that was transported from the site of the parent rock and redeposited at a new location through the action of glacial ice, water, wind, and gravity.

The principal parent materials in Worth County are glacial drift, loess, alluvium, and eolian or wind-deposited sand. Much less extensive parent materials are organic deposits and residuum.

Glacial drift is all rock material transported by glacier ice, all deposits made by glacier ice, and all deposits of dominantly glacial origin made in the sea or in bodies

Figure 16.—**The slightly higher areas of Harcot soils dry first and have a grayish center. These soils have a seasonal high water table.**

of glacial melt water, and it includes glacial till. Glacial till is unsorted sediment in which particles range in size from boulders to clay (*7*).

Glacial till is the most important parent material in the formation of the soils of Worth County. At least twice during the glacial period, continental ice or glaciers moved over the entire county. The last glacier, the Cary Drift (*7*), covered the area to the west of a line that generally runs from the Deer Creek community to the west edge of Northwood and then south to the county line. The record of these ice invasions is contained in the unconsolidated rock material that was deposited by the melting ice and melt water streams.

The older ice sheet, known as the Nebraskan, occurred some 750,000 years ago (*4*). It was followed by the Aftonian interglacial period. The Kansan Glaciation is thought to have started about 500,000 years ago. A more recent glaciation was recognized by Leighton (*5*) as the Iowan substage of the Wisconsin Glaciation, but recent studies of the presence and identification of Iowan glacial till indicate that the conclusions formed from studies made before 1960 are questionable (*8*). Intensive, detailed, geomorphic, stratigraphic work shows that the landscape is a multi-level sequence of erosion surfaces and that many of the levels are cut into Kansan and Nebraskan till. The study by Ruhe et al. (*7*) in the vicinity of Alburnett demonstrated that the Iowa till does not exist, but that an erosion-surface complex does exist in the Iowan region. The Iowan surface is multi-level and is arranged in a series of steps from major drainageways toward bounding divides. The Iowan surface is marked where it cuts Kansan and Nebraskan till by a stone line. The stone line occurs on all levels of the stepped surfaces where they occur, and it passes under the alluvium along the drainageways.

The Cary Glaciation (*7*) occurred between about 13,000 and 14,000 years ago, the time decreasing from the east to the northwest. The evidence for the geological youth of the Cary Glaciation is the lack of deep weathering, the unleached calcareous till at a shallow depth, and the poorly developed surface drainage and many closed depressions.

Bassett, Clyde, Donnan, the dark variant of Donnan, Floyd, Kenyon, Oran, Readlyn, and Schley soils formed in the glacial drift and glacial till on the Iowan erosion surface. A loamy surficial sediment about 12 to 24 inches thick overlies the glacial material and is thicker in the Clyde, Floyd, and Schley soils on the lower concave slopes and in waterways. A stone line or pebble band commonly separates the friable, loamy, surficial sediment from the firm loam or clay loam glacial till. The Donnan and the dark variant of the Donnan soils formed in loamy material and the clayey paleosol derived from glacial till.

Canisteo, Clarion, Harps, Kilkenny, Lester, Le Sueur, Nicollet, Okoboji, Rolfe, Storden, and Webster soils formed in the Cary glacial drift. The Minnetonka, Shorewood, and some of the Kilkenny soils formed in lacustrine deposits within the Cary Drift area.

Loess is a silty material deposited by wind. It consists mostly of silts and clay. It does not contain coarse sand or gravel because those materials were too large to be moved more than a short distance by wind, but it does contain small amounts of fine and very fine sand. The thickness of the loess is about 20 to 40 inches. Loess

covers about 20 percent of Worth County and is confined to the eastern half of the county. Dinsdale, Franklin, Klinger, and Maxfield soils formed in loess and the underlying till.

Alluvium is material that was deposited by waters on the flood plains and benches along the streams and on upland outwash plains. These materials occur as lenses and layers of sand, gravel, silt, and clay. The thickness of alluvial material is variable. In most places along Shellrock and Winnebago Rivers and along Deer Creek and the lower part of Elk Creek the material ranges from 24 inches to about 30 feet in thickness and is underlain by limestone bedrock. Along other streams and on the upland outwash plains most of the alluvial deposits range from 10 to more than 60 feet in thickness.

Some of the alluvial material has been transported only a short distance and has accumulated at the foot of the slope on which it originated. This material is called local alluvium, and it retains many characteristics of the soils in the area from which it was eroded. The Terril soil is the only soil formed in this material.

Calco, Coland, and Turlin soils and loamy alluvial land are on the flood plains.

Flagler, Harcot, Hayfield, Hoopeston, Lawler, Marshan, Saude, Talcot, Wapsie, and Waukee soils on the stream benches and outwash plains formed in moderately coarse to moderately fine textured loamy materials 20 to 40 inches thick underlain by sand or gravel. Richwood soils formed in about 48 to 60 inches of medium textured silty alluvium underlain by sand or gravel on the benches and outwash plains. Wacousta soils formed in medium and moderately fine textured lacustrine deposits on the stream benches. In the Salida soils sandy loam ranging from less than 5 to 15 inches in thickness is underlain by gravelly sand or gravel.

Eolian material is sandy and loamy material deposited by wind. It consists of silts, fine and very fine sand, and a small amount of clay. Most of this material occurs as low mounds or dunes in the uplands and on the stream benches. The sand in these eolian deposits consists largely of quartz, which is highly resistant to weathering. It has not been altered appreciably since it was deposited. Bolan, Dickinson, and Sparta soils formed in this material.

Limestone is the most extensive sedimentary rock in Worth County. With the exception of a few outcrops, it is covered by glacial drift, loess, alluvium, eolian materials, and organic deposits. The thickness of this cover ranges from 20 to 40 inches in soils that are strongly affected by the bedrock, namely, Faxon, Kensett, Rockton, and Tilfer, to an estimated 100 to 250 feet thick in parts of the Cary Drift area. In only a few places the soils influenced by limestone bedrock show evidence of limestone residuum (fig. 17). The water table is only a few feet below the surface in Faxon and Tilfer soils.

Organic deposits consist of plant material that has accumulated in old lakebeds, hillside seepy areas, and drainageways that support a thick growth of water-tolerant plants. Organic soils occupy wet areas in the county where poor drainage has retarded the decay of plant remains that have accumulated over a period of time. In Worth County the thickness of the organic material ranges from 16 inches to more than 10 feet. Houghton muck, Palms muck, and Boots mucky peat formed in these organic deposits.

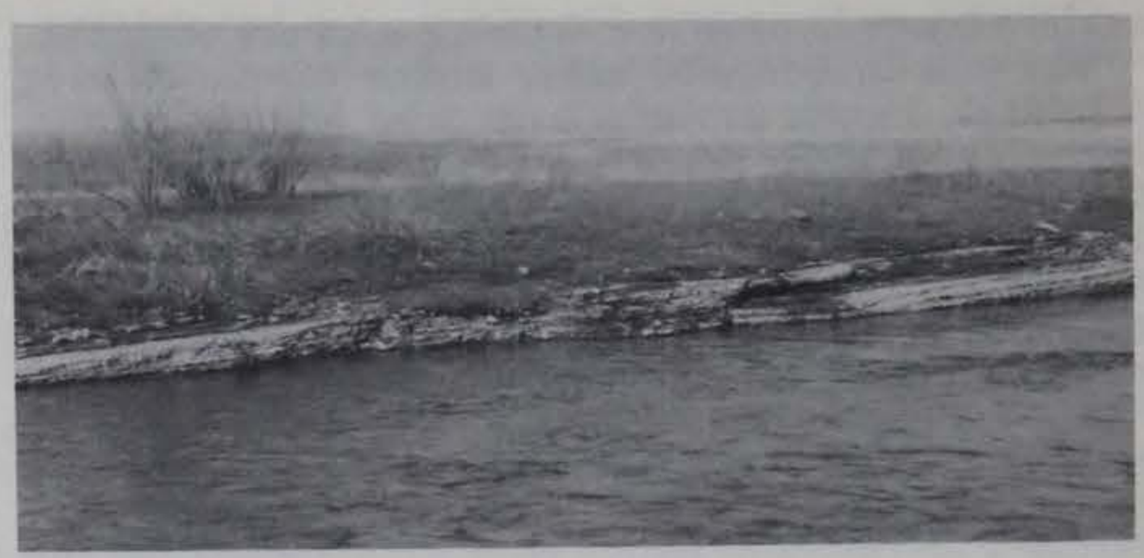


Figure 17.—Limestone bedrock along the Shellrock River.

Climate

According to available evidence, the soils of Worth County formed under the influence of a midcontinental, subhumid climate over a period of at least 5,000 years. Between 5,000 and 16,000 years ago the climate was conducive to the growth of forest vegetation (*6, 16*). The morphology of most of the soils in the county indicates that the climate under which the soils formed is similar to the present one. At present, the climate is fairly uniform throughout the county, but is marked by wide seasonal extremes in temperature. Precipitation is distributed throughout the year.

Climate is a major factor in determining what soils develop from the various plant materials. The rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by the climate. Temperature, rainfall, relative humidity, and length of the frost-free period are important in determining the vegetation.

The influence of the general climate of the region is somewhat modified by the local conditions in or near the forming soil. For example, south-facing dry, sandy slopes have a local climate or microclimate that is warmer and less humid than the average climate or nearby areas. Low-lying, poorly drained areas are wetter and colder than most areas around them. These contrasts account for some of the differences in soils within the same general climatic regions.

Plant and animal life

All living organisms are important to soil formation. These include vegetation, animals, bacteria, and fungi. The vegetation chiefly determines the amount of organic matter, color of the surface layers, and the amount of nutrients in the soil. Animals such as earthworms and burrowing animals help keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

Most of the soils in Worth County formed under prairie grasses or a mixture of prairie grasses and water-tolerant plants. Because the grasses have many roots and tops that have decayed on or in the soil, the soils formed under these conditions have a thick, dark

surface layer. Kenyon and Webster soils are examples.

The soils that formed under timber vegetation have a thinner, lighter surface layer. The organic matter, derived principally from leaves, was deposited only on the surface of the soil. A number of soils in the county formed under prairie grasses and then under forest vegetation. These soils are intermediate between those that formed entirely under grass and those that formed under forest. Lester and Bassett soils are examples.

Clarion and Lester soils are members of a group of soils that formed from the same parent material and under comparable environment except for native vegetation. Differences in native vegetation account for the main differences in morphology and soils of this group.

Relief

Relief is an important cause of differences among soils. Indirectly it influences soil formation through its effect on drainage. In Worth County the relief ranges from level to steep. Many nearly level areas are frequently flooded and have a high or periodically high water table. On stronger slopes, much of the rainfall runs off.

In general the soils in Worth County that formed where the water table was high or periodically high have a dominantly olive-gray subsoil, like Canisteo, Clyde, Marshan, and Webster soils. Those that formed where the water table was below the subsoil have a yellowish-brown subsoil, like Clarion, Kenyon, and Lester soils. The Floyd, Readlyn, Oran, and Lawler soils formed where natural drainage was intermediate, and their subsoils are grayish brown in color and are mottled. Of the soils that formed under prairie, those that have a high water table generally have more organic matter in the surface layer than those that have good natural drainage.

Aspect, as well as gradient, has a significant influence on soil formation. 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. Sparta soils, for example, are excessively drained, even though they are no more than moderately sloping, because they are rapidly permeable.

Maxfield, Klinger, and Dinsdale 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. Maxfield soils are on broad, nearly level upland flats. Klinger soils are on broad, nearly level ridges and long, very gently sloping side slopes. Dinsdale soils are on nearly level ridge crests and gently sloping side slopes. Topography influences the drainage of these soils.

Terril soils are on foot slopes and have properties related to the soils upslope from which they receive sediment.

Time

Time is necessary for the various processes of soil formation to take place. The amount of time necessary ranges from a few days for the formation of soils in fresh alluvial deposits, such as Mixed alluvial land, to thousands of years for the paleosols that make up the subsoil of Donnan soils. In general, if other factors are favorable, with increasing time the texture of the subsoil becomes finer and a greater amount of soluble material is leached out as the soils continue to weather. Exceptions to this rule are soils formed in quartz sand, such as Sparta soils, or in other materials that are resistant to weathering. Such soils do not change much over a long period of time. Other exceptions are steep soils that have a small amount of water infiltration and receive a large amount of runoff. Such soils weather more slowly than soils in stable, less sloping landscapes.

Where organic material, such as trees, has been buried by later deposition through the action of ice, water, or wind, the age of a landscape can be determined by a process known as radiocarbon dating (*9*). The loess that covers the eastern parts of Worth County, in which Dinsdale, Franklin, and Klinger soils formed, is probably about 14,000 to 20,000 years old. The maximum age for these soils on stable summits would be 14,000 years (*6*, *9*). Recent studies by Ruhe et al. (*8*) show that the Iowan erosion surface formed during the deposition of loess. Radiocarbon dates show this to be between 14,000 to 20,000 years ago. The Iowan surface beneath the loess could be as young as 14,000 years, which dates the close of the major loess deposition in Iowa. The surface can also be younger than the loess. The Iowan surface, where covered by loam sediment, is younger than 14,000 years. It is this erosional surface with its loamy and silty overburden in which about 30 percent of the soils in the county formed including Bassett, Dinsdale, Franklin, Kenyon, Klinger, Maxfield, Oran, and Readlyn soils. Floyd, Clyde, and Schley soils are younger, and they are cut in and below these higher lying soils.

Radiocarbon dates indicate some of the soils in Worth County are as young as 2,000 to 6,000 years (*8*). This perhaps accounts for the weakly developed profile in Nicollet, Webster, Floyd, and Clyde soils.

Time is needed for soil formation, but the age of the parent material does not necessarily reflect the true age of the soil formed in that material.

Man's influence on the soil

Important changes take place in the soil when it is drained and cultivated. Some of these changes have little effect on soil productivity; others have drastic effects. Changes caused by erosion generally are the most apparent. On many of the cultivated soils in the county, particularly the steeper slopes, part or all of the original surface layer has been lost through sheet erosion. Even in fields that are not eroded, the compaction of the soil by heavy machinery during cultivation reduces the thickness of the surface layer.

Man has done much to increase productivity of the soils and to reclaim areas not suitable for crops. For example, tile drainage has been installed in many places in the county and has lowered the water table sufficiently to permit rowcropping of these areas. Through the use of commercial fertilizers, man has been able to counteract deficiencies in plant nutrients and make the soil more productive. To date most of the soils in the

eastern half of Worth County and many in the western half have not been seriously affected by erosion. This is mainly because much of this area has low relief.

Man has it within his power to improve the soil for more crop production by good management practices, or to reduce soil fertility and crop production by improper land use.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. Through classification and use of soil maps we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification that are used in detailed soil surveys permit knowledge about the soils to be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison of large areas, such as countries and continents.

The system currently used for classifying soils was adopted for general use by the National Cooperative Soil Survey in 1965 (*11, 13*). The current system is under continual study.[5] Therefore, readers interested in development of this system should search the latest literature available. In table 6, some of the classes in the current system are given for each soil series in the county. The classes in the current system are briefly defined in the following paragraphs.

Orders.—Ten orders are recognized: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate orders are those that tend to give broad climatic groupings of soils. Two exceptions are Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Mollisol).

Four orders are represented in Worth County: Alfisols, Mollisols, Entisols, and Histosols. Alfisols have a clay-enriched B horizon that is high in base saturation. Entisols do not have genetic horizons, or have only the beginning of such horizons. Mollisols have a thick surface layer that has been darkened by organic matter. Histosols formed in organic material. They include soils commonly called muck, peat, organic soil, or bogs.

Suborders.—Each order is divided in suborders, mainly on the basis of soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders reflect mainly the presence or absence of wetness or soil differences resulting from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is Udoll (*ud,* meaning humid, and *oll* from Mollisol).

Great groups.—Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Hapludalf (*hapl,* meaning simple, *ud* for humid, and *alf* for Alfisol).

Subgroups.—Each great group is divided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Mollic Hapludalf.

Families.—Families are established within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. The family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names of texture, mineralogy, and so on that are used as family differentiae. An example is the fine-loamy, mixed, mesic family of Mollic Hapludalfs.

Series.—The series consists of a group of soils that formed in a particular kind of parent material and have genetic horizons that, except for texture of the surface soil, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

New soil series must be established, and concepts of some established series—especially older ones that have been used little in recent years—must be revised in the course of the soil survey program across the county. A proposed new series has tentative status until review of the series concept at state, regional, and national levels of responsibility for soil classification results in a judgment that the new series should be established. It is given the name of a geographic location near the place where it was first observed and mapped. Examples of proposed new series are Bolan, named after a small village in eastern Worth County, and Tilfer, derived from reversing syllables in the name of Fertile, a small town in the southwest corner of Worth County.

General Nature of the County

U.S. Route 65, running north and south, and State Highway 9, running east and west, intersect near the

[5] See the unpublished working document "Selected Chapters from the Unedited text of the Soil Taxonomy" available in the SCS State Office, Des Moines, Iowa.

TABLE 6.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Bassett	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Bolan	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Boots	Euic, mesic	Typic Medihemists	Histosols.
Calco	Fine-silty, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Canisteo	Fine-loamy, mixed (calcareous), mesic	Typic Haplaquolls	Mollisols.
Clarion	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Clyde	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Coland	Fine-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Dickinson	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Dinsdale	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Donnan [1]	Fine-loamy over clayey, mixed, mesic (fine)	Aquollic Hapludalfs	Alfisols.
Donnan, dark variant	Fine-loamy, mixed, mesic	Typic Arguidolls	Mollisols.
Faxon	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Flagler	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Floyd	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Franklin	Fine-silty, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Harcot	Fine-loamy over sandy or sandy skeletal, mixed, mesic	Typic Calciaquolls	Mollisols.
Harps	Fine-loamy, mixed, mesic	Typic Calciaquolls	Mollisols.
Hayfield	Fine-loamy over sandy or sandy skeletal, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Hoopeston	Coarse-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Houghton	Euic, mesic	Typic Medisaprists	Histosols.
Kennsett	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Kenyon [2]	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Kilkenny	Fine-montmorillonitic, mesic	Mollic Hapludalfs	Alfisols.
Klinger	Fine-silty, mixed, mesic	Aquic Argiudolls (Hapludolls)	Mollisols.
Lawler	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Aquic Hapludolls	Mollisols.
Lester	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Le Sueur [3]	Fine-loamy, mixed, mesic	Aquic Argiudolls	Mollisols.
Marshan	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Haplaquolls	Mollisols.
Maxfield	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Minnetonka	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.
Nicollet	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Okoboji	Fine, montmorillonitic, mesic	Cumulic Haplaquolls	Mollisols.
Oran [4]	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Palms	Loamy, mixed, euic, mesic	Terric Medisaprists	Histosols.
Readlyn [5]	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Richwood	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Rockton	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Rolfe	Fine, montmorillonitic, mesic	Typic Argialbolls	Mollisols.
Salida	Sandy-skeletal, mixed, mesic	Entic Hapludolls	Mollisols.
Saude	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Typic Hapludolls	Mollisols.
Schley	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Shorewood [6]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Sparta	Sandy, mixed, mesic	Entic Hapludolls	Mollisols.
Storden	Fine-loamy, mixed (calcareous), mesic	Typic Udorthents	Entisols.
Talcot	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic.	Typic Haplaquolls	Mollisols.
Terrill	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Tilfer	Fine-loamy, mixed (calcareous), mesic	Typic Haplaquolls	Mollisols.
Turlin	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Wacousta	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Wapsie	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic.	Mollic Hapludalfs	Alfisols.
Waukee	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Webster	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.

[1] The upper material contains more silt and less sand than is defined as the range for the Donnan series, and the lower material does not contain enough clay to provide a contrasting texture as defined as the range for the series.

[2] These soils have a thinner B2 horizon and are less acid in the lower part of the 10- to 40-inch control section than is defined as the range for the Kenyon series.

[3] These soils do not have a mollic epipedon and are classified as Udollic Ochraqualfs in the survey area. They are taxadjuncts to the Le Sueur series.

[4] These soils are taxadjuncts to the Oran series. They have less sand in the upper part of the solum than is defined as the range for the series.

[5] These soils are taxadjuncts to the Readlyn series. They have a mollic epipedon that is thinner than is defined as the range for the series.

[6] These soils are taxadjuncts to the Shorewood series. They have a thicker solum and are deeper to free carbonates than is defined as the range for the series.

south-central part of the county at Manly. Route 65 and State Highway 105 intersect near the north-central part of the county at Northwood, the county seat. These routes are connected to all parts of the county by State Route 379 and by good asphalt, crushed rock, or graveled county roads. Every farmstead is on an all-weather road. U.S. Highway 35 runs north and south through the western part of the county about 2 miles east of Hanlontown. Northwood, Kensett, and Manly are on main line railroads. Scheduled airline transportation is available at Mason City, 20 miles south of Northwood. Bus transportation is available on U.S. Highway 65 and State Highway 9 east of Manly. Motor freight lines serve every trading center in the county.

The county is primarily agricultural but has a few industries. Hog-buying stations and grain elevators are in most towns.

Recreation.—Nearly every town and village has a local park. Silver Lake is in the northwest part of the county, and State Line Lake is on the north county line 1 mile east of Emmons in the northwest corner of the county. Rice Lake is along the west edge of the county, 2 miles northwest of Joice. There are several small bodies of water and several marsh areas, including the Iowa Conservation Commission's Elk Creek Marsh, that are suitable for fishing or hunting. All of these, with the exception of Worth County Lake, are west of U.S. Highway 65. Worth County Lake, a former gravel pit, is 2 miles northeast of Kensett. This area and other areas in the county are owned and managed by the Worth County Conservation Board. Hunting, fishing, and, in some places, scenic areas are provided by the Shellrock and Winnebago Rivers and numerous creeks. The landscape along the Shellrock River from Northwood south to the county line is nearly level or gently sloping. Pheasants are hunted throughout the county.

Farming.—The trend in recent years has been toward a decrease in the number of farms in the county and an increase in the size. Livestock farms outnumber all other types, and most of the crops harvested are consumed by livestock on the farms where the crops are grown.

The county had a total of 1,001 farms in 1970, according to the Iowa Farm Census. In the same year 247,288 acres were in farms, and the average size of the farms was 247 acres. Most of the cultivated acreage that is added to a farm consists of areas that were formerly wetlands but have been tile drained and are suitable for cultivated crops. Nearly all of these added lands are depressions. A few small, timbered areas have been cleared for cropland.

According to the same census, 46.7 percent of the land in Worth County was owned by the operator in 1970, and 53.3 percent was tenant operated. The percentage of owner-operated farms is lower than the State average, which was 52.8 in 1970.

Crops.—Except for soybeans, most field crops grown in Worth County are fed to livestock. Some corn is sold as a cash crop, but the amount varies from year to year and depends largely on the price of feeder cattle, the market for fat cattle, the market for hogs, the cash price for corn, and the quality of the corn crop. Although corn is the principal crop, the acreage of soybeans has increased in recent years. Following is the acreage in various crops in Worth County in 1970:

	Acres
Corn for all purposes	77,486
Oats	13,270
Soybeans for beans	62,269
Total all hay	9,614

Livestock.—Beef cattle, dairy cattle, and hogs are the livestock most extensively raised in Worth County. According to the Iowa Annual Farm Census, the principal kinds of livestock raised and sold in 1970 were as follows:

	Number
Milk cows, 2 years or older	2,409
Beef cows, 2 years or older	3,971
Lambs born	2,234
Sows farrowing, fall of 1970	7,302
Sows farrowing, spring of 1971	7,901
Hogs marketed	93,524
Grain-fed cattle marketed	13,009
Grain-fed sheep and lambs marketed	3,829

Relief and Drainage

Most of the landscape to the east of a line from about Deer Creek to Fertile is nearly level and gently sloping. The slopes are generally long and uniform, and a system of drainageways and small streams is well established.

To the west of this line most of the landscape is nearly level, gently undulating, and gently rolling. Some areas are hilly and steep. Other than those adjacent to the major streams, the drainageways are poorly established. There are many land-locked depressions ranging in size from a small fraction of an acre to several hundred acres.

About 35 percent of Worth County has poorly or very poorly drained soils, and about 1.5 percent is Marsh land. Most of the poorly drained and very poorly drained soils have been tiled sufficiently for crop production. With the increased size of farm machinery in recent years, some of the drained areas need more tile to speed up soil drying in spring and following prolonged wet seasons.

Some of the somewhat poorly drained soils have been tile drained. In recent years larger acreages of these soils and some moderately well drained soils are being tile drained.

More detailed information about specific parts of the county is given in the section "General Soil Map."

Most of the county except the southwest corner and the northeast corner are drained by the Shellrock River and its tributaries. The Shellrock runs slightly to the southeast from where it enters the county northwest of Northwood. The largest tributary is Elk Creek, which drains most of the west-central part of the county. Deer Creek runs southeast from where it enters the State at Deer Creek. The Winnebago River, which enters Worth County south of Fertile, flows eastward for about 4 miles and then southeastward out of the county. It has several small tributaries. There are a few small streams flowing southward out of the county between the Shellrock and Winnebago Rivers. The extreme northwest corner of Worth County drains into Minnesota and into

Winnebago County, Iowa, but this is a part of the Winnebago River watershed.

The bottoms of the Shellrock and Winnebago Rivers and the lower end of Deer Creek are limestone bedrock. This bedrock has kept these streams from cutting more deeply into the landscape and has probably caused the low relief in the eastern part of Worth County. Most of the county east of the line from Deer Creek to Fertile is at an elevation between 1,150 and 1,250 feet. To the west of this line most elevations are between 1,250 and 1,400 feet.

Climate [6]

Worth County is located in the northernmost tier of counties, fifth from the northeast corner of the State of Iowa. The county is traversed by the southeastward flowing Shellrock River and, in the southwest part, by the Winnebago River.

The climate at Northwood is representative of Worth County, except for the usual variability in shower activity and the minimum temperature variations of a few to several degrees on calm, clear mornings. Tables 7 and 8 give climate data for the county.

About 70 percent of the annual precipitation falls during the warm half year from April to September. During the warm half year, most of the annual thunderstorms and attendant damaging high winds, hail, or heavy rainfalls are recorded. Thus, erosion is greatest during the growing season. About 17 or 18 days a year have half an inch or more of rain, about 56 days have a tenth of an inch or more, and 95 days have measurable precipitation. Rainfall in a 24-hour period is as much as 3.8 inches once in 5 years, 5.1 inches once in 25 years, and 6.4 inches once in a century.

Snowfall amounts to nearly 45 inches a year, about 15 percent of the annual precipitation. The first 1-inch snowfall usually occurs around November 25 after the first trace about a month earlier. On the average, an inch or more of snow covers the ground 84 days a year. Northwood reported the State's heaviest seasonal snowfalls on record, 90.4 inches in 1908–09 and 113.4 inches during the calendar year 1909.

Ideally, during crop planting the topsoil should be relatively dry but the subsoil should have ample moisture, since rainfall is rarely sufficient to provide the 1 inch per week of moisture necessary for growing corn. About 3 or 4 weeks in 10 have the chance of receiving an inch or more of rainfall a week during the growing season, and the best chance (40–45 percent) occurs late in May and early in June.

Extreme temperatures in Worth County range from –37° F on January 12, 1912, to 107° on July 14, 1936. In about half the years, temperatures drop to as low as –22° and rise to as high as 95°.

On the average, 159 days a year have freezing temperatures and on 15 days temperatures rise to 90° or higher, a threshold beyond that for optimum corn growth. The growing season is normally 153 days.

[6] This section was prepared by PAUL J. WAITE, director, Iowa Weather Service, and climatologist for Iowa, National Weather Service, U.S. Department of Commerce.

Literature Cited

(1) American Association of State Highway Officials. 1961. Standard specifications for highway materials and methods of sampling and testing. Ed. 8, 2 vol., illus.

(2) Bender, William H. 1961. Soils suitable for septic tank fields. USDA Soil Conserv. Serv. Agric. Inf. Bull. 243, 12 pp., illus.

(3) Jenny, Hans. 1941. Factors of soil formation. 281 pp., illus.

(4) Kay, G. F., and Apfel, E. T. 1929. The pre-Illinoian pleistocene geology of Iowa. Iowa Geol. Surv. Annu. Rep. 1928, 34: 1–304, illus.

(5) Leighton, M. M. 1933. The naming of the subdivisions of the Wisconsin glacial age. Sci. (new ser.) vol. 77, p. 168.

(6) Ruhe, R. V. 1956. Geomorphic surfaces and the nature of soils. Soil Sci. 82: 441–455.

(7) _____ 1969. Quaternary landscapes in Iowa. Iowa State Uni. Press, 255 pp., illus.

(8) Dietz, W. P., Fenton, T. E., and Hall, G. F. 1968. Iowan drift problems of northeastern Iowa. Iowa Geol. Surv. Rep. of Invest. 7: 1–40, illus.

(9) Rubin, Meyer, and Scholtes, W. H. 1957. Late pleistocene radiocarbon chronology in Iowa. Am. J. Sci. 255: 671–689, illus.

(10) Schnur, Luther G. 1937. Yield, stand, and volume tables for even-aged upland oak forest. USDA tech. bull. 560, 88 pp., illus. (Reprinted in 1961)

(11) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137: 1027–1034, illus.

(12) United States Department of Agriculture. 1951. Soil survey manual. USDA Handb. 18, 503 pp., illus.

(13) _____ 1960. Soil classification, a comprehensive system, 7th approximation. 265 pp., illus. Suppl. issued March 1967 and Sept. 1968.

(14) United States Department of Defense. 1968. Unified soil classification system for roads, airfields, embankments and foundations. MIL-STD-619B, 30 pp., illus.

(15) United States Department of Health, Education, and Welfare. 1958. Manual of septic-tank practice. Public Health Serv. Publ. No. 526, 85 pp., illus.

(16) Walker, P. H. 1966. Postglacial erosion and environments in relation to landscape and soils on the Cary Drift, Iowa. Res. Bull. 549, Iowa Agric. and Home Econ. Exp. Stn., Iowa State Univ., pp. 838–875, illus.

Glossary

Acidity, soil. See Reaction, soil.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Bench terrace. A shelflike embankment of earth that has a level or nearly level top and a steep or nearly vertical downhill face, constructed along the contour of sloping land or across the slope to control runoff and erosion. The downhill face of the bench may be made of rocks or masonry, or it may be planted to vegetation.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

TABLE 7.—*Temperature and precipitation data*

[Data recorded at Northwood]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average maximum	Average minimum	Average total	One year in 10 will have—		Average number of days with snow cover of 1 inch or more—	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	Inches	Inches	Inches		Inches
January	25	6	43	—20	1.1	0.2	2.2	24	6
February	29	10	46	—14	.9	.1	2.2	21	7
March	39	21	61	— 2	2.1	.9	3.9	17	6
April	57	35	79	21	2.5	1.2	5.4	1	3
May	70	47	87	30	4.2	1.8	7.5	0	----------
June	79	57	92	43	5.2	2.3	8.6	0	----------
July	84	61	93	49	3.5	1.6	6.1	0	----------
August	82	60	92	45	4.3	.6	8.0	0	----------
September	73	50	88	33	3.4	1.1	7.2	0	----------
October	63	39	82	23	1.9	.2	4.8	1	(1)
November	43	24	64	4	1.7	.2	2.6	4	3
December	30	13	49	—13	1.1	.2	1.9	16	4
Year	56	35	95	—22	31.9	22.8	40.5	84	6

[1] Less than one-half inch.

TABLE 8.—*Probability of last freezing temperatures in spring and first in fall*

[Data from Northwood, elevation 1,235 feet]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 8	April 19	April 26	May 8	May 18.
2 years in 10 later than	April 2	April 13	April 21	May 3	May 13.
5 years in 10 later than	March 23	April 2	April 10	April 23	May 4.
Fall:					
1 year in 10 earlier than	October 26	October 18	October 8	September 29	September 19.
2 years in 10 earlier than	October 31	October 23	October 14	October 4	September 24.
5 years in 10 earlier than	November 11	November 3	October 25	October 15	October 4.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Glacial drift (geology). Rock material transported by glacial ice and then deposited; also includes the assorted and unassorted materials deposited by streams flowing from glaciers.

Glacial outwash (geology). Cross-bedded gravel, sand, and silt deposited by melt water as it flowed from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many;* size—*fine*, *medium*, and *coarse;* and contrast— *faint*, *distinctive*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.0 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.6 to 6.0	Moderately alkaline	7.9 to 8.4
Slightly acid	6.1 to 6.5	Strongly alkaline	8.5 to 9.0
		Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Second bottom. The first terrace above the normal flood plain of a stream.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Taxadjunct. Soils that do not fit in a series that has been recognized in the classification system, nor are they recognized in a separate series. These soils strongly resemble soils of a recognized series, but they have one or more characteristics that are outside the range defined for the series.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay,*

silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Other information is given in tables as follows:

Acreage and extent, table 1, page 12.
Predicted yields, table 2, page 67.
Engineering, tables 4 and 5, pages 78 to 109.

Map symbol	Mapping unit	Page	Capability unit		Woodland group	
			Symbol	Page	Number	Page
6	Okoboji silty clay loam, 0 to 1 percent slopes	43	IIIw-1	64	13	71
27B	Terril loam, 2 to 5 percent slopes	55	IIe-1	61	2	68
29	Clarion-Nicollet loams, 1 to 3 percent slopes	17	I-2	61	6	70
41B	Sparta loamy fine sand, 2 to 5 percent slopes	53	IVs-1	65	8	70
41C	Sparta loamy fine sand, 5 to 9 percent slopes	53	IVs-1	65	8	70
55	Nicollet loam, 1 to 3 percent slopes	42	I-2	61	6	70
62D3	Storden loam, 5 to 14 percent slopes, severely eroded	53	IIIe-1	63	10	71
62E3	Storden loam, 14 to 18 percent slopes, severely eroded	53	IVe-1	65	10	71
73C	Salida sandy loam, 2 to 9 percent slopes	49	IVs-1	65	9	70
73D	Salida sandy loam, 9 to 14 percent slopes	49	VIs-1	65	9	70
73F	Salida sandy loam, 14 to 30 percent slopes	49	VIIs-1	66	9	70
83	Kenyon loam, 0 to 2 percent slopes	32	I-1	61	2	68
83B	Kenyon loam, 2 to 5 percent slopes	32	IIe-1	61	2	68
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded	32	IIIe-1	63	2	68
84	Clyde silty clay loam, 0 to 2 percent slopes	19	IIw-1	62	13	71
95	Harps loam, 1 to 3 percent slopes	28	IIw-6	63	13	71
107	Webster silty clay loam, 0 to 2 percent slopes	59	IIw-1	62	13	71
135	Coland silty clay loam, 0 to 2 percent slopes	19	IIw-5	63	13	71
138	Clarion loam, 0 to 2 percent slopes	16	I-1	61	2	68
138B	Clarion loam, 2 to 5 percent slopes	17	IIe-1	61	2	68
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	17	IIIe-1	63	2	68
151	Marshan clay loam, moderately deep, 0 to 2 percent slopes	40	IIw-1	62	13	71
152	Marshan clay loam, deep, 0 to 2 percent slopes	39	IIw-1	62	13	71
153	Marshan clay loam, depressional, 0 to 1 percent slopes	40	IIIw-1	64	13	71
169B	Clarion loam, 2 to 5 percent long slopes	17	IIe-1	61	2	68
171	Bassett loam, 0 to 2 percent slopes	13	I-1	61	2	68
171B	Bassett loam, 2 to 5 percent slopes	13	IIe-1	61	2	68
173	Hoopeston fine sandy loam, 0 to 2 percent slopes	30	IIIs-1	64	12	71
174	Bolan loam, 0 to 2 percent slopes	14	IIs-1	63	3	69
174B	Bolan loam, 2 to 5 percent slopes	14	IIe-3	62	3	69
175	Dickinson fine sandy loam, 0 to 2 percent slopes	20	IIIs-1	64	5	69
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	20	IIIe-3	64	5	69
175C	Dickinson fine sandy loam, 5 to 9 percent slopes	20	IIIe-3	64	5	69
177	Saude loam, 0 to 2 percent slopes	50	IIs-1	63	5	69
177B	Saude loam, 2 to 5 percent slopes	50	IIe-3	62	5	69
177C	Saude loam, 5 to 9 percent slopes	50	IIIe-2	63	5	69
178	Waukee loam, 0 to 2 percent slopes	58	I-1	61	3	69
178B	Waukee loam, 2 to 5 percent slopes	59	IIe-1	61	3	69
184	Klinger silty clay loam, 1 to 3 percent slopes	35	I-2	61	6	70
188	Kensett silt loam, 0 to 2 percent slopes	31	IIs-1	63	6	70
198	Floyd loam, 1 to 3 percent slopes	26	IIw-2	62	6	70
213	Rockton loam, deep, 0 to 2 percent slopes	47	I-1	61	3	69
213B	Rockton loam, deep, 2 to 5 percent slopes	47	IIe-1	61	3	69
214	Rockton loam, moderately deep, 0 to 2 percent slopes	47	IIs-1	63	5	69
214B	Rockton loam, moderately deep, 2 to 5 percent slopes	47	IIe-3	62	5	69
221	Palms muck, 0 to 1 percent slopes	45	IIIw-2	64	14	71
221B	Palms muck, 1 to 4 percent slopes	45	IIIw-2	64	14	71
225	Lawler loam, moderately deep, 0 to 2 percent slopes	35	IIs-1	63	6	70
226	Lawler loam, deep, 0 to 2 percent slopes	35	I-2	61	6	70
235	Coland-Turlin complex, 0 to 2 percent slopes	19	IIw-5	63	13	71
236B	Lester loam, 2 to 5 percent slopes	36	IIe-1	61	2	68

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit		Woodland group	
			Symbol	Page	Number	Page
236B2	Lester loam, 2 to 5 percent slopes, moderately eroded--	36	IIe-1	61	2	68
236C	Lester loam, 5 to 9 percent slopes----------	36	IIIe-1	63	2	68
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded--	37	IIIe-1	63	2	68
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded-	37	IIIe-1	63	2	68
236E2	Lester loam, 14 to 18 percent slopes, moderately eroded----------	37	IVe-1	65	2	68
236F	Lester loam, 18 to 25 percent slopes----------	37	VIe-1	65	4	69
274	Rolfe silt loam, 0 to 1 percent slopes----------	48	IIIw-1	64	13	71
284	Flagler sandy loam, 0 to 2 percent slopes----------	25	IIIs-1	64	5	69
284B	Flagler sandy loam, 2 to 5 percent slopes----------	25	IIIe-3	64	5	69
C315	Mixed alluvial land, channeled----------	41	Vw-1	65	13	71
321	Boots mucky peat, 0 to 1 percent slopes----------	15	IIIw-2	64	14	71
325	Le Sueur loam, 1 to 3 percent slopes----------	38	I-2	61	6	70
329	Webster-Nicollet complex, 1 to 3 percent slopes--------	59	IIw-1	62	13	71
335	Harcot loam, 0 to 2 percent slopes----------	27	IIw-6	63	13	71
354	Marsh----------	38	VIIw-1	66	14	71
377	Dinsdale silty clay loam, 0 to 2 percent slopes--------	21	I-1	61	1	68
377B	Dinsdale silty clay loam, 2 to 5 percent slopes--------	21	IIe-1	61	1	68
382	Maxfield silty clay loam, 0 to 2 percent slopes--------	41	IIw-1	62	13	71
399	Readlyn loam, 1 to 3 percent slopes----------	46	I-2	61	6	70
407	Schley silt loam, 1 to 3 percent slopes----------	51	IIw-2	62	6	70
471	Oran silt loam, 1 to 3 percent slopes----------	44	I-2	61	6	70
T506	Wacousta silt loam, benches, 0 to 2 percent slopes-----	57	IIw-1	62	13	71
507	Canisteo silty clay loam, 0 to 2 percent slopes--------	16	IIw-1	62	13	71
558	Talcot clay loam, moderately deep, 0 to 2 percent slopes----------	54	IIw-1	62	13	71
559	Talcot clay loam, deep, 0 to 2 percent slopes----------	54	IIw-1	62	13	71
583	Minnetonka silty clay loam, 1 to 3 percent slopes------	41	IIw-3	62	13	71
621	Houghton muck, 0 to 1 percent slopes----------	30	IIIw-2	64	14	71
638B2	Clarion-Storden loams, 2 to 5 percent slopes, moderately eroded----------	17	IIe-1	61	10	71
638C2	Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded----------	17	IIIe-1	63	10	71
651	Faxon silty clay loam, 0 to 2 percent slopes----------	24	IIIw-3	64	13	71
695	Tilfer silty clay loam, 0 to 2 percent slopes----------	56	IIIw-3	64	13	71
706	Donnan silt loam, dark variant, 0 to 2 percent slopes--	23	IIw-4	62	11	71
706B	Donnan silt loam, dark variant, 2 to 5 percent slopes--	23	IIe-2	62	11	71
725	Hayfield loam, moderately deep, 0 to 2 percent slopes--	29	IIs-1	63	6	70
726	Hayfield loam, deep, 0 to 2 percent slopes----------	29	I-2	61	6	70
733	Calco silty clay loam, loamy substratum, 0 to 2 percent slopes----------	15	IIw-5	63	13	71
755	Nicollet loam, 1 to 3 percent long slopes----------	42	I-2	61	6	70
761	Franklin silt loam, 1 to 3 percent slopes----------	27	I-2	61	6	70
777	Wapsie loam, 0 to 2 percent slopes----------	57	IIs-1	63	5	69
777B	Wapsie loam, 2 to 5 percent slopes----------	58	IIe-3	62	5	69
777C2	Wapsie loam, 5 to 9 percent slopes, moderately eroded--	58	IIIe-2	63	5	69
782	Donnan silt loam, 0 to 2 percent slopes----------	22	IIw-4	62	11	71
782B	Donnan silt loam, 2 to 5 percent slopes----------	22	IIe-2	62	11	71
782C2	Donnan silt loam, 5 to 9 percent slopes, moderately eroded----------	22	IVe-2	65	11	71
836B	Kilkenny silty clay loam, 2 to 5 percent slopes--------	33	IIe-1	61	7	70
836B2	Kilkenny silty clay loam, 2 to 5 percent slopes, moderately eroded----------	33	IIe-1	61	7	70
836C2	Kilkenny silty clay loam, 5 to 9 percent slopes, moderately eroded----------	34	IIIe-1	63	7	70
836D2	Kilkenny silty clay loam, 9 to 14 percent slopes, moderately eroded----------	34	IVe-2	65	7	70
855	Shorewood silty clay loam, 1 to 3 percent slopes-------	52	IIw-4	62	7	70
956	Okoboji-Harps complex, 0 to 3 percent slopes----------	43	IIIw-1	64	13	71
977	Richwood silt loam, 0 to 2 percent slopes----------	46	I-1	61	1	68

☆ U.S. GOVERNMENT PRINTING OFFICE: 1976— 596-119/28

WORTH COUNTY, IOWA

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads

- Divided
- Good motor
- Poor motor
- Trail

Highway markers

- National Interstate
- U. S.
- State or county

Railroads

- Single track
- Multiple track
- Abandoned

Bridges and crossings

- Road
- Trail
- Railroad
- Ferry — FY
- Ford — FORD
- Grade
- R. R. over
- R. R. under

Buildings

School

Church

Mine and quarry — QU.

Gravel pit — G.P.

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line

- Perennial
- Intermittent

Streams, single-line

- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canal or ditch, single-line, irrigation

Lakes and ponds

- Perennial — water, w
- Intermittent — int

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments

- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

Soil boundary and symbol — Dx

Gravel

Stoniness
- Stony
- Very stony

Borrow area — B.A.

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Made land

Severely eroded spot

Blowout, wind erosion

Gully

Limestone outcrop, ½ to 2 acres

Soil sample site

Small spot of Gray Clay at depths of 20–36 inches, ½ to 1 acre

Calcareous less than 2 acres

Muck less than 2 acres

Small hump of well drained soils less than 2 acres

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

IOWA AGRICULTURAL AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

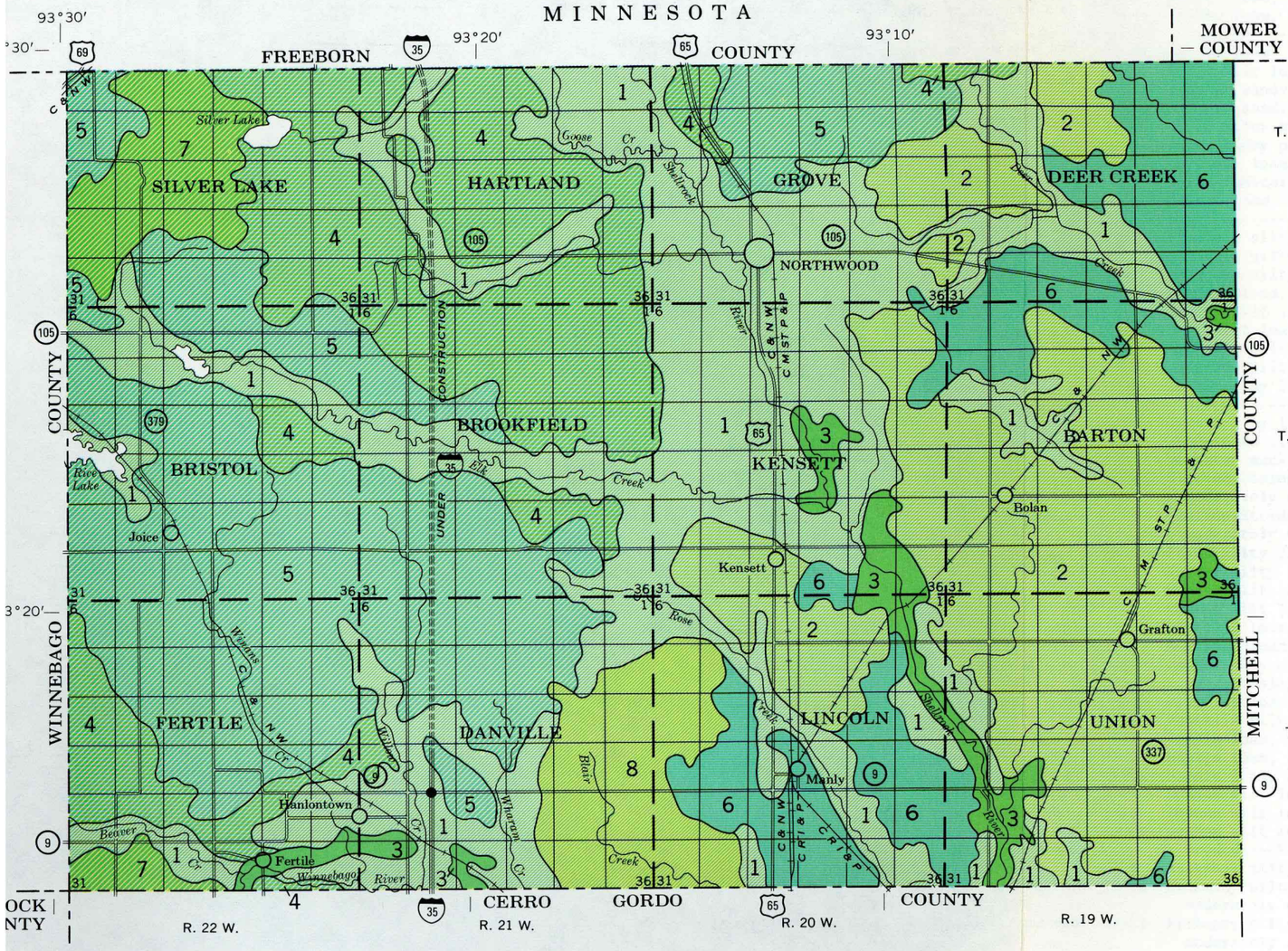
GENERAL SOIL MAP

WORTH COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 4 Miles

N



SOIL ASSOCIATIONS

1 — Marshan-Saude-Lawler association: Nearly level to moderately sloping or gently rolling, poorly drained to well-drained soils that formed in loamy alluvial sediment underlain by sandy and gravelly sediment; on stream benches and uplands

2 — Maxfield-Klinger-Franklin association: Nearly level and very gently sloping, poorly drained and somewhat poorly drained soils that formed in loess and the underlying glacial till; on uplands

3 — Rockton-Faxon association: Nearly level to gently sloping, well-drained and poorly drained soils that formed in 20 to 40 inches of loamy glacial sediment over limestone bedrock; on stream benches and uplands

4 — Lester-Webster-Nicollet association: Nearly level to steep, well-drained to poorly drained soils that formed in loamy glacial till and glacial sediment, on uplands

5 — Clarion-Webster-Nicollet association: Nearly level to gently rolling, well-drained to poorly drained soils that formed in loamy glacial till and glacial sediment; on uplands

6 — Clyde-Kenyon-Oran association: Nearly level to moderately sloping, well-drained to poorly drained soils that formed in loamy sediment and the underlying glacial sediment or glacial till; on uplands

7 — Kilkenny-Minnetonka association: Nearly level to rolling, well-drained to poorly drained soils that formed mainly in silty lacustrine sediment; on uplands

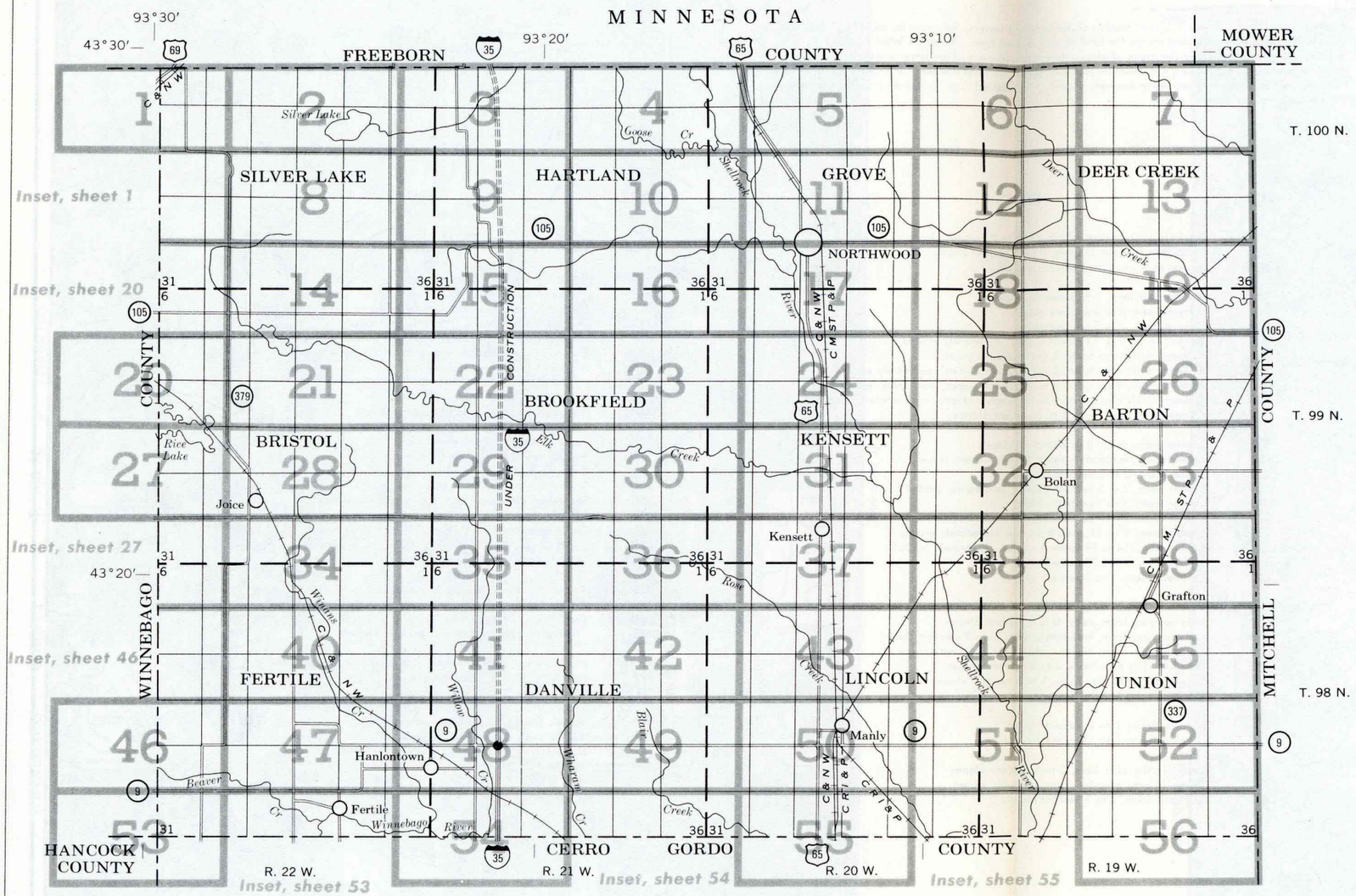
8 — Clarion-Webster association: Nearly level to gently sloping, well-drained to poorly drained soils that formed in glacial till and glacial sediment; dominantly long slopes on uplands

Compiled 1973

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

lined on this map consists of e kind of soil. The map is thus neral planning rather than a basis on the use of specific tracts.



INDEX TO MAP SHEETS

WORTH COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 4 Miles

N

SECTIONALIZED TOWNSHIP

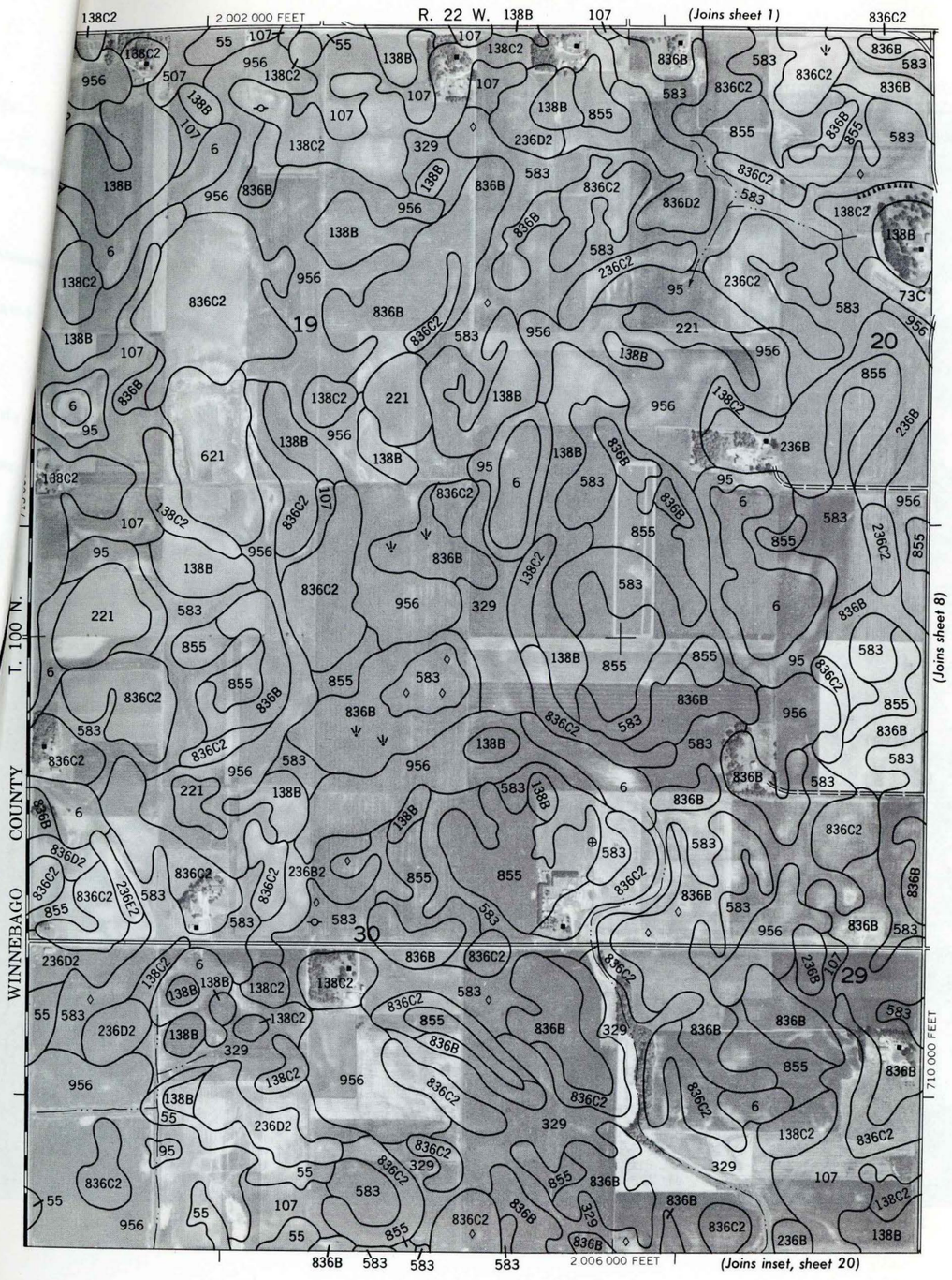
6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

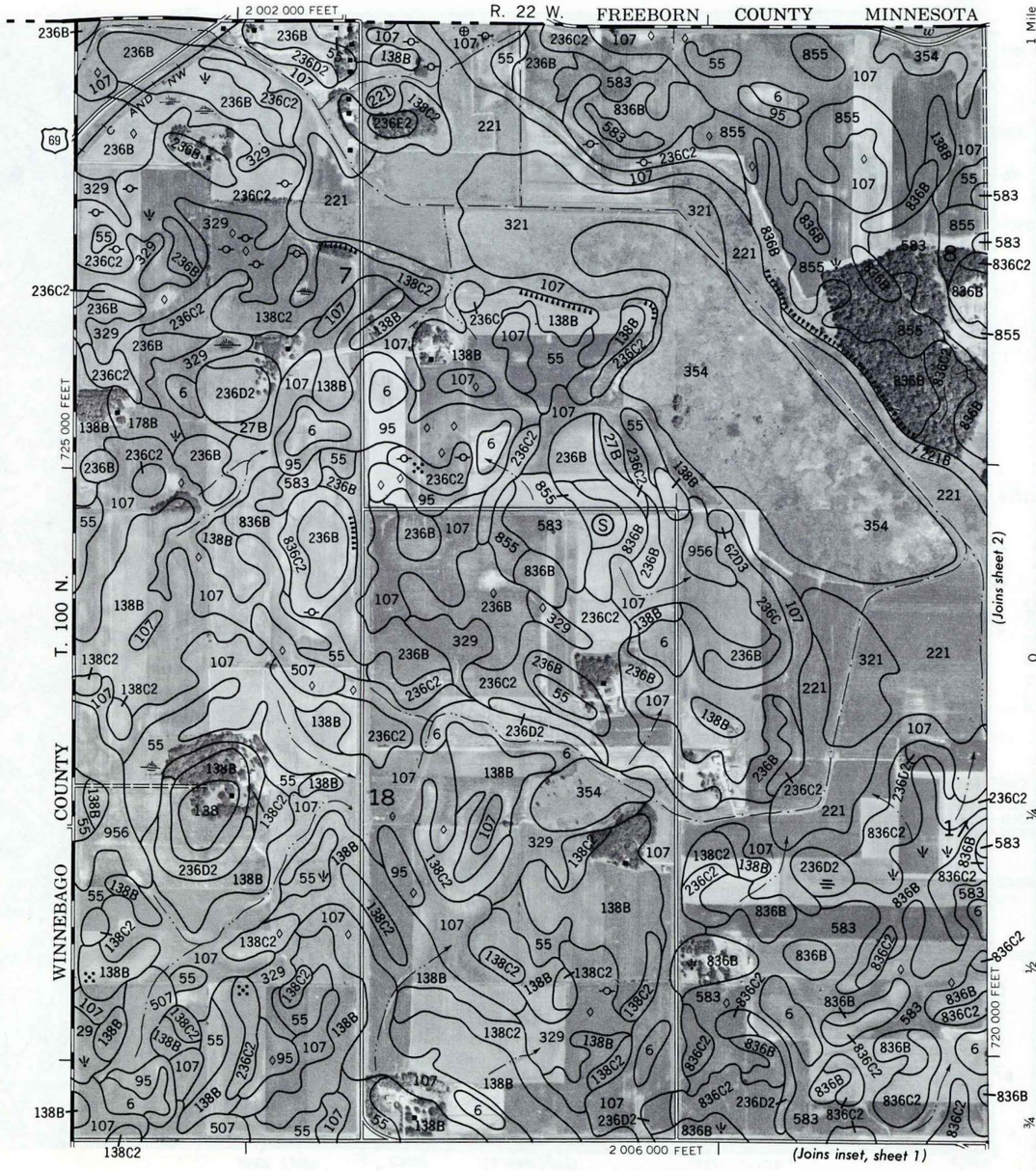
Symbols consist of numbers or a combination of numbers and letters, for example, 84, 174, 175B, 638C2. The 1, 2, or 3 digit number designates the kind of soil or land type. A capital letter B, C, D, E, or F following a number indicates the class of slope. Symbols without a slope letter are those of nearly level soils or land types that have a considerable range of slope. A final number 2 or 3 in the symbol indicates that the soil is moderately eroded or severely eroded. The capital C or T used as a prefix indicates a channeled phase or a bench phase.

SYMBOL	NAME
171	Bassett loam, 0 to 2 percent slopes
171B	Bassett loam, 2 to 5 percent slopes
174	Bolan loam, 0 to 2 percent slopes
174B	Bolan loam, 2 to 5 percent slopes
321	Boots mucky peat, 0 to 1 percent slopes
733	Calco silty clay loam, loamy substratum, 0 to 2 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes
138	Clarion loam, 0 to 2 percent slopes
138B	Clarion loam, 2 to 5 percent slopes
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded
169B	Clarion loam, 2 to 5 percent long slopes
29	Clarion-Nicollet loams, 1 to 3 percent slopes
638B2	Clarion-Storden loams, 2 to 5 percent slopes, moderately eroded
638C2	Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded
84	Clyde silty clay loam, 0 to 2 percent slopes
135	Coland silty clay loam, 0 to 2 percent slopes
235	Coland-Turlin complex, 0 to 2 percent slopes
175	Dickinson fine sandy loam, 0 to 2 percent slopes
175B	Dickinson fine sandy loam, 2 to 5 percent slopes
175C	Dickinson fine sandy loam, 5 to 9 percent slopes
377	Dinsdale silty clay loam, 0 to 2 percent slopes
377B	Dinsdale silty clay loam, 2 to 5 percent slopes
782	Donnan silt loam, 0 to 2 percent slopes
782B	Donnan silt loam, 2 to 5 percent slopes
782C2	Donnan silt loam, 5 to 9 percent slopes, moderately eroded
706	Donnan silt loam, dark variant, 0 to 2 percent slopes
706B	Donnan silt loam, dark variant, 2 to 5 percent slopes
651	Faxon silty clay loam, 0 to 2 percent slopes
284	Flagler sandy loam, 0 to 2 percent slopes
284B	Flagler sandy loam, 2 to 5 percent slopes
198	Floyd loam, 1 to 3 percent slopes
761	Franklin silt loam, 1 to 3 percent slopes
335	Harcot loam, 0 to 2 percent slopes
95	Harps loam, 1 to 3 percent slopes
726	Hayfield loam, deep, 0 to 2 percent slopes
725	Hayfield loam, moderately deep, 0 to 2 percent slopes
173	Hoopeston fine sandy loam, 0 to 2 percent slopes
621	Houghton muck, 0 to 1 percent slopes
188	Kensett silt loam, 0 to 2 percent slopes
83	Kenyon loam, 0 to 2 percent slopes
83B	Kenyon loam, 2 to 5 percent slopes
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded
836B	Kilkenny silty clay loam, 2 to 5 percent slopes
836B2	Kilkenny silty clay loam, 2 to 5 percent slopes, moderately eroded
836C2	Kilkenny silty clay loam, 5 to 9 percent slopes, moderately eroded
836D2	Kilkenny silty clay loam, 9 to 14 percent slopes, moderately eroded
184	Klinger silty clay loam, 1 to 3 percent slopes
226	Lawler loam, deep, 0 to 2 percent slopes
225	Lawler loam, moderately deep, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
236B2	Lester loam, 2 to 5 percent slopes, moderately eroded
236C	Lester loam, 5 to 9 percent slopes
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded
236E2	Lester loam, 14 to 18 percent slopes, moderately eroded
236F	Lester loam, 18 to 25 percent slopes
325	Le Sueur loam, 1 to 3 percent slopes
354	Marsh
152	Marshan clay loam, deep, 0 to 2 percent slopes
151	Marshan clay loam, moderately deep, 0 to 2 percent slopes
153	Marshan clay loam, depressional, 0 to 1 percent slopes
382	Maxfield silty clay loam, 0 to 2 percent slopes
583	Minnetonka silty clay loam, 1 to 3 percent slopes
C315	Mixed alluvial land, channeled
55	Nicollet loam, 1 to 3 percent slopes
755	Nicollet loam, 1 to 3 percent long slopes
6	Okoboji silty clay loam, 0 to 1 percent slopes
956	Okoboji-Harps complex, 0 to 3 percent slopes
471	Oran silt loam, 1 to 3 percent slopes
221	Palms muck, 0 to 1 percent slopes
221B	Palms muck, 1 to 4 percent slopes
399	Readlyn loam, 1 to 3 percent slopes
977	Richwood silt loam, 0 to 2 percent slopes
213	Rockton loam, deep, 0 to 2 percent slopes
213B	Rockton loam, deep, 2 to 5 percent slopes
214	Rockton loam, moderately deep, 0 to 2 percent slopes
214B	Rockton loam, moderately deep, 2 to 5 percent slopes
274	Rolfe silt loam, 0 to 1 percent slopes
73C	Salida sandy loam, 2 to 9 percent slopes
73D	Salida sandy loam, 9 to 14 percent slopes
73F	Salida sandy loam, 14 to 30 percent slopes
177	Saude loam, 0 to 2 percent slopes
177B	Saude loam, 2 to 5 percent slopes
177C	Saude loam, 5 to 9 percent slopes
407	Schley silt loam, 1 to 3 percent slopes
855	Shorewood silty clay loam, 1 to 3 percent slopes
41B	Sparta loamy fine sand, 2 to 5 percent slopes
41C	Sparta loamy fine sand, 5 to 9 percent slopes
62D3	Storden loam, 5 to 14 percent slopes, severely eroded
62E3	Storden loam, 14 to 18 percent slopes, severely eroded
559	Talcot clay loam, deep, 0 to 2 percent slopes
558	Talcot clay loam, moderately deep, 0 to 2 percent slopes
27B	Terril loam, 2 to 5 percent slopes
695	Tilfer silty clay loam, 0 to 2 percent slopes
T506	Wacousta silt loam, benches, 0 to 2 percent slopes
777	Wapsie loam, 0 to 2 percent slopes
777B	Wapsie loam, 2 to 5 percent slopes
777C2	Wapsie loam, 5 to 9 percent slopes, moderately eroded
178	Waukee loam, 0 to 2 percent slopes
178B	Waukee loam, 2 to 5 percent slopes
107	Webster silty clay loam, 0 to 2 percent slopes
329	Webster-Nicollet complex, 1 to 3 percent slopes

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

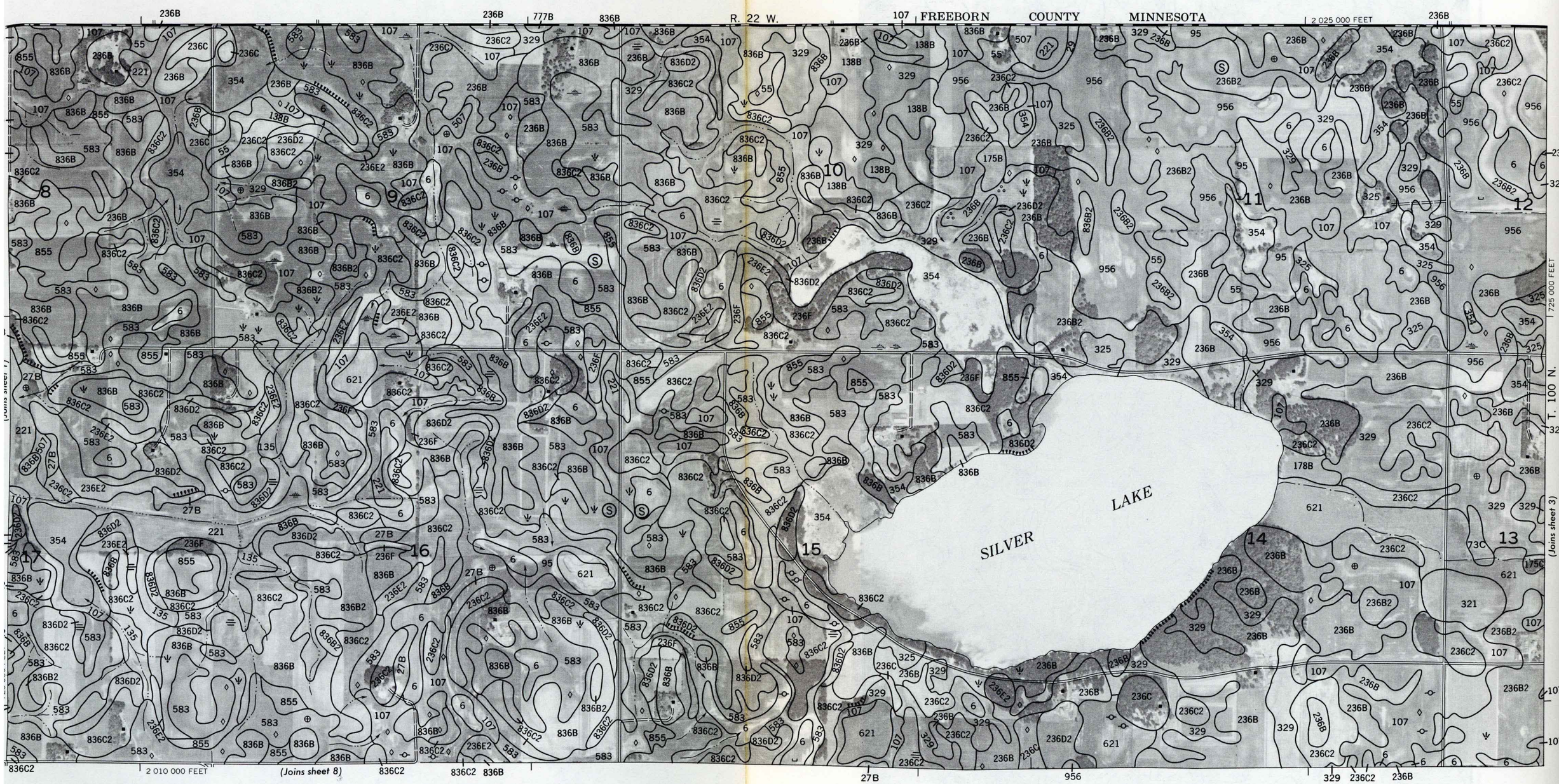


4 000 AND 5 000-FOOT GRID TICK INTERVALS



4 000 AND 5 000-FOOT GRID TICK INTERVALS

tobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
roximate and based on Iowa coordinate system, north zone.

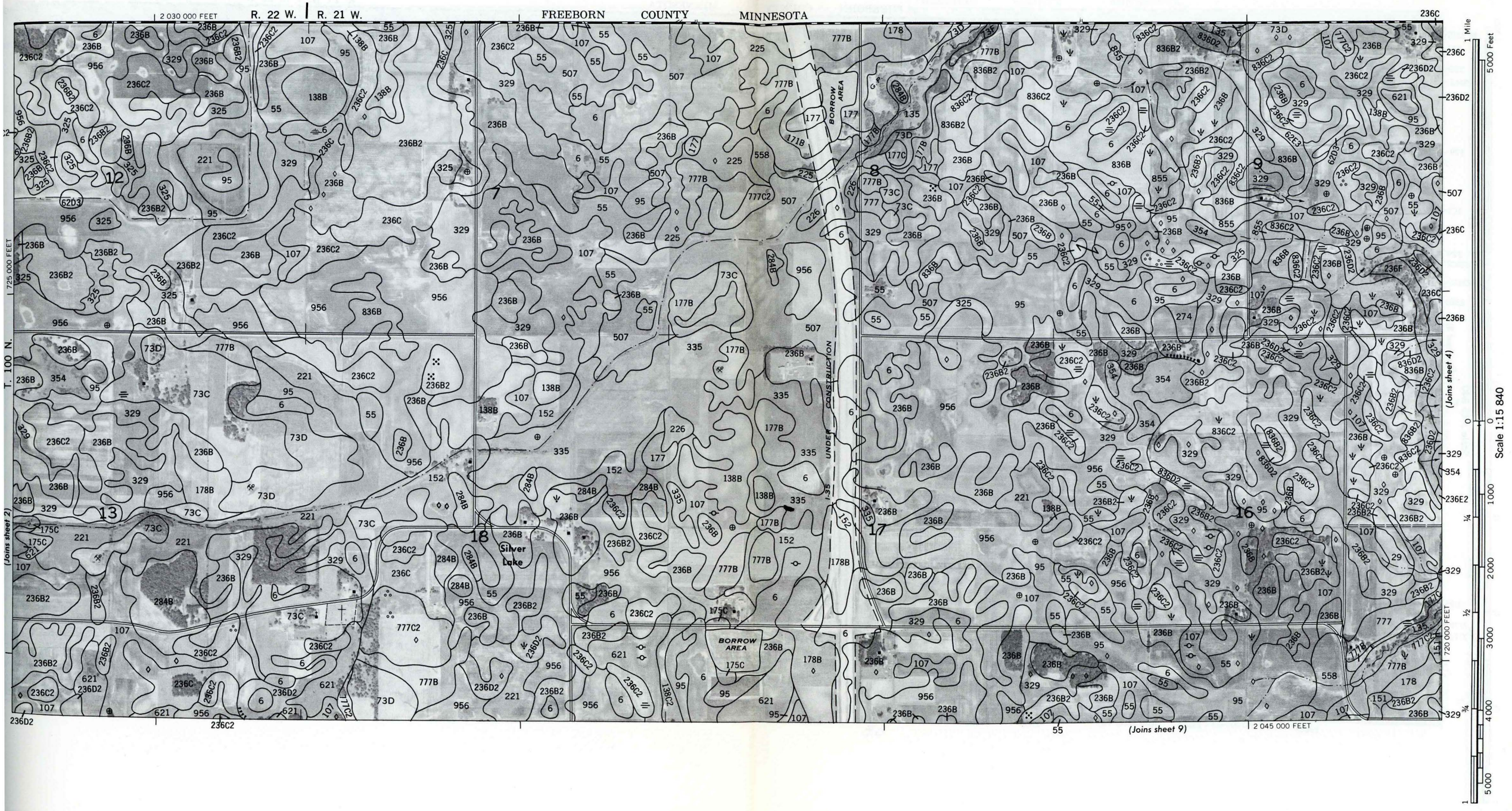


Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NO. 2

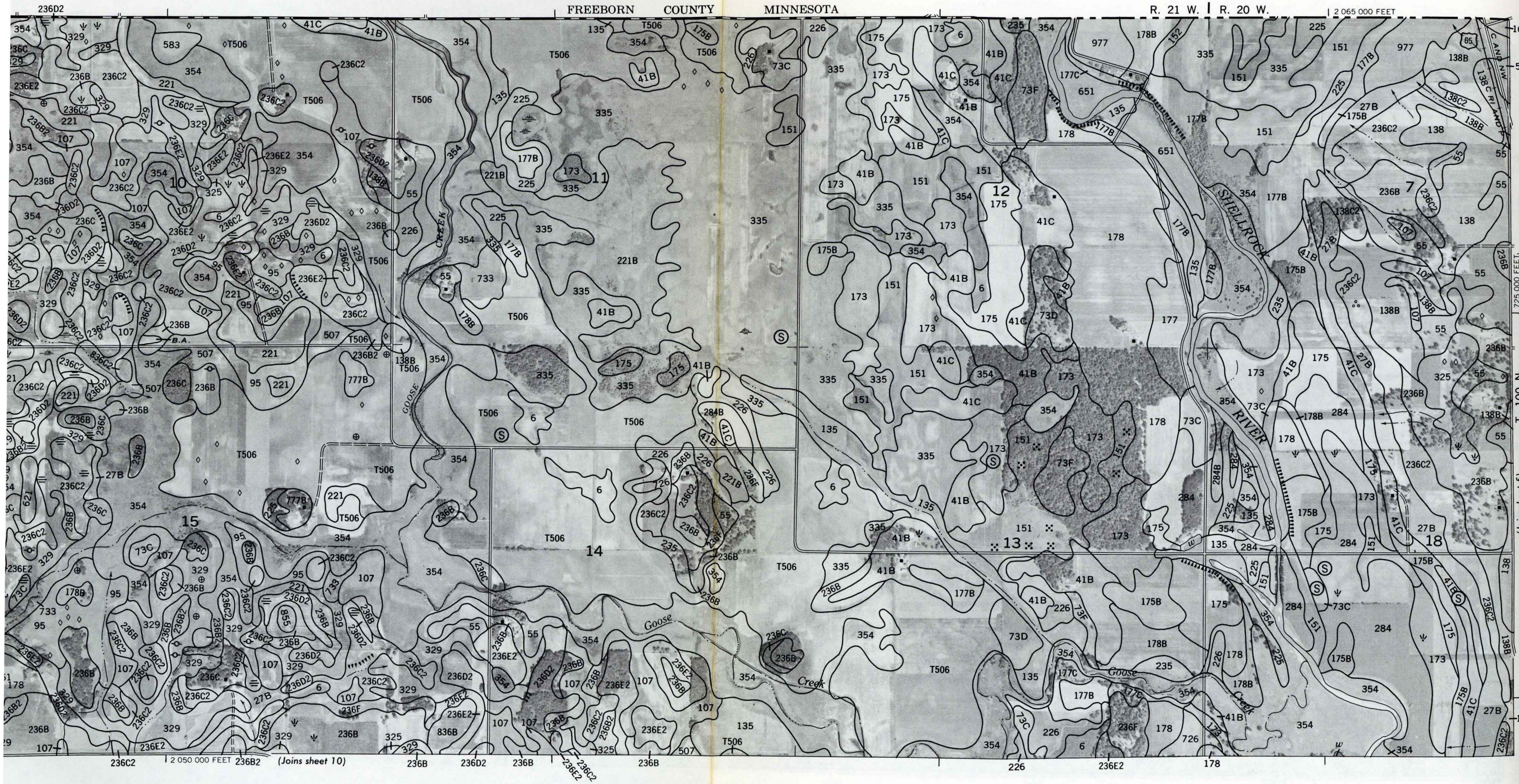


N

1 Mile
5000 Feet

Scale 1:15 840

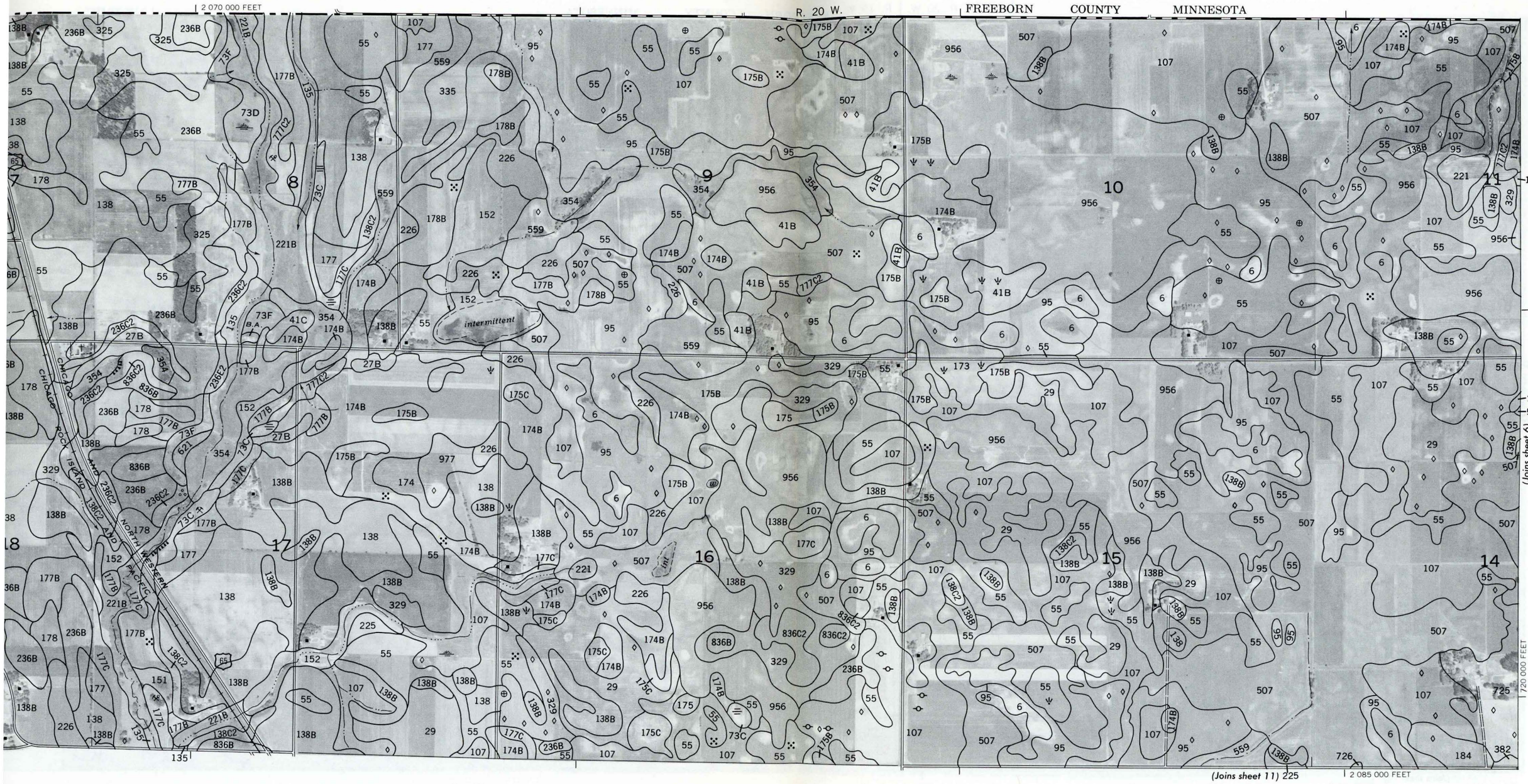
Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.



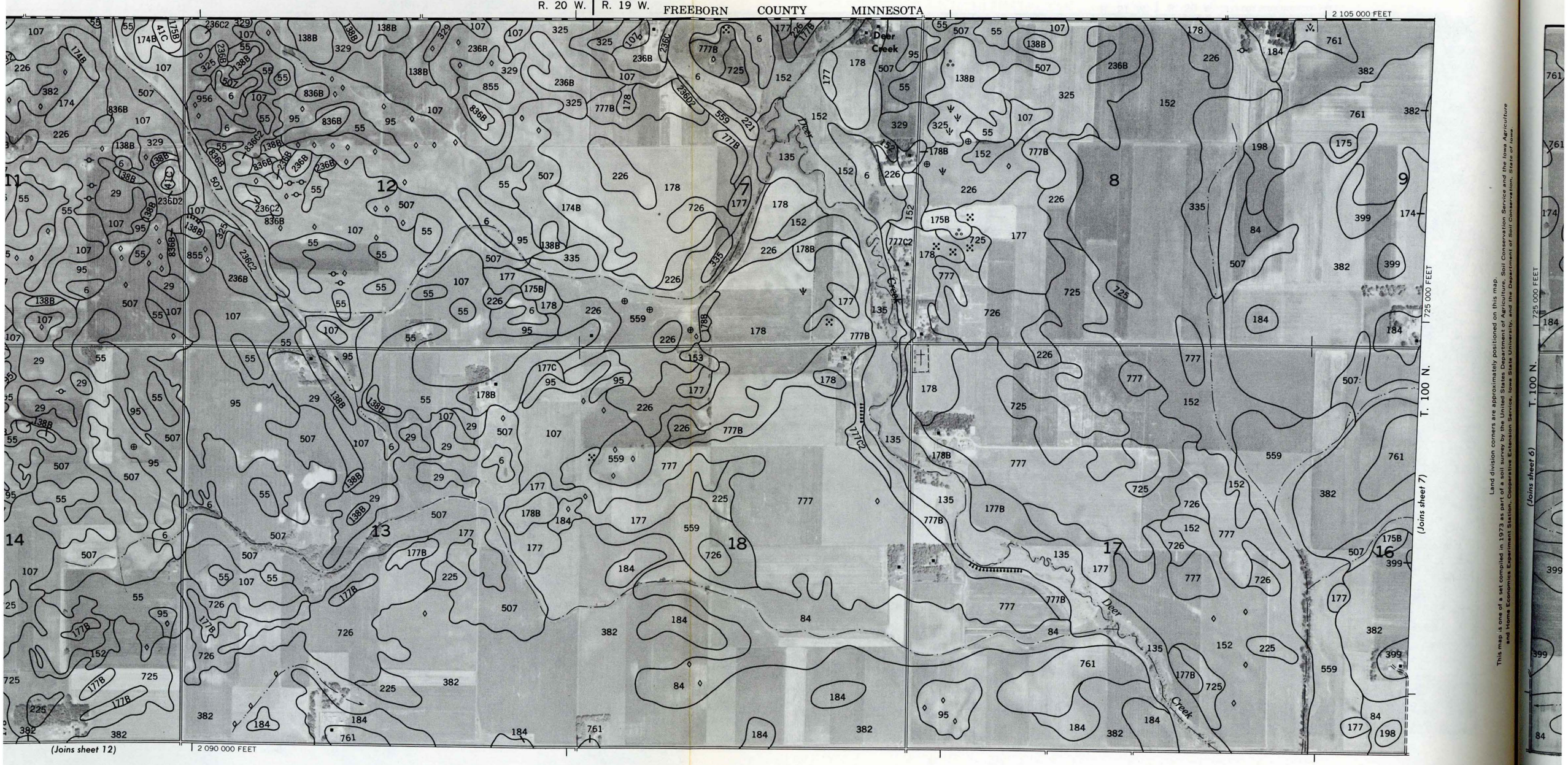
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.



hotobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
pproximate and based on Iowa coordinate system, north zone.



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

FREEBORN COUNTY MINNESOTA

MOWER COUNTY MINNESOTA

R. 19 W.

2 110 000 FEET

9 10 11 12

16 15 14 13

MITCHELL COUNTY

7 720 000 FEET

(Joins sheet 13)

2 125 000 FEET

N

1 Mile 5000 Feet 0

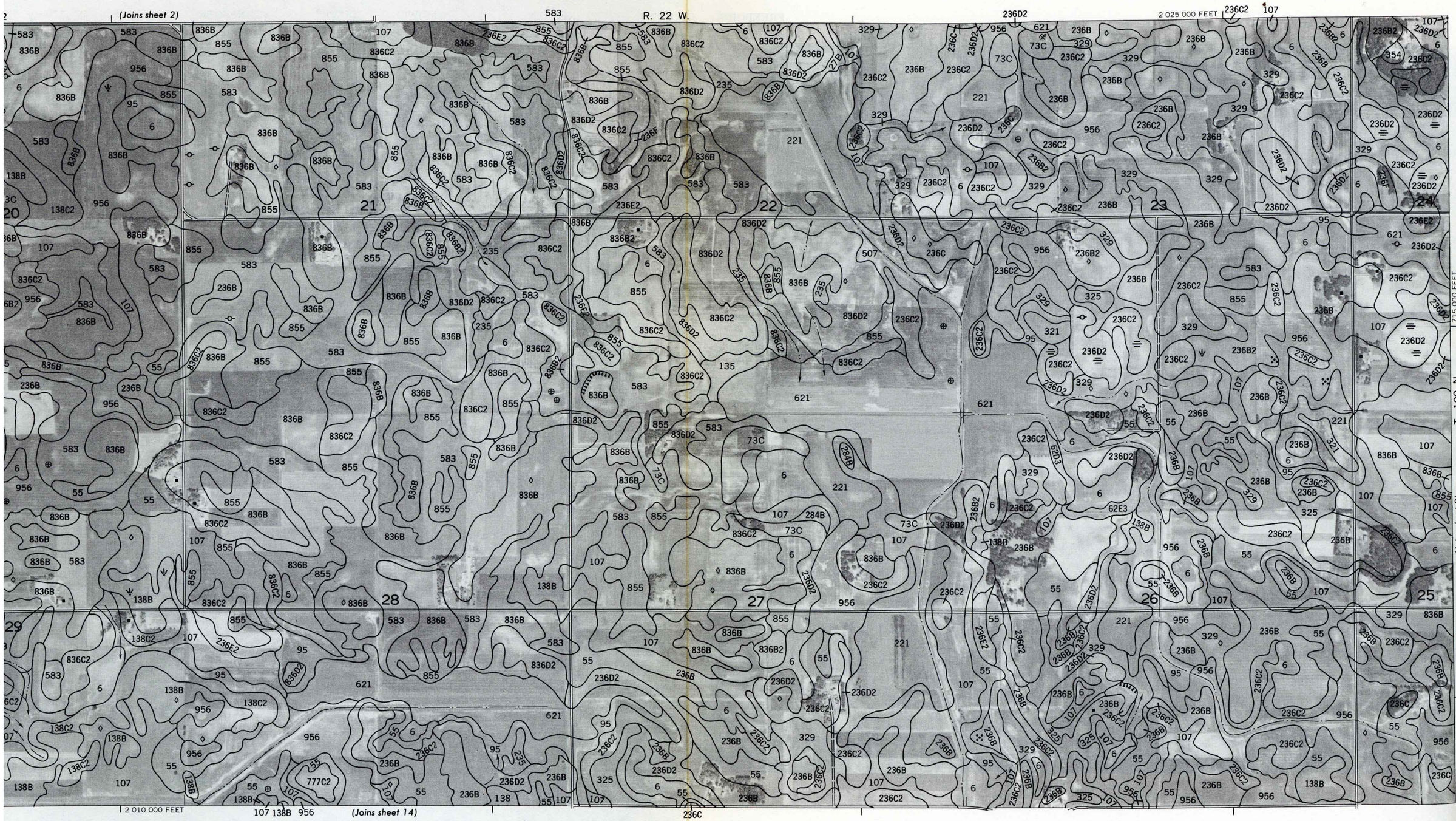
Scale 1:15 840

0 ¼ ½ ¾ 1

1000 2000 3000 4000 5000

tobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
roximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 8

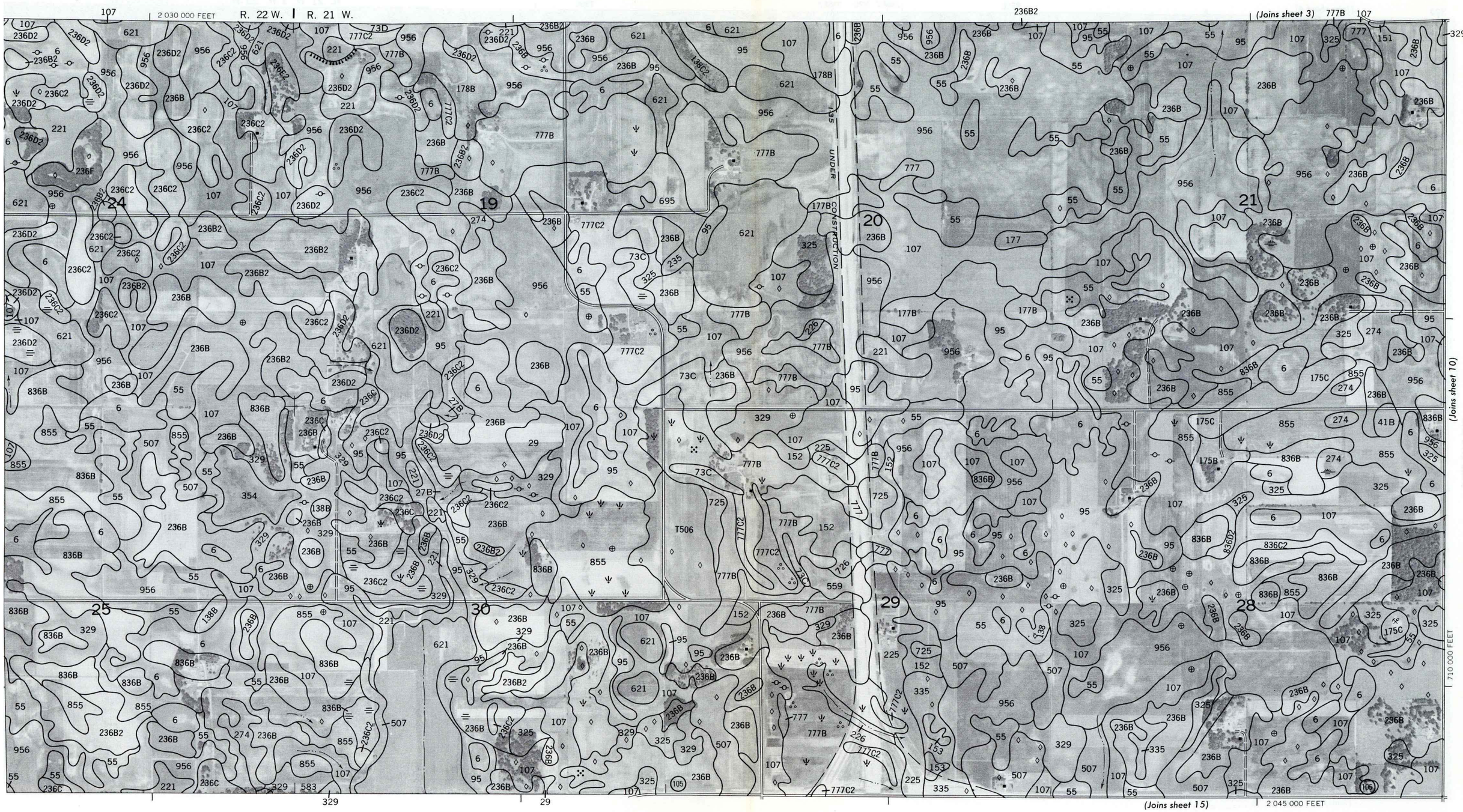


Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

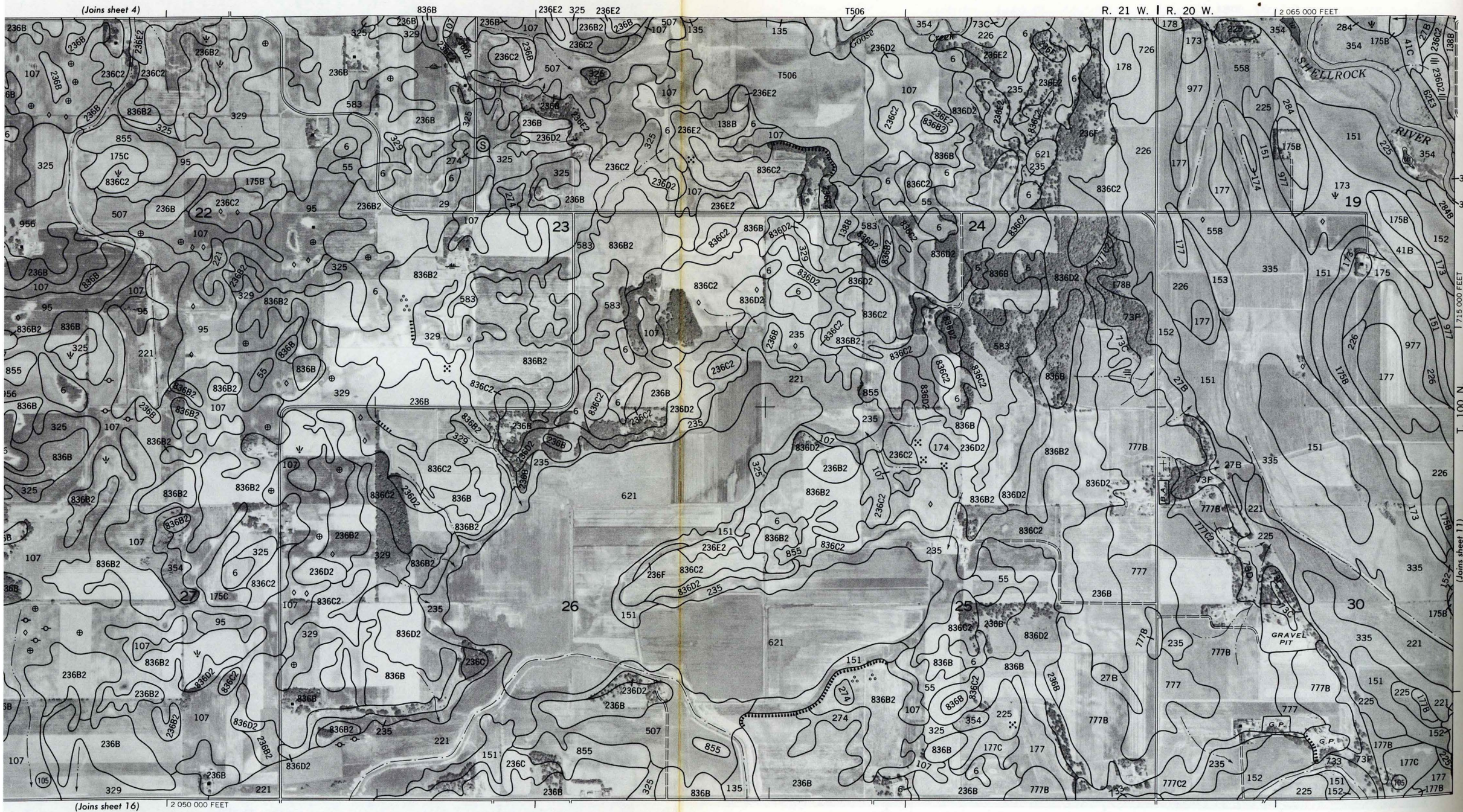
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Land division corners are approximately positioned on this map.



obase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
oximate and based on Iowa coordinate system, north zone.



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 11

11

N

R. 20 W.

(Joins sheet 5)

2 070 000 FEET

Northwood
(county seat)

SHELLROCK RIVER

CHICAGO ROCK ISLAND AND PACIFIC NORTH WESTERN

GRAVEL PIT

QUARRY

(Joins sheet 12)

(Joins sheet 17)

2 085 000 FEET

710 000 FEET

1 Mile

5000 Feet

Scale 1:15 840

base from 1971 aerial photography. Positions of 5,000-foot grid ticks are
ximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 12

R. 20 W | R. 19 W.

T. 100 N.

(Joins sheet 6)

(Joins sheet 11)

(Joins sheet 13)

(Joins sheet 18)

2 105 000 FEET

2 090 000 FEET

715 000 FEET

710 000 FEET

Deer Creek

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

13

N

2 110 000 FEET

R. 19 W.

(Joins sheet 7)

21

22

23

24

28

27

26

25

DEER CREEK

Meltonville

MITCHELL COUNTY, IOWA

1 Mile

5000 Feet

710 000 FEET

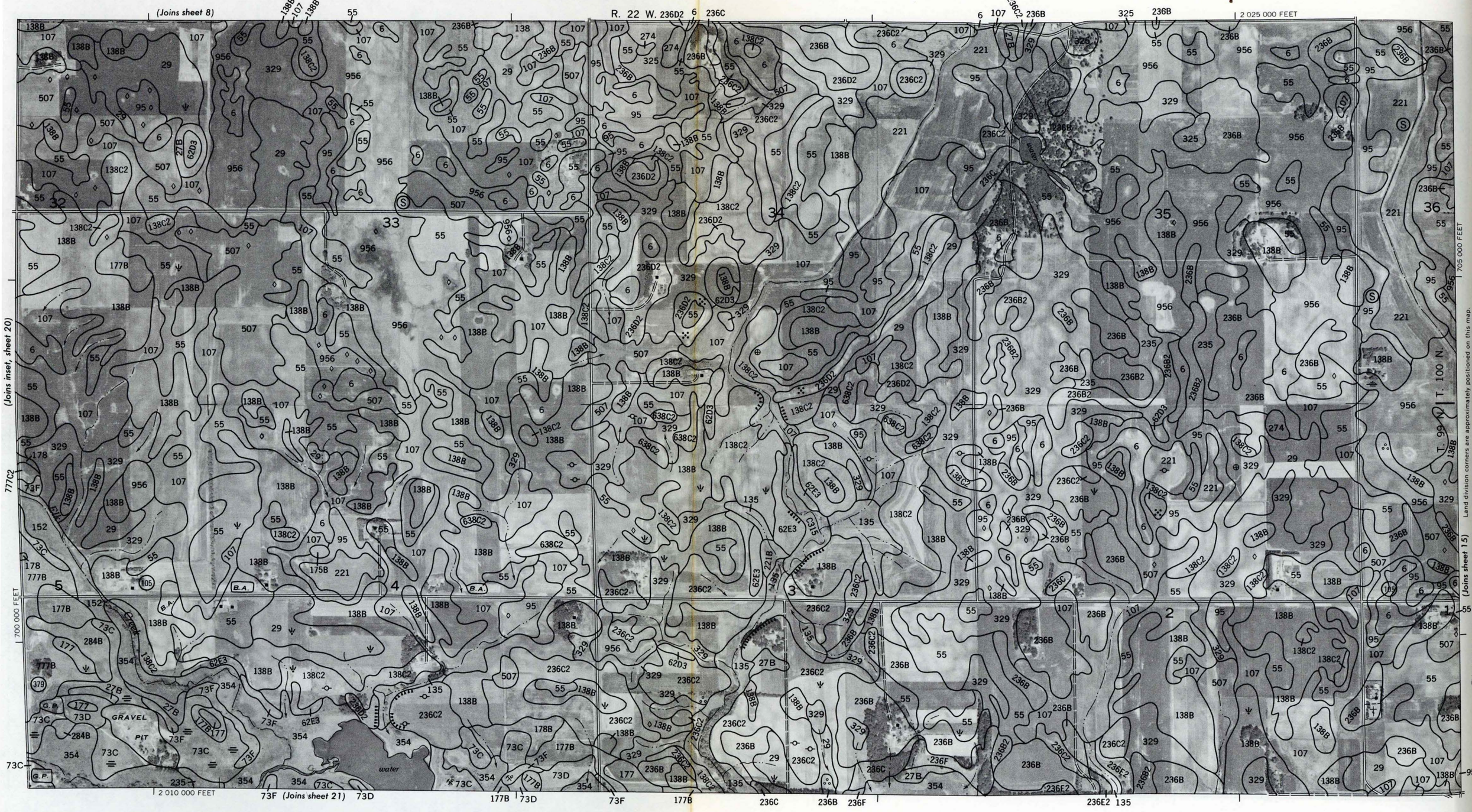
Scale 1:15 840

(Joins sheet 19)

2 125 000 FEET

ase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
imate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 14



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

15

N

2 030 000 FEET

R. 22 W. | R. 21 W.

(Joins sheet 9)

(Joins sheet 16)

(Joins sheet 22)

2 045 000 FEET

700 000 FEET

107

1 Mile

5000 Feet

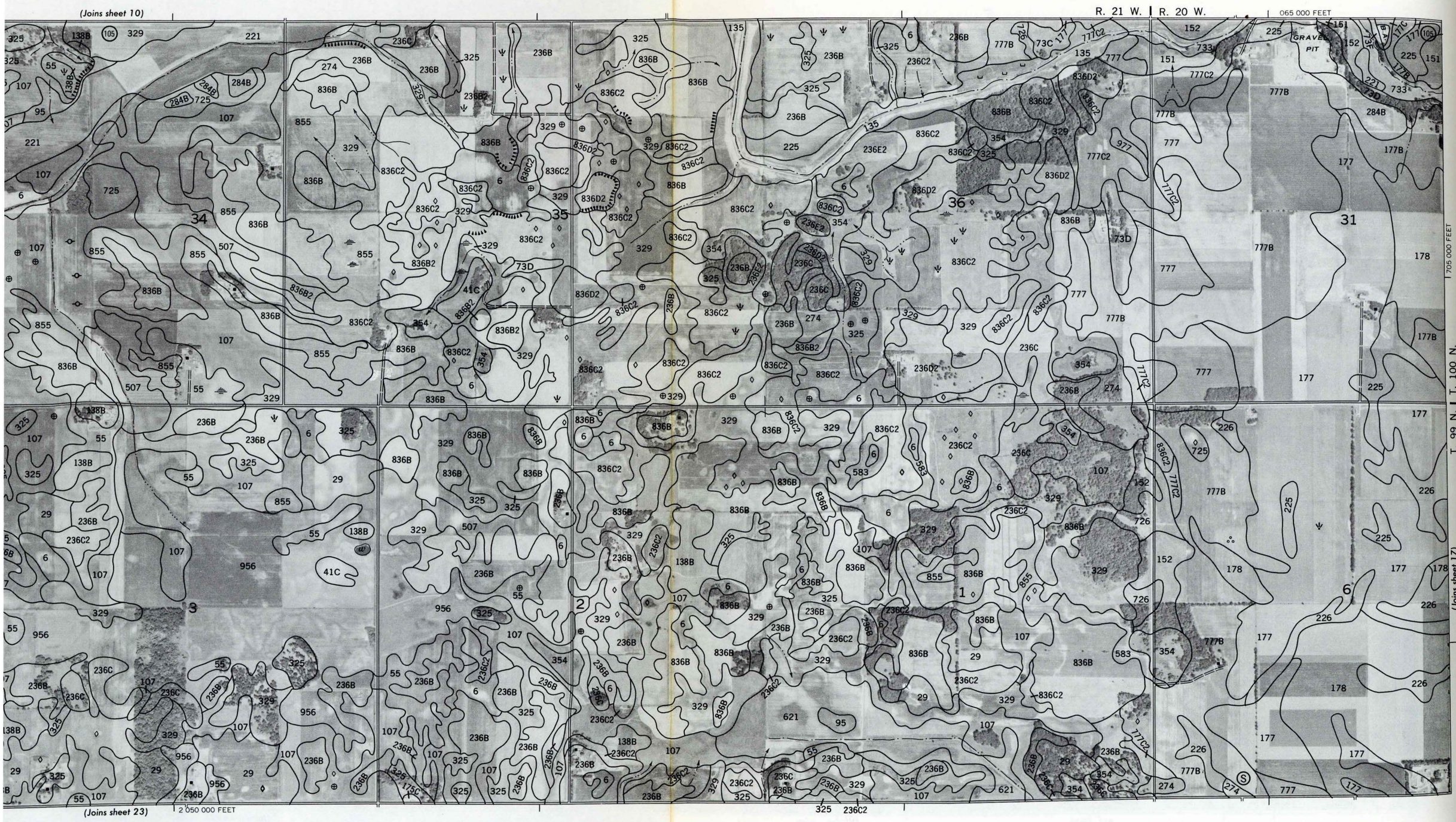
Scale 1:15 840

1 0 0 ¼ 1000 ½ 2000 ¾ 3000 4000 5000

I-35 UNDER CONSTRUCTION

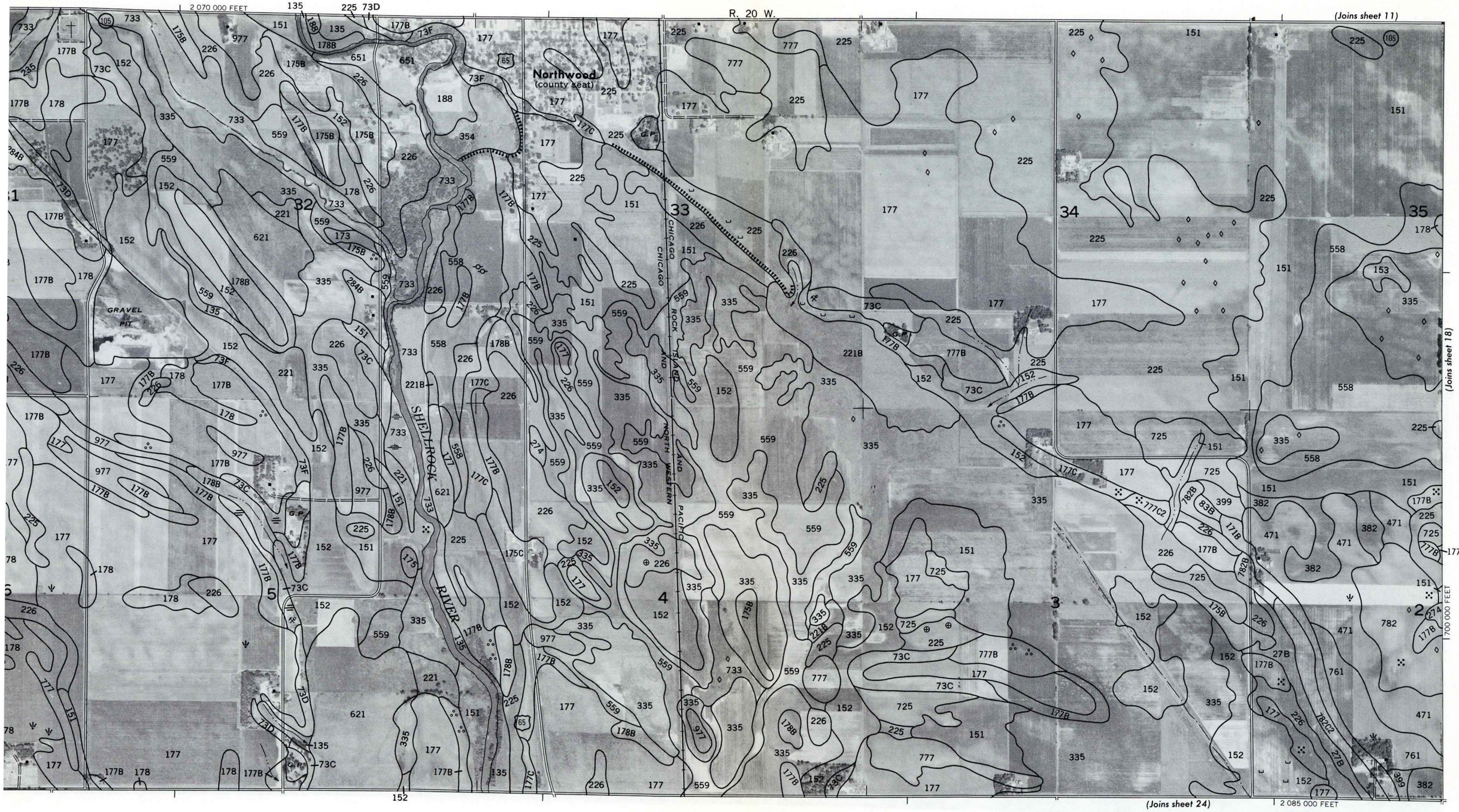
BORROW AREA

base from 1971 aerial photography. Positions of 5,000-foot grid ticks are
ximate and based on Iowa coordinate system, north zone.

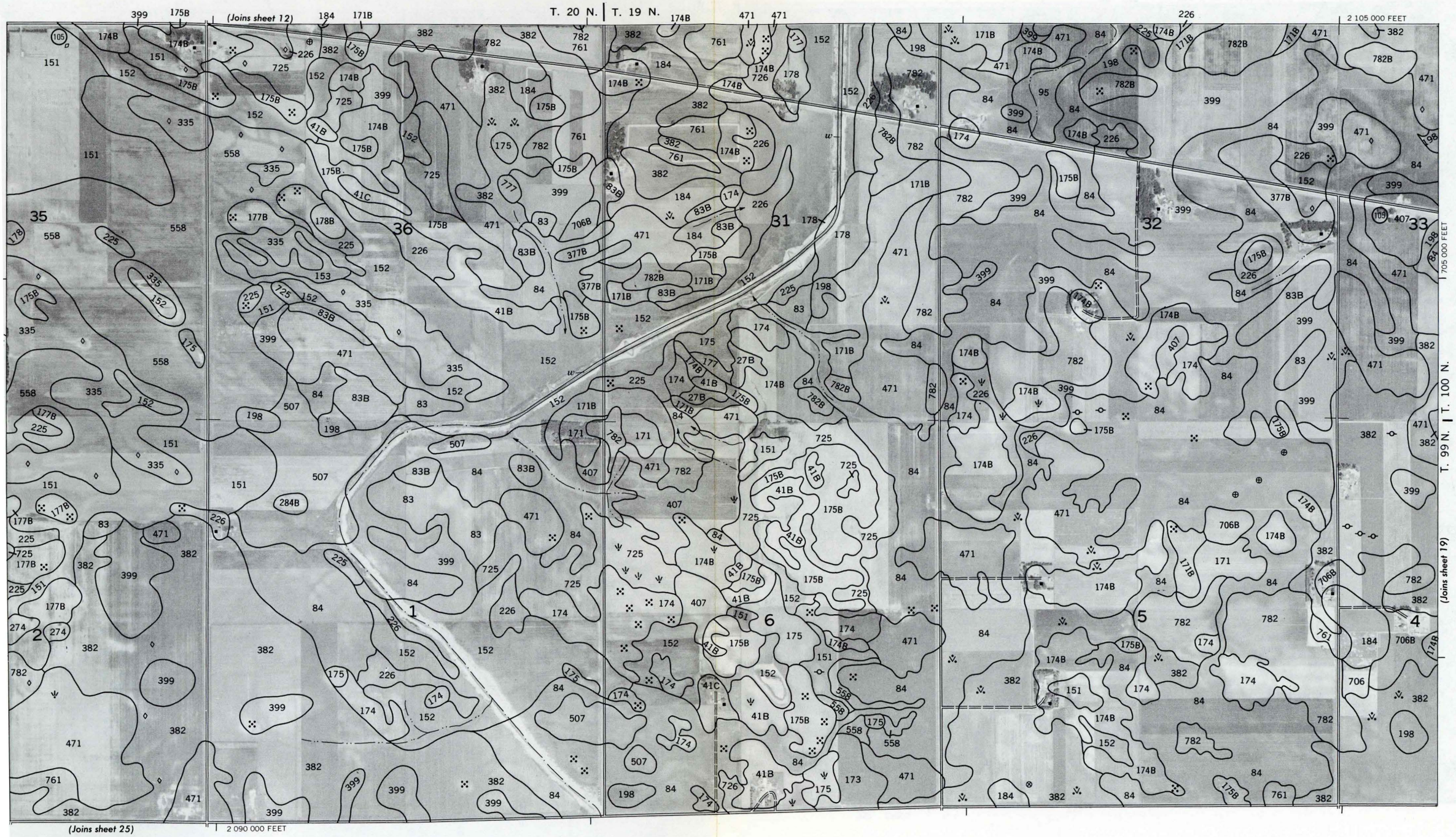


Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.
Cooperative Extension Service, Iowa State University, and Home Economics Experiment Station, Land division corners are approximately positioned on this map.



otobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
roximate and based on Iowa coordinate system, north zone.



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

obase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
oximate and based on Iowa coordinate system, north zone.

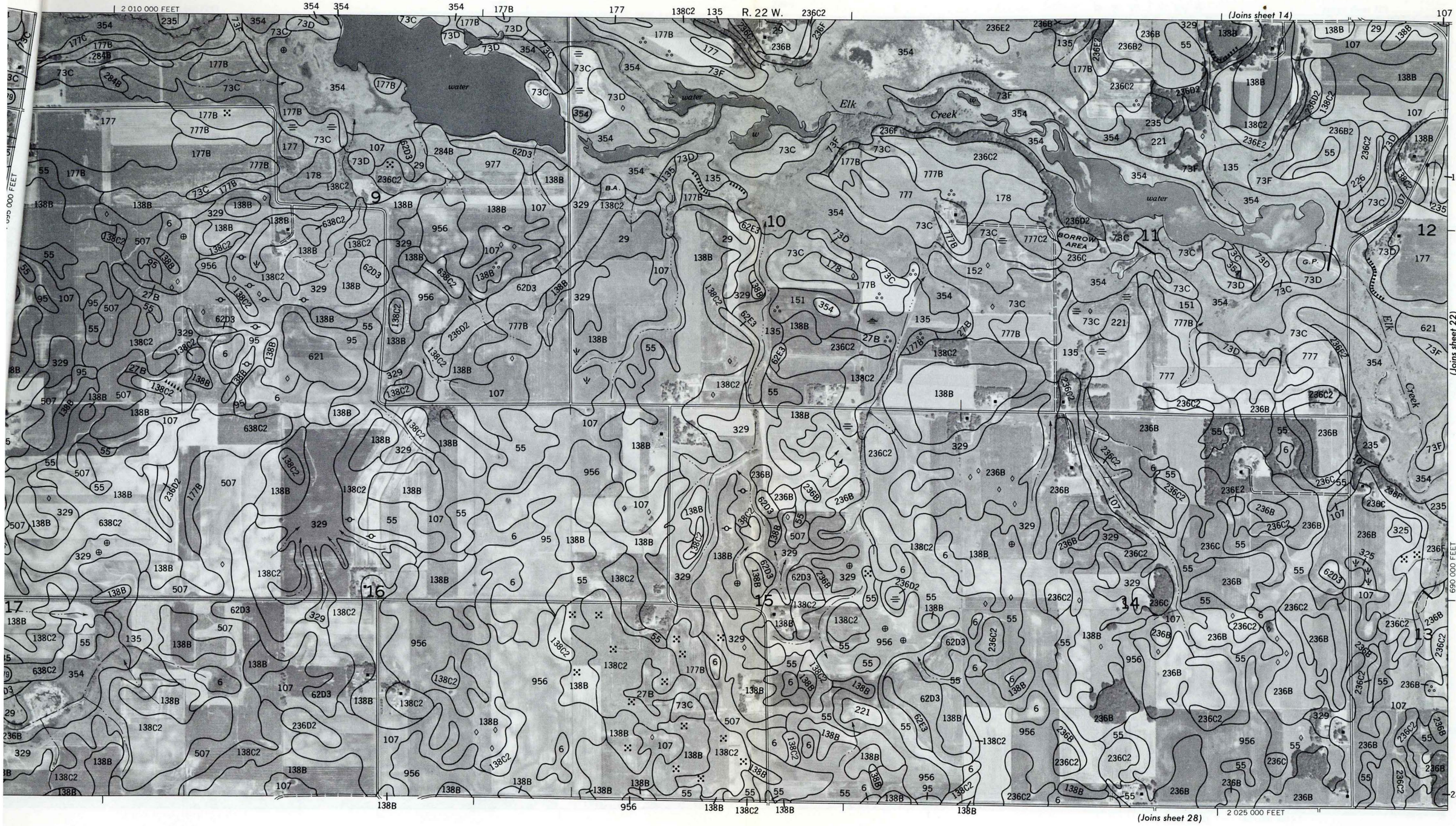
4 000 AND 5 000-FOOT GRID TICK INTERVALS

4 000 AND 5 000-FOOT GRID TICK INTERVALS

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.



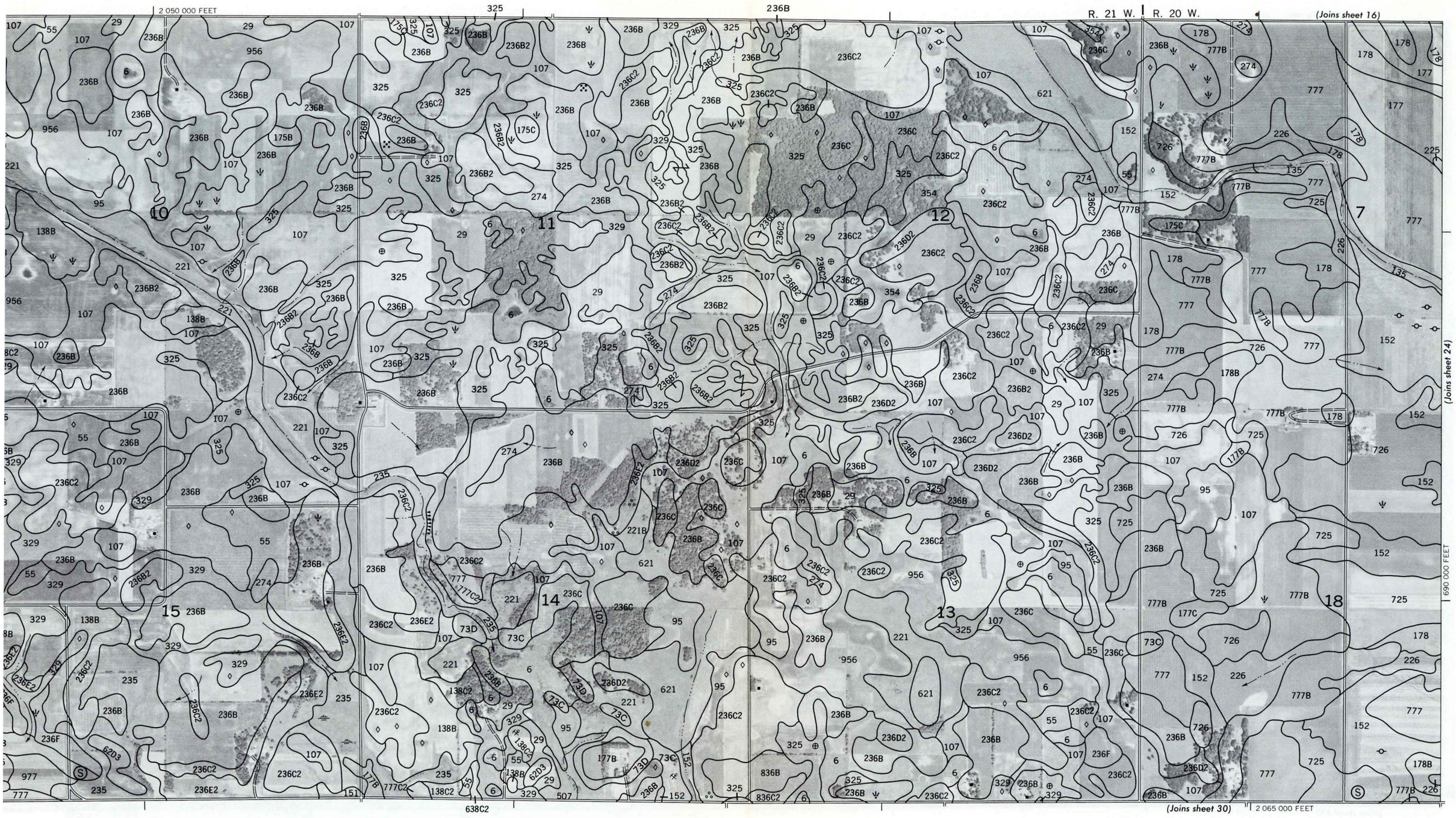
base from 1971 aerial photography. Positions of 5,000-foot grid ticks are
ximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 22

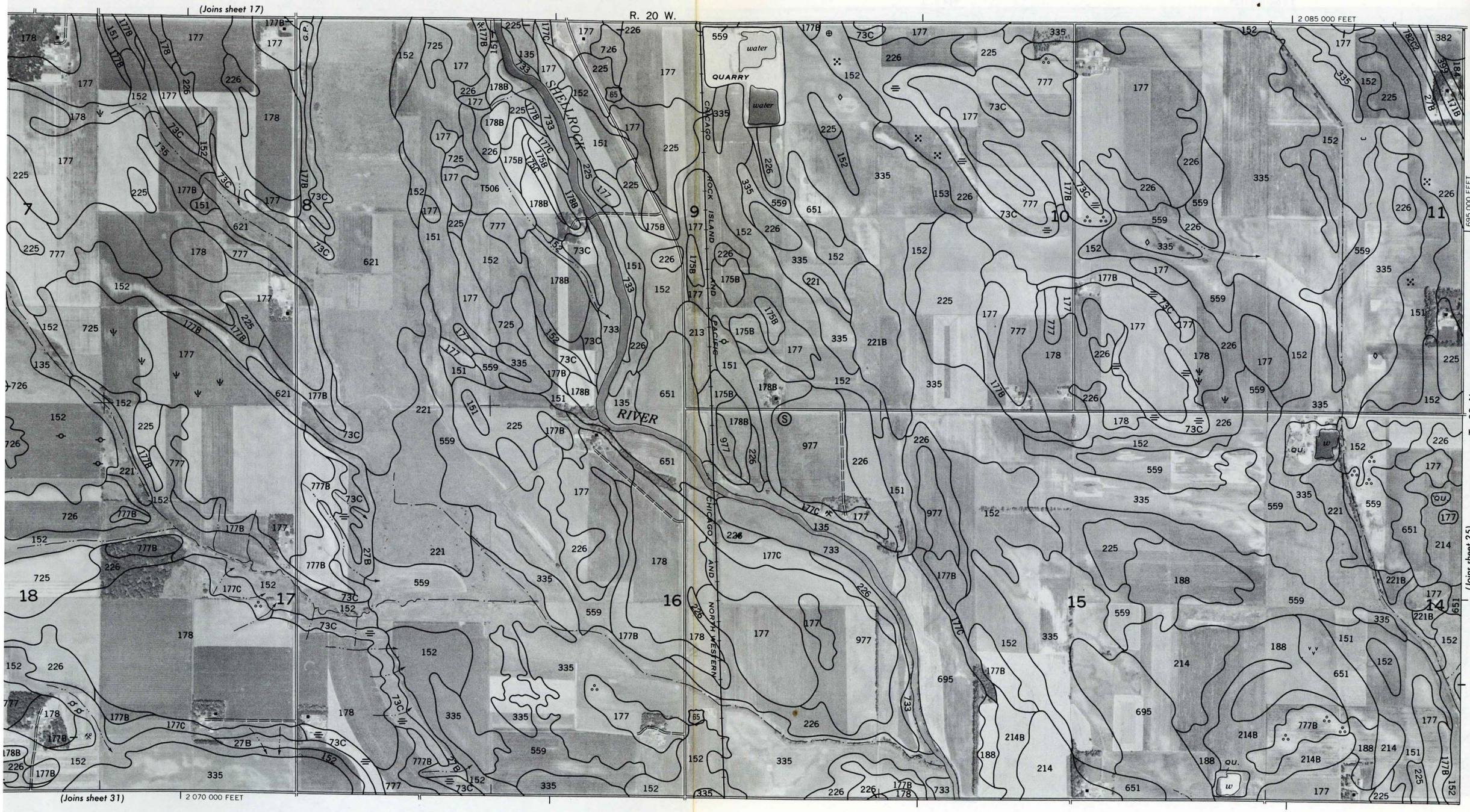
Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.



base from 1971 aerial photography. Positions of 5,000-foot grid ticks are
ximate and based on Iowa coordinate system, north zone.



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture

WORTH COUNTY, IOWA — SHEET NUMBER 25

25

N

R. 20 W. | R. 19 W.

2 090 000 FEET

695 000 FEET

T. 99 N.

(Joins sheet 24)

(Joins sheet 18)

(Joins sheet 26)

(Joins sheet 32)

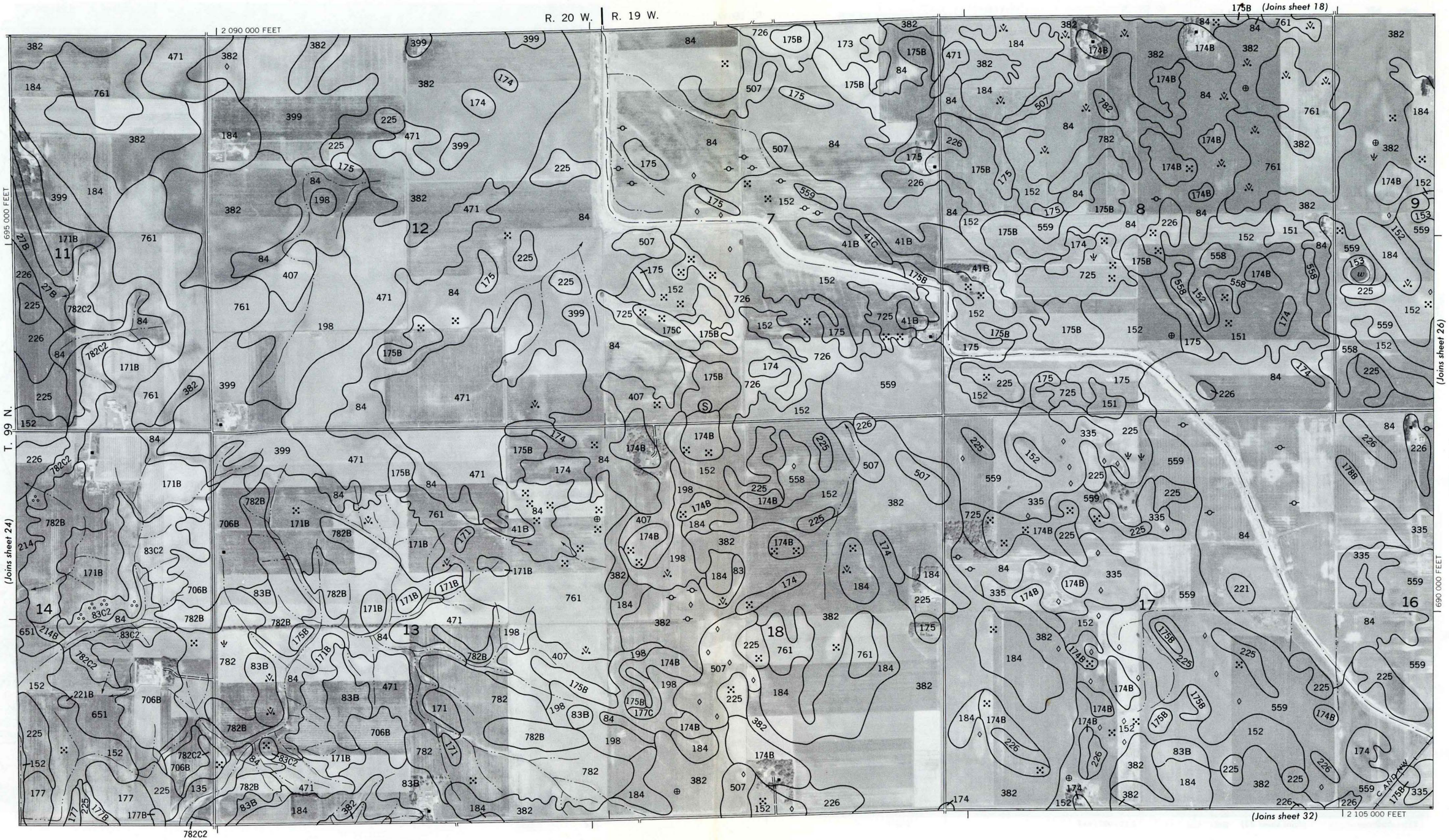
690 000 FEET

2 105 000 FEET

1 Mile

5000 Feet

Scale 1:15 840



atobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
roximate and based on Iowa coordinate system, north zone.

(Joins sheet 19)

R. 19 W.

2 125 000 FEET

695 000 FEET

T. 99 N.

9 10 11 12 16 15 14 13

CHICAGO AND NORTH WESTERN

CHICAGO ST PAUL MILWAUKEE AND PACIFIC

(Joins sheet 33)

2 110 000 FEET

MITCHELL COUNTY, IOWA

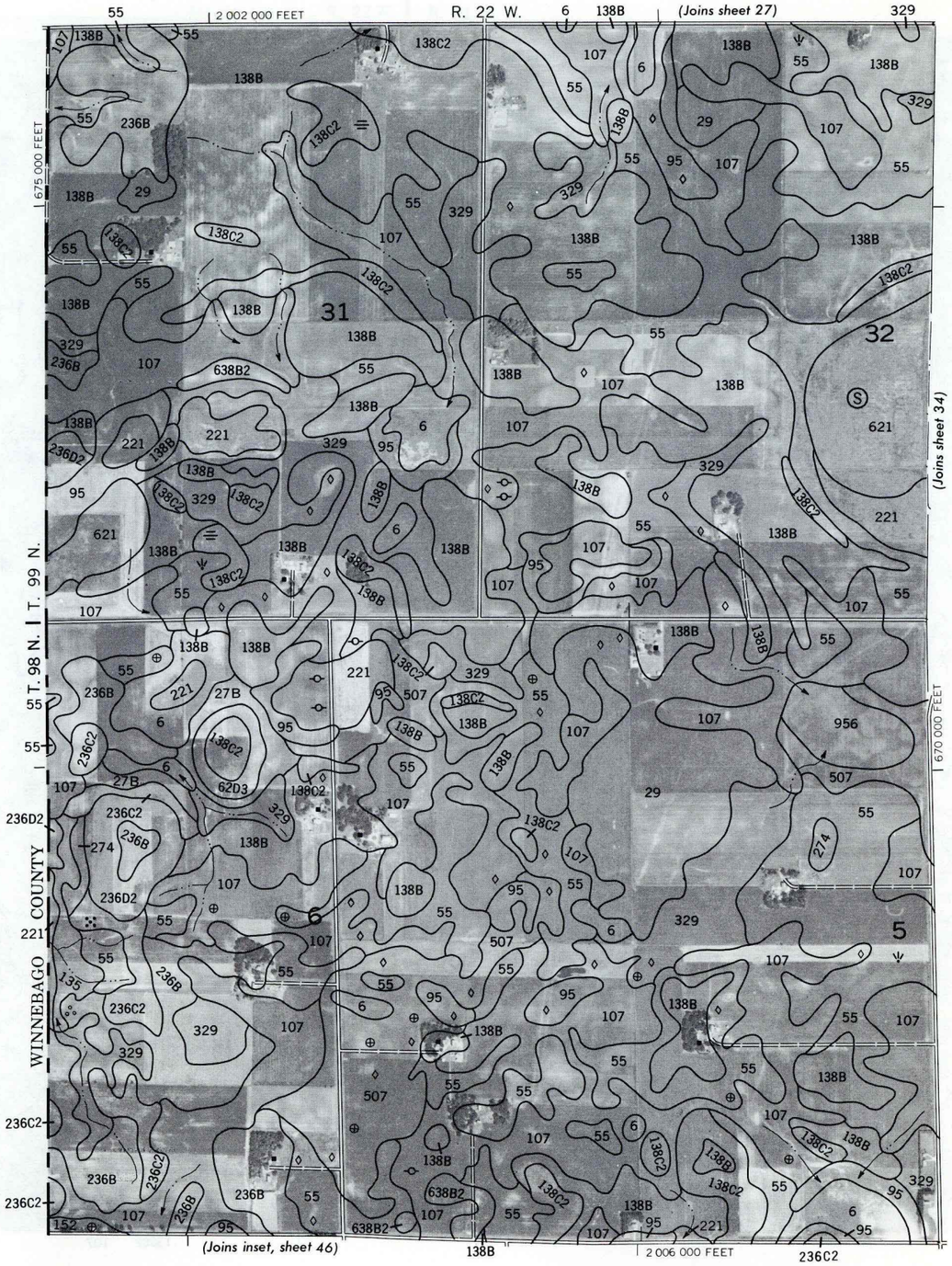
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Land division corners are approximately positioned on this map.

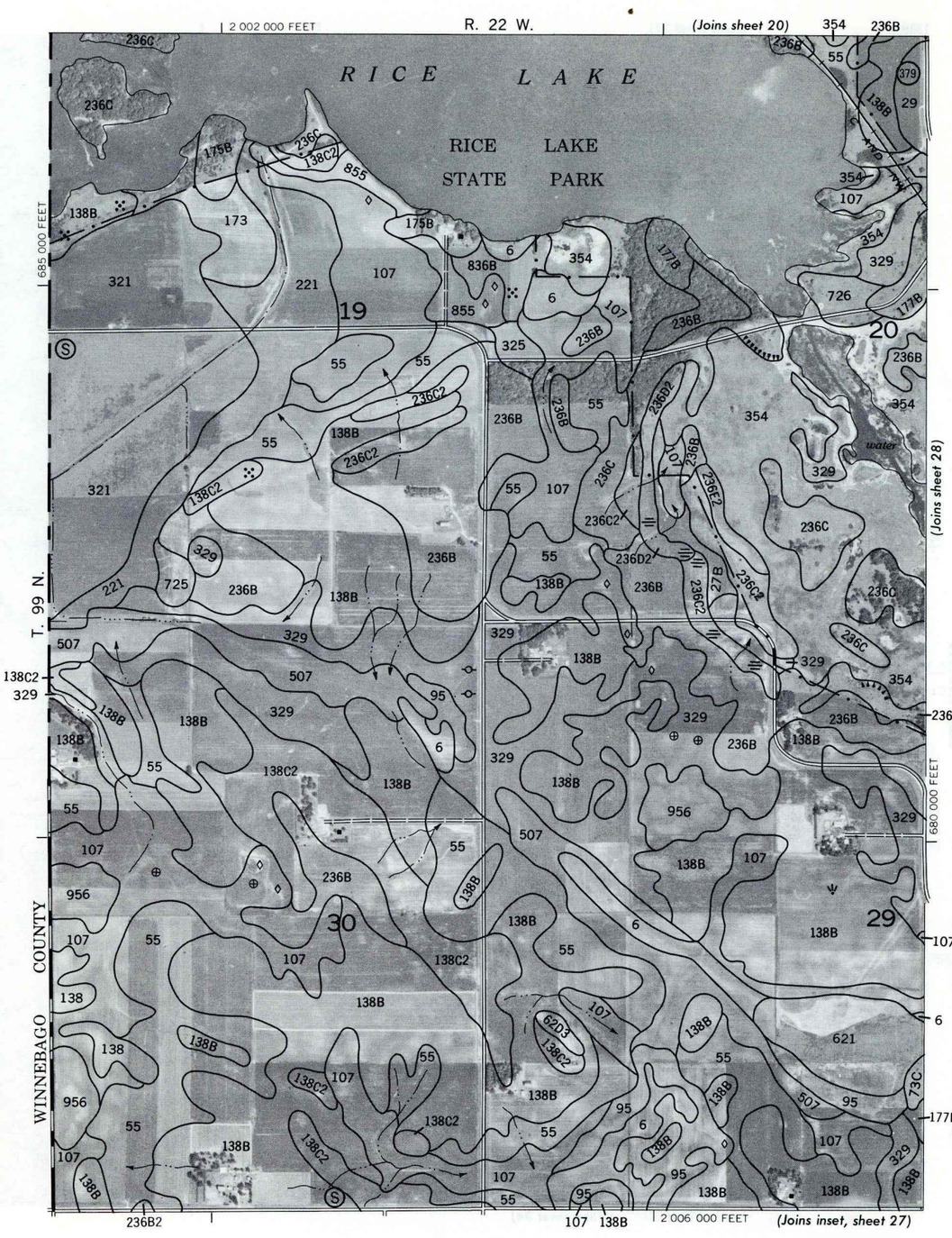
Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Land division corners are approximately positioned on this map.

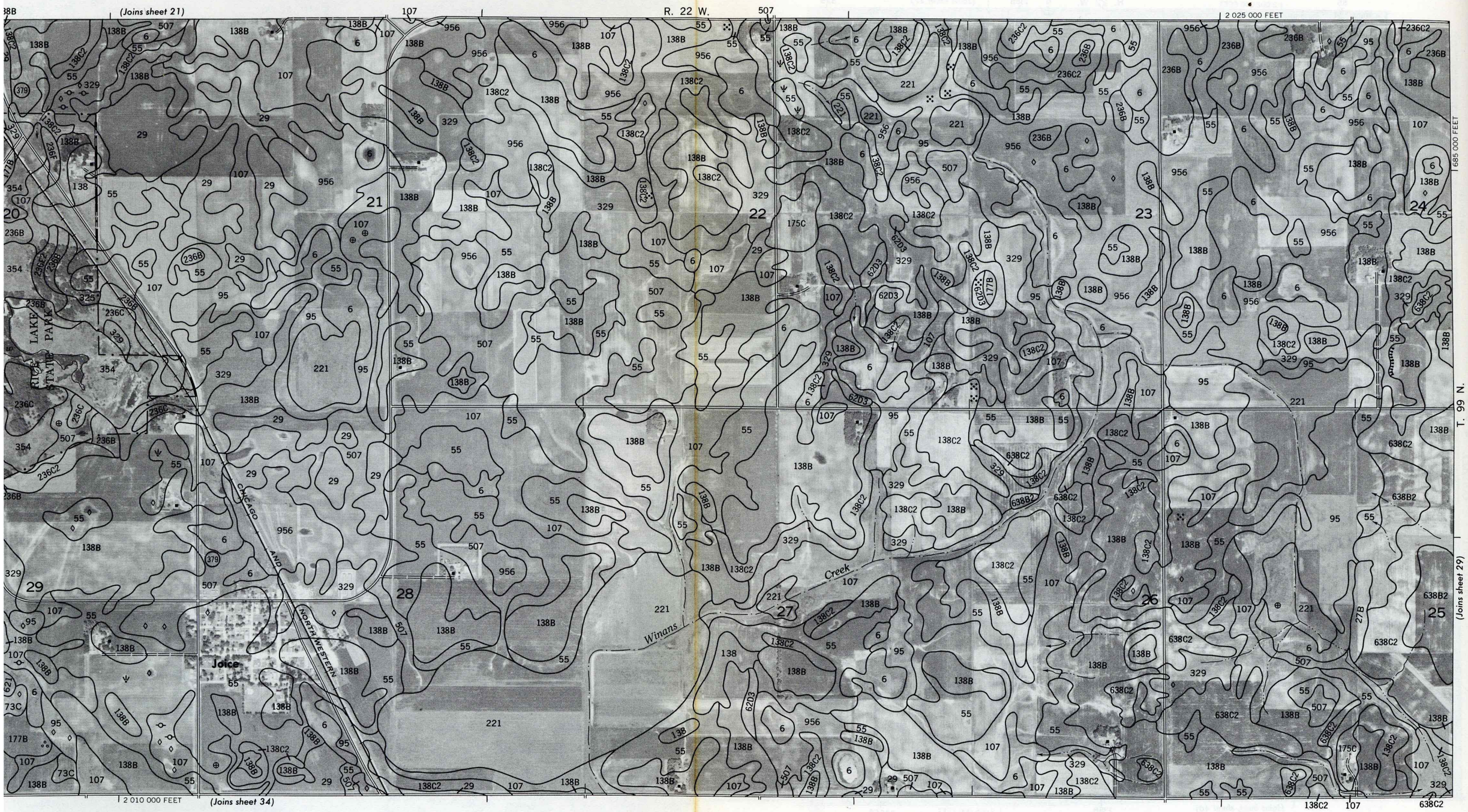


4000 AND 5 000-FOOT GRID TICK INTERVALS



4000 AND 5 000-FOOT GRID TICK INTERVALS

tobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
roximate and based on Iowa coordinate system, north zone.

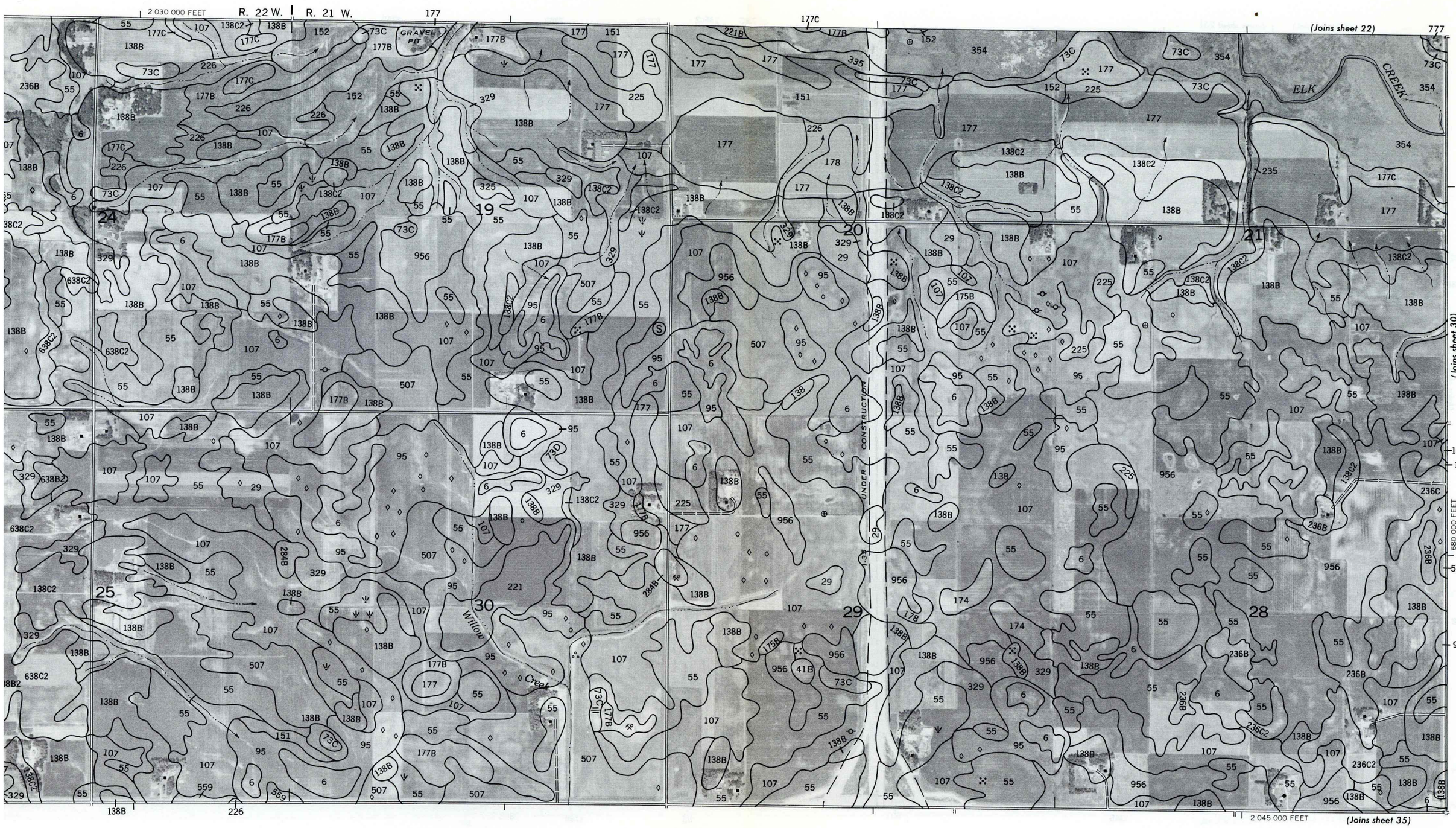


Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

WORTH COUNTY, IOWA — SHEET NUMBER 28 — Soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.



29

N

1 Mile

5000 Feet

Scale 1:15 840

680 000 FEET

base from 1971 aerial photography. Positions of 5,000-foot grid ticks are
ximate and based on Iowa coordinate system, north zone.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

31

N

2 070 000 FEET

R. 20 W.

(Joins sheet 24)

(Joins sheet 32)

(Joins sheet 37)

2 085 000 FEET

680 000 FEET

1 Mile

5000 Feet

Scale 1:15 840

CHICAGO ROCK ISLAND AND PACIFIC

CHICAGO NORTH WESTERN

SHELLROCK RIVER

ELK CREEK

GRAVEL PIT

Kensett

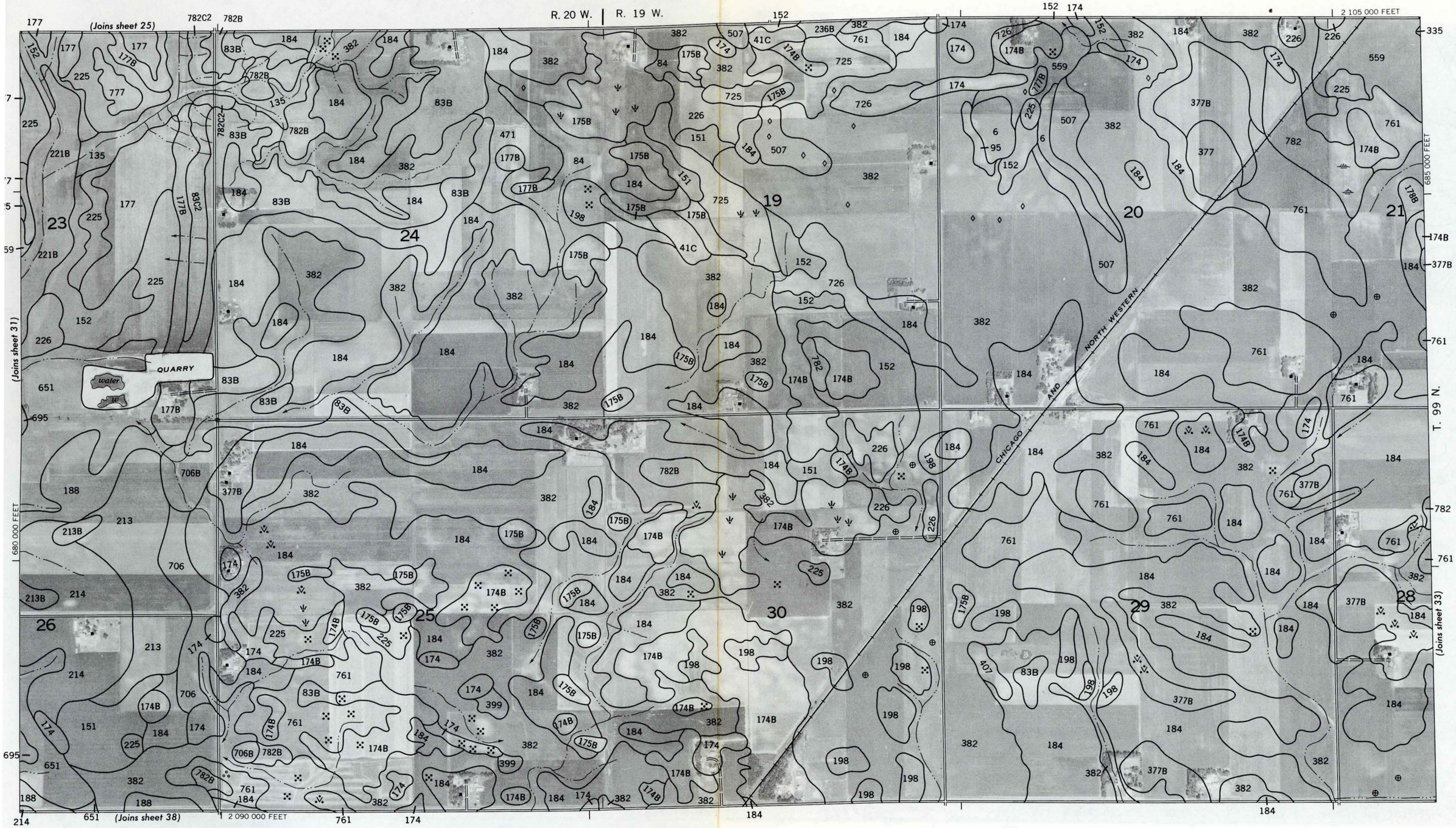
19 20 21 22 23 24 25 26 27 28 29 30

198

213B

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

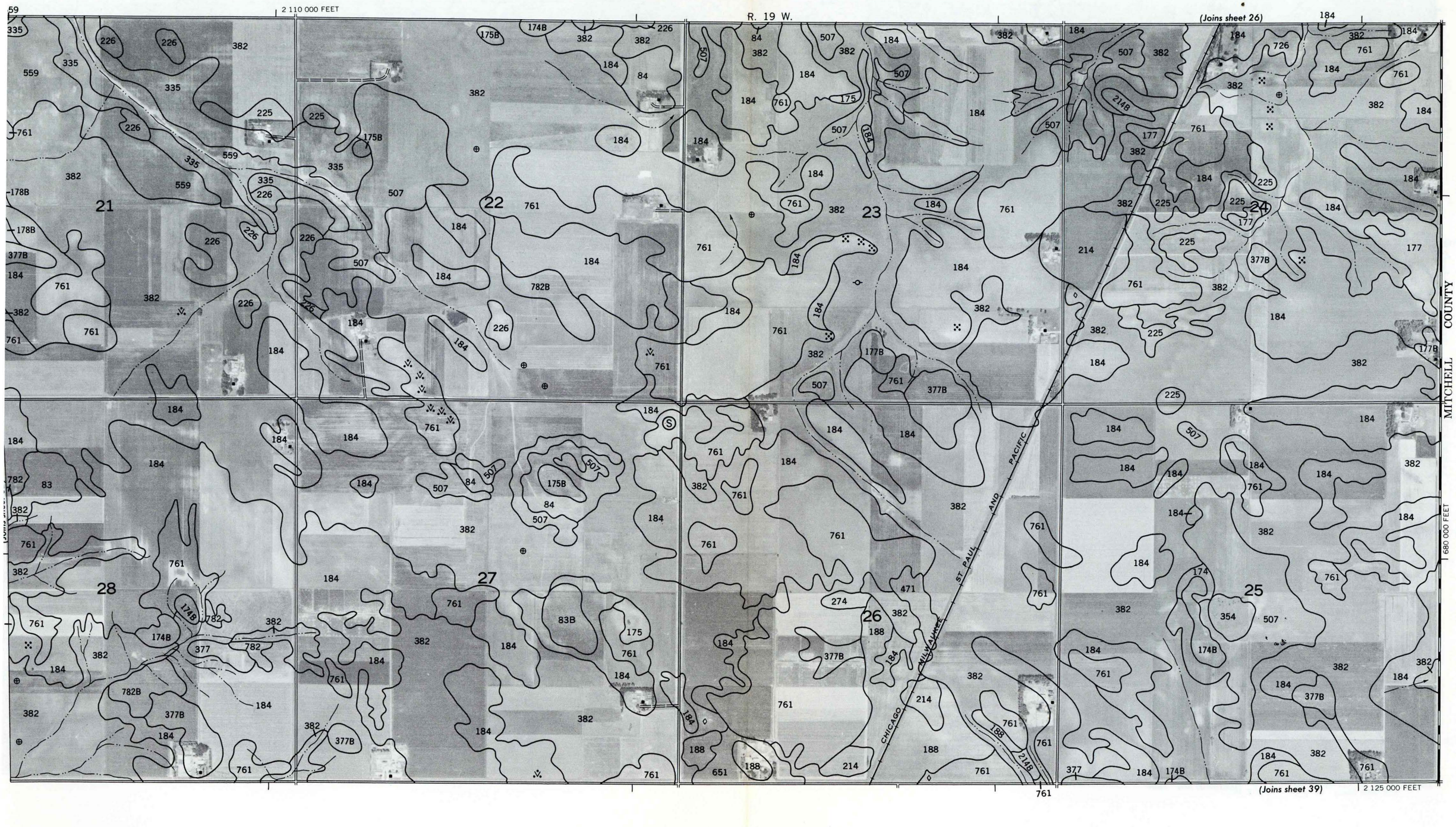
WORTH COUNTY, IOWA — SHEET NUMBER 32



Land division corners are approximately positioned on this map.

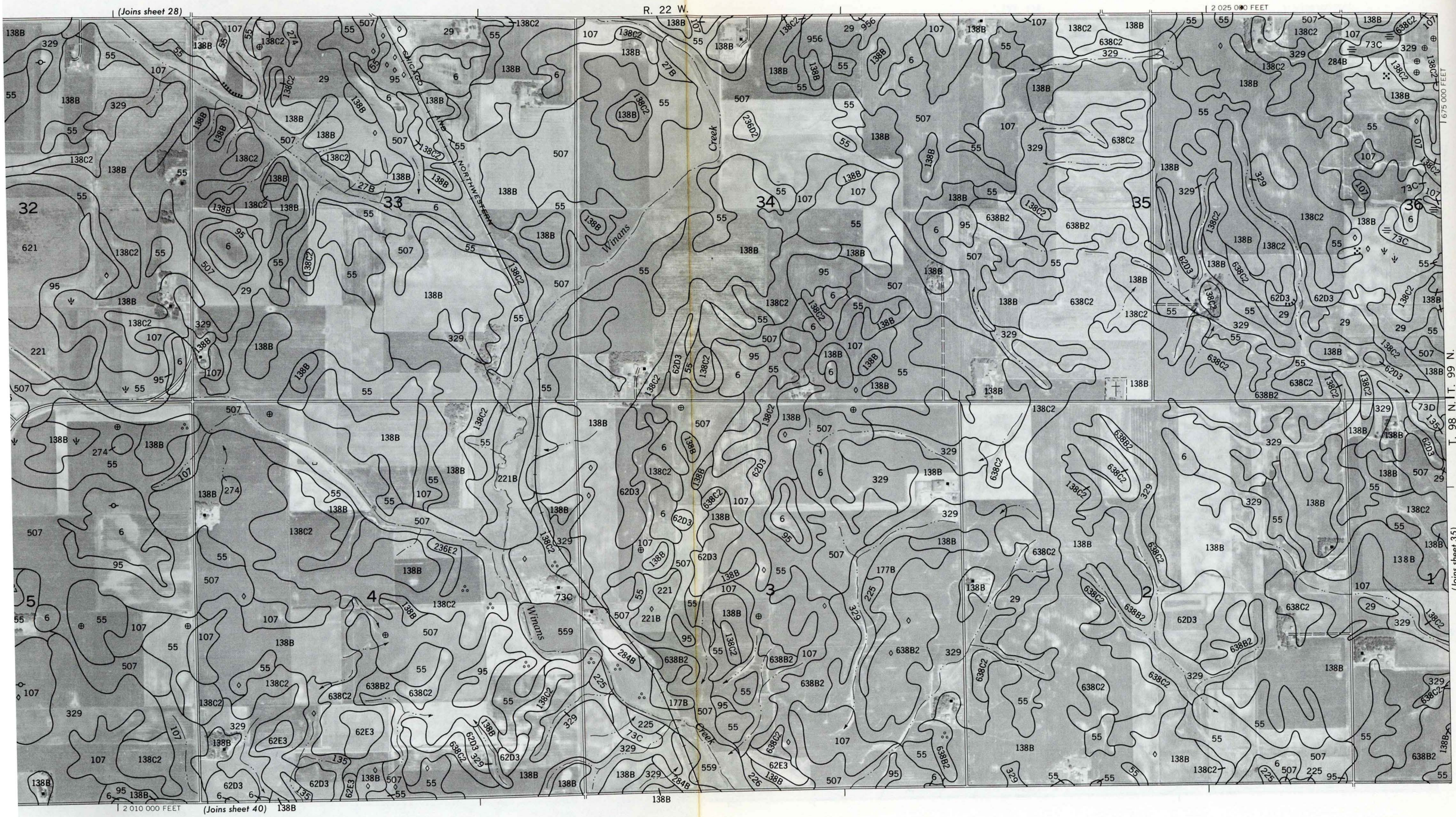
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.



Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 34



Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

WORTH COUNTY, IOWA NO. 34

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

35

N

R. 22 W. | R. 21 W.

2 030 000 FEET

(Joins sheet 29)

(Joins sheet 36)

(Joins sheet 34)

(Joins sheet 41)

2 045 000 FEET

670 000 FEET

Willow Creek

174B

284B

BORROW AREA

UNDER CONSTRUCTION I-35

36 31 32 33 1 6 5 4

Scale 1:15 840

1 Mile

5000 Feet

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

(Joins sheet 30)

R. 21 W. | R. 20 W.

2 065 000 FEET

675 000 FEET

T. 99 N. | T. 98 N.

(Joins sheet 37)

(Joins sheet 42)

2 050 000 FEET

Rose Creek

WORTH COUNTY, IOWA NO. 36

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

2 070 000 FEET

R. 20 W.

177 (Joins sheet 31)

Kensett

CHICAGO, ROCK ISLAND AND NORTH WESTERN PACIFIC

SHELLROCK RIVER

Rose Creek

31 32 33 34 35 6 5 4 3 2

(Joins sheet 38)

(Joins sheet 43)

2 085 000 FEET

670 000 FEET

N

1 Mile

5000 Feet

Scale 1:15 840

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

(Joins sheet 32)

R. 20 W. | R. 19 W.

2 105 000 FEET

675 000 FEET

T. 99 N. | T. 98 N.

(Joins sheet 39)

(Joins sheet 44)

2 090 000 FEET

SHELLROCK

QUARRY

RIVER

NORTH WESTERN AND CHICAGO

35 36 31 32 33 2 1 6 5 4

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

WORTH COUNTY, IOWA NO. 38

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

39

N

2 110 000 FEET

R. 19 W.

(Joins sheet 33)

(Joins sheet 38)

(Joins sheet 45)

2 125 000 FEET

33 34 35 36

4 3 2 1

Grafton

CHICAGO, MILWAUKEE, ST. PAUL & PACIFIC

MITCHELL COUNTY

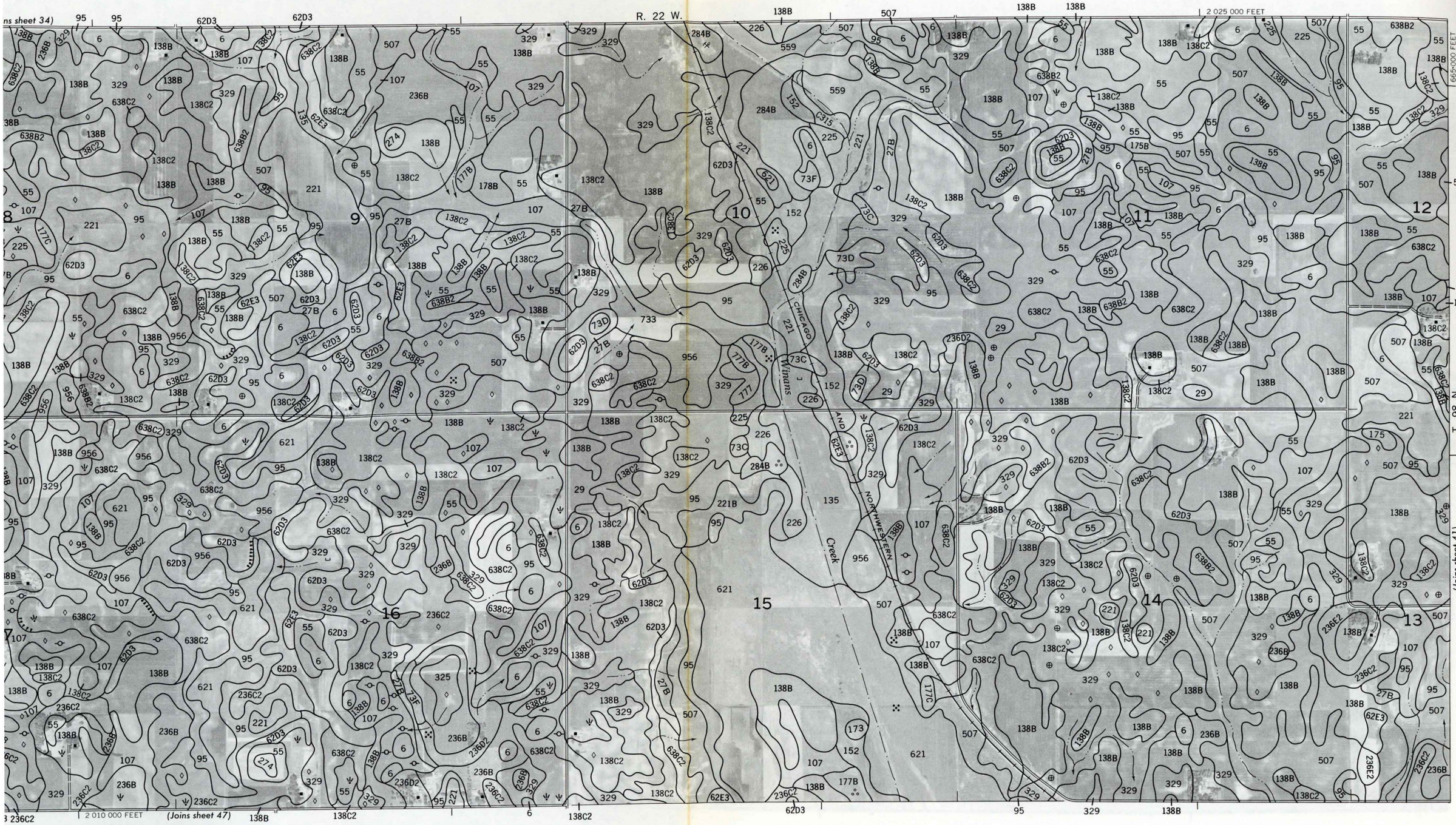
1 Mile

5000 Feet

6 670 000 FEET

Scale 1:15 840

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.



Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

WORTH COUNTY, IOWA NO. 40

41

N

2 030 000 FEET

R. 22 W. | R. 21 W.

(Joins sheet 35)

Willow Creek

BORROW AREA

I-35 UNDER CONSTRUCTION

BORROW AREA

intermittent

Willow Creek

(Joins sheet 42)

660 000 FEET

507

2 045 000 FEET

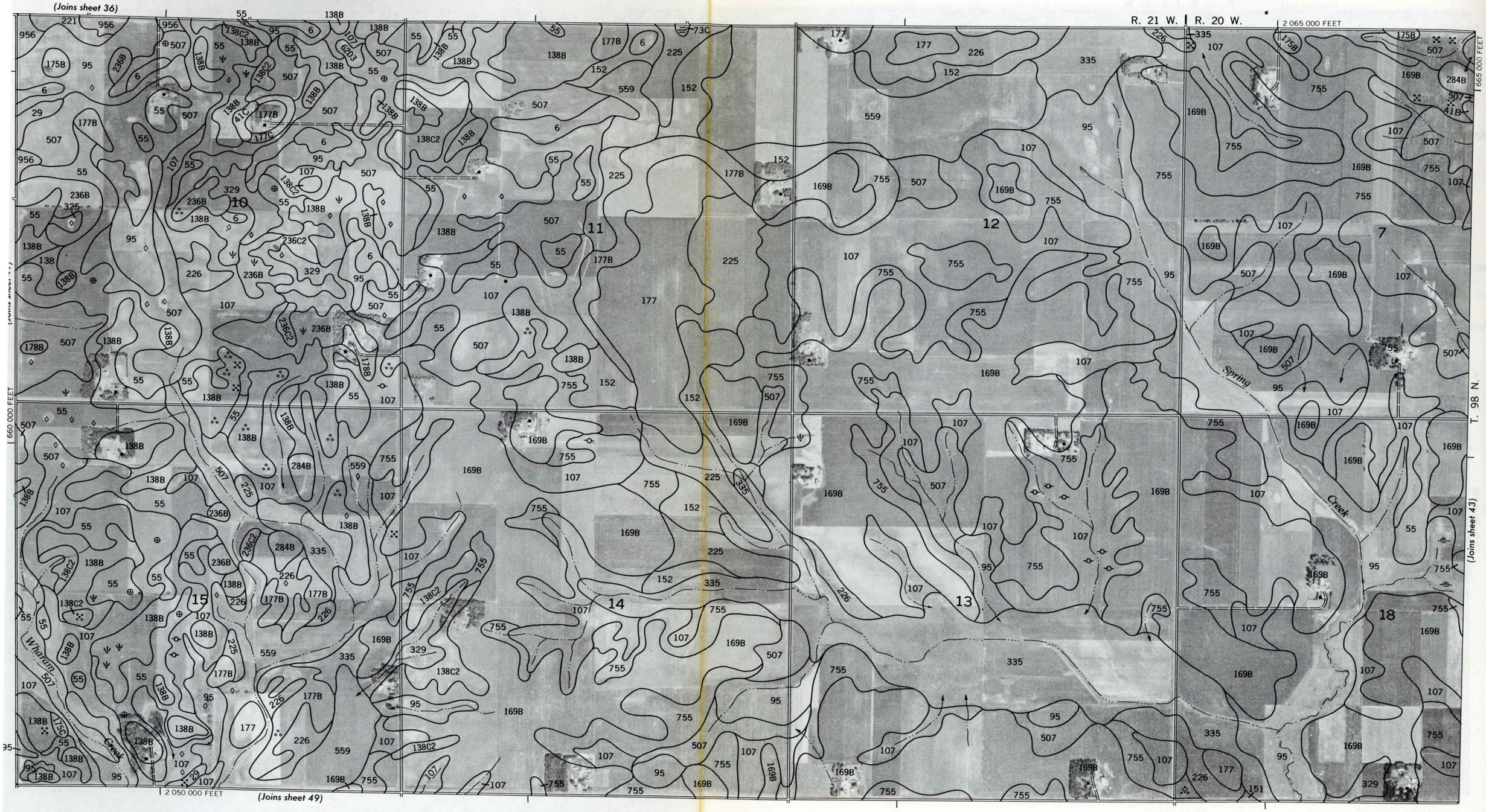
(Joins sheet 48)

1 Mile

5000 Feet

Scale 1:15 840

otobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
proximate and based on Iowa coordinate system, north zone.



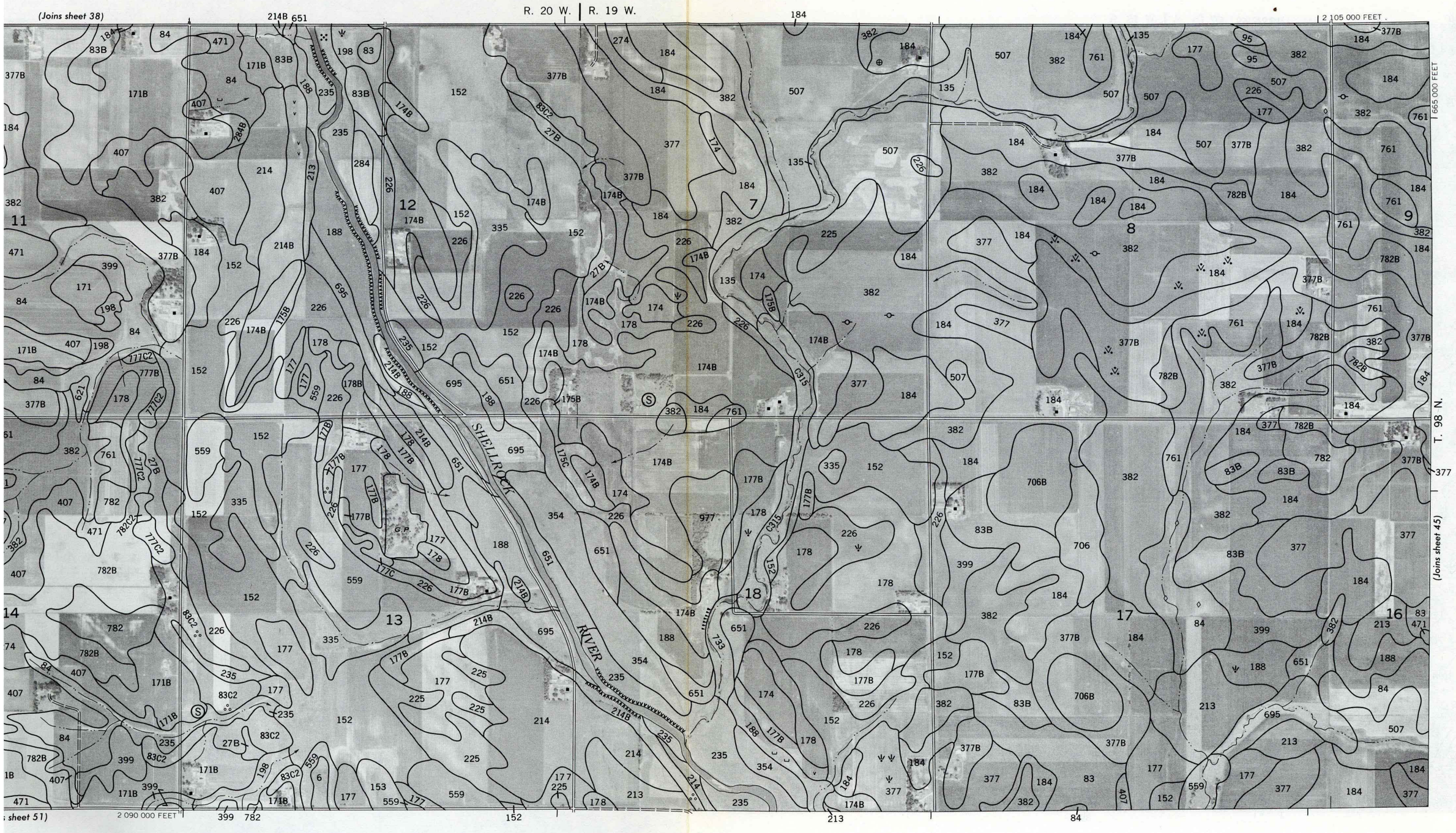
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 44



Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

WORTH COUNTY, IOWA

N

2 110 000 FEET

R. 19 W.

(Joins sheet 39)

Grafton

ST PAUL AND PACIFIC

CHICAGO MILWAUKEE

9 10 11 12 16 15 14 13

Rock Falls Creek

MITCHELL COUNTY

660 000 FEET

(Joins sheet 52)

2 125 000 FEET

1 Mile

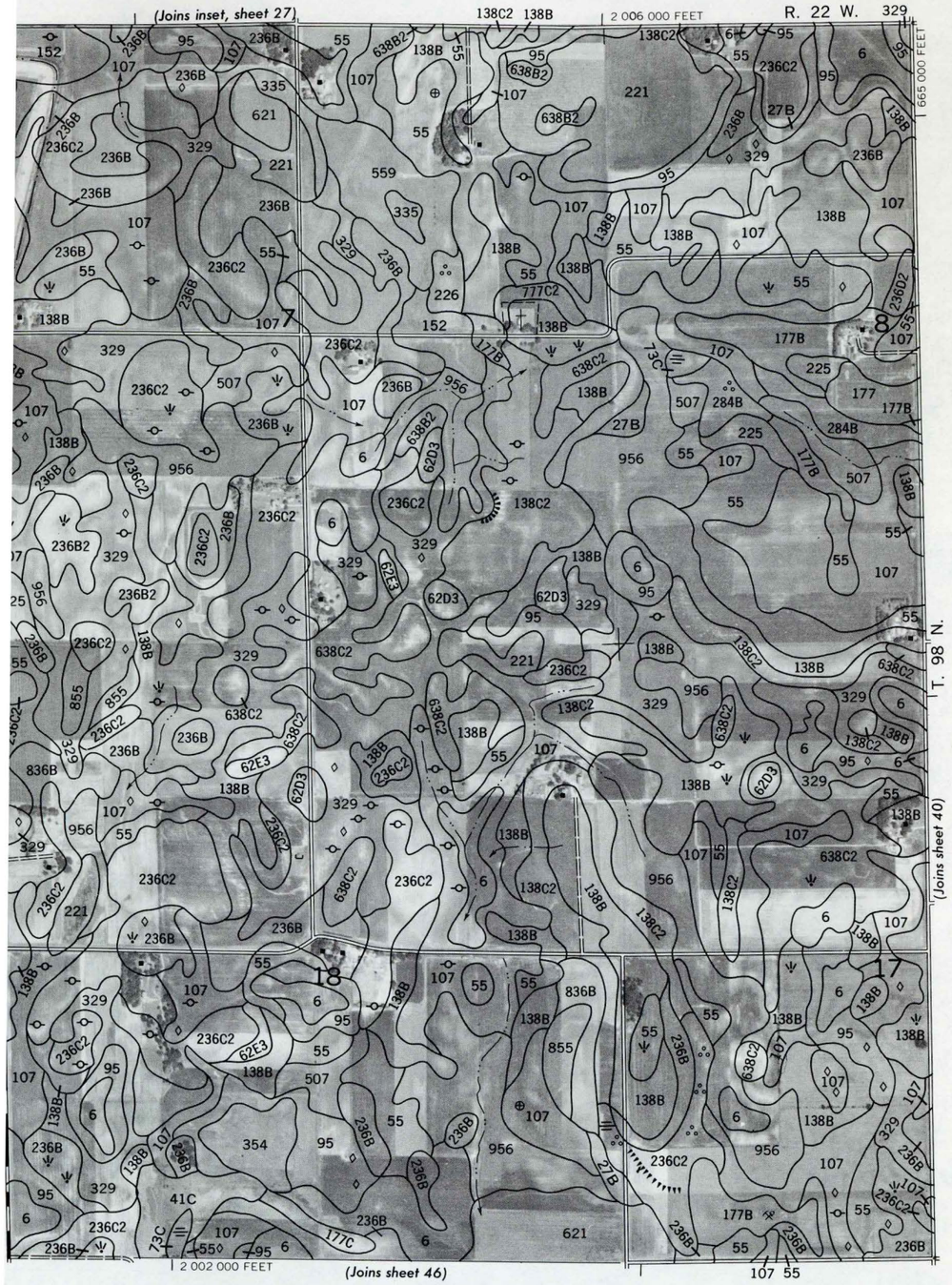
5000 Feet

Scale 1:15 840

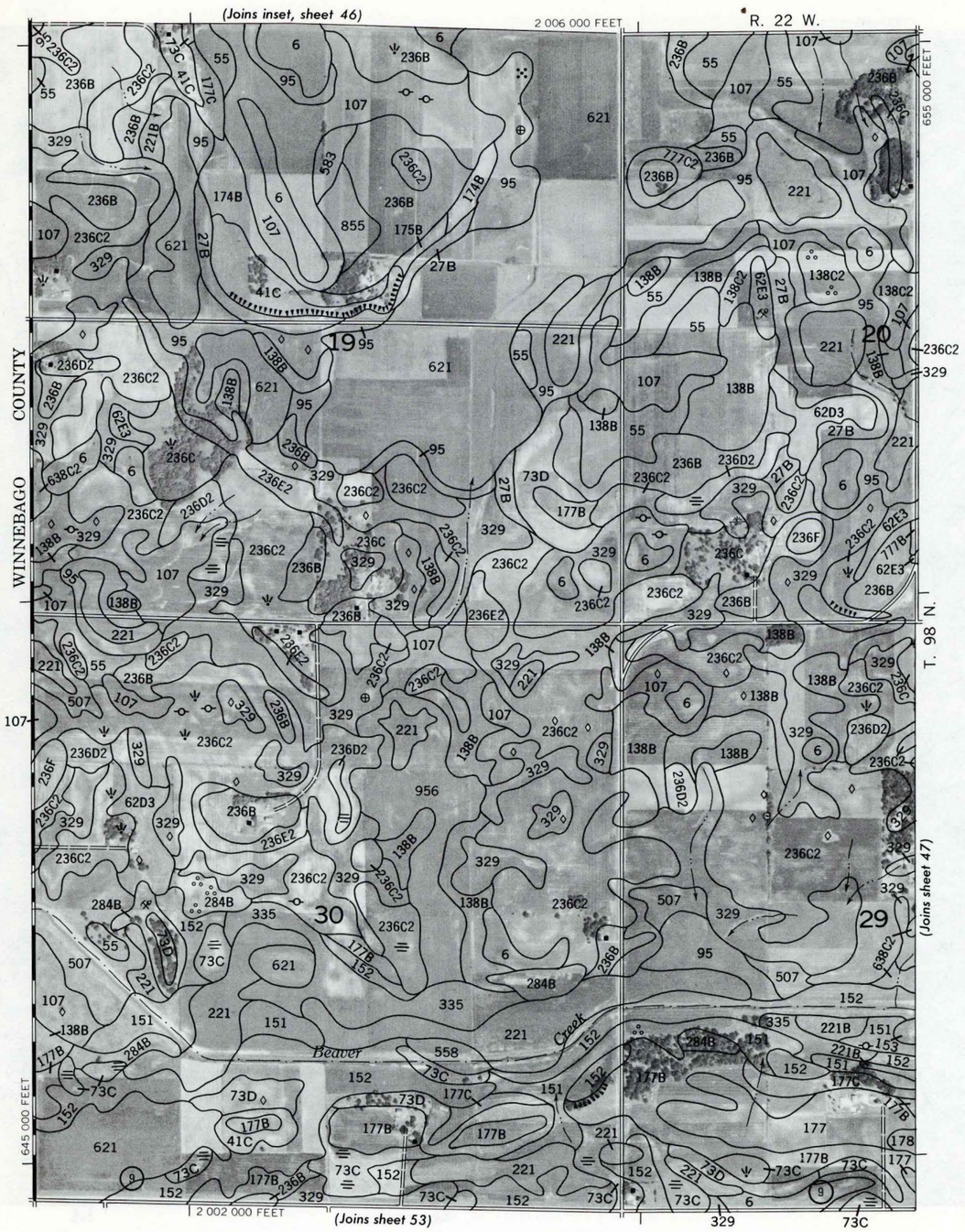
1 0 ¾ ½ ¼ 0

5000 4000 3000 2000 1000 0

hotobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
pproximate and based on Iowa coordinate system, north zone.



4 000 AND 5 000-FOOT GRID TICK INTERVALS



4000 AND 5 000-FOOT GRID TICK INTERVALS

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

hotobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are
pproximate and based on Iowa coordinate system, north zone.

(Joins sheet 41)

R. 22 W. | R. 21 W.

T. 98 N.

2 045 000 FEET

655 000 FEET

2 030 000 FEET

(Joins sheet 54)

(Joins sheet 49)

Hanlontown

BORROW AREA

BORROW AREA

GRAVEL PIT

UNDER CONSTRUCTION

Winans Creek

Wharton Creek

CHICAGO AND NORTHWESTERN

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

49

N

2 050 000 FEET

655 000 FEET

R. 21 W.

R. 20 W.

(Joins sheet 42)

(Joins sheet 50)

(Joins sheet 48)

(Joins inset, sheet 54)

2 065 000 FEET

645 000 FEET

T. 98 N.

22

23

24

19

27

26

25

30

Wharam Creek

Spring Creek

Blair Creek

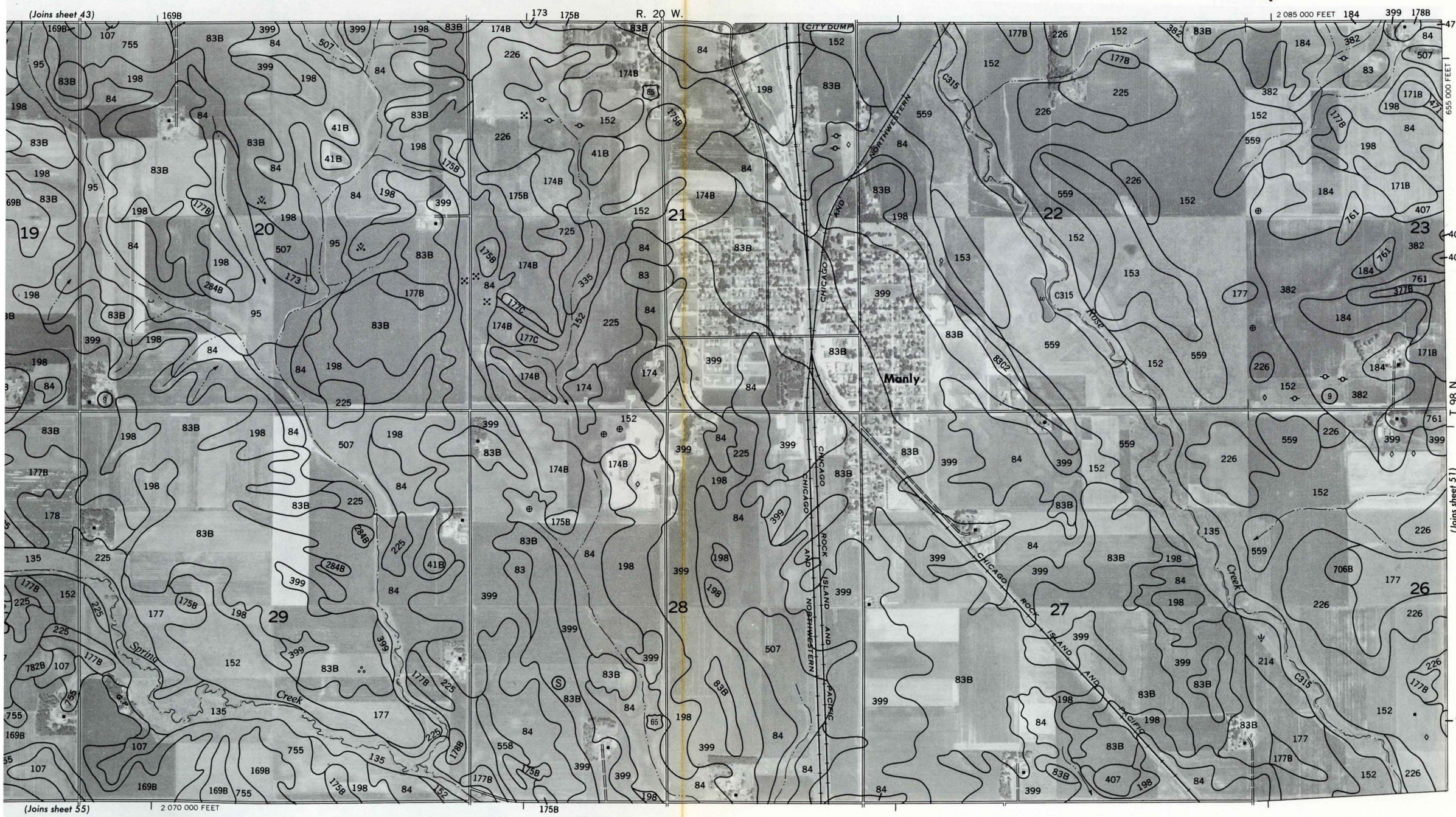
1 Mile 5000 Feet

Scale 1:15 840

0 1000 2000 3000 4000 5000

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 50



Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

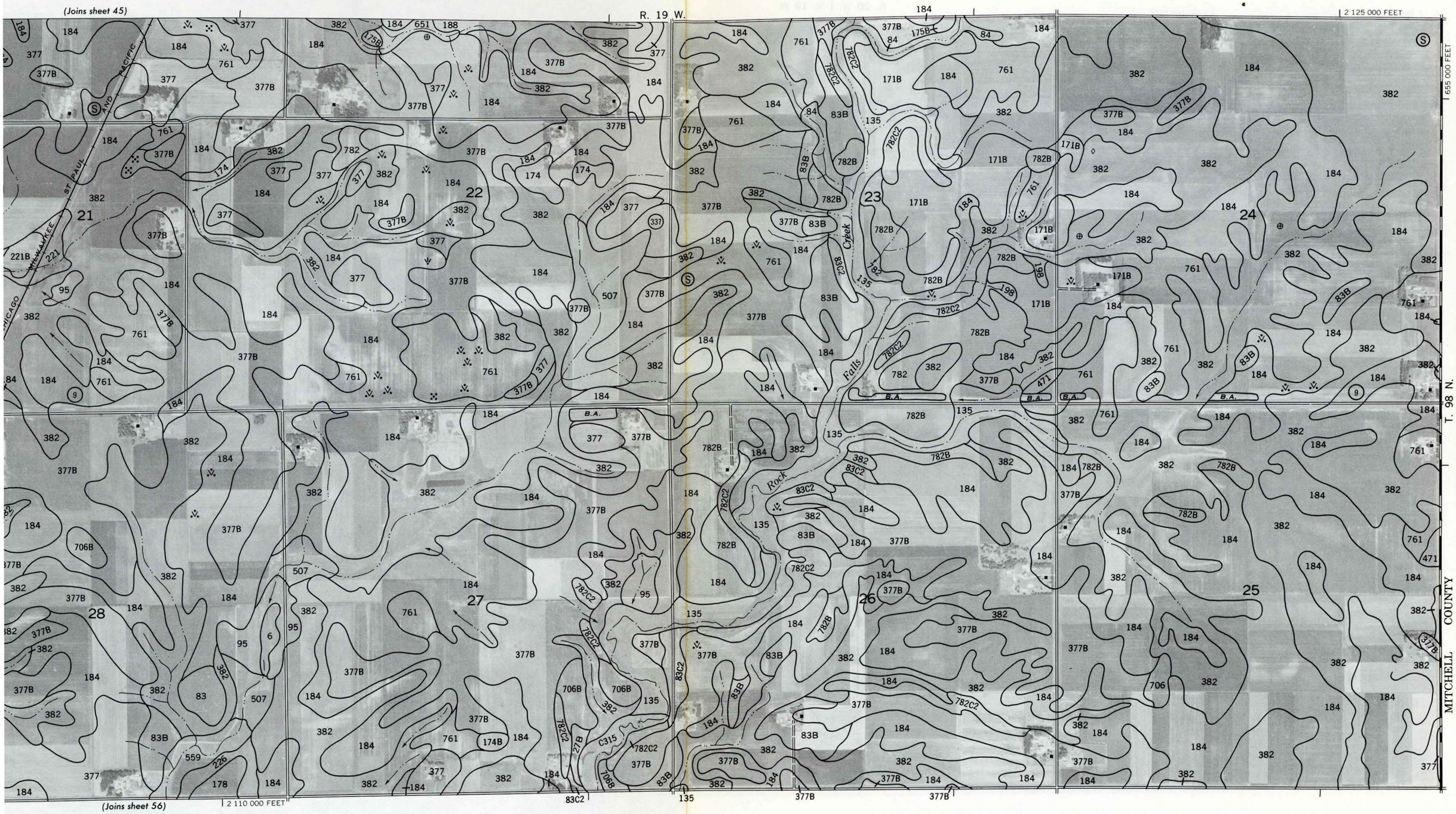
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

WORTH COUNTY, IOWA NO. 50

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.



Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA NO. 52

WORTH COUNTY, IOWA — SHEET NUMBER 53

53

N

1 990 000 FEET

R. 22 W.

T. 98 N.

WINNEBAGO COUNTY

CERRO GORDO COUNTY

4 000 AND 5 000 FOOT GRID TICKS INTERVALS

2 005 000 FEET

(Joins sheet 46)

(Joins inset, sheet 53)

1 Mile

5000 Feet

640 000 FEET

2 010 000 FEET

R. 22 W.

(Joins sheet 47)

(Joins sheet 54)

Fertile

River

Creek

GRAVEL PIT

water

2 025 000 FEET

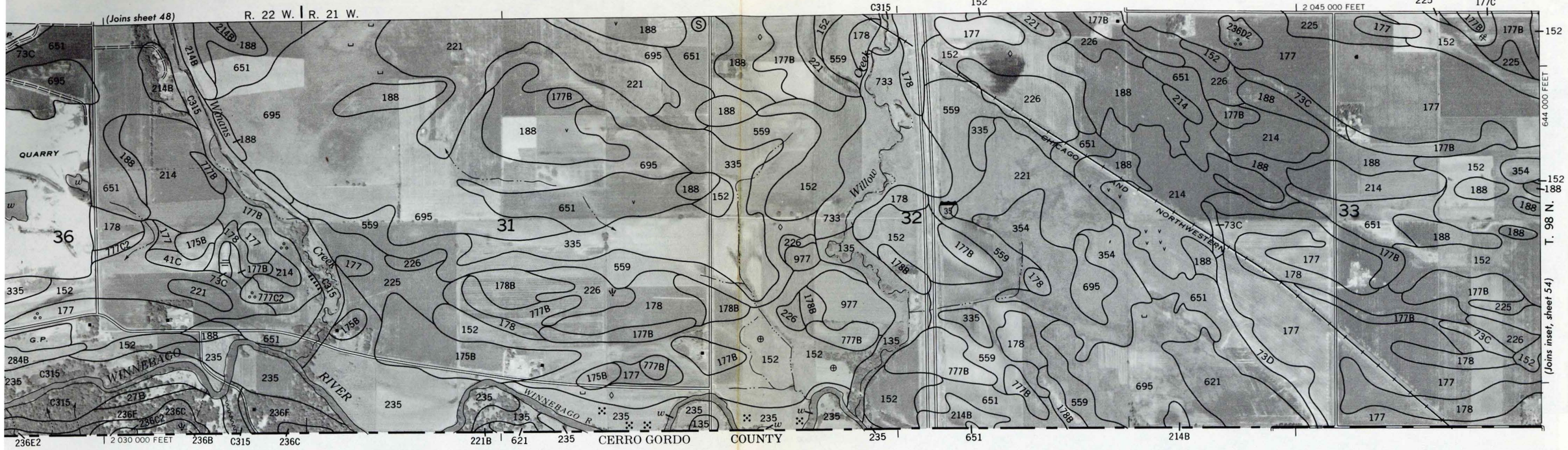
640 000 FEET

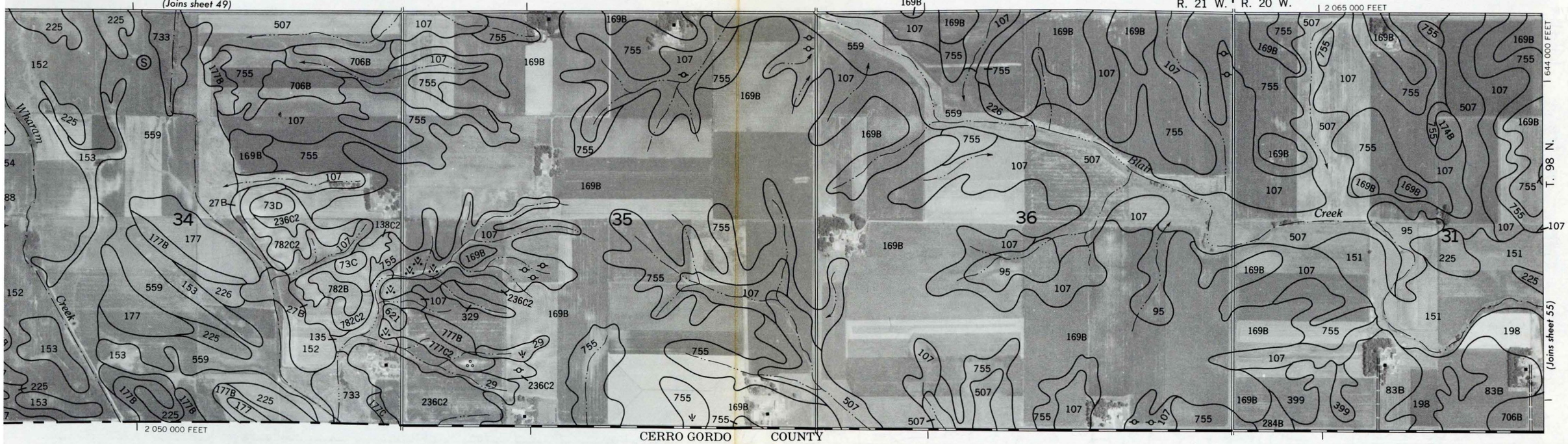
Scale 1:15 840

0 AND 5 000-FOOT GRID TICK INTERVALS

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 54





Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture Soil Conservation Service, Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

WORTH COUNTY, IOWA — SHEET NO. 54

This map compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture

WORTH COUNTY, IOWA — SHEET NUMBER 55

55

N

2 070 000 FEET

644 000 FEET

R. 20 W.

(Joins sheet 50)

T. 98 N.

(Joins inset, sheet 54)

(Joins inset, sheet 55)

640 000 FEET

2 085 000 FEET

CERRO GORDO COUNTY

4 000 AND 5 000-FOOT GRID TICK INTERVALS

1 Mile

5000 Feet

2 090 000 FEET

645 000 FEET

R. 20 W. | R. 19 W.

175B,651

(Joins sheet 51)

T. 98 N.

(Joins sheet 55)

(Joins sheet 56)

640 000 FEET

2 105 000 FEET

B.A.

CERRO GORDO COUNTY

Scale 1:15 840

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

WORTH COUNTY, IOWA — SHEET NUMBER 56

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

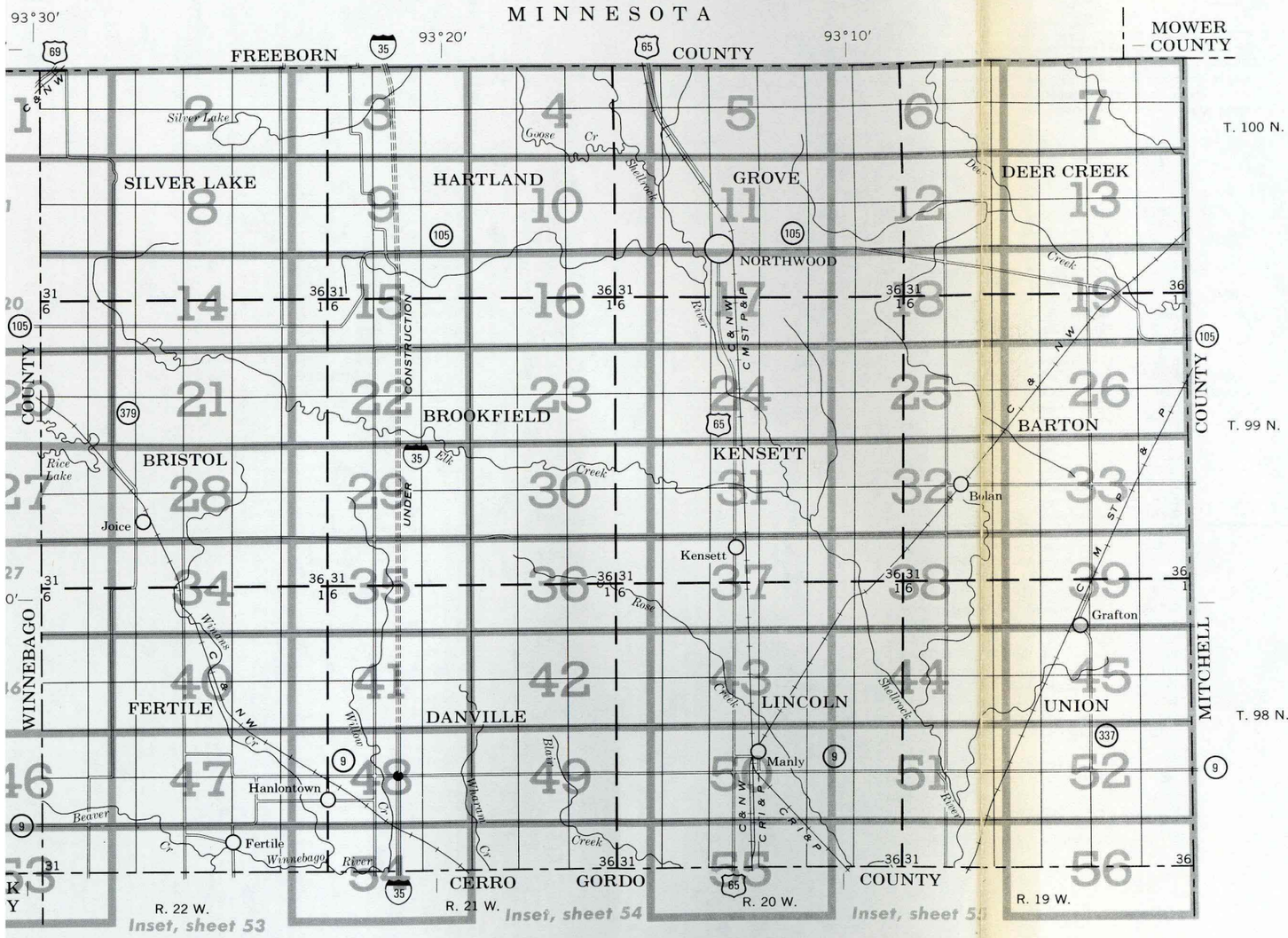
WORTH COUNTY, IOWA NO. 56

Photobase from 1971 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on Iowa coordinate system, north zone.

SOIL LEGEND

Symbols consist of numbers or a combination of numbers and letters, for example, 84, 174, 175B, 638C2. The 1, 2, or 3 digit number designates the kind of soil or land type. A capital letter B, C, D, E, or F following a number indicates the class of slope. Symbols without a slope letter are those of nearly level soils or land types that have a considerable range of slope. A final number 2 or 3 in the symbol indicates that the soil is moderately eroded or severely eroded. The capital C or T used as a prefix indicates a channeled phase or a bench phase.

SYMBOL	NAME
171	Bassett loam, 0 to 2 percent slopes
171B	Bassett loam, 2 to 5 percent slopes
174	Bolan loam, 0 to 2 percent slopes
174B	Bolan loam, 2 to 5 percent slopes
321	Boots mucky peat, 0 to 1 percent slopes
733	Calco silty clay loam, loamy substratum, 0 to 2 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes
138	Clarion loam, 0 to 2 percent slopes
138B	Clarion loam, 2 to 5 percent slopes
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded
169B	Clarion loam, 2 to 5 percent long slopes
29	Clarion-Nicollet loams, 1 to 3 percent slopes
638B2	Clarion-Storden loams, 2 to 5 percent slopes, moderately eroded
638C2	Clarion-Storden loams, 5 to 9 percent slopes, moderately eroded
84	Clyde silty clay loam, 0 to 2 percent slopes
135	Coland silty clay loam, 0 to 2 percent slopes
235	Coland-Turlin complex, 0 to 2 percent slopes
175	Dickinson fine sandy loam, 0 to 2 percent slopes
175B	Dickinson fine sandy loam, 2 to 5 percent slopes
175C	Dickinson fine sandy loam, 5 to 9 percent slopes
377	Dinsdale silty clay loam, 0 to 2 percent slopes
377B	Dinsdale silty clay loam, 2 to 5 percent slopes
782	Donnan silt loam, 0 to 2 percent slopes
782B	Donnan silt loam, 2 to 5 percent slopes
782C2	Donnan silt loam, 5 to 9 percent slopes, moderately eroded
706	Donnan silt loam, dark variant, 0 to 2 percent slopes
706B	Donnan silt loam, dark variant, 2 to 5 percent slopes
651	Faxon silty clay loam, 0 to 2 percent slopes
284	Flagler sandy loam, 0 to 2 percent slopes
284B	Flagler sandy loam, 2 to 5 percent slopes
198	Floyd loam, 1 to 3 percent slopes
761	Franklin silt loam, 1 to 3 percent slopes
335	Harcot loam, 0 to 2 percent slopes
95	Harps loam, 1 to 3 percent slopes
726	Hayfield loam, deep, 0 to 2 percent slopes
725	Hayfield loam, moderately deep, 0 to 2 percent slopes
173	Hoopeston fine sandy loam, 0 to 2 percent slopes
621	Houghton muck, 0 to 1 percent slopes
188	Kensett silt loam, 0 to 2 percent slopes
83	Kenyon loam, 0 to 2 percent slopes
83B	Kenyon loam, 2 to 5 percent slopes
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded
836B	Kilkenny silty clay loam, 2 to 5 percent slopes
836B2	Kilkenny silty clay loam, 2 to 5 percent slopes, moderately eroded
836C2	Kilkenny silty clay loam, 5 to 9 percent slopes, moderately eroded
836D2	Kilkenny silty clay loam, 9 to 14 percent slopes, moderately eroded
184	Klinger silty clay loam, 1 to 3 percent slopes
226	Lawler loam, deep, 0 to 2 percent slopes
225	Lawler loam, moderately deep, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
236B2	Lester loam, 2 to 5 percent slopes, moderately eroded
236C	Lester loam, 5 to 9 percent slopes
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded
236E2	Lester loam, 14 to 18 percent slopes, moderately eroded
236F	Lester loam, 18 to 25 percent slopes
325	Le Sueur loam, 1 to 3 percent slopes
354	Marsh
152	Marshan clay loam, deep, 0 to 2 percent slopes
151	Marshan clay loam, moderately deep, 0 to 2 percent slopes
153	Marshan clay loam, depressional, 0 to 1 percent slopes
382	Maxfield silty clay loam, 0 to 2 percent slopes
583	Minnetonka silty clay loam, 1 to 3 percent slopes
C315	Mixed alluvial land, channeled
55	Nicollet loam, 1 to 3 percent slopes
755	Nicollet loam, 1 to 3 percent long slopes
6	Okoboji silty clay loam, 0 to 1 percent slopes
956	Okoboji-Harps complex, 0 to 3 percent slopes
471	Oran silt loam, 1 to 3 percent slopes
221	Palms muck, 0 to 1 percent slopes
221B	Palms muck, 1 to 4 percent slopes
399	Readlyn loam, 1 to 3 percent slopes
977	Richwood silt loam, 0 to 2 percent slopes
213	Rockton loam, deep, 0 to 2 percent slopes
213B	Rockton loam, deep, 2 to 5 percent slopes
214	Rockton loam, moderately deep, 0 to 2 percent slopes
214B	Rockton loam, moderately deep, 2 to 5 percent slopes
274	Rolfe silt loam, 0 to 1 percent slopes
73C	Salida sandy loam, 2 to 9 percent slopes
73D	Salida sandy loam, 9 to 14 percent slopes
73F	Salida sandy loam, 14 to 30 percent slopes
177	Saude loam, 0 to 2 percent slopes
177B	Saude loam, 2 to 5 percent slopes
177C	Saude loam, 5 to 9 percent slopes
407	Schley silt loam, 1 to 3 percent slopes
855	Shorewood silty clay loam, 1 to 3 percent slopes
41B	Sparta loamy fine sand, 2 to 5 percent slopes
41C	Sparta loamy fine sand, 5 to 9 percent slopes
62D3	Storden loam, 5 to 14 percent slopes, severely eroded
62E3	Storden loam, 14 to 18 percent slopes, severely eroded
559	Talcot clay loam, deep, 0 to 2 percent slopes
558	Talcot clay loam, moderately deep, 0 to 2 percent slopes
27B	Terril loam, 2 to 5 percent slopes
695	Tilfer silty clay loam, 0 to 2 percent slopes
T506	Wacousta silt loam, benches, 0 to 2 percent slopes
777	Wapsie loam, 0 to 2 percent slopes
777B	Wapsie loam, 2 to 5 percent slopes
777C2	Wapsie loam, 5 to 9 percent slopes, moderately eroded
178	Waukee loam, 0 to 2 percent slopes
178B	Waukee loam, 2 to 5 percent slopes
107	Webster silty clay loam, 0 to 2 percent slopes
329	Webster-Nicollet complex, 1 to 3 percent slopes



INDEX TO MAP SHEETS

WORTH COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 4 Miles

N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36